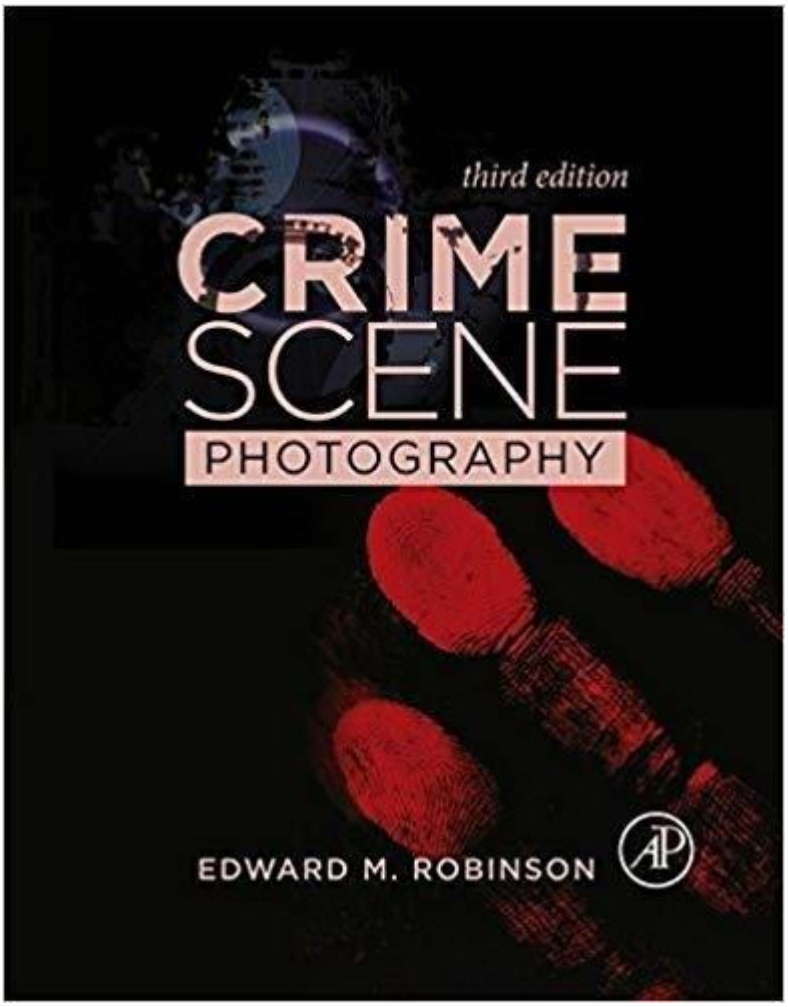


CRIME SCENE PHOTOGRAPHY 3RD EDITION UPDATES

STUDY GUIDE FOR CCSI, CCSA, CSCSA, CFP

ABSTRACT

Each chapter broken down to assist you in preparing for your IAI Certifications. It is STRONGLY suggested that you read the book completely. However, as you read these notes will assist you in retaining the information.

ADDED 02/10/2020 - End of Chapter Review Questions

Various Authors helped compile this information. Please read and update and SHARE to help others!

IAI Requirements as of February 2020

Crime Scene Certifications:

1. **Certified Crime Scene Investigator (CCSI)**
    a. Must have a minimum of one (1) year in crime scene related activities.
    b. Must have completed a minimum of 48 hours of Crime Scene Certification Board approved instruction in crime scene related courses within the last five (5) years.
2. **Certified Crime Scene Analyst (CCSA)**
    a. Must have a minimum of three (3) years in crime scene related activities.
    b. Must have completed a minimum of 96 hours of Crime Scene Certification Board approved instruction in crime scene related courses within the last five (5) years.
3. **Certified Senior Crime Scene Analyst (CSCSA)**
    a. Must have a minimum of six (6) year in crime scene related activities.
    b. Must have completed a minimum of 144 hours of Crime Scene Certification Board approved instruction in crime scene related courses within the last five (5) years and ONE of the following:
        - Must have authored or coauthored an article on some phase of crime scene investigation published in a professional journal, OR
        - Made a presentation on some phase of crime scene investigation to a professional organization, OR
        - Be an active instructor in some phase of crime scene investigation who is currently teaching at least once a year, OR;
        - Completed 16 hours of Courtroom Testimony training in addition to the required 144 hours of crime scene related training (listed above)

IAI Certifications that use this textbook as required reading:

1) **Certified Crime Scene Investigator (CCSI) –** 200 questions with a time limit of 3 hours
    - All Chapters EXCEPT 1, and 8 through 12)
2) **Certified Crime Scene Analyst (CCSA) –** 300 questions with a time limit of 4 hours
    i. All Chapters EXCEPT 1, Subchapters 9.4, 9.6 and 9.7, and Chapters 10 through 12)
3) **Certified Senior Crime Scene Investigator (CSCSA) –** 400 questions with a time limit of 5 hours
    - All Chapters EXCEPT 1, Subchapters 9.4, 9.6 and 9.7, and Pages 712-735)

4) **Certified Forensic Photographer –** 100 questions with a time limit of 3 hours

    - *Entire Book* – At this time EDITION 2 is required so study the differences. Most information is the same with more added to version 3. So, if you understand this version you should be good with version 2 overall.

Chapter1: History of Forensic Imaging

- **Camera Obscura**: the first pinhole camera – Early scientists used pinhole cameras to observe the sun and by artists to make sketches. (Roger Bacon in 1267 and Leonardo da Vinci in 1490.
- Arab scholar Hassan bin al Haitham wrote about this camera in 1038

THREE (3) Evolutions in design before the camera became a basic functioning camera

- **#1 in 1550** – Girolamo Cardano added a lens to the design of the camera obscura.
  - Used the word "Lens" because the color of the glass lens reminded him of brown lentils that were used in Italian soup.
- **#2 in 1558 and published in 1588** – the addition of lenses and curved mirrors to produce an upright image.
- **#3 in 1568** – the invention of a diaphragm, believed to have been made by Daniele Barbaro in 1568.

- **1614 –** Angelo Sala observed that sunlight turned silver nitrate black.

- **1725** – Johann Heinrich Schulze proved that some silver salts were darkened by exposure to light.

- **1737** – Jean Hellot was reported to have used a photographic process to make secret writings visible by exposure to light. Hellot was reported to be the FIRST to use the word "Photography" which means writing with light.

- **1777** – Carl Wilhelm Scheele discovered that silver chloride was reduced to blackened silver by exposure to light, and that ammonia dissolved the silver chloride without affecting the blackened silver.

- **1795** – First known attempt by Thomas Wedgwood to use a photographic process to take a photograph with a camera obscura. Though the attempt failed due to a combination of underexposure and Wedgwood's inability to fix the image.

- The Term Panorama was first used to refer to paintings with a wide field of view that was either mounted or painted on the walls of a circular shaped building. The first record of such a building was the "circular panorama building" that was built in Leicester Square in London by Robert Barker in **1792**. He received a patent for this concept in **1787**.

- **1800** – Sir William Herschel made a discovery that would be extremely important to law enforcement photographers. Invisible Infrared region of light.

- **1816** – Joseph Niepce began his photography experiments

- **1819** – John Herschel discovered that hydrosulfite of soda dissolves silver salts. This was the missing link needed to fix a developed photographic image.

- **1826** – Joseph Niepce successfully made the first known photograph. For this reason, he has been credited as being the inventor of photography.

- **1822** – Mathematicians started working on what later developed into **Photogrammetry**.

- **1829** – Louis Daguerre formed a partnership with Joseph Niepce and after Josephs death with Isidore Niepce.

- **1835** – Fox Talbot is reported to have produced a photographic negative. He also invented the **Calotype**

- **1839** – The Daguerreotype was announced by Arago.

- **1841** – Talbot patented the Calotype

- **1839 – 1841** – Three significant uses of Daguerreotypes.
  1) **1839** – Noel Lerebor's scenic Daguerreotypes were copied by engravers for publication. Helped develop the use of modern newspapers
  2) **1840** – The first portrait studio in New York City was opened by Wolcott and Johnson.
  3) **1841** – Paris police department may have been the first agency to use Daguerreotype prisoner mug shots, sadly none survived. However, in 1843 Belgium prison inmates sample photographs with the same method did survive.

- **1841** – Talbot patented the Calotype

- **1843** – Josef Puchberger patented a **Panoramic Camera** in Austria.

- **1841** – Talbot patented the Calotype

- **1844** – Talbot developed an improved **Calotype** paper negative. This process eventually evolved into the photographic negative printing process that is still in use today.

- **1849** – The "Father of Photogrammetry" Aime Laussedat complied topographic maps from terrestrial photographs.

- **1851** – Frederick Scott Archer developed the collodion or **Wet-Plate Process**.

- **1852** – Sir George G. Stokes discovered UV Fluorescence and formulated **Stokes' Law**.

- **1854** – First recorded use of photographs of wanted criminals used in Switzerland

- **1857** – Rouges Gallery opened by the New York City Police Department appeared for more public relations effort which was criticized for humiliating criminals.

- **1854 – 1855** – three new photographic processes became available that produced lower-quality photographs but were cheaper than the daguerreotype process.
    1) **1854** – J. A. Cutting invented the Ambrotype.
    2) **1854** – Andre-Adolphe-Eugene Disderi invented and patented the Carte-de-Visit process
    3) **1855** – Hamilton Smith invented the **Tintype** – which is also called the ferrotype.

- **1858** – French photographer and balloonist Gaspar Felix Tournachon, nicknamed "Nador" who was the first known aerial photograph of a French Village.

- **1859** – United States Supreme Courted on the admissibility of photographs used as evidence in *Luco v. US, 64 US (23 How.) 515, 162L, Ed. 545 (1859).*

- **1860** – Due to this case America Wanted posters became common in the Western United States region.

- **1860** – Stereophotography was very popular and stereo viewers with stereo prints and stereo transparencies were commonly found in upscale homes.

- **1861** – Maxwell and Sutton developed color photography

- **Orthochromatic film** – Film that has no sensitivity to red light was commonly used at the time.

- **1861** – Mathew Beady began coverage of the American Civil War using the profits from his portraits studios to finance his team of photographers.

- **1865** – Important Development for photogrammetry was the Paulo Ignazio Pietro Porro's invention of a photogoniometer which was designed to remove lens distortion.

- **1867** – Crime Scene Photograph was born and replaced crime scene sketches

- **1860's – 1870's** – ushered in the era of the fake **Ghost Photographs** used to commit fraud.

- **Spirit Photographs** – Fake photographs done by a double exposure either in camera or in the darkroom.

- **1870** – milestone for mug shots. First-known mug shot collections were established in London.

  1874 – Paris
  1875 – Berlin

- **1885** – The science of photogrammetry evolved to record and document the ancient ruins of Persepolis

- **1873** – Dr. Hermann Wilhelm Vogel developed Dye-Sensitizing technology that extended the color sensitivity of black and white films into the red region of the visible light spectrum. This was the key discovery that led to the development of modern black and white **Panchromatic Film.**

- **1888** – Paris Police Department mug shot collection was organized by Alphonse Bertillon based on his anthropometric measurement identification system measurements of each individual who was photographed.

- **1887** – Patent filed and granted in 1898 for flexible transparent film by Reverend Hannibal Goodwin.

- **1887** – Banks started using camera to photograph persons attempting to break into them

- **1887** – James Fairman patented an "apparatus for aerial photography in the United States"

- **1898** – The US Army reported to have used kites to take aerial reconnaissance photographers during the Spanish-American War.

- **1890** – Eastman Kodak patent application for flexible transparent film

- **1893** – Bank photographs were used to identify a bank robbery suspect in New York City. This can be considered the beginning of what evolved into imaging subspecialty of forensic video analysis.

- **1900** – Important developments in photographic technology and photogrammetry. Grouped into "four development cycles"

- **1904** – The Lumiere brothers patented the Autochrome Color Photography Plates that were put into production in 1907.

- **1904** – The Cirkut panoramic camera was patented by William J. Johnson. This camera was unique because both the camera and film rotated.

- **1907** – "How-To" Trick Photography books were published – "Trick Photography" and "How to Take and Fake Photographs"

- **1907** – All intoxicated persons in Denver, Colorado were being photographed by the police department. The state of Massachusetts approved the use of photographic speed recorders to detect speeders

- **1909** – The International Society for Photogrammetry was formed and heled their first congress in Vienna, Austria in 1910

- **1910** – Kodak dominated the amateur market and most of today's photographic techniques had already been developed.

- **1912** – Siegrist and Fischer wee able to produce color images by chemically forming dyes in the emulsion layer during development.

- **1915** – International Association for Identification formed

- **1916** – *Duncan v. Kiger, 6 Ohio App. 57 (1916)* was in the forefront of defining the standard for the admissibility of imaging evidence. It ruled that a motion picture was not admissible because it did not show the details clearly enough to be useful. Because a motion picture was not an accurate **Representation**.

- **1917** – Radio-Controlled "aerial torpedo" or "flying bomb" developed by Elmer Sperry. This was the first of what today is considered "drones"

- **1925** – First version of the Leica 1 was developed

- **1928** – *Beach v. Chollett, 31 Ohio App. 8 (1928)* ruled that photographs of X-Rays were not admissible in place of the X-Rays because the photographs did not show some significant details that were visible in the original X-Rays.

- **1930** – the newly invented flashbulb was in widespread use.

- **Fair and Accurate Photographic Representation** Court Cases – A photograph is determined to be misleading or confusing, if it is not a fair and accurate photographic representation of the original object.

  Beach v. Chollett, 31 Ohio App. 8 (1928)

  Commonwealth v. Rollen, 100 P. Super. 125 (1930) – Accepted sound motion picture recordings of confessions.

  People v. Greenspawn*, 179 N.E. 98, 346 ILL. 484 (1931)* – affirmed the use of X-rays by a dentist to identify a person

New Hampshire State Supreme Court in *State v. Thorp, 171 A. 633, 86 N.H. 501 (1934)* – upheld the admissibility of an ultraviolet photograph of footprints in blood.

Snyder v. Massachusetts, 54S. Ct. 330, 291 US 97, 78 L.Ed. 674 (1934) – the courts were also looking at the photographer stating, "in careless, unskilled, or uninterested hands, photography sometimes produces misleading and confusing results". This court case started the foundation that forensic photographer is in need of training to be effective in their job.

US v. Morton, 107 F.2 d 834 (C.C.A.2, 1938) – an early case in which the admissibility of the microfilm of a document was admitted in place of the document.

Green v. City and the County of Denver, 142 P.2 d 277, 111 Colo. 390 (1943) – The admissibility of a color photograph was upheld in court.

Kauffman v. Meyberg, 140P.2 d 210, 59 Cal. App. 2d 730 (1943) – The admissibility of an IR Photograph of erased writing was upheld in court.

- **1932** – The Leica Model II camera was introduced
- **1933** – Contax Model I camera was introduced by Canon
- **1934** – The American Society for Photogrammetry was formed.
- **1935 or 1936** – Hansa Canon 35mm rangefinder camera with a focal plane shutter was sold in Japan.
- **1938** – The Super-Six-20 camera was introduced by Kodak that featured an automatic exposure capability.
- **1939** – The first stroboscopic flash system was developed.
- **1941** – Kodak introduced Kodacolor color negative film
- **1942** – The FBI lab was split into two sections, the processing unit and the special photographic unit
- **1942** – Ektachrome color slide film was introduced
- **1947** – Wisconsin state crime laboratory was created first in Madison by state stature with photography being listed as a separate forensic discipline.
- **1947** – Ektacolor color negative film was introduced
- **1947** – The Polaroid Land Camera by Edwin Land was released
- **1948** – Polaroid Black and White print film was released

- **1948** – Nikon 1 rangefinder camera was released

- Tennessee State Supreme Court in *Brown v. State, 210 S. W. 2 d 670, 186 Tenn. 378 (1948)* – that best evidence rule does not ordinarily apply to photographic evidence. – Summary: Unless there is a stipulation by the opposing party, a witness with first-hand knowledge of what is depicted in the photograph must testify that the photograph is a fair and accurate photographic representation of what the witness saw.

- *Spence v. Rasmussen, 226 P2d 819m 190 Or. 662 (1951)* – Added: A photograph, like other documents, must be submitted to the opposing party before being admitted as evidence.

- **1957** – Videotape recorder was introduced

- **1959** – Xerox made their first photocopiers, Flatbed scanners evolved from this technology.

- **1959** – Canon – Canonflex and Nikon – Nikon F - first introduced a Single-Lens-Reflex Camera system (SLR).

- **1962** – The United States was using Drones for photographic surveillance in foreign countries.

- **1963** – Polaroid Polacolor instant print film was announced

- **1965** – Super 8 mm movie equipment was introduced and became a hit with consumers until replaced with camcorders

- **1967** – Videotapes began to be used as evidence.

- **1973** – 1975 - ACE-V development began with several court cases

- **1973** – The American Society of Crime Laboratory Directors (ASCLD) was formed.

- **1975** – Matsushita developed the VHS videotape format

- **1976** – Color checker chart developed by C.S. McCamy

- **1977** – Dalrymple, Duff, and Menzel published results of their research into and practical application of laser dye-staining of superglue-fumed latent prints that are then photographed under a laser or Alternate Light Source.

- **1978** – Kodak engineers patented a digital camera that used a CCD sensor

- **1978** – Forensic odontology for comparative analysis using photographs was upheld in court.
- **1980** – 120 roll films to photograph latent prints on circular objects
- **1985** – Microsoft Windows Version 1.01 was released, 3D scanners incorporated lasers into create point clouds from which an accurate graphical representation could be reproduced from the area being scanned.
- **1987** – Canon introduced the EOS camera lens mount
- *US v. Alexander (1987)* – Court ruled that the exclusion of expert testimony by an orthodontist based on a photographic comparison that the defendant was not the person depicted in the bank surveillance film was reversible error.
- **1991** – Photoshop Version 1 was released only on the Macintosh operating system.
- **1992** – Kodak DSLRs introduction of IR, monochrome, and color versions of the Kodak DSC200 DSLR.
- **1992** – CAD Zone developed the Fire Zone CAD programs which is representative of some of the current crime scene sketching programs.
- **1993** – The start of what would evolve into the Leica Geosystem 3-D laser scanner
- **1994** – Photoshop released in both Windows and Macintosh operating systems.
- **1995** – Apple Quick Time was released – this started what we know today as virtual tour capability.
- **1995** – Crime Zone CAD program for crime scene sketches was released – the first dedicated to crime scene documentation.
- **1997** – IAI Resolution 97-9 providing acceptance of digital imaging in the forensic science community as a scientifically valid technology that is "dependent upon the technical specifications of the equipment, the quality control procedures, and the training, experience, and ability of the photographer or imaging specialist"
- **2002** – The Foveon sensor was released. Unique in that like color negative film, it had three light-sensitive layers.
- **2002** – The first Canon DSLR with a full frame sensor was released

- **2004** – Corel's purchased PaintShop Pro from Jasc Software – this started the Digital forensic artist concept.

- **2007** – Fuji FinePix IS Pro UV/IR DSLR was released and used as the first widely spread UV/IR camera within law enforcement.

- **2007** – IAI Resolution 2007-8, rejecting the use of Optical Watermarks to authenticate and/or verify the integrity of a digital photograph or video image. IAI Resolution 2007-7, recognized that validity of photographic comparisons and some of the limitations in this type of examination.

- **2012** – Kodak stopped making digital cameras and filed for bankruptcy

- **2015** – Drone cost dropped dramatically allowing law enforcement to purchase more.

Chapter 2: Composition and Cardinal Rules

- "Phos" Greek word for light
- "Graphia" Greek word for writing or drawing
    - Together they mean "writing with light" or "drawing with light."
- Once the "primary subject" has been defined in the mind of the photographer, the photographer should then become very aware of everything that is not his "primary subject".
- This composition will usually satisfy two goals at the same time:
    - It will be the composition that shows the primary subject most effectively.
    - It will be the viewpoint that excludes as many irrelevant items and areas surrounding the primary subject as possible.
- Before depressing the shutter button, the photographer must do at least three separate things:
    - The scene or primary subject must be composed.
    - The proper exposure must be determined.
    - The camera must be focused.
- **Cardinal Rules can also be considered key crime scene photography concepts**.
    - Fill the frame.
    - Maximize depth of field.
    - Keep the film plane parallel.
- **Eliminate the Irrelevant**: Is there any part of the composition that can be eliminated to make the overall photograph better?
    - Background. Eliminate
    - Choose a different viewpoint
    - Provide your own backdrop
    - Tilt the camera
    - Get closer to the item
    - Zoom in
- Foreground:
    - Foreground. Eliminate
    - Choose a different viewpoint
    - Raise the camera
    - Get closer to the item
    - Zoom in
- ***Shadow Control***:
    - Shadows from sunlight. Avoid having your own shadow in the field of view. Reposition your body so shadow completely covers the area to be photographed. Have the scene be completely shadow free or completely in the shadow.
    - Shadows from flash. Bounce the flash. Reposition the flash to avoid shadows. Take flash off camera.
- **Lens Flare**: If possible, avoid photographing with the sun in front of you. Objects will be backlit and underexposed.

- **Maximize Depth of Field**: Depth of field is the variable range, from foreground to background, of what appears to be in focus. Focusing to maximize the depth of field is one distinguishing feature of crime scene photographers that separates them from other photographs. Utilize the following to maximize the Depth of Field
    - Use the reciprocal exposure that uses the smallest aperture. Multiple shutter speed and aperture combinations result in the same exposure level.
    - Hyper focal focus when infinity is in the background. This maximizes the depth of field range for large outdoor scenes. (Need a DOF Scale and Distance Scale).
    - Zone focus when infinity is not in the background. Use the "rule of thirds".
    - Pre-focus the camera at its closet focusing distance by rotating the focus ring to its shortest focusing distance. Then move the camera to the subject until the subject is in focus. (like a Macro Lens).
- These focusing techniques frequently result in a depth of field range that encompasses the entire crime scene or area of interest.
- **Film Plane Parallel**: Keep the back of the camera parallel to the subject length of lens perpendicular to the subject etc. Linear viewpoints should always be avoided because of perspective distortion effect. Reasons:
    - Diagonal views of walls have one wall closer to the camera than the other causing distortion.
    - Distance issue between foreground and background
    - Flash will cause under/over exposure.
        - Exceptions: mirror or window showing your reflection
        - Hot spots on walls.
        - Large buildings. Diagonal is only way to show the building because of its size.
- If the film plane is not parallel to the subject, the close up cannot be used for comparison purposes.

Chapter 2 – Review Questions

1. **Briefly explain why photography can be considered to be both a scientific enterprise and an artistic expression of the photographer**. If the individual using the camera does not understand the basic fundamental principles that dictate how the light and shutter speeds will affect the photographs that are being taken then they will never be able to fully utilize the camera. The pictures that are take will look good for the most part, especially if they are being shot on program mode, however, there is a lot of things that could be done better. When it comes to the artistic expression, it is all based on the composition of the photograph. You have people that can compose a photograph a 1000 times better than others, simply because they see the potential of adjusting an angle or using the light in a different way. Everyone has taken the same photographs of scenery like Ansel Adams, however, his photographs are better. It is because he had a complete understanding of the science as well as the artistic knowledge when he was behind the lens.

2. **Can a properly exposed crime scene photograph still be unsuccessful? Why**? If you are having in your line of view items that are unnecessary or take away from the focal point of the photograph then the exposed photograph was not a success. It distracts or takes away from what needs to be seen. If you shoot the photograph and you don't have the correct depth of field and items either in the foreground or background are out of focus, then you were unsuccessful. If you have heavy shadows that block out pieces of evidence or the scene you were unsuccessful. All of these items need to be taken into account to have a good photograph. Remember the three main concepts: fill the frame, maximize the depth of field, and keep the film plane parallel. All of these will also help to bring a perfect photograph that will have everything in focus, not distorted, and not distracting.

3. **How can the photographer's viewpoint affect whether an image correctly depicts the spatial relationship between objects?** Try to arrange the subject and the fixed feature of the scene so they ae the same, or as close to the same, distance from you as possible. This eliminates perspective distortion, where one item looks closer to another than it really is. (The isosceles triangle with photographer at top, evidence and fixed feature at base). An easy way to think of this is to consider a wagon wheel, with equal length spokes, that can also be thought of as diameters of the circular wheel. When the wheel is viewed upright, from the side, all the spokes/diameters have an equal length. However, drop the wheel on the ground, and look at it from a perspective view, the circle turns into an ellipse, and the spokes appear to be different lengths, although you know they are still the same length. It is the perspective view that makes the different spokes appear to be different lengths.

4. **How can both ambient and flash shadows be controlled**? Avoid having your own shadow appear in the field of view. Reposition your body or use your body to block out all light. Use a fill flash if you cannot get the shadows out of your photograph. Reposition your body in relation to the scene. Trying different angles might alleviate the issues of the shadows. When the electronic flash is being utilized you have the potential to create a heavy shadow, especially in rooms. Move your body to change the location of the shadow or get rid of it. Use bounce flash to taken care of the issue. Either bouncing it off of the ceiling, or off of a piece of white paper to reflect light back onto the subject, thereby minimizing the shadow being created.

Chapter 3: Crime Scene Photography

- **Photo identifier**: Information that should be recorded on the first frame of very roll of film: case number, date and time, address, name, number of film roll.
- **Rule of Thumb 3.1**: Anytime one of the variables on the photo identifier changes, a new photo identifier needs to be photographed.
- **Photo Memo Sheet**: A form to log all the specific data related to the camera, film, and specific variables used to capture each individual photograph. The sheet is a means by which mistakes can be corrected in the future.
- **Labeled Scale**: A scale that has more than dimension information on it. It includes similar information as the photo identifier.
- **Rule of Thumb 3.2:** Whenever scales are used, they should be positioned on the SAME PLANE as the evidence.
- **(2) Two reasons scales should be on same plane**:
    - So, the piece of evidence can be scaled properly
    - Depth of field is severely reduced with close up photography. To keep scale and item of evidence in focus they should be on same plane.
- **Overall Photographs**: These document the general conditions of the scene, both which exterior and interior views, and how the specific crime scene relates to the surrounding areas.
- **Natural Perspective**: A viewpoint of the scene that has the photographer standing at full height.
- The 50mm lens will neither compact relative distances nor will it elongate the size of any room.
- **Midrange Photographs**: The purpose of midrange photographs is to show a relationship between an individual item of evidence and a fixed feature of the scene previously photographed in one of the overalls. To the extent possible, midrange photographs should also be taken from a natural perspective.
- Proper viewpoint to avoid perspective distortion. When the term "distortion" is mentioned, two different kinds of distortion come to mind:
    - Lens distortion
    - Distortion from the photographer's point of view
- When elements of a scene are aligned vertically, or at varying distances from the photographer, using different focal length lenses will have a dramatic impact on the perceived distances between those elements.
- If crime scene obstructions or if other evidence in the crime scene prevents the crime scene photographer from composing a midrange photograph with a 50mm lens, the photographer should know that a proper midrange photograph can still be obtained by standing a different distance from the evidence and the fixed feature and composing the scene with a different focal length lens.
- The first close up photograph should show the evidence "as found" in the scene before any alteration or movement of anything in the scene. Nothing should be added to the scene, and nothing should be taken away from the scene when the evidence is first photographed. Aka "in situ" (Latin for in place).

- When doing close up photographs, you should invariably be using one of two apertures. If the close-up photograph will be used for comparison with another item of evidence, then f-11 should be used, and the other camera variables altered to ensure a proper exposure with the f-11. The f-11, as you should recall, still gives a good depth of field, while avoiding image softness that can be caused by diffraction. It the photograph will not be used for critical comparisons, an f-22 should be used. There would be no benefit to using any other aperture in this case.
- "**Altered" close up photographs**. After the item of evidence has been moved and is photographed again. Might see additional evidence and it will also give a better background. They should be done in a way that makes it immediately obvious to the view that this photograph is of evidence that has been moved. The photographer must be assured that no one viewing the "altered" photograph can confuse it with any other "as found" photographs.
- **Rule of Thumb 3.3:** "Altered" close-up photographs should be done in a way that makes it immediately obvious to the viewer that this photograph is of evidence that has been moved. The photographer must be assured that no one viewing the "altered" photograph can confuse it with any of the "as-found" photographs.
- **Body Panorama**: A series of photographs showing the body from all four sides, it includes a full face shot for identification purposes. It also includes a photographed from directly over the body.
- To fill the frame with a face and still have it look like the person being photographed, professional portraiture photographers use lenses with focal lengths between 100mm and 120mm because if you get close enough to a face to fill the frame with it when using a 50mm lens, the face gets distorted to varying degrees. The nose, being closer to the camera, usually looks a bit enlarged. You do this to make the face look like it appeared to the viewer.
- **Rule of Thumb 3.4:** If you want to fill the frame with a face, while remaining back a distance that does not enlarge the nose, it is best to use a lens in the 100 to 120mm focal length, which is the perfect portraiture lens focal length range.
- If blood is in the scene, it will reflect more light than normal scenes.
- If using a flash, consider using the manual flash mode, which will not turn the flash off early because of higher amounts of reflected light.
- A trick to consider in the situation where all previous images have captured many "hot spots" is to use bounce flash.
- The opposite extreme of this reflection issue is a body that absorbs light because it is covered in soot or is itself charred black.
- Document insects and their variety, the extent of their infestation, and signs of their long term presence at the scene. Insects can be the cause of artifacts that can be confused with wounds.
- Cadaveric spasm is sometimes confused with rigor mortis, where selected muscles immediately stiffen at death.
- It would be a good addition to your collection of crime scene images to photograph the process of putting the body in the body bag. Also photograph the body bag tag or label.
- A full-face shot should be taken early. Additional photographs of the face after it has been washed, because blood, debris, and hair may initially mask a full view of the face.

- If wound paths are determined by the insertion of probes, these images are critical to the investigation. The angle and directionality of wounds are very important to any reconstruction of a crime.
- X-rays can be photographed without a flash. Usually ISO 400 film, 1/60th shutter speed and f-8 will produce good results.
- If a pattern is present, however, and this pattern can be linked to a specific item that made it, the entire pattern should be captured in the same image along with a scale.

Chapter 3 – Review Questions

1. **Briefly explain the written documentation that should accompany each photograph. When scales are used, explain why they should also be labeled**. The photo memo sheet. Every individual photograph should be logged on a photo memo sheet, which is a form to log all the specific data related to the camera, film and specific variables used to capture each individual photograph. Two reasons exist for documenting all the data regarding each image. First, when the case goes to court it can be used to refresh your memory. Second, if there are bad images you can learn from your mistake. A labeled scale makes it easier to get the image admitted into court as evidence.

2. **Briefly explain the types of exterior overall photographs. Explain the issues related to the different lenses that can be used and the perspective that is suggested**. Exterior overall photographs relate the crime scene to the general surrounding area. If the crime was committed indoors, overall photographs also show external views of the building in which the crime occurred. It will be the job of the crime scene photographer to walk the viewer of the photographs into the crime scene from its outer perimeter. When possible, the crime scene photographer should begin at the intersection closest to the crime scene. It acclimates any interested parties of the crime to the general surroundings. When photographing street signs, do so in a way that indicates to the viewer which of the two street names is the one on which the crime occurred. When composing this shot, make the street the crime occurred on more predominate in the photograph. If there are no street signs try and get a prominent land mark. Both wide angle lenses and telephoto lens can frequently be used for overall photos, if you carefully use them for their strengths, while avoiding their weaknesses. The strength of the wide-angle lens is its ability to capture a wider view of the scene. Its weakness is its tendency to elongate the scene. The strength of the telephoto lens is its ability to magnify distant details. Its weakness is its tendency to show the scene to be more compact or shorter, than it really was. When taking exterior overalls, include a photograph of the building address or the building name. Show the entire perimeter of the property with emphasis on ingress/egress and the point of entry.

3. **Briefly explain interior overall photographs. Explain the issues related to the different lenses that can be used and the perspective that is suggested**. Interior overall photographs are the bridge between the exterior overall photographs and the individual items of evidence within the crime scene. It should be photographed “as is” before anything is moved. Preference should be given to the use of a “normal” lens for most of this photography. It will capture these areas as you saw

them. The normal lens will neither compact relative distances nor will it elongate the size of any room. Once inside take a complete set of interior overall photographs.

4. **Midrange photographs have a specific purpose. Explain. They, too, have lens and perspective aspects. Explain them**. With midrange photographs, you now begin to document individual items of evidence. Before taking a series of close up photographs of the evidence, you need to link the evidence to the crime scene. These photographs will be informative only if it is known where these close ups are located within the crime scene. It is the purpose of midrange photographs to do this job. Midrange photographs should also be taken from a natural perspective. A 50mm lens is usually used to avoid lens distortion that will occur with wide angle and telephoto lenses. The best point of view is to have the film plane parallel to an imaginary line between the item of evidence and a fixed feature (isosceles triangle). Squatting, kneeling and standing will all give you a different perspective and change the way a piece of evidence is seen in relation to a fixed object. This is why it is so important to do the triangle. Camera equal lengths away from the evidence and a stationary reference point like a wall.

5. **Explain the four different types of close-up photographs that can be taken of evidence**.

    a. As Found (In Situ): Photograph to show the evidence in the scene before any alteration or movement of anything in the scene. Fill the frame.
    b. Fully Labeled Scale (on the same plane): Photograph that includes a fully labeled scale alongside the evidence. This helps size the evidence, enlargements can be made if necessary. The labeling information helps document the image. Fill the frame and scale on the same plane.
    c. Portion of the scale in view: This is to get as close to the evidence with a scale in it (fill the frame).
    d. "Altered" close Up: Take photographs of the evidence after it is moved to show all sides as well as what is underneath it.

6. **Explain the "full body panorama" series of photographs**. The series of required photographs begins with a midrange photograph relating the body to a fixed feature of the scene. After the midrange photograph of a body, a complete set of body panorama series is photographed. This includes a series of photographs showing the body from all four sides. These are close-up photographs of the body, attempting to fill the frame with just the body, eliminating everything else. A full-face shot, for identification purposes should also be part of a full body series. It should also include a photograph from directly over the body.

7. **Explain the advice to "zoom in, crop, and drape" when taking photographs of "sensitive" areas of the body**. Any area covered by a bathing suit should be covered up during photographs unless absolutely necessary. If that part of the body is being photographed the crop out the face of the victim trying to remain as modest as possible so that the photographs are not tossed out by the judge.

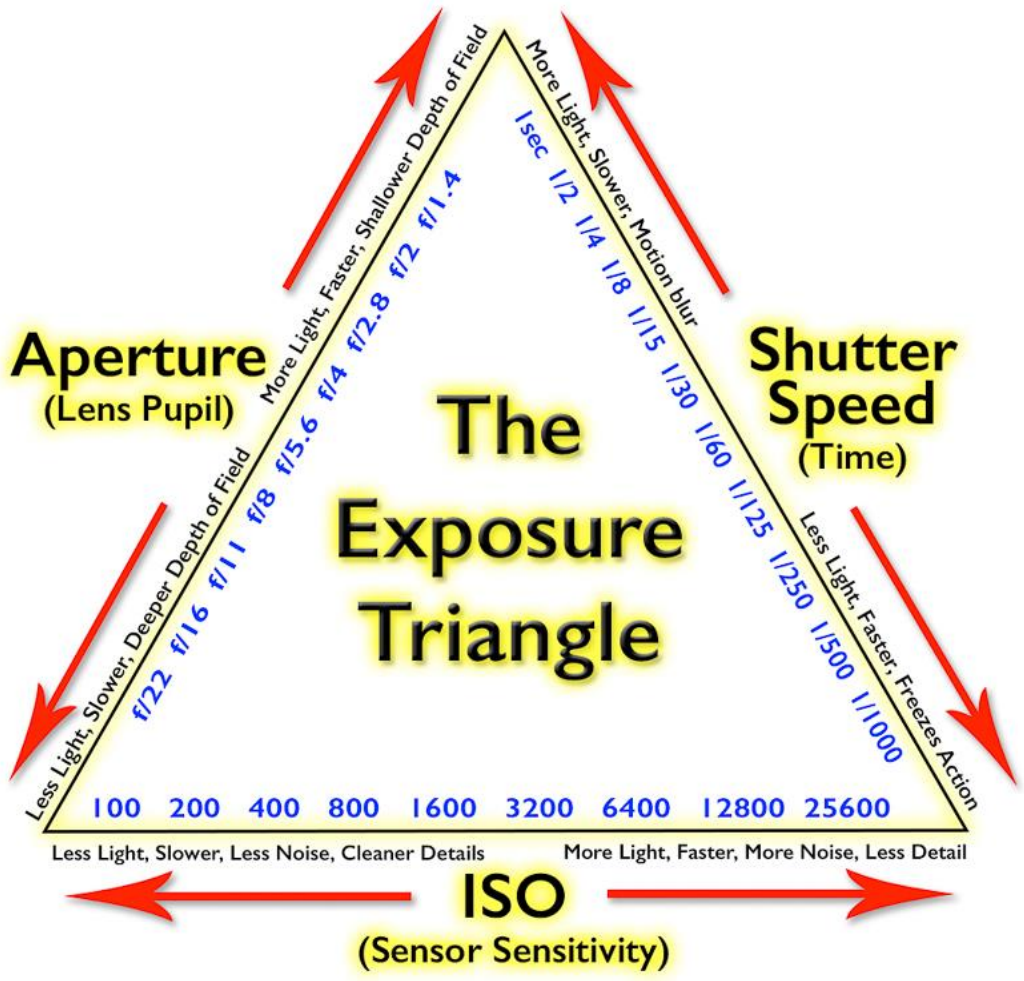
Chapter 4: Basic Exposure (Non-Flash) Concepts

- **Exposure Stops**: Normally expressed as a change that either halves or doubles the overall lighting from the original exposure.
  - **+1** exposure **doubles** the lighting.
  - **-1** exposure **halves** the lighting.
- **Four (4) variables that directly affect exposure**:
  - Shutter speed
  - Apertures
  - Film speed/ISO
  - The lighting of the scene
- **Shutter:** In a single lens reflex (SLR) camera is frequently located in the camera body, just in front of the film/digital sensor, where light entering the lens is brought into focus. Because of this it is also called a focal plane shutter. In some other cameras, the shutter can be located in the lens itself, rather than the camera body.
  - The shutter speeds are fractions of a second.
  - The longer the shutter is left open, the lighter the photograph becomes.
  - Shutter Speeds are represented in whole numbers but are really fractions.
  - Shutter speeds are 1/1, ½, ¼, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000 from slowest shutter speed to fastest (most exposure time to least).
  - If a shutter speed of 1/60 leads to proper exposure, then 1/125 will let in half of the light and the photo will be underexposed.
- **The term Single Lens Reflex (SLR) has two concepts**:
  - The image viewed by the photographer through the viewfinder and the light striking the film both come from a single lens
  - To accomplish this dual role, the light coming from the lens is reflected by a series of mirrors to the viewfinder.
- **Sensor**: Is the place where the camera is designed to focus the light coming in through the lens. Use to be the film.
- **F/Stops**: Sometimes referred to as the aperture of a lens or the diaphragm opening of the lens. But these terms are different.
  - **Diaphragm**: Is a set of blades, forming a circular opening, which can be opened to let more light through the lens or closed to restrict the light entering the camera.
  - **Aperture**: is the size of the resulting diaphragm opening. Considered "wide, large, or opened up," when the diaphragm produces a large opening. Considered "narrow, small, or closed down," when the diaphragm produces a smaller opening.
  - The term f-stop is actually a fraction relating the size of the aperture opening to the lens currently being used.
  - The larger the aperture, more light that is let in, the lighter the photo becomes.
    - F/stops are f/2 (Largest most exposed), f/2.8, f/4, f/5.6, f/8, f/11, f/16 (Smallest, least exposed).

        - Although shutter speeds are fractions of a second, f-stops are fractions of the focal length of the lens.
- **ISO**: Is the sensor's relative sensitivity to light to create proper exposure (equivalent to film speed).
    - The digital sensor is the light receptor. The image captured by the digital sensor is eventually transferred to some type of digital memory card.
    - Sensors that require more light have lower numbers (100), require less light = high number (3200).
    - Changing from 100 to 200 ISO means it is twice as sensitive to light (resulting in a 1 exposure increase (+1). 800 to a 400 would result in a (-1) decrease.
- **ISO Selection**: Is usually the first important decision you have to make about the ultimate exposure. The decision process usually proceeds as follows:
    - Ambient light conditions: Bright = slow ISO, Dim = fast ISO
    - Shutter Speed: typically, 1/60 because most SLR cameras are using a 50mm lens.
    - Scene is composed through the view finder.
    - Camera's reflective light meter will determine the f/stop automatically.
- **Exposure Triangle – memorize these numbers for reciprocity questions**
    - Shutter speeds are: 1/1, ½, ¼, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000, 1/2000, 1/4000, 1/8000
    - f/stops are: 1.0, 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 22, 32
    - ISO are: 50, 100, 200, 400, 800, 1600, 3200, 6400, 12800, 25600

LET'S BREAK DOWN RECIPROCITY IN A LITTLE MORE DETAIL

This is NOT in the book but more a breakout session to assist you in understanding this aspect of photography. Many people worry about this topic and below is a method to make it simple and easy to understand.



Remember when working Reciprocity questions, the correct answer MUST always equal ZERO. For example:

You as a crime scene photographer accurately meters a nighttime exposure at ISO 100, f/4.0, for 1 second shutter speed. However, you need to stop motion with a faster shutter speed. Which would be an EQUAL or reciprocal exposure?

A. ISO 400, f/22, for 1/60th of a second
B. ISO 800, f/8, for 1/15th of a second
C. ISO 1600, f/4, for 1/500th of a second
D. ISO 3200, f/2.0, for 1/125th of a second

Let's break down answer A using the Exposure Triangle Diagram above:

ISO 100 to 400 is 2 MORE of light. f/22 from f/4.0 is 5 LESS of light. 1/60 to 1/1 is 6 LESS of light.

So that is 2-5-6 = -9 – So NOT CORRECT

Let's break down answer B using the Exposure Triangle Diagram:

ISO 100 to 800 is 3 MORE of light. f/4.0 to f/8.0 is 2 LESS of light. 1/1 to 1/15 is 4 LESS of light.

So that is 3-2-4= -3 – So NOT CORRECT

Let's break down answer C using the Exposure Triangle Diagram:

ISO 100 to 1600 is 4 MORE of light. f/4.0 to f/4.0 is 0 / EVEN of light. 1/1 to 1/500 is 9 LESS of light.

So that is 4+0-9 = -5 – So NOT CORRECT

Let's break down answer D using the Exposure Triangle Diagram:

ISO 100 to 3200 is 5 MORE of light. f/4.0 to f/2.0 is 2 MORE of light. 1/1 to 1/125 is 7 LESS of light.

So that is 5+2-7 = ZERO – SO THIS IS THE CORRECT ANSWER.

The key is to REMEMBER what which is additive light and what is subtractive light. If you work each problem in this manner you will easily breeze through any Reciprocity questions on the tests. ALL Questions MUST EQUAL ZERO to be correct. If you have none that do – redo the options. If you have two at Zero look closely and see if you went the wrong direction with the positive or negative of light. (It can happen very easily if you do not pay attention). As soon as you get the test write down the memorized ISO, f/stop, Shutter Speed settings in green on the earlier pages on your piece of paper. Do this before you even put your name on the test. Then when the questions come up you will be ready!

- **Rule of Thumb 4.1:** Outside, during the middle of a sunny day (loosely equivalent to 10 am to 3 pm), select a 100 ISO.
- **Rule of Thumb 4.2:** Whenever capturing examination quality / Critical Comparison Photographs, use ISO of 100.
- **Rule of thumb 4.3:** All other times, early in the morning, late in the afternoon, at night, or when photographing indoors, lean towards the initial use of an ISO of 400.
- **DX Coding = Data Exchange**: Contain three different types of information:
    - ISO film speed of the film
    - Number of exposures on the roll,
    - Exposure latitude of the film.
- **Ambient Light**: The light present at the scene. We can either work with the light or supplement it with an electronic flash, ALS or flashlights. Light is a variable in our exposure calculations. We can alter the ambient lighting in two ways:
    - Flash

  - Intentionally creating a shadow over part of the scene.
- **Rule of Thumb 3.4:** For accurate color capture, only use either midday sunlight, which is approximately the bright yellow sunlight from 10 AM to about 3 PM, use an electronic flash, or ensure the digital white balance setting is for your current lighting.
- **Color Tint Corrections**:
  - Day color films = yellow discoloration. Fix with flash or blue 80A filter
  - Indoor fluorescent = **green** discoloration. Fix with Fluorescent filters (F, FL or FLD).
  - Overcast day = **blue** discoloration. Fix with 81 B, 81 C filters.
  - Heavy overcast/sun blocked = **deep blue** discoloration. Fix with 85A and 85B filters.
- **Exposure Latitude**: One of the meanings of exposure latitude is that daylight color film has an inherent inability to properly expose items within wide extremes of light. The positive aspects of exposure latitude is to realize that film can have exposure errors corrected in the wet-chemistry dark room. Different ISO speeds have different exposure latitudes. The best fix for this is to use a fill flash. Not to expose at the middle ground between the two extremes.
- **Rule of Thumb 4.5:** If an exposure error is unavoidable, it is better to underexpose digital images a bit. More detail can be obtained from a digital underexposure than a digital overexposure.
- **Dynamic Range**: Is similar to exposure latitude in film. Refers to the exposure extremes digital pixels can detect and record. Cameras that can detect large amounts of shadow and detail have a high dynamic range.
- **Clipped Highlights/shadows**: When there is more data than the camera's sensor can capture, either in the shadow or highlight area, it is said that the resulting image captured has Clipped highlights or clipped shadows. You know this if you look at the histogram. If high peaks at an end, this is representing the data that has been lost.
- When using film, if an exposure error is unavoidable, it is better to overexpose film than to underexpose it. Overexposed film is more easily correctable.
- It's best to underexpose digital exposures. Detail in overexposed digital images cannot be salvaged.
- The exposure latitude is more restricted when a digital camera is used. Digital overexposures and underexposures are more difficult to correct with digital software.
- After the "normal" exposure of the entire print, the area previously underexposed can receive additional light, while the rest of the image is masked so it does not receive too much light. This is called "**Burning"**. It adds light to, or burns, areas previously underexposed. Areas of the negative that were originally overexposed require less light for a proper exposure. During the "normal" exposure of the entire print, the area previously overexposed can be masked for part of the normal exposure. This is called "**Dodging**." Light is held back, or dodged, from areas needing less light than the print as a whole.
- **Shutter Speed can control three (3) types of movement**:
  - Photographer body movement
  - Subject motion
  - Camera movement
- To eliminate possible blur from hand-holding the camera, use the shutter speed that is the closest to the focal length of the lens on the camera, inverted into a fraction. For instance, if the camera had

the standard 50 mm lens mounted on it, 50 inverted into a fraction would be 1/50. Therefore, using the shutter speed that is nearest would be 1/60 of a second. Wide angle lenses, however, do not follow this rule. Telephoto lenses, however, do follow the rule.

- **Rules of Thumb 4.6:** To eliminate possible blue from hand-holding the camera, use the shutter speed that is the closest to the focal length of the lens on the camera, inverted into a fraction.
- Motion:
  - 1/125th walker, face recognizable
  - 1/250th jogger, jumping
  - 1/500th bicycle, 30mph
  - 1/1000th vehicle, 60 mph
  - 1/2000th propeller airplane
- Raindrops or snowflakes can be intentionally blurred so much that they cease to be captured on the film if you have a long exposure time. The exposure time is 2-3 seconds.
- **Neutral density filter**: One type of filter that can block some of the light coming in through the lens. "Sunglasses" for the lens. They do not affect any colors within the scene; they merely reduce the overall lighting in precise increments. Used when daylight snowstorms and trying to get rid of snow in the photographs.
- **Polarizer Filter**: A filter used to eliminate reflections from glass and water. It also uniformly reduces the light coming through it.
- **Reciprocal Exposures**: A variety of f-stops and shutter speed combinations result in the exact same exposure. Changing one of the exposure variables is permissible if the other exposure variable is also changed to balance the first adjustment.
- **Rule of Thumb 4.7:** To the extent possible, most crime scene images should be captured with a shutter speed of 1/60th of a second in combination with one of these four f/stops: f/22, f/16, f/11, and f/8.
- **Reciprocity failure**: Many different combinations of shutter speeds and apertures will result in the same exposure. Increasing one variable while decreasing the other results in the same exposure. When exposures are either too long or too short, this concept of reciprocity breaks down. Usually exposures longer than 1 second or shorter than 1/1000th of a second will suffer from reciprocity failure. Either extreme results in underexposures.
- **Digital cameras do not suffer from Reciprocity failure**. With long shutter speeds, many digital cameras do have a well-known problem, although. It is called **Dark Noise.**
- **Dark Noise**: When a digital sensor is exposed for long time intervals in dim situations, the result is often a "grainy" appearance to the image, where individual pixels are not properly recording colors and light levels accurately. Rather than smooth evenly toned surfaces, the "noisy" digital image appears speckled with odd random colors. This can be reduced using the Noise Reduction Setting. This makes for softer photographs however and should be used with care.
- **Most crime scene images should be captured with a shutter speed of 1/60 with f/stop f/22, f/16, f/11 or f/8**

- **18% Gray Card:** Is the standard. It is used because the real world, considering its light and dark shades, typically reflects 18% of the light that strikes it. If a card is not available, the following can be used:
    - Large area of green grass
    - Used/weathered asphalt
    - The palm of your hand
- **Reflective Light Meters**: 35mm SLR cameras typically have reflective light meters built into them, designed to meter/measure the amount of light reflected from the scene through the lens into the camera and then determine the amount of light needed for the photograph.
- **Incident Light Meters**: This is a handheld meter that the photographer will hold near the person or object being photographed. It is designed to measure the amount of light falling on the subject, rather than the light reflected from the subject towards the camera.
- **Averaging/Center Weighted Meters**: Measure most of the light coming in through the lens, emphasizing the light from the center of the area of view, because that is where most people place the important aspects of their photographs.
- **Spot Meters**: Only measure the light reflected from a very small area of the center of the viewfinder. By doing so, the photographer can be very specific about what area of the photograph he/she wants properly exposed, disregarding the rest of the scene.
- **Matrix meters**: Produce very accurately exposed photographs. It is normally preferred as the standard metering system. It uses very complex algorithms to "weigh" the differing amounts of light coming in from the various grids.
- Four well recognized "non-normal" scenes will require exposure compensations to provide for proper exposures.
    - Predominantly light-colored scenes.
    - Predominantly dark colored scenes.
    - Scenes with a lot of sky in the field of view.
    - Back lit scenes or scenes with both bright highlights and dark shadows in the same composition.
- When taking photographs that have a large amount of reflective material, white material, sand, and/or snow, it may be necessary to manually set the aperture to be 1-2 f/stops larger from what is recommended to prevent the camera from overcompensating and creating underexposed images
    - Likewise, when shooting black surfaces, it may be necessary to set the aperture 1-2 f/stops smaller than the automatic setting suggests preventing underexposure
- If the photograph to be taken is to contain a large amount of sky, take a meter reading (suggested f/stop when shutter button is depressed half way) of the primary object, e.g. a building, filling the entire photo, manually set the f/stop to this reading and then recompose the original photo
- If there are very bright and very dark areas of a photograph to be taken, it may be necessary to use fill-in flash
    - Take a meter reading of the brighter areas, manually set the f/stop, use a fill-flash to light the dark areas, the dark and light areas will now be properly exposed

- "**Dirty Snow**": If the reflective light meter is relied on when taking images of snowy scenes, the result will be dirty snow, or dark underexposed snow. So when using the built in sensor photographing predominantly bright scene, bump the exposure up 1 ½ - 2 stops or the photograph will be underexposed.
- "Normal" Caucasian skin has been measured to reflect approximately 36% of the light that strikes it. So, if you are photographing all skin and count on the built-in meter, you will be under exposed by 1 stop. So, when photographing you have to open the stop up +1 more than what it tells you to use.
- **Fill-Flash**: A flash technique to ensure a scene including bright sunlit areas and dark shadows can have both areas properly exposed in one photograph. The sunny areas are metered to properly expose the sunlit areas of the scene. Flash is used to properly expose the shady areas. The flash exposure is balanced for the exposure necessary to properly expose the sunlit area. It is the cure to lighting extremes.
- **Exposure Modes**: There are four common exposure modes:
    - Manual,
    - Program,
    - Aperture Priority,
    - Shutter Priority.
- **Manual Exposure**: The photographer is responsible to manually set the f-stop and shutter speed.
- **Program Exposure**: The camera sets both the f-stop and shutter speed on the base of the amount of reflected light coming into the camera. The use of the program exposure mode reduces everything to just one narrow concern: Exposure.
- **Aperture Priority**: The photographer manually sets the f-stop desired, and the camera will automatically set the corresponding shutter speed required to properly expose the photograph for the reflected light coming into the camera.
- **Shutter Speed Priority**: The photographer sets the shutter speed desired and the camera will automatically set the corresponding aperture required to properly expose the photograph on the basis of the light reflected into the camera.
- **Automatic exposure mode bracketing**: The camera automatically compensates for an adjustment to either the f-stop or shutter speed so that another proper exposure is still achieved. A reciprocal exposure is the result.
- **Exposure compensation dial**: To bracket in one of the automatic exposure modes, this dial is set to the appropriate exposure desired, usually ranging from +2 to -2 stops.
- The exposure compensation dial should only be used for bracketing when one of the automatic exposure modes are in use. The exposure compensation dial does not produce a bracket when the manual exposure made is in use. In the manual exposure mode, bracketing is accomplished by manually altering the shutter speed or the aperture. When doing the manual bracketing remember the cardinal rule: underexposed maximize the depth of field.
- **Rule of Thumb 4.8**: Before using an f/5.6, or wider aperture, for a crime scene consider these options:
    - Use the electronic flash.
    - Use a tripod

- Reset the ISO

- **f-16 Sunny Day Rule:** This rule recommends the f-stops and shutter speed combinations for normally occurring outdoor lighting conditions. The following are a set of rules to follow on different times of the day in different lighting conditions:
  - On a bright sunny day where there are crisp, distinct shadows, tend towards the use of 100 ISO, f/22, and 1/60 shutter speed (second is 100 ISO, f/16, 1/125 shutter speed)
  - On a bright but hazy day where shadows are soft and indistinct, tend towards the use of 100 ISO, f/16, and 1/60 shutter speed (second is 100 ISO, f/11, 1/125 shutter speed)
  - On a bright but cloudy day where there are no shadows created by the sun, tend towards the use of 100 ISO, f/11, and 1/60 shutter speed (second is 100 ISO, f/8, 1/125 shutter speed)
  - On an overcast day or when in shade but the sky above is clear, tend towards 100 ISO, f/8, and 1/60 shutter speed (second is 100 ISO, f/5.6, 1/125 shutter speed)
  - On a heavily overcast day with no shadows visible, tend towards 400 ISO, f/11, and 1/60 shutter speed
  - In a deep shade photo, where there is little to no sky visible overhead, tend towards the use of 400 ISO, f/8, and 1/60 shutter speed
- **UV/Haze/1A/Skylight Filters:** A filter used to protect a camera lens from damage. It also filters out UV light from the sky, providing better exposure. It also corrects the blue color in the sky, so it doesn't look overexposed/washed out.
- **Rule of Thumb: 4.9**: Always screw filters onto the lens when the lens is aimed at the ceiling or straight up. This reduces the chances of dropping the filter.
- **Polarizer filter**: A two-part lens. The outer part can be rotated to reduce or eliminate reflections or glare on a variety of surfaces. As you deviate from that 34-degree viewpoint, the polarizer filter will become more and more ineffective.
  - This is typically a 2-stop light reduction because of the light being blocked from the sensor.
  - A polarizer can remove the glare on the pavement at an accident scene, making the skid marks present at the scene more obvious. It is recommended that you view the skid marks from both ends. The polarizer filter may be more effective from one direction than another.
  - Improves the color of the photograph.
  - Linear polarizer filter should be used with a manual focus lens.
  - Circular polarize filter should be used with an auto focus lens.

Chapter 4 Review Questions

1. **What are the four variables that affect exposure? Why does changing one of them require an adjustment to one of the other exposure variables? What are the two main reasons for changing exposure variables while maintaining the same exposure?**
   a. The four variables that directly affect exposure are: Shutter Speeds / Apertures / Film speeds (ISO) / Ambient lighting of the scene or any supplemental lighting that can be used.
   b. Any variance in one of these variables results in a change in the exposure of a photograph.

c. You're bracketing a photograph making sure to over/under expose in order to make sure that you are getting the quality photograph that you need. Changing the depth of field to make sure everything is in focus.

2. **How do different types of lighting affect the overall colors in your images?** Although you do not normally see the different effects that various lighting sources will have on their surroundings, daylight digital sensors can record these different effects. When the task is to faithfully capture colors within a crime scene, you should know only two choices of lighting can be used when using film. Choices with digital cameras can be manipulated. Film use only midday sunlight, which is approximately the bright yellow sunlight from 10 am to about 3 pm, or use an electronic flash. Both of these light sources will ensure that various colors within the crime scene were accurately captured on daylight color film. Other lighting conditions will result in various tints to the scene and the evidence within the scene. On shade, cloudy days or twilight you photographs will shift towards blue. Sunrise/Sunset will get an orange/red color tint. Tungsten = yellowish/amber tint (indoor lighting). Fluorescent = green.

3. **What are two meanings of exposure latitude**? One of the meanings of exposure latitude is that daylight color film has an inherent inability to properly expose items within wide extremes of light. (Knife under a white car at high noon). Using an exposure between both extremes would over or under expose both areas. Not a good compromise. One solution is to use a technique called fill-in flash. Use the attached flash to add light into the photograph. It is the primary method to "even" the lighting extremes when bright areas of a scene and dark shadows are present in the same area. A second solution to this exposure problem is to realize that the exposure problem will exist and then to make exposure corrections either in the wet lab or in Photoshop.

4. **Shutter speeds affect motion. Which kinds of motion are affected**? Generally, three types of movement can be controlled by an appropriate shutter speed:
    a. Photographer body movement: To do this use the shutter speed that is the closest to the focal length of the lens on the camera, inverted into a fraction.
    b. Subject motion: 1/125 = walker, 1/250 = runner, 1/500 = bicycle, 1/1000 = vehicle (60mph), 1/2000 = airplane propeller
    c. Camera movement: Use a tripod and shutter release cord/remote/timer.

5. **To determine a "proper" exposure, you must use some standard. What is this standard? Explain "normal" and "non-normal" scene, how can you determine the "proper" exposure**? A proper exposure looks "correctly" exposed, neither too light nor too dark. It seems "normal", as we would expect to see it. Details within the image are neither hidden in dark shadows nor washed out by being overexposed. An image may be properly exposed, which is usually referred to as being "O" (stops), or what is believed to be the optimal exposure. Normal scenes reflect 18% of the light.

6. **There are various methods for determining "proper" exposures. What are the different exposure modes**? There are four common exposure modes: manual, program, aperture priority and shutter priority exposure modes. These modes allow you to choose different options to determine how a proper exposure is obtained.

a. Manual Mode: The camera is totally controlled by the photographer.
b. Program Mode: The camera is controlling all the settings. Not recommended for crime scenes because the depth of field cannot be controlled.
c. Aperture Priority: The photographer manually sets the f/stop desired, and the camera will automatically set the corresponding shutter speed required to properly expose the photograph for the reflected light coming into the camera. Issues with this is when the f/stop is so small the camera cannot be hand held without blurring the photograph. Fill flash/tripod or adjusting the f/stop will need to be done in order to have an in focus photograph.
d. Shutter Priority: The photographer sets the shutter speed desired, and the camera will automatically set the corresponding f/stop required to properly expose the photograph on the basis of the light reflected into the camera. In this the photographer usually sets the shutter speed to the lowest it can be hand held, $1/60^{th}$ and the camera does the rest of the adjustments to the aperture.
e. Reciprocal Exposures. The same exposure may be obtained from a variety of different exposure settings. A smaller aperture may be used as long as a longer corresponding shutter speed is used. A wider aperture may be selected as long as a corresponding shorter shutter speed is used. Each change in apertures either halves (with smaller apertures) or doubles (with wider apertures) the light allowed to reach the film. Each change in shutter speeds either halves (with faster SSs) or doubles (with slower SSs) the light allowed to reach the film. Selecting an exposure that halves one variable while doubling the other variable results in the same exposure. Why alter exposure settings? To maximize DOF with smaller apertures, or to freeze motion with faster shutter speeds. With crime scene photography the f stops that should be used are f/22, f/16, f/11 and f/8. We are worried most about the depth of field. That is how you would determine the proper exposure when adjusting the shutter and f/stop settings.
f. **Reciprocity Failure Corrections**:
    i. **If the indicated shutter speed is 1 second, adjust the exposure by +1 stop**
    ii. **If the indicated shutter speed is 10 seconds, adjust the exposure by +2 stops.**
    iii. **If the indicated shutter speed is 100 seconds, adjust the exposure by +3 stops.**
    iv. **If the indicated shutter speed is 1/1000 seconds, adjust the exposure by +1 to +2 stops.**

7. **Explain the different methods to bracket at shot**. When your camera is set in shutter or aperture priority, if you adjust one of the settings the camera will automatically adjust the other setting to make sure that the photograph comes out right. Due to this you cannot bracket simply by changing the shutter speed or aperture setting. You have to adjust or use the bracketing button (exposure compensation dial) on the camera to have this take place, or you have to go to the fully manual setting and adjust. Bracketing means that you take a photograph at the setting you believe the camera should be set at and then change to a +1 and -1 taking photographs in each setting. This will give you the ability to add light or take away light from the photograph. You can also use you flash and bracket by turning the compensation dial to a +1 or -1 exposure. This will allow the flash to fire hotter or cooler depending on the setting.

8. **Explain the f/16 sunny day rule and its corollaries**. Recommends both an f/stop setting and a corresponding shutter speed for most outdoor photographic situations. It is not the best exposure combination if you wish both a proper exposure and you also want to maximize the depth of field. Rule states: at midday, on a bright and sunny day, where there are crisp distinct well-defined shadows, use an f/16 and convert the ISO film speed to the shutter speed. If you are using 100 ISO, convert it to a shutter speed of 1/125th of a second. If you are using 400 ISO speed, convert to 1/500th of a second shutter speed.

9. **Explain the various filters commonly used by photographers and their effects on images**.
    a. UV/Haze/1A/Skylight Filters: Used for an inexpensive lens cover to prevent scratches, dents, cracks etc. It is also used to have the sky represent a true blue/correctly. Cameras will automatically filter out excessive blues from the sky. These filters do not reduce the other light coming through the lens in any significant way, so exposure compensations are not necessary.
    b. Polarizer Filter: Used to reduce the glare/reflections that happen on a variety of surfaces. It can also be used to enhance skid marks on traffic accidents, shooting through water, enhancing the blue of the sky. You will have to bracket when using it because it will reduce the amount of light hitting the sensors, approximately 2 steps when all the light is being blocked.

Chapter 5: Focus, Depth of Filed and Lenses

- **Rule of Thumb 5.1**: The entire scene, and all the evidence within the crime scene, should be in focus. If you know a part of the scene will be out of focus if the photograph is captured as composed, you should attempt to recompose the scene so the out of focus area is no longer in the field of view.
- **Resolution:** Camera resolution is the ability of the camera system, which includes the lens optics, camera sensor (film or digital sensor), and camera processing software, to distinguish, or "resolve" groups of alternating line pairs as the lines become increasingly thinner and they become increasingly closer together. The classic line pair consists of a black line and a white line. As these become thinner and closer together, at a point the distinction between the black lines and white lines will become less distinct, and the result becomes a blending into gray.
- **SWGIT (Scientific Working Group on Imaging Technology):** This group was created to provide leadership to the law enforcement community by developing guidelines for best practices for the use of imaging technologies within the criminal justice system. 8 megapixels is SWGIT standards on some evidence photographs.
- **1:1 Magnification Ratio**: When an item of evidence is life size on a negative. The National Institute of Standards and Technology (NIST) ultimately decided on 1000 pixels per inch (ppi) at 1:1 as a minimum resolution for latent print transmission.
- **Acutance:** The rendering of a sharp edge in the subject as a sharp edge in the photograph. This is obviously part of what we think of when we speak of sharp focus and good resolution. It means a clear and precise distinction exists between the edge of one object and the beginning of another adjacent object.
- **Aberration**: A term encompassing a variety of causes that result in poor image quality. They come from imperfect lens design and construction. Because perfect lens construction is impossible, the best lenses can only minimize aberrations.
- **Circles of Confusion**: As long as the light, reflected from a single point in space, enters the lens and remains a circle, rather than coming together at the film plane at a specific point, the image is "confused" and out of focus.
- **Depth of Field**: The extended area in front and behind the plane of precise focus that still appears to the eye to be in focus.
- Manual focusing on single items of evidence is best done with the film plane parallel to the top surface of the evidence.
- **When is auto-focus likely to fail?**
    - Subject matter needs to have prominent vertical elements,
    - Subject require prominent horizontal elements.
    - Dim, low lighting conditions.
    - Back lit, bright lights
    - Nearby and distant elements are near the center of the viewfinder
    - Every lens has a close focusing distance. Closer than this distance, the lens cannot focus.

- When photographing a single digit fingerprint, it is best to pre-focus the camera to the closest focus distance and then move the camera closer to the print until it is in focus.
- **Hyperfocal Focusing**: The technique to maximize the depth of field when infinity is composed in the background. Infinity is the equivalent of 60 to 80 feet and beyond.
    - When taking a large area overall photograph, and there is no large object, like a wall, in the background, maximize the depth of field with hyperfocal focusing
        - f/22 focus on 12'
        - f/16 focus on 16'
        - f/11 focus on 24'
        - f/8 focus on 30'
- **Rule of Thumb 5.2:** If you are composing on an area as your primary subject, the entire area, from front to back, should be in focus.
- Thinking like a camera, then, we can place photographs into three rough categories:
    - Large scenes, with infinity in the background
    - Medium distance scenes, where infinity is not in the background
    - Close up images of individual items of evidence.
- **Depth of Field Scale**: A tool to enable the photographer to determine the DOF; the area that will appear to be in focus, when the image is processed. DOF is the range, in front of and behind the plane of exact focus, of what also appears to the eye to be in focus.
- **Circles of confusion**: Areas perceived by the eye to be in focus. They move further away from the film plane, which is the explanation for the larger DOF produced by using smaller apertures.
- One of the camera's variables that affect DOF is the f-stop selection. The DOF scale is designed to be used in conjunction with the distance scale. The DOF scale is composed of pairs of f-stop numbers radiating outward from the point of exact focus.
- **DOF Range**: The distance that falls between the pair of f-stop numbers on the DOF scale. Wider apertures result in narrower DOF ranges; smaller apertures result in progressively longer DOF ranges.
- **Zone Focusing**: The technique to maximize the DOF for an area when infinity is not in the background. With zone focusing, it is necessary to determine the distance of the background.
- **Rule of Thumb 5.3:** The DOF extends one third in front of the exact point of focus, and two thirds behind the point of exact focus.
- **Rule of Thumb 5.4:** When attempting to maximize the DOF with crime scenes ranging from 5' to 30', the most effective way to do this is to focus at a distance that appears to be midway between the top and the bottom of the composed image.
- **Diopter Adjustment Dial**: A feature that allows individuals to adjust the viewfinder for their particular eye quality.
- Three camera variables directly affect the DOF range. They are:
    - F-stop
    - Lens choice
    - Camera to subject distance
- **f-stops:** Has a relationship to the focal length of the lens.

  - Large lens openings produce relatively short DOF ranges,
  - Small lens openings produce relatively long DOF ranges,
  - Purely a function of the way they bend light to converge at the film plane and the relative distance of the circles of confusion from the point of exact focus at the film plane.
- **Lens choice** affects DOF because FFL/(f/stop) = DOD
  - FFL=focal length of lens
  - DOD=diameter of the diaphragm (size of lens opening)
- Because of FFL/(f/stop) = DOD, at any f/stop, wide-angle lenses will have a better DOF range than a normal lens, and a normal lens will have a better DOF than a telephoto lens
- For a 35mm SLR camera, a 50mm lens is "normal" that is it does not distort distances
  - A wide-angle lens (focal length 50mm or less) will elongate the distance between foreground and background, a telephoto lens (focal length 60mm-1200mm) will compress the distance between foreground and background
- **Camera to Subject Distance**: As you get closer and closer to your subject matter, the DOF range begins to collapse. Casing example – focus not on the top of the casing but midway between top and ground. This will give a greater depth of field.
- **Rule of Thumb 5.5:** On bright sunny days, ISO 100 will allow photography with the smaller f/stops. Otherwise, on cloudy or dark days, at nighttime, or indoors when using electronic flash, use a faster ISO like ISO 400.
- **Focal Length**: The distance in millimeters between the optical center of a lens and the film plane when the camera is focused on infinity.
- Together, the shutter speeds and the f-stops control the total quality of light that is allowed to ultimately reach the film for an exposure. The light intensity can be controlled by volume (f-stops); and time (shutter speed).
- The 50mm lens is the focal length of choice when it is a crime scene photographer's intention to offer the photograph of the crime scene in court and maintain that the photograph is "a fair and accurate representation of the scene."
- **Rule of Thumb 5.6:** The use of a different focal length lens will introduce lens distortion into the photograph. Wide angle lenses will elongate the distance between the foreground and background. Telephoto lenses will compress the distance between the foreground and background. Only the 50mm lens will capture the image without this distance distortion.
- One other aspect of the 50mm lens is that it only provides a view of the world that is about 46 degrees of the field of view.
- Lenses with focal lengths less than 50mm are referred to as wide angle lenses; lenses with focal lengths more than 50mm are referred to as telephoto lenses.
- **Focal Length Multipliers**: Sensors built into the camera that will actual extend the length of the focal plane by 1.5 -1.6. It in a sense "crops" what would have been captured with a full-frame digital sensor.
- **Telephoto Lenses:** Lenses with focal lengths greater than 50 mm
  - Magnify distant objects
  - Narrow the field of view

- Compress the foreground to background distance/distortion
- Narrow depth of field
- Used very seldom by crime scene photographers, only when a distant object can't be photographed from a closer position due to hazards
  - The photo cannot contain multiple distances/objects, only one object can be in the field of view due to the compression of distances
  - In surveillance situations, to be confident magnification will be adequate to recognize either a subject's face or to read a license plate, you should use a lens that has a focal length of 2mm of lens per foot of distance between the camera and the subject.
  - Because the background will be magnified with a telephoto lens, making it appear enlarged, the relative perceived distance between the camera and the background is necessarily compressed. Objects appear closer together than they really were.

- **Rule of Thumb 5.7:** In surveillance situations, to be confident magnification will be adequate to recognize either a subject's face or to read a license plate, you should use a lens that has a focal length of 2mm of lens per foot of distance between the camera and the subject.
- **Wide Angle Lenses**: Lenses with a shorter focal length than 50mm. The optical centers of these lenses are significantly closer to the film plane than a 50mm lens' distance. This difference produces distinct changes to a photograph compared with the 50mm lens look. These differences are:
  - Wider field of view
  - Elongation of foreground to background distances
  - Increased depth of field
    - With moderate wide-angle lenses, such as 35mm and 28mm lenses, the only perceived difference in photographs is this wider field of view. As much wider focal lengths are used, usually at around 20mm and wider, another effect can also be noticed. Vertical lines at the left and right edges of the image begin to bow outward more and more.
    - **Barrel Distortion**: The bowing outward of vertical lines at the edges of an image.
    - A wide-angle lens seems to make the background appear farther away than it really was.
    - Strength = ability to capture more detail to the left and to the right.
    - Weakness = perspective distortion in the form of foreground to background elongation.
- **Macro Lenses:**
  - Magnify small objects
  - A 50mm lens usually cannot focus when the object is 18" or closer to the lens
    - This means that anything smaller than 6"x9" will need magnification
    - This relates to a 1:7 magnification maximum
      - A nickel (or single digit fingerprint) when photographed with a 50mm lens at its minimum focusing distance will be 1/7th of its actual size when the print of the photo is done in real size

  - A macro lens is capable of achieving 1:1 magnification
    - A nickel (or single digit fingerprint) photographed with a macro lens will be life sized and in focus
  - There are three options to achieve a macro effect
    - Macro Lenses (1:1 [real size objects] or 1:2 [half of real size objects] magnification)
    - Extension Tubes (Fits between camera body and lens to move optical center further from film plane, causing magnification)
    - Close-Up Filters (Fit on end of lens to provide magnification from 1:6 to 1:2)
- **Rule of Thumb 5.8**: Whenever critical comparison or examination quality photographs are to be taken, never use the two smallest or the two widest apertures on the lens' f-stop continuum.
- **Extension Tubes**: a supplemental lens, inserted between the primary lens and the camera body, to move the optical center of the primary lens farther from the film plane.
- **Close-up Filters/Diopters/Sub-Lenses**: A set of filters with differing magnifications can be stacked for different magnification ratios.
- **Vibration Reduction/Image Stabilization**: guarantee the absence of blur when using shutter speeds at least 2 stops slower than "normal." Particularly well suited for surveillance situations.
- **Three problems with camera lenses have been identified:**
  - Aberrations
  - Diffraction
  - Distortion
- **Lens Aberrations**: Or defects in an image produced by a lens, account for a reduction in the resolution of an image. Most, but not all, involve the inability of a lens to focus light at a precise point on the film plane. The result is frequently an impression of "softness" to the image and a loss of clarity of the details in the image.
  - Most lens aberrations occur at the widest apertures of a lens.
- **Chromatic Aberrations:** As light travels through the various lens elements, the different colors in white light will refract differently. The primary colors of red, green, and blue will separate and converge near the film plane at different locations, rather than at one precise point. If these colors do not focus at the same point, the image is noticeably softer, and the colors may appear to be a bit out of line.
  - The longitudinal chromatic aberration involves light coming into the lens from directly in front of the camera, which is called on-axis light. The lateral chromatic aberration involves light coming into the lens from the sides of the scene which is called off-axis light.
- **Spherical Aberrations**: Is caused by the different points of light that will converge near the film plane, but this is not related to the colors of white light being refracted by the lens elements. The difference is attributed to the various parts of the lens the light comes through. The cure for spherical aberrations is to stop down the aperture. Do not use the widest apertures when critical comparison photographs are being taken.
- **Coma Aberrations**: Light coming into the camera from an off-axis location is focused at different areas of the film plane, depending on what area of the lens it came from: the perimeter, the midpoint, or intermediate distances between those two. The result of coma is a lack of sharpness,

contrast, and resolution on the film plane. The cure to coma is to use a smaller diaphragm opening or a smaller f-stop.

- **Diffraction:** The bending of light when it strikes an edge. The effect of diffraction is a loss of resolution, a loss of edge sharpness, and a loss of clarity in an image. Diffraction is most severe when using the smallest apertures of a lens' f-stop. Only cure: open the aperture at least 2 stops from the smallest aperture of the lens.
- As desperate as we are for the sharpest, clearest, most in focus image we can get, when trying to capture critical comparison images, use of the smallest apertures of a lens is counterproductive.
- **Poisson's Spot**: The bright spot in the center of a circular shadow from light striking a circular opaque barrier and bending around the edges and meeting in the center of the shadow.
- **Airy Disk**: When light from a single point comes through a small circular aperture, the diffraction of light striking the edges of the aperture forms a figure with a bright central feature, with progressively dimmer radiating rings that are light and dark. (Discovered by Sir George Airy).
- Aberrations can degrade images captured with the widest aperture of the lens; diffraction can degrade images captured with the smallest apertures of the lens, which can also be expressed by saying lenses can be aberration-limited and diffraction-limited.
- Two other effects lenses can have on an image are barrel distortion and pincushion distortion. These are usually effects caused by the use of wide angle and telephoto lenses.
    - **Barrel Distortion**: Usually a result of using a wide-angle lens, an image may show straight lines at the edge of the image bowed slightly outward.
    - **Pincushion Distortion**: Usually a result of using a telephoto lens; image may show straight lines at the edge of the image bowed slightly inward.

Chapter 5 – Review Questions

1. **Briefly explain the nuances of each of these terms: "resolution," "acutance," and "sharpness."**
    a. Resolution: Is the ability of the camera system, which includes the lens optics, camera sensor (film or a digital sensor), and image processing software, to distinguish, or "resolve" groups of alternating line pairs as the lines become increasingly thinner and they become increasingly closer together.
    b. Acutance: Refers to the camera's ability to render a sharp edge of the subject as a sharp edge in the photograph.
    c. Sharpness: Being in focus. Light coming into a camera through the lens and converging at the sensor at a precise point. As light makes its way through the lens, it becomes a smaller and smaller circle, which looks like the converging ellipses. (Circles of confusion).

2. **Automatic focus has difficulties locking in on some types of scenes. Explain two situations in which it may be better to use manual focusing**. Manual focusing on single items of evidence is best done with the film plane parallel to the top surface of the evidence. When a subject matter lacks distinct detail for the camera's focus on system to lock onto, like interior walls or uniformly blue sky. Dimly lit rooms/conditions. Overly bright or strongly backlit scenes. When there are nearby and distant elements near the center of the viewfinder. The auto focus might not know what you are

looking at and not be able to focus. Or if there are two distinct types of subject matters which are near each other.

3. **Explain the concept of the circles of confusion. How are they related to different apertures? How are they related to different focal lengths**? Simply stated, as long as the light, reflected from a single point in space, enters the lens and remains a circle, rather than coming together at the sensor at a specific point, the image can be considered "confused" and out of focus. It does not matter whether the light would have become a point in front of or after the sensor. If a circle of light is formed on the sensor, the result is an out of focus image.

4. **Explain hyperfocal focusing. Include an explanation of how to use the technique when you do have a depth of scale on your lens and when you do not**. Is a technique to maximize the depth of field when infinity is composed in the background. Infinity is normally considered an unimaginable large number or quantity. It is used when maximizing depth of field is a primary concern. On the focusing ring there is a third pair of numbers on either side of the focusing point called the depth of field scale (DOF Scale). The DOF Scale is a tool to enable photographers to determine the DOF, the area that will appear to be in focus when the image is processed. When there is a scale, determine the f/stop required for the lighting at the scene. Once this has been determined, align that f/stop on the DOF scale with the infinity symbol on the distance required. When there is no DOF scale, first determine the f/stop required for the scene lighting. Then focus at one of the following distances appropriate for your f/stop: f/22 = focus 12', f/16 = focus 16', f/11 = focus 24', f/8 = focus 30'.

5. **Explain zone focusing. Include an explanation of how to use the technique when you do have a depth of scale on your lens and when you do not**. Zone focusing is the technique to maximize the DOF for an area when infinity is not in the background. This technique also relies on your lens having a DOF scale. As in the hyperfocal focusing technique, the first step is to determine the f/stop required for the lighting at the scene, which is done by simply taking a meter reading of the crime scene. The second step is to determine the distance of the background of this particular crime scene, which may be a real obstruction, like a wall, or it may be the distance from your camera you decide will be the top of your field of view when you compose this image. If there is no DOF scale, the quickest, and most accurate method of focusing to maximize the DOF is to focus at the distance that is midway between the top of the composed image and the bottom of the composed image. A general rule to remember is that the DOF extends one third in front of the point of exact focus and two thirds behind the point of exact focus.

6. **Explain the camera variables that affect depth of field, that maximize depth of field, and that minimize depth of field**. DOF, by definition, is the variable range, from foreground to background, of what appears to be in sharp focus. Three camera variables directly affect the DOF range. They are:
    a. **F/stop choice**: The DOF range will increase as f/stops are changed, moving on a continuum from f/2 to f/22. F/stops representing large lens openings produce relatively short DOF ranges, and f/stops representing small lens openings produce relatively long DOF ranges. So, f/2 results in the shortest DOF range, and DOF range of f/22 produces the longest.

b. **Lens choice**: At any f/stop, wide angle lenses will have a better DOF range than normal lenses, and normal lenses will have a better DOF than telephoto lenses. Another way of saying this is to state that the same f/stop number will result in different lens openings, depending on which focal length of lens is being used. Because wide angle lenses produce smaller lens openings than normal and telephoto lenses, the resultant DOF range will be greater. Because normal lenses produce smaller lens openings than telephoto lenses, their resultant DOF range will be greater.
c. **Camera to subject distance**: As you get closer and closer to your subject matter, the DOF range begins to collapse.

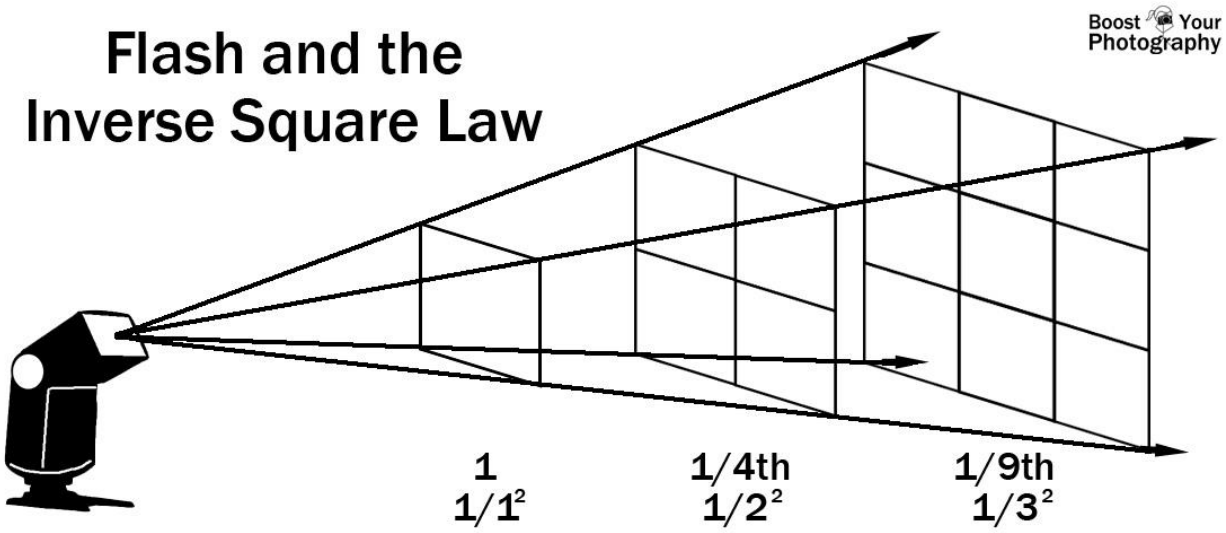
7. **Explain which focal length of lens is most appropriate for most crime scene photography and why this is so**. The focal length of the lens is, by definition, the distance in millimeters between the optical center of a lens and the sensor when the camera is focused on infinity. When focused on infinity, the lens is at its most compact configuration. The 50mm lens, used with an SLR camera with a full-frame sensor, is the focal length of choice when it is a crime scene photographer's intention to offer the photograph of the crime scene in court and maintain that the photograph is a "fair and accurate representation of the scene." Use of a different focal length lens will introduce lens distortion into a photograph. Wide angle lenses will elongate the distance between the foreground and the background. Telephoto lenses will compress the distance between the foreground and background. Only the 50mm lens will capture the image without this distance distortion.

8. **Most of the time depth of field is the most important concern. When does diffraction most affect crime scene photographs? What is its effect? What is the "cure?**" Diffraction is the bending of light when it strikes an edge. The effect of diffraction is a loss of resolution, a loss of edge sharpness, and a loss of clarity in an image. Diffraction is most severe when using the smallest apertures of a lens' f/stop continuum. Diffraction is the reason small apertures (f/22 f/16) are not recommended when images to be used for critical comparisons are being captured. When examination quality images are the issue, the aperture of choice should be f/11. An image will suffer more from diffraction than it will suffer from a lack of the largest DOF range as provided by the smallest apertures. This cannot be overemphasized. As desperate as you are for the sharpest, clearest, most in focus image you can get, when you are trying to capture examination quality images, use the smallest apertures of a lens is counterproductive. Aberrations can degrade images captured with the widest apertures of a lens; diffraction can degrade images captured with the smallest apertures of a lens, which can also be expressed by saying lenses can be aberration limited and diffraction limited.

Chapter 6: Electronic Flash

- **Guide Number**: The guide number is a means to discuss a flash's relative output power. It can also be used to determine the f-stop to properly expose an object at a particular distance by using the formula:
    - Guide Number / Distance = (f/stop)
        - Distance = distance from photographer to object to be photographed
        - Ex. Flash of 120, 10 feet to object = 120/10 = 12: use f/stop of f/11
- When using flash, shutter speeds are not as variable as they are when non flash images are being exposed.
- Crime scene photographers should not use weaker flashes that require wide apertures. Those wider apertures will result in poorer depth of field.
- **Sync Speed:** The shutter speed to use whenever an electronic flash is also used; the shutter speed that has the shutter completely open when the flash fires.
    - Using a faster than sync shutter speed means the shutter will be closing when the flash unit fires. Due to this part of the shutter will be covering the film or digital sensor when the flash fires, and that part of the image will receive no light at all.
- Two negative effects of slow shutter speed:
    - Slower than 1/60th of a second, the image may appear blurred from camera movement.
    - If enough ambient light is in the scene and movement is present within the scene, you may capture a "ghost" in your image.
- With flash photography, shutter speeds no longer serve either purpose. Exposure is now a function of the intensity of the flash unit, with the shutter speed chosen only so the flash fires when the shutter is open. Motion control is now fully taken over by the flash unit's duration.
- Most cameras are designed to have "front-curtain" syncs. That means as soon as the camera's shutter has completely opened, the flash will fire. The shutter will then remain open until the full 1/125th of a second has elapsed, and then it will close. "Rear-curtain" sync cameras have the shutter open, some time passes, and then just before the shutter is ready to close, the flash fires.
- Unless the flash "knows" the ISO film speed being used, all images captured with the flash may be incorrectly exposed.
- **Manual Flash Mode**: In the manual flash mode, the full power of the flash is used each time the flash is fired. Because the flash is used to photograph objects at different distances, the usual way to alter exposures is to change f-stops.
- **Rule of Thumb 6.1:** Most flash units are not designed to be used at distances closer than 2 feet. When doing close-up photography, resist the urge to bend the elbow of the arm holding the flash unit. Try to keep this elbow straight so the flash does not get too close and overexpose the image.
- **Flash Calculator Dial**: In the manual flash mode, it suggests different f-stops at different distances from the flash.
- A fast shutter speed is not necessary to freeze motion when the flash is being used.
- Manual flash provides the right light for distance. It does not matter whether the subject is white, black or gray tones. Manual flash provides the right light for the distance.

- Flash units have been designed to work properly in the manual flash mode when it is used in a "normal" room.
    - "**Normal Room**": 10'x12' in dimension, it has white ceilings about 9'or 10' high, and it has light colored walls, rather than walls painted with any other color.
    - Most flash units are not designed to be used closer than about 2' to the subject matter.
- **Rule of Thumb 6.2:** Manual flash used outside is at least 1 stop less bright than what is suggested by the flash LED screen.
- **Rule of Thumb 6.3:** When you are 5' or closer to your intended subject matter, remove the flash from the camera's hot shoe, so it can more accurately be aimed at your intended target.
- **PC (Prontor and Compur) and Remote Flash Cord:** The PC cord is an electronic cord, frequently coiled, that allows a remote flash to remain electronically connected to a camera so that the flash will fire when the camera shutter button is depressed. Besides enabling the flash to sense when the shutter is tripped, the remote flash cord can also let the flash "know" what the ISO film setting is. It also signals the flash unit when the camera's zoom focal length has been changed, so the flash may also accommodate its flash throw for the new focal length selected.
- **Ring-Lites**: Enable the flash to be closer to the subject than the normal 2' distance recommended.
- The closer the flash is to the camera's lens, the higher the probability red eye will occur.
- When the flash is disconnected from the camera, it is essential to ensure the camera and flash orientation correspond. Otherwise, the light from the flash will not adequately light the scene and underexposed edges of the images will be noticed.
- When the flash head is elongated for a telephoto lens setting, the light of the flash is narrower than it would be at the normal setting, and because of this, the light travels farther than it would otherwise.
- **Rule of Thumb 6.4:** If the flash recycle time exceeds 30 seconds, it is time to replace the flash batteries. Major crime scenes are not the place for you to be waiting long periods of time for the flash to recycle.
- **Inverse Square Law**: States that as light spreads outward from a point of light source, its intensity varies inversely by the square of the distance it travels. Specifically, if the distance light travels are doubled, the intensity of the light at this new distance is quartered.
    - As the ***Distance*** light travels is doubled, its ***Intensity*** is quartered. The light at 2D covers four times the area as at 1D, therefore the light is ¼ as bright at any single point. To determine this, take the distance change, 2, and invert it (make it a fraction). 2 becomes ½. Square that (1/2 x ½), and the result is the ***Intensity*** of the light (1/4 I) at that new ***Distance*** (s2). The ***Intensity*** of light at any ***Distance*** change can be expressed by this equation: I = 1/D (2). (see page 238).



- $I = 1/D^2$ where I = Light Intensity D = Change in distance (as a multiplier)
  - Ex. At 10' the proper exposure is achieved at f/22. Distance is changed to 20'. D = 2 (twice the distance) $I = 1/2^2 = ¼$ Each ½ of light intensity is a -1 stop change, so it is a ½ * ½ = ¼ change resulting in a -2 stop change. This means use f/11 to achieve proper exposure.
  - The f/stop numbers are based on the inverse square law, because the number represents the distance (in feet) where light changes by +1 or -1 stop of light from a single light source
- Each "larger" number (further distance) represents ½ the light of the previous number, which is the same relationship the f-stop numbers have with each other. The inverse square law is the foundation for the derivation of the f-stop numbers.
- **Automatic flash exposure mode**: The sensor eye on the flash unit measures the amount of light reflected from the scene, and when it has determined that enough light has been reflected toward it for a proper exposure, this unit can actually cut short the flash duration to prevent overexposures.
  - Sensors can be fooled and shut off early
  - Sensors can be fooled and stay on too long/overexposure
  - Bracket your flash settings
- **Speed of Light**: Is frequently expressed as 300,000,000 meters per second, or as 186,000 miles per second.
- When the sensor receives 18% of the light that reflects from the surface of the scene, the sensor will shut off the flash.
- **Rule of Thumb 6.5:** When using flash, the world beyond 42' to 46' does not exist, because beyond that, the scene will either be underexposed or a wider aperture will have to be used, which results in a small depth of field range.
- The flash head sensor eye is designed to provide the proper exposure when it is relatively close to the film or digital sensor. If the flash is removed from the camera's hot shoe and used with a PC or remote shutter cord, it must still be aimed relatively directly toward the subject. The automatic flash sensor eye cannot provide good exposures when the flash is used obliquely to the subject.

- **Dedicated flash exposure mode**: The camera and the flash unit are designed to work together closely. Rather than relying on a sensor eye on the front of the flash unit, a dedicated flash's light output is controlled by the light meter in the camera body.
- **TTL: Through the Lens.** Deals with the flash. This represents a vast improvement in exposure determination because the light is metered inside the camera body, next to the film or digital sensor where it is critical, rather than at the automatic flash's sensor eye.
- **Built In Flash Units:** The biggest negative aspect of this is their low guide numbers. Many of them feature guide numbers around 35, indicating that at a 10' distance an aperture of f/3.5 would be appropriate. No depth of field with this. Light directed in a very direct line towards the subject. Produces harsh hot spots. Produces red eye.
- **Fill In Flash**: Parts of the scene will be lit with relatively strong ambient light, and an electronic flash unit will supplement that light to produce softer lighting in areas currently in the shadows produced by the stronger ambient lighting. The fill in light is intentionally set so that it is not as bright as the ambient light. The fill in light is set to be exactly 1 stop less bright than the ambient light.
- **Fill Flash Technique**:
    - Set the film for the proper ISO (100 if outside on a sunny day)
    - Set the f/stop for the sync shutter speed
    - Meter the well-lit area (a non-reflective surface) by filling the field of view with the well-lit area and manually set the camera for that f/stop
    - Set the camera/flash to manual mode and select the flash for proper fill flash
        - This should create a 1:2 ratio of fill flash to the natural bright light
        - If outside on a sunny day and attempting to photo evidence in the shade under a bench a -1 is necessary
        - Because you are outside the flash is already -1 at full power because there are no reflective walls
    - Aim the flash toward the shade if possible and take the photograph
- **Oblique Flash**: Electronic flash can be removed from the camera's hot shoe but still be attached with a PC or remote flash cord. It can then be held at the side of 3D evidence to produce shadows within the texture or pattern of the evidence. These shadows allow the details of the evidence to be seen rather than being washed out by direct flash.
- **Hard Shadows**: Shadows created by oblique flash. They are very dark, and details necessary for the identification of the impression may not be seen within them. Hide details.
- **Soft Shadow**: When a reflector is used with oblique flash, the light from the flash strikes the impression and continues past it until the light strikes the reflector. The light then bounces back toward the impression, lighting areas previously covered by "hard" shadows. The reflected light is not strong enough to wash out the shadows, but it is strong enough to light details within the shadow area. Shadows are called "soft" shadows when details within them can be seen. Reveals details.
- **Bite Marks**: When photographing bite marks take a photo of both bridges together and of each bridge individually. Scale. Photograph the upper and lower portion of the bite as if they are

separate pieces of evidence. Due to the surface they will be difficult to photograph otherwise, without having distortion.

- **Indented Writing**: Place the light source at the corner of the document and skim it horizontally across the document. This will give you better results and show more detail.
- **Bounce Flash**: Aim the flash up at the ceiling or wall and have the light bounce off that and back into the camera. Prevents hot spots, odd shadows from mirror reflections. Photographs will be underexposed when using this process.
- **Rule of Thumb 6.6:** When you are using bounce flash, if the subject of the photograph is 9' or farther from you, you may need to use an f/5.6 or a wider aperture, which will diminish the depth of field. Consider ways to get closer to the subject to avoid having to use wide apertures. Or, consider bumping up the ISO from 400 to 800.
- **Painting with Light**: Is the photographic technique to be used whenever a single flash would be inadequate for the size of a large dimly lit scene. The painting with light technique properly lights a large scene as if it were daylight.
    - Set up the photo so that the evidence is in a skinny, long line
    - Put the camera on a tripod at eye level and tilt it so that the bottom of the view is at 15'
    - Use ISO 400 or ISO 800
    - Determine the f/stop by measuring the distance across the camera's view at the furthest piece of evidence divided by two
    - Hyperfocal focus at this distance so the DOF is set to infinity
    - Use a 120 GN flash at full power
    - Mark the "safe spots" where you will walk outside the camera's view with the flash
    - Hold the flash above your head at arm's length with the flash tilted just shy of the middle of the scene
    - Open the shutter and walk around the scene on both sides, outside of the view of the photo and manually fire the flash so that the entire scene is lit (flash about every five paces), including a flash from the camera position
        - If two people are available for the photograph, have one person at the camera covering the lens with a piece of matte black cardboard and the other walking with the flash; every time the flash is to be fired remove the cardboard and quickly replace it
        - If a large obstruction (like a car) is present in the scene it may be necessary to make the flash operator "like a snowflake"
            - Have the flash operator walk through the scene holding the flash on the opposite side of their body, flash the car from about 15' with about ¼ flash power and continue walking (never stopping) through the other side of the scene; the camera will ignore the motion because they were not static long enough in the picture to be captured on film

Chapter 6 – Review Questions

Explain the meaning of flash guide numbers. How can it be determined which guide numbers of flashes are best suited for crime scene work? When electronic flash units are compared, it is common to inquire about a particular flash unit's guide number. The guide number is a mean to discuss a flash unit's relative output power. With shutter speeds, you have to make sure that the sync speed of the camera will not conflict with the flash. When you are using a flash, shutter speeds are not as variable as they are when non-flash images are being exposed. The guide number of the flash unit allows the f/stop to be determined for any particular flash unit, depending on the distance between the flash and the subject matter. The guide number divided by the distance between the flash and the subject matter equals the required f/stop for a proper exposure. The one best suited for crime scenes is a GN120. Guide Number 120. A flash unit with a GN of 56 puts out less light, so it requires a wider aperture at the same distance as higher GN. It therefore, goes without saying, that crime scene photographers should not use weaker flashes that require wider apertures. Those wider apertures will result in poorer depths of field. To determine your GN, make sure the flash is set for ISO 100. Notice which f/stop is recommended for a subject 10 feet away, multiply that f/stop by the number 10, and that is the guide number of your flash unit.

1. **Is there just one sync speed a camera can use with a particular flash unit? Although most cameras designate one shutter speed as that camera's sync speed, can "faster" or "slower" shutter speeds ever be used effectively at crime scenes**? The sync (short for synchronization) speed is the fastest shutter speed at which cameras should be set whenever an electronic flash is used. Each camera has one particular shutter speed that has been designated as its sync speed, which actually is a benefit to the photographer because it reduces the number of photographic variables that have to be considered and manipulated to ensure that a proper exposure has been correctly calculated when using flash. If no resource is available to determine the particular sync speed of your camera, you can presume that 1/60th of a second will work as the sync speed of your camera. Why? Because, even if another shutter speed has been designated as the particular sync speed for a camera, 1/60th of a second will also work. It is not slow enough to incur blur problems from hand holding the camera, and it is fast enough that ambient light present will not normally overexpose the image. The sync speed is the shutter speed that has the shutter completely open when the flash unit fires. Using a faster-than-sync shutter speed means the shutter will be closing when the flash unit fires. That means a part of the shutter will be covering the film or digital sensor when the flash fires, and that part of the image will receive no light at all.

2. **Discuss the nuances of the manual flash exposure mode, including the presupposition that the flash is used in a "normal" room and the flash is used as direct flash rather than bounce or oblique flash**. In the manual flash mode, the full power of the flash is used each time the flash is fired. When it is stated that the full power of the manual flash goes off each time the flash unit is fired, this usually means that the flash fires at its normal duration. The intensity of a flash is related to the duration of the flash. Reducing the intensity of a flash is the same as reducing its duration. Faster flash is dimmer flash. Because the flash is used to photograph objects at different distances, the usual way to alter exposures is to change the f/stop. In the manual flash mode, the flash unit's sensor eye is actually disabled, or covered, so it cannot "sense" reflected light. Recall that we

previously stated that the flash now controls motion, whereas with non-flash photography the shutter speed controlled motion. At 1/1000thof a second, or faster, the flash can, indeed, stop most motion. A faster shutter speed is not necessary to freeze motion when the flash is being used. The manual flash exposure recommendations also presume the flash is aimed directly at the subject or object to be photographed. When it is taken off and flash cord is used the manual flash cannot account for this. Manual flash presumes you are also using it in a "normal" room where there will be additional light bounced off of the white ceiling and walls, adding more light into the camera sensors. Manual flash used outside is at least 1 stop less bright than what is suggested by the calculator dial/LED panel.

3. **Indicate one circumstance when it would be better to choose the manual flash mode over either the automatic or dedicated flash mode. Why**? Camera meters and flash sensors can often be fooled by the reflectivity of certain subjects. If this can be anticipated, just switch to the manual flash mode and the problem has been solved. Manual flash provides the right light for the distance. It does not matter whether the subject matter is white, black or gray toned. Manual flash mode would be the best choice to use then when photographing any surface that is reflective.

4. **Indicate one circumstance when it would be better to choose the automatic flash mode over either the manual or dedicated flash mode. Why**?
   An automatic unit can determine that enough light has been reflected toward it and cut short the flash duration to prevent overexposures. The automatic flash mode should be used as the primary flash mode most of the time; however they may be fooled by the reflectivity of very light toned surfaces and very dark toned surfaces. It conserves the battery power by shutting the flash off when the sensors reach the 18% of the light reflecting from the scene. Recharging time is shorter because of this. The automatic flash mode also uses flash ranges rather than just 1 f/stop for every different distance.

5. **Indicate one circumstance when it would be better to choose the dedicated flash (flash mounted on the shoe that is removable) mode over either the manual or automatic flash mode. Why**? With a dedicated flash unit, the camera and the flash unit are designed to work together closely. Rather than relying on a sensor eye on the front of the flash unit, a dedicated flash's light output is controlled by the light meter in the camera body. This mode represents a vast improvement in exposure determination because the light is metered inside the camera body, next to the film or digital sensor where it is critical, rather than at the automatic flash's sensor eye. Many flash photographs are taken with the flash unit removed from the camera body, further distancing the auto flash sensor eye from the film or digital sensor area. In these instances, a dedicated flash unit will always provide more accurate exposures than automatic flash units. The dedicated flash mode is not adversely affected if it is used obliquely to the subject.

6. **In what circumstances does fill-in flash result in distinct benefits to exposure**? With the concept of exposure latitude and dynamic range, sensors cannot record fine detail in both deep shadow areas and well-lit areas. In these situations, you can use the ambient lighting to properly expose those areas that are brightly lit and use the electronic flash to properly expose those areas that are dimly lit. The trick is to determine the proper balance between the two, so the scene does not look as if it

were lit by two suns, or two flash units lighting the scene from different directions. In the fill-in-flash situation, the flash is delegated to being just a supplement to the bright ambient light at the scene. It is normally recommended to balance the two light sources so that the light coming from the flash unit is 1 stop less bright than the bright ambient light in the scene. Fill-in-flash ensures that both parts of the scene are properly exposed, both the area that had been sunlit and the area that was backlit. Whenever lighting conditions include bright sunlit areas and dark shadows, the use of the fill in flash should be considered. If the sun is producing noticeable shadows, the use of fill in flash will benefit most photographs.

7. **Explain all the concerns related to tire track photography**. Side lighting, or oblique lighting, provides the shadow necessary to better visualize 3D aspects of evidence. If you have ambient light of a flash aimed directly down onto the impressions valuable detail is lost or filled in by the light. With oblique lighting you will also have issues. You have the potential of having shadows produced onto the impressions, covering details. To prevent this issue from happening you need to have light reflected back onto the impression after it has reached to opposite side of the light. This is done by placing I bright white board opposite your flash. This helps soften the hard shadows that hide detail. The reflected light is not strong enough to wash out the shadows, but it is strong enough to light details within the shadow area. Mount the camera on a tripod. Shoot between each leg. For each location take and bracket one above and below the main photograph to ensure that the photographs are not over/under exposed. Set the f/stop to f/11 to prevent any distortion, and have the ISO set at 100. If the impressions is in the sun, block all light hitting the impression and then use the detached flash to create the ambient light. Make sure that you situate the flash at least six feet from the impression to make sure that the light disperses evenly across the impression. This helps prevent hot spots on one end and darker on the other end of the impression.

8. **Bounce flash produces dim light on the subject. Explain why this is so and the method to determine a proper exposure when using bounce flash**. If you need to light a crime scene with a flash bounced off the ceiling, the light must travel further than normal. It must travel from the flash head to the ceiling and then reflect down onto the surface of the scene of interest. The inverse square law teaches that when light goes further to get to its destination, it is dimmer when it gets there, which is unfortunately, just one cause of the dimness of bounce flash. Direct flash is very effective at lighting its subject matter. The light proceeds directly from the flash head to the subject matter. When the flash is aimed at the ceiling and bounces from it downward toward the scene of interest, it is diffused wider than the direct flash of light. Some of this light striking the ceiling bounces away from the intended target. Some of the light is lost to the surroundings that may be outside the area of the particular image that has been composed in the viewfinder. Because this light misses the subject altogether, the light that does fall on the subject is dimmer still. Many ceilings are not just solid surfaces painted white. Many ceilings, particularly in offices, are made with acoustical tiles. Being porous so they will absorb sound, they can also absorb light. Some of the light striking acoustical tiles will be absorbed and never reflected from the ceiling. This also diminishes the light eventually reaching the subject matter. Bounce flash is dim light. To fix the under-exposure it will be necessary to open the aperture to let in more light. To use a wider aperture, you must first establish what the “starting” aperture is. Because it is necessary to know the distance the light will have to travel, the first step is to calculate the flash-to-bounce surface-to-

subject distance. You can also take the flash off the camera and hold it close to the ceiling. This can help minimize the distance the light has to travel. When using bounce flash, if the subject is 9' or farther from you, you may need to use an f/5.6 or a wider aperture, which will only diminish the DOF. Consider ways to get closer to the subject to avoid having to use wide apertures. Or consider bumping up the ISO from 400 to 800.

Explain the differences between the PWL technique from one side and the PWL technique from two sides. Painting with light (PWL) is the photographic technique to be used whenever a single flash would be inadequate for the size of a large dimly lit scene. PWL from one side. Sometimes it is impossible to flash into the scene from two sides. A riverbank or cliff may be on one of the sides of the scene. All flashes will come from one side of the scene. PWL from two sides. Light is shot in from both sides of the scene not just one.

Chapter 7: Ultraviolet, Infrared, and Fluorescence

- **Electromagnetic Spectrum**: This spectrum depicts light as a wave of radiation, which has both a peak height (amplitude) and a distance between peaks (wavelength).
- **Visible Light**: This range on the electromagnetic spectrum between 400 and 700nm. A nm is one billionth of a meter.
- **Ultraviolet Light**: The region on the electromagnetic spectrum between 100 and 400 nm. It is also sometimes divided into long, medium, and short-wave ultraviolet light (UV). At times, it is thought of as:
    - UVA: (315-400 nm)
    - UVB: (280-315 nm)
    - UVC: (<280 nm)
- **Infrared Light**: The photographic area of the infrared (IR) range is in the near IR part of the electromagnetic spectrum, 700 to 1100nm.
- Light, as a region of waves on the electromagnetic spectrum, reacts differently when it strikes different surfaces.
- **Four (4) main reaction of light with the different substrates it strikes are**:
    - Reflection
    - Absorption
    - Transmission
    - Conversion of light from one state to another, usually regarded as luminescence.
- White light is the combination of various colors. Most are aware of the ability of a prism to "split" white light up into its component colors, the rainbow.
- When all the light is being reflected, the result is an impression that the surface itself is white.
- Technically speaking, the paper itself is not white; because it reflects all the light that strikes it, the brain "assigns" the color white to it.
- When no colors are reflected by a surface, the brain interprets this surface as being black. Technically speaking this surface, itself is not black; because it absorbs all the light that strikes it, the brain "assigns" the color black to it. Actually, black is the absence of color. It is really not a color at all.
- Most surfaces partially absorb some parts of white light, and partially reflect some parts of white light. The results are surfaces that appear to be colored or manifesting varying shades of gray.
- Some materials, certainly not all, will convert the light. Some materials will absorb the light that strikes them and convert that light into a light of longer wavelength and lower intensity, which is normally understood as fluorescence.
- **Fluorescence**: A stimulating light, usually from a laser or alternating light source, is directed onto a surface. Molecules in the surface will become excited, and some of their elections will rise to a higher electronic state. As they return to their previous state, energy is emitted. The light subsequently emitted has a lower intensity than the original stimulating light. Light of a different wavelength and frequency also has a different color.

- The light subsequently emitted has a longer wavelength and lower intensity than the original stimulating light. Light of a longer wavelength and lower intensity also has a different color.
- It is known that the fluorescence created by an argon ion laser emitting what is perceived to be a light blue light. To photograph this light, you need an orange filter.
- To photograph this fluorescence, aperture priority exposure mode can be used with an f-11 with the camera loaded with 400 ISO film.
- **Luminescence:** Means a molecule's ability to emit light from causes other than heat, the luminescence and phosphorescence are both types of luminescence.
- **Incandescence**: Is an example of fluorescence cause by heat.
- **Luminescence and phosphorescence are both types of luminescence**. What differentiates them?
    - Fluorescent materials emit a "glowing" light only while they are currently being stimulated by a stronger, higher intensity light. Turn off the stimulating light and the fluorescence also immediately ends.
    - Phosphorescence is the ability of some materials to retain some of the radiation they have absorbed after the stimulating light has ceased. This energy can then be released over long durations: "glow in the dark" toys are an example.
- **Rule of Thumb 7.1:** When searching a crime scene with a forensic light source, or ALS emitting a UV light, use a UV filter or a yellow filter to see and photograph the fluorescence generated.
- **Rule of Thumb 7.2:** When searching a crime scene with a forensic light source, laser, or ALS emitting a blue light, use an orange filter to see and photograph the fluorescence generated.
- **Rule of Thumb 7.3:** When searching a crime scene with a forensic light source, laser, or ALS emitting a green light, use a red filter to see and photograph the fluorescence generated.
- **Ultraviolet Light (UV)**
    - 315-400nm = long wave UV aka "Black Light"
    - 280-315nm = medium wave UV
    - 200-280nm = short wave UV
- A long wave UV light is normally a light emitting approximately 365nm.
- **RUVIS (Reflected Ultra-Violet Imaging System):** Equipment using high intensity short wave UV to visualize untreated latent fingerprints. Should not be used at a crime scene until all samples of body fluids have been collected as DNA exposure to short wave UV can preclude the eventual successful typing of DNA.
- A camera's focusing system is designed for visible light, not infrared light. Attempting to capture detail in the ultraviolet will also require a focus adjustment. The focusing adjustment for ultraviolet photography, however, is the opposite required for infrared photography. Most traditional lens glass elements block UV below 35 nm.
- **Reflected Ultraviolet Photography**: Involves capturing images with only long wave UV light being allowed to strike the film or digital sensor, which is easier said than done. Reflected UV is perhaps one of the most difficult types of photography. Reasons:
    - A UV sensitive camera sensor is required
    - Necessary to have a lens that transmits UV light

  - It is necessary to block all visible light from entering the lens by using an **18A filter (will transmit some IR light through the filter though).**
  - Requires the UV focus adjustment
  - A long wave UV light source is required.
- **Two main applications for Reflective UV Photography**:
  - Questioned Documents to differentiate between inks
  - Deep muscle bruising that has healed and no longer visible with room lights. Melanin will absorb UV light.
- The foundation for the use of reflective ultraviolet photography in circumstances of deep muscle bruising is based on the migration of melanin to the wound's perimeters beneath the skin during the healing process.
- Optimal time for visualization of deep muscle bruising with reflective UV photography is between 3 weeks and 5 months. Before that, visible light photograph and IR photography should be attempted.
- To view and photograph the fluorescence caused by the UV light, a UV absorbing filter (**UV, 1A, 2A or 2B Filter**) can be used. It would be possible to see and photograph also with a **YELLOW FILTER**.
- Photographing fluorescence in the visible light range can be done with 100 ISO, f-11, aperture priority exposure mode with an exposure compensation set to -2.
- Photographic infrared Range: The range on the electromagnetic spectrum between approximately 700-1100nm.
- Necessary to have camera sensor that is sensitive to IR light.
- **Wrattan #87 Filter**: An Infrared Filter used to block all visible light while transmitting IR light.
- Types of evidence IR can reveal at a crime scene:
  - Ink differentiations
  - Gunshot residue
  - Writing on burned documents
- **What are the effects of IR light on different substrates**?
  - Absorb it.
  - Reflect it
  - Transmit it (making it appear to disappear, revealing whatever is beneath it)
  - Convert it (turning it into heat – fluorescence)
- **Rule of Thumb 7.04:** When photographing fluorescent evidence, the proper exposure is frequently 2 stops less than what the camera's exposure meter recommends. At a -2 exposure compensation, it would then be best to bracket. The camera's exposure meter is designed to provide proper exposures for "normal" scenes, reflecting 18% of the light that strikes them. The fluorescent situation is far from "normal."
- Visualize body fluids using a blue ALS and an **ORANGE Filter.** Can be used to visualize bone.
- Blood absorbs UV light and gets darker. When chemically treated, blood can also fluoresce. Luminol reacts with the heme in the hemoglobin. It is a Chemiluminescence reaction.
- If the surface is both non-porous and vertical, the blood pattern will run. Three solutions have been offered to counter this problem:

- Shorten the shutter speed, to reduce the volume of liquid used.
- Thicken the luminal reagent
- Fix/Stabilize the blood stain

Chapter 7 – Review Questions

1. **Explain the relative location on the electromagnetic spectrum of UV light, visible light and IR light**. Visible light is generally regarded to be the range on the electromagnetic spectrum between 400 and 700 nm. Immediately below the 400 nm range is the region of ultra violet light, which is 100 to 400 nm. Immediately above the 700 nm range is the region of infrared light, with the region of infrared applicable to photography being approximately 700 to 1100 nm.

2. **How is fluorescence related to the Stokes shift**? Some materials react to light quite differently. Some materials, certainly not all, will convert the light. First pointed out by Irish physicist, George G. Stokes in 1852, some materials will absorb the light that strikes them and convert that light into a light of longer wavelength and lower intensity, which is normally understood as fluorescence. Molecules in the surface will become excited, and some of their electrons will rise to a higher electronic state. As they return to their previous state, energy is emitted. The fluorescence stimulated by the laser is weaker in intensity than the original laser light. The stronger light of the laser overwhelms the fluorescence it creates. To see and photograph the fluorescent urine stains, you need to eliminate the laser light without turning it off, which is done with a filter.

3. **Light can behave differently when striking various surfaces and substrates. What are these different effects**? White light is the combination of various colors. When all the light is being reflected, the result is an impression that the surface itself is white. When no colors are reflected by a surface, the brain interprets this surface as being black. (Actually black is the absence of color. It is really not a color at all). Being gray is a result of a surface partially reflecting white light and partially absorbing white light. The main reactions of light with the different substrates it strikes are:
    a. Reflection
    b. Absorption
    c. Transmission (water/glass etc.)
    d. Conversion (fluorescence)

4. **What are some positive and negative aspects of using UV light at crime scenes to locate and visualize evidence**?
    a. Short wave UV light did not have a use at crime scenes until the advent of the Reflected Ultra-Violet Imaging System (RUVIS). This equipment uses high-intensity short wave UV light to visualize untreated latent fingerprints. Short wave UV light will damage DNA evidence, however, so all samples should be collected prior to use.
    b. Reflective Ultraviolet Photography: used for questioned documents and deep muscle bruising. Difficult to photograph due to the cameras and lenses not being able to block all of the UV/IR light etc. out of the photographs. Film cameras work the best with the 18A filter applied. All others will have slight issues unless a very expensive lens is purchased for the camera.

c. Determining the camera settings for reflective UV photography is difficult. The biggest problem is that camera meters are not designed to provide proper exposures for UV lighting. Because different subject matters may react differently to UV light, no standard exposure combination can be recommended.
d. Absorbed UV light in the visible light range: Blood on multicolored substrates can also be hidden. In these cases, the use of a long wave UV to search for and find "invisible" bloody residues can have remarkable effects. The blood absorbs the UV light and appears to get darker, so it can easily be seen.
e. Ultraviolet Fluorescence Photography: UV light can also stimulate fluorescence in the visible light range, which is one example of the Stokes shift. To view and photograph the fluorescence caused by the UV light, you can use a UV absorbing filter (camera filters called UV, 1A, 2A, or 2B). It would also be possible to see and photograph the fluorescence through a yellow filter.

5. **Discuss some of the advantages of having IR imaging capabilities at major crime scenes**. The Photographic infrared range is in the near IR part of the electromagnetic spectrum, 700 to 1100 nm. The human eye and normal daylight films cannot sense infrared light. You will have to have a special camera for this type of photography, or have a SLR camera adapted for IR photography. None of the focusing issues that UV light photography had is eliminated. The normal IR filter, which is a Wrattan #87 filter is used to block all visible light while transmitting IR light through it. Therefore, to the eye, it appears opaque. The types of evidence that IR can reveal fall into three categories:
    a. **Ink differentiations:** blue/green light used. Ink will fluorescence (conversion), absorb, transmit or reflect the light.
    b. **Visualizing gunshot residue:** the GSR will absorb IR light so it will remain dark or turn darker than it originally was.
    c. **Visualizing the writing on burned documents:** Some paper may just darken and turn black instead of disintegrating when burned. If this happens, it is similar to the GSR on black fabric. The charred paper my reflect IR light and lighten or turn white. The ink may absorb the IR light so it is visualized.

6. **Discuss some of the types of evidence that can be visualized with the use of alternate light sources**. Body fluids, blood, GSR, fibers, drug residue, handwriting, inks, bones, etc.

7. **Using alternate light sources, UV light and IR light at crime scene also requires using the appropriate filters or goggles. Which filters or goggles are required for these different light sources**?

    a. Yellow: When searching a crime scene with a forensic light source or an ALS emitting a UV light, use a UV filter or a yellow filter to see and photograph the fluorescence generated.
    b. Orange: If a blue light (which can be emitted by a laser, forensic light source or an ALS is used to stimulate fluorescence, the stronger blue light can be absorbed by using an orange filter. Used mainly for visualizing nonblood body fluids.
    c. Red: If a green light is used to stimulate fluorescence, the stronger green light can be absorbed by use of a red filter.

Chapter 8: Photogrammetry

- Three aspects of Crime Scene Investigation/Documenting – These three items complement each other, with all three, every aspect of the crime scene has been fully documented.
    - Photograph the scene
    - Crime scene and evidence within it need to be measured, sketched, and diagramed
    - Meticulous notes are needed to be written
- **Photogrammetry** – a method where measurements can be developed just as accurate as those derived by the use of traditional measurements of a crime scene with a tape measure. However, this method, while it could replace the traditional measurement method is still considered a supplement to the traditional baseline coordination and triangulation measurement techniques.
- **Photogrammetry** – refers to the activities of:
    - Photographing an object
    - Measuring the image of the object on the processed photograph
    - Reducing the measurements to some form such as a topographic map or a scaled crime scene diagram
- **Photogrammetry** is the science or art of obtaining reliable measurements by means of photographs. By this, photographs can be used to make up for a lack of suitable measurements, to supplement inadequate measurements, and, in some cases, to substitute for measurements.
- If a department does not have the access to laser sighting devices, Photogrammetry can fill a very big void between laser system and hand drawn crime scene diagrams
- **Rule of Thumb 8.1:** When the perspective grid is photographed at the crime scene, it is composed so that it is low and centered in a photograph, with evidence beyond it and to the left and right of the grid.
- The Perspective Grid when using photogrammetry is considered the scale for an overall photograph. Instead of giving the view an impression of the layout of the entire scene, another photograph can be taken from the same position, but this time a perspective grid can be included in the scene.
- All evidence within the perspective grid can be link to the grid in extremely accurate manner
- Commonly 1-foot by 1-foot grids are done, or better putting four 1'x1' square floor tiles together to make a 2'x2' perspective grid. However, any known rectangle can be used, and this can include your clipboard.
- Advantage of floor tiles is that they lay flat, moisture does not hurt them, and stay in place in high winds

Grid Extension - The Process – Step by Step

- Place the grid in the scene whereas many items of evidence as possible can be composed in a single photograph with the grid.
- If you cannot get all items of evidence in a single photo it is possible to reposition the gird so that the remaining items of evidence can be linked to the grid in a second or third photograph.

- Using the grid system, it is easy to see the center of an edge of the evidence closest to the viewer of the photograph. Select the center of one edge of the evidence where it comes into contact with the surface it is on and place a dot there. That dot will now represent the evidence
- Just remember using Photogrammetry measurement system the dots used to measure/scale the evidence in the photograph represent one side of the evidence, NOT the center of the mass (as traditional measurement systems using go by)
- Once the items of evidence are marked with a dot – one can then extend the perspective grid system over all the evidence in the scene. This will be done by putting a checkboard of known dimensions over the scene to make it easy to determine the location of the evidence.
- When extending the four sides of the originally 2'x2' grid it is very important to use care when doing so, because any inaccuracies in extending the grid sides will result in progressive inaccuracies in the eventual measurements that are determined.
- Remember to extend the grid from the outside edge of the square not the inside edge – if a black line is used to mark the edges.
- Where the left and right sides of the grid meet can be labeled the **Y-intersection point** – this is also called the "**Vanishing Point**"
- The Lines extending the top and bottom of the original grid can now be referred to as **Horizontal Parallel Lines.**
- The Lines extending the left and right sides of the original grid can now be referred to as **Vertical Parallel Lines.**
- The line that is extension of the base of the original grid can now be considered the **X-Line of the (x, y) coordinate system.**
- Measure the distance of the base of the original 2'x2' and be as accurate as possible.
- After you have this measurement – repeat this spacing on the bottom of the baseline horizontally across the entire scene. Place a "hash mark" on the baseline at these locations.
- At the hash marks (starting point for the line) use a straight edge to connect to the Y-intersection point.
- If any evidence lays outside of the final lines drawn – you will need to extend the process until they are within the boundaries of the process.
- On the originally 2'x2' grid used in the photo, extend the diagonal lines that connect the corners until they reach the sides of the outmost line of the "teepee" you created when drawing the lines from the baseline hashmarks to the Y-intersection point.
- NOTE: Where these diagonal lines intersect the vertical parallel lines coming from the **first** two hash marks on the baseline from the original grid. These two points are now the "connecting hashmarks" for the next Horizontal line to draw. *(once drawn you should have three horizonal lines – the bottom of the originally 2'x2', the top of the originally 2'x2' and now the new line just drawn).*
- Where the second set of diagonals intersect with the vertical parallel lines is the **second** set of hash marks. Connecting these two will be your next horizonal line.
- By doing this you will now have another 2'x2' square above the original one you can use to repeat the process to extend the grid up higher if needed.

Grid Reduction

- Once every item is inside the grid, it is now necessary to reduce the size of EACH grid to more accurately determine the exact location of the dot representing each item of evidence.
- Cross the corners of every 2'x2' square that has an item of evidence within it. (Note: these lines do not need to extend outside the 2'x2' square.
- Cross the corners of an adjacent 2'x2' square that has evidence within it, then pick another to the left or right (if evidence is in it) and repeat the process.
- Each 2'x2' square with evidence in it cannot be bisected, both vertically and horizontally. To do this vertically, align the X formed by crossing the corners with the 2'x2' with the Y-intersecting point.
- Only draw a line in the squares that bisects a 2'x2' square.
-
-
- STILL NEED TO FINISH THIS PART
-
-
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Perspective Disc Photogrammetry – is an alternative method that can be used instead of the Perspective Grid Technique. It is believed to result in more accurate measurement determinations because the horizon line is more precisely located during the process. While often real, the differences are too small to make an effective difference in crime scene diagrams

- Three circular discs are used instead of the square or rectangular grid.
- Each disk can be any diameter as long as all three are the same.
- One disk is arranged low and centered in the composition, just as the perspective grid was
- One disk is put somewhere on the right side of the composed image
- One disk is placed on the left side of the composed image
- Next step is to draw tangential lines from the lower grid to both the other two discs. Draw lines from the right side of the lower disc past the right side of each other disc.
- Draw lines from the left side of the lower disc past the left side of the other disc.
- Both pairs of vertical lines will eventually intersect.
- A Line can connect these two intersecting points, which is equivalent to the horizon at the scene.
- This is the foundation claim to being more accurate than the Perspective Disk Method. With the perspective grid technique, the horizon was determined by extending the left and right sides of the perspective grid. The Y-intersecting point was a point on the horizon line. Some claim that amore precise way to determine the horizon is to use three discs rather than one square or rectangle.

Natural Grid Photogrammetry – Sometimes, natural features within a crime scene will make the addition of perspective grids or perspective discs unnecessary to apply photogrammetry techniques due to the natural pattern given. (i.e.: squares inside cement walkway).

Reverse Projection Photogrammetry – A method used when no grid or three discs were positioned in the photograph. The viewer finds a known item within the crime scene photo and "works backwards" from the fixed feature to create the measurements.

Rhino Photogrammetry – A software that allows you to create 3D objects and view them from any perspective. It has a grid system for determining the size and proportions of any object created. This grid system will be utilized and eventually superimposed over the crime scene images.

Chapter 8 Review Questions

Chapter 9: Special Photography Situations

(NOTE: In this Chapter the "Rules of Thumbs" are out of order. This is most likely due to not adjusting the material from the 2nd version to 3rd. However, for the purpose of this document, they are listed in the correct sections and numbered as seen in Edition 3 of the book)

Subchapter 9.1 – Aerial and Elevated View Photography

- Aerial photography should be done between 10 am and 2 pm.
  RULE OF THUMB 9.7: The shutter speed for aerial photography should be at least 1/500 second, if not 1/1000 second.
- **Aerial Photography Concerns**:
  - Motion Control
  - Focus
  - Lenses
  - Filters
  - Composition
  - ISO
  - Exposure
  - Safety
- **Motion:** Eliminate blur. Motion of objects on ground, aircraft, camera. The shutter speed for aerial photograph should be at least 1/500th second if not 1/1000th of a second.
- **Focus:** Focus on infinity. The depth of field requirement is small at aerial heights, usually a minimum of 500'
- **Filters:** As the distance between the camera and the subject being photographed lengthens, the contaminants in the air can begin to degrade the resultant image. When doing aerial photography this matters. Low-level aerial photography, below 5000' usually does not require the use of filters. Use a true haze filter. Simple ultraviolet filters are not effective for aerial photography. Yellow, orange and red filters are known to be able to effectively cut through haze when black and white film is used. They also filter some of the light coming through them. If you use them use an ISO of 200 or 400.

Subchapter 9.2 – Autopsy Photography

- Two unique aspects of autopsy photography that distinguish it from other forms of evidence documentation.
  - As in other fields of forensics, serves as documentation of physical evidence. However, the body is likely never to be available for examination again after final disposition.
  - Autopsy photographs become the physical evidence, they must be true and accurate, scaled substitutes for the body, not just documentation of evidence.
  - Photographs should have more humanity to them, therefore greater impact on family, juries, media and general public.

  - Include both internal and external surfaces
- An Autopsy is indeed a medical procedure performed by a physician upon a patient to determine the cause and manner of death.
- Manipulation of the body in death, as in life, must occur in order for the physician to fully examine and diagnose the patient.
- An Autopsy begins with the inspection of the external surfaces of the entire body in an organized fashion.
- The procedure then turns to the inside of the body by reflection of the skin of the chest and abdomen to reveal the ribs of the chest, and the organs of the abdomen.
- The examination of the head/scalp is followed by the removal of the cranium, and then the brain.
- The sensitive structures of the neck are often the last to be examined.
- The Autopsy is an invasive medical procedure and photography is necessary to capture the graphic detail of the procedure. However, the images themselves should be treated with the consideration given to other physical evidence.
- One of the main functions of the autopsy photograph is to provide visual identification of the decedent.
- At least one photo of the face should be taken and should be done with a clean face, recognizable, and presentable to the family or jury.
- Each photograph should include a unique identifying number assigned to that case.
- If face is not a reliable means of identification, photographs of scars, tattoos, and birthmarks should be documented. However, the face should still be photographed.
- Surgical implants should be photographed outside the body if removed, with the exception includes plates in the skull or artificial hip joints that are difficult to remove.
- Capture an impression of the decedent's fingerprints
- Both outside and inside should be photographed.
- Should have plenty of light as well as correctly white balanced – if not correct your WB inside the camera
- L-Shaped scaled provided by the American Board of Forensic Odontology (ABFO No. 2) should be used when capturing detailed images
- **Overall Images** should be captured of the sealed body bag before it is opened, as well as the overall state of the body when first documented by the Medical Examiner.
- Clothing and personal items should be removed, and body photographed once again
- Use ladders or stools when needed for overhead photography
- **Close-Up Photographs** demonstrate anatomic relationships of the body, the close-up photograph serves to record specific details without the distraction of other anatomic findings.
- No specific criteria defining close range, but generally speaking the range should be such that the pertinent findings and associated detailed are centered in the frame of the photograph.
- Pitfall of Close Up photographs is that the spatial orientation is lost by virtue of excluding unrelated anatomy.

- **Intermediate Photographs** All injuries should be photographed at this range which includes an anatomic landmark (belly button, ear, kneed cap, finger) in addition to the scale and unique identifying number.
- **Intermediate Photographs** captures the relationship of injuries to one another.
- When photographing internal organs, the background upon which the organ is placed is easily controlled by the photographer.
- Use of an ABFO scale may be helpful if an injury is to be documented of a curved surface like the confined spaces of an internal abdominal cavity.
- Use of water can assist in keeping fragile specimens from collapsing. Try and capture both in and out of water if needed.
- 2 elements are necessary for a witness to authenticate autopsy photographs
  1) the identification of the photograph
  2) that the image accurately represents what it is claimed to show.
- Readjust the body if the wound is in a moveable limb to see if it matches the injuries better (ie: Arm shot through and through into the chest area)
- When capturing knife wounds push the skin back together as naturally the skin will be wider than the actual blade of the knife. Then capture the wound again.
- Use a macro lens when capturing postmortem interval determination via the adjust stage of insects.

Subchapter 9.3 – Bloodstain Pattern Analysis and Photography

- **Roadmapping** is an efficient way to manage and photograph multiple bloodstain patterns on one or multiple surfaces.
- The roadmapping methods requires that every photograph have a label and scale to provide reference to the location of each photograph with respect to the scene and other patterns and stains.
- Before photo documentation with roadmapping technique can proceed, the crime scene specialist must prepare the bloodstained surface through the use of scales, labels, and other aids to visually assist with orientation, movement of the bloodstain patterns, or even the area where a DNA sample was collected.
- **Wolson in 1994 coined the term roadmapping** as a method to document multiple bloodstain patterns and stains at the crime scene. The following is a list for photo documentation through the use of roadmapping technique:
  1) Identify distinct bloodstain patterns
  2) Photograph the overall surface or surfaces containing the patterns and stains in situ before labels or scales are introduced.
  3) Photograph each distinct pattern in situ without labels or scales.
  4) Outline the perimeter of the area containing all the patterns and stains with large vertical and horizontal scales.
  5) Place sequentially numbers labels and scales adjacent to each individual pattern or stain.
  6) Add guides to assist the viewer (eg, arrows)

7) Photograph the overall surface or surfaces containing the patterns and stains with the labels, scales, and guides in place.
8) Photograph each individual pattern or stain with labels, scales, and guides in place.
9) Take close-up photographs of important pattern details or individual spatter stains used for analysis.
10) If necessary, create co9nvergence lines for impact patterns and photograph the convergence.
11) If necessary, create an area of origin with strings and photograph from various angels (assuming forensic blood stain pattern software is not used).

- Keep the film plane (digital sensor) parallel with the surface containing the patterns.
- Mounting the camera on a tripod provides stability when composing, is useful for proper exposure in low light, and provides a means of attaining an improved depth of field.
- 50mm lens is preferred for overall photographs and a macro lens is preferred for close-up.
- Do not use a natural perspective when capturing blood patterns as capturing them at the photographer's eye level can cause distortion.
- Raise or lowering the camera height to near the center of the area bordered by the vertical and horizontal scales can assist with keeping the scales looking proper.
- Center the lens when photographing individual stains.
- At least one scale and label corresponding to the pattern being documented.
- Guides of various types can be placed on the surface to assist the viewer (eg: up or down or north)
- After all labels, scales, guides are placed, overall photography of the entire surface containing the patterns and stains can begin.
- To photograph individual spatter stains of an impact pattern, the film plane MUST be parallel, and an attempt must be made to fill the frame with the stain and the scale with the lens used.
- On curved surfaces a tripod is the preferred, using a prefocusing technique.
- After choosing and documenting spatter stains from an impact pattern, convergence lines can be created by drawing on the surface or by using art tape.
- Different colored art tape can be used to differentiate various impact patterns.
- Next is to complete an area of origin reconstruction, if warranted
- It is important to use the "sweet spot" when photographing individual stains, patterns, or details. This is usually around f/11 which minimizes lens aberrations and diffraction.
- Should be captured in a lossless image file format such as RAW or TIF
- If DNA swab samples are collected, photographs documenting the pattern as well as the location where the sample was collected. These photographs can be taken after the sample is collected.
- Roadmapping can be used to document bloodstain patterns and stains on clothing
- **Grid Method** – breaking up each area of larger spatter patterns into equally sized smaller areas for more detailed examination.
- Prior to establishing the grid, photographs of the area should be taken of all the individual patterns or stains.
- The grid is added after the photographs are finished
- Each grid is photographed individually before any labels, scales or guides are put in place.

- Since direct flash can cause blood to reflect light or "flash burn" overexpose, it can fool the camera's internal light meter, resulting in an underexposed image overall. Due to this the flash should be placed off camera using a PC Sync Cord or Wireless Option.
- **Chemiluminescene** – The reaction caused when Luminol and other chemicals reagents are used to search for and locate latent blood.
- Follow the below steps and settings when photographing a light reaction to blood with a chemical reagent like luminol.
- 1) After locating chemiluminescence and collecting samples for DNA, place the camera on a tripod close to the chemical light reaction.
  2) Set the ISO to 800
  3) Set the aperture between f/5.6 and f/11
  4) Set the shutter speed between 15 and 45 seconds depending on the aperture setting
  5) Use manual focus
  6) Turn off the flash
  7) Darken the room
  8) Apply the chemical reagent
  9) Depress the shutter button with a shutter-release cable or similar control
  10) Examine the picture on the viewfinder
  11) Without moving the camera or changing the lens settings, take another picture with a flash
  12) Merge both photographs into a single image

Subchapter 9.4 – Drones

- Drones extend the reach of the photographer, expanding the range and detail of crime and accident scene photography.
- Remote photography uses the same functionality as traditional photography but managed through remotely located monitors and controls
  - Camera positioning
  - Settings
  - Photos
- What Does Change:
  - Require a new skill set – Operators need training in navigation, repair and maintenance, and frequent, ongoing practice. Normally, a second person is needed, as it is difficult to photograph and operate the system simultaneously.
  - Drones are new equipment. Selection and deployment of systems is time consuming
  - Drones are regulated by unfamiliar agencies, one we must adhere to privacy and search laws, and require certification.
- Unmanned systems add value by their ability to access points of interest in virtually any environment with imaging equipment.
- Access:
- Perspective

- Preservation
- Safety
- Collaboration
- Productivity
- Cost Efficiency

Subchapter 9.5 – Photographic Documentation of Shooting Incidents

- Once fired a bullet may strike, ricochet or deflect from, perforate, or penetrate a variety of surfaces and object. Therefore, proper documentation and processing of shooting scenes is critical to the reconstruction of shooting incidents.
- Each defect should be sketched and photographically documented through a systematic mapping technique. Prior to touching or manipulating the defect, the analyst should chemically test for the presence of copper and lead using the applicable examination method.
- Since shooting scenes reveal multiple bullet holes requiring documentation, overall and mid-range photographs provide a means for understanding where in the scene the bullet defects exist. The close-up photographs, however, afford minimal identification differences between the defects.
- Roadmapping delivers a useful means for unique defect identification.
- Because roadmapping is a very invasive procedure, it occurs at the conclusion of all other documentation and evidence collection actions.
    1) The analyst places a scale tape vertically and horizontally on the affect surface in the area of the identified bullet defects.
    2) The legible scale tape establishes the baseline measurement for locating the defect evidence.
    3) Identify each bullet defect individually, they can be marked using alpha or numeric identifies.
    4) Multiple defects configured in a linear and sequential order can be designated in a manner such as A1, A2, and A3 to support the relationships among defects created by the same bullet.
    5) Each defect must have a scale reference, an ABFO No. 2 Photomacrogrphic Scale works well
    6) Repeat for all bullet defeats in the scene
- Trajectory tools are necessary for creating a visible and recognizable trajectory. These include rods, string, and lasers.
- To determine trajectory angles, the analyst uses zero-edge protractors, inclinometers, and plumbs
- Wooden dowels are cheap but bend
- Metal, composite, and fiberglass are straight but often short and need to be connected to another
- String can be useful for producing trajectory demonstrative over short distances but is the least useful of the three. This is due to it continues to stretch and sag resulting in a weak demonstrative of trajectory.
- One of the primary purposes of shooting incident reconstruction is to, at best as practical, identify the paths of all bullets fired during a firearm discharge event.

- Bullet defect evidence can be misleading since a single bullet might be responsible for creating more than one wound or defect.
- Testing possible defects with chemical treatment shows all documentation endeavors strengthen the corroboration of complete scene processing
- The most common classifications of bullet defects are perforations and penetrations.
- **Perforation** refers to a projectile that passes through an article
- **Penetration** refers to a projectile striking the surface of an object and causing an entry defect but without exiting.
- Proper subject to lens orientation when photographing bullet defects is essential for documenting the perspective of the defect.
- Photographed defects can provide the analyst with the ability to measure the long axis and short axis of elliptically shaped defects and calculate its angle by using trigonometry.
- After all bullet holes have been classified, documented, and photographed, efforts should be made to determine bullet trajectories.
- An important factor required by the trajectory analyst is for the bullet to have perforated a minimum of two surfaces or objects along its trajectory or created two distinct points to align a trajectory. Meaning it must have two holes to form the flight path.
- The trajectory created by two bullets into or through a target produces two angles requiring analysis and documentation.
- 1) The first is the horizontal angle, also known as the **Azimuth.** This angle measures the degree of trajectory to the right or left of the horizontal plane
- 2) The second is the vertical or elevation angle. The vertical angle measures the degree of the trajectory up or down along the vertical plan.
- To photographically document the vertical angle, the analyst positions the camera on a tripod perpendicular to the previously inserted trajectory rod.
- When photographing the trajectory rod, the analyst should include a plumb line in the field of view and adjacent to the rod.
- Placing an inclinometer onto the trajectory rod is another method for determining the vertical angle.
- The Beginning process of trajectory analysis involves evaluation, measuring, and photographer before the physical insertion of trajectory rods into the identified bullet defects.
- After roadmapping the bullet holes, the trajectory analysis continues by inserting the rod and centering it in the bullet hole.
- Lasers are suitable for use in reconstructing trajectories and come in many types, styles and price ranges.
- Spray fogs are beneficial for producing visible spans of the beam in divers lighting conditions.
- Walking a reflective card along a laser beam is simple method for creating a visible laser trajectory

Subchapter 9.6 – Surveillance Photography

- **Rule of Thumb 9.4:** Use 2mm of lens for every foot of distance between the camera and the subject
- The shutter speed for all surveillance photography must be selected to freeze the anticipated movement of the subject to be photographed. Although certainly an exposure variable, when doing surveillance photography, freezing subject motion is the shutter speed's primary function.
  - 1/125 will freeze a person walking or talking and turning his or head to speak to different people.
  - 1/250 will freeze a person jogging, jumping, or riding a bicycle at normal speeds.
  - 1/500 will freeze a person in a car traveling at 30 mph.
  - 1/1000 will freeze a person in a car traveling at 60 mph.
- **Rule of Thumb 9.5:** The shutter speed for all surveillance photography must be selected to freeze the anticipated movement of the subject to be photographed. Although shutter speed is certainly an exposure variable, when you are doing surveillance photography, freezing the subject motion is the shutter speed's primary function.
- Use the slowest ISO film possible for the lighting conditions at the scene when taking surveillance photographs.
- Photographing though a fence line, making fence disappear from the photographs:
  - Use the longest focal length lens you have
  - Use the widest aperture of your lens
  - Get close to the cage and focus on the animal. Being close to the fence will help ensure the cage is outside the animal's depth of field range.
  - Push Processing: This can sometimes bring out underexposed detail on the film. Usually, it means the film will be allowed to remain in the chemical developing baths longer. It increases graininess and an increase in the contrast of the images. Mid-tones will be lost. Pushing films has its limits.

Subchapter 9.7 – Underwater Photography

- **Underwater Photograph**: Water is approximately 600 times denser than air, so light travels through it very differently.
- The least ambient light reflection occurs on bright calm days between 10 am and 2 pm.
- Because the underwater lighting is much dimmer than when on dry land, electronic strobes will almost always have to be used to prevent underexposure.
- **Refraction:** Then light changes from one medium to another, it will bend. Viewing underwater objects will be affected by refraction. The result is that objects underwater appear approximately 25% closer to the viewer than they really are.
- The least amount of bending occurs when the sun is directly overhead. As light bends, it has to travel farther to reach a given depth, and the increased distance the light must travel reduces its intensity.
- **Refraction creates two problems**: If an object appears to be at x distance from the photographer, but we know it is really at y distance from the camera, how do you focus and where do you aim your flash?

- **Scatter:** Light that is reflected from objects in the water travels through a medium filled with floating debris; this causes the light to be scattered and diffused. Because of scatter, we do not get a clear view of the subject.
- **Backscatter:** Flash reflections off of underwater particles will result in bright spots between the flash and the prime subject matter (like snow).
- How to correct for backscatter and scatter: Keep your light source as far away from the camera as possible and light your subject from an angle of approximately 45 degrees.
- Water acts as a filter, absorbing the different colors of white light at different depths. The only way to ensure the capture of proper colors at any but the shallowest depts. Is use electronic strobes. Because the light from an electronic flash travels much shorter distances underwater, you can be sure that the backgrounds in most of your shots will likely be green or blue if you are deeper than 25' or so.
- Wide angle lenses are regarded as the lens of choice for most underwater photography. Because a wide-angle lens tends to make an object seem farther from the camera compared with a 50mm lens, to fill the frame with the object, you will have to get closer to it than when using a 50mm lens.

Subchapter 9.8 – Vehicle Crash Photography

- **Rule of Thumb 9.1:** The first responsibility of a law enforcement officer has to be to protect the vehicle crash scene itself so that no further crashes can occur.
- **Perishable Evidence:**
    - Inclement Weather
    - Path of travel
    - Biological or physiological processes
- **Rule of Thumb 9.2:** Efforts should be made to take photographs from the eye level of the drivers involved.
- Situations Point of Possible Perception, Point of Actual Perception and Point of no Escape
- **Rule of Thumb 9.3:** It is just as important to document the obvious damage as it is the areas of the vehicles that are not damaged.
- Often a critical element of the accident may be the preexisting conditions of the roadway itself. It may have. Photograph:
    - Tires: damaged, worn, signs of skidding and pattern type.
    - License plates and VIN numbers
    - Pedals: brakes, clutch, accelerator. Looking for footwear imprints.
    - Safety equipment: airbags, seat belts
    - Paint transfer
    - Vehicle lamp filaments
    - Speedometer dial
    - Detached/missing vehicle parts
    - Overhead view

- Undercarriage view.

Chapter 9 – Review Questions

Section 9.1

1. **What are the main lighting concerns related to aerial photography**? The sun will obviously be considered the sole light source in an aerial photograph. If it is your intent to have the sun light a scene viewed from overhead, it is best to have the sun as high as possible in the sky. With the sun high in the sky, long oblique shadows will be minimized, if not totally eliminated. This means taking photographs between 10 and 2 pm would be the best time of all. An alternative to having the sun high on a bright day is doing the aerial photographs on an overcast day. In this situation, a uniform cloud cover produces bright light without any shadows at all.

2. **How is all the motion related to aerial photography controlled**? The shutter speed for aerial photography should be at least 1/500th second, if not 1/1000th second. This will take care of all of the motion of the aircraft. You just have to make sure that the proper exposures are maintained if you take the shutter speed to those settings. Motion comes from the objects on the ground, the motion of the aircraft, and the motion of the camera. Vibrations from the surfaces you are sitting or leaning against as well. So, minimize what your touching and don't lean against anything while you are photographing the scene.

3. **Indicate some safety concerns related to aerial photography**. The amount of air swooshing around you is difficult to imagine on the ground. When you are advised to strap everything down, the reason is that not only will gravity pull loose things down, but the air flow will pull things out of the aircraft laterally. A jacket, backpack, camera equipment can get swept out of a helicopter and get sucked up into the rear rotors.

Section 9.2 Autopsy Photography – None in Book
Section 9.3 Bloodstain Pattern Analysis and Photography – None in Book
Section 9.4 Drones – None in Book
Section 9.5 Photographic Documentation of Shooting Incidents – None in Book

Section 9.6 Surveillance Photography

4. **Discuss the surveillance photography issues related to lens choice and shutter speed choice**. The lens choice is determined by knowing the distance to your subject. You should use 2mm of lens for every foot of distance between the camera and the suspect. If you don't do this you will have a difficult time using the photograph because you will be blurry/pixelated as you zoom in on your subject or try and enlarge the print. The focal length of the lens made into a fraction is the safe shutter speed to use to be sure that there will be no blur from your heartbeat while hand holding the lens. Image stabilization and vibration reduction lenses would be a distinct advantage in surveillance situations in which dim lighting or telephoto lenses are used. If you mounted the camera on a tripod you would be able to select an ISO that is 2 stops less sensitive to light (3200 to 800). Therefore, just by switching to a tripod, you could take the photograph at a faster shutter

speed in the same lighting conditions, netting a slower ISO for more sharpness and clarity. The shutter speed for all surveillance photography must be selected to freeze the anticipated movement of the subject to be photographed. Although shutter speed is certainly an exposure variable, when you are doing surveillance photography, freezing subject motion is the shutter speed's primary function.

5. **How is the ISO film speed optimally determined in nighttime surveillance photography situations**? Use the slowest ISO possible for the lighting conditions at the scene when taking surveillance photos. To determine the slowest ISO that can be used, just set all the other exposure variables and begin taking meter readings of a surrogate scene lit the same way the real scene is expected to be lit. Even better is to take a meter reading of the actual scene several days before the real shoot. Take a meter reading with the camera set at ISO 400. If the meter indicates that it will result in an underexposure, try the next faster ISO, 800. Continue until the meter indicates a proper exposure has been obtained. Using a faster ISO than necessary diminishes the quality of the photographs unnecessarily. Use the spot meter reading if you have it. The variables required are as follows:
    a. Distance from subject
    b. Shutter speed to stop anticipated movement
    c. Focal length of the telephoto lens
    d. ISO setting
    e. f/stop selection
    f. Lighting conditions
    g. Focus on infinity
    h. Camera mounted on a tripod

6. **Explain the camera variables that allow a photographer to blur intervening obstructions to the point they begin to "disappear**." The factors that minimize depth of field and allow you to blur intervening obstructions is as follows:
    a. Use the widest aperture of the lens
    b. Use a telephoto lens
    c. A close camera-to-subject distance minimizes the depth of field. In this case, being close to the obstruction you are using for concealment will help ensure it blurs when the image is captured.
    d. Make sure that 10-15% of the lens can still see the subject of interest while the rest of the lens is hidden behind the obstruction. The photograph will not be as clear as it would with 100% of the lens unobscured, but the photographs are still usable.

7. **Compare film and digital sensors regarding the ability to recover details from underexposed images**.
    a. Film: If the film was underexposed you can ask that the film be "push-processed" in the darkroom. This can sometimes bring out underexposed detail on the film. There are two issues when pushing film. It results in graininess and an increase in the contrast of the images. Mid-tones will be lost. Therefore pushing film has its limits. At some point, the resolution of the desired image will be totally lost. Research indicates that pushing film

about 3 stops is usually the practical limit, and is presumed you are dealing with a highly skilled lab.

b. Digital: the processing of underexposed photographs in Photoshop was more successful than pushing film. You can retrieve more information and detail in the digital photographs. With the exercise described in the book they stated that they did not find a failure limit of Photoshop processing.

Section 9.7 Underwater Photography

8. **Indicate some safety concerns related to underwater photography**. The diver must be aware of location, depth, total time in the water, and air supply. You are never alone in the water. There are animals that could hurt you be aware of this. The additional weight and drag of the equipment are fatigue factors important to remember. Dive only with a partner. The buddy system works and saves lives. Do not use a camera neck strap. Instead consider using a wrist strap that you can easily slip free from if it becomes entangled in underwater debris.

9. **Effectively lighting underwater objects with electronic flash differs from using a flash on dry land. What are the main issues and solutions**? Water is approximately 600 times denser than air, so light travels through it very differently. The best ambient light penetration into the water occurs during the hours around noon. At different times of the day, more light reflects off the surface of the water, and less light makes it beneath the water. Surface conditions also affect reflection. Calm water reflects less light. Choppy water reflects more. The least ambient light reflection occurs on bright calm days between 10 am and 2 pm. Because lighting underwater is much dimmer than when on dry land, electronic strobes will almost always have to be used to prevent underexposures. Reflection of the strobe's light from the surface of the subject back towards the camera can result in unanticipated exposures. Make sure you bracket. Refraction also causes issues with light and what the camera sees. Refraction is the bending of light rays as they pass from one medium to another. It will make an object look like it is bent or larger/closer (25% closer) than it really is to you. Refraction causes two underwater problems for photographers. If an object appears to be at a distance "x" from you, but you know it is really at distance "y" from the camera, how do you focus, and where do you aim the flash? Backscatter is also another issue. Backscatter results from minute underwater particles suspended in the water, that reflect light from the flash or strobe, which results in bright spots between the flash and the prime subject matter (looks like snow). With less water between the camera and the subject, and the flash held in the correct position, backscatter is eliminated. The correct position for the light source is as far away from the camera as possible and light your subject from an angle of approximately 45 degrees.

10. **How can you be sure the colors of underwater objects are accurately captured**? Water acts as a filter, absorbing the different colors of white light at different depths. Depending on the clarity of the water, the color red will be absorbed in the first 5' to 10'. Blue is the last color to be absorbed, which will occur at about 100'. The only way to ensure the capture of proper colors at any but the shallowest depths is to use electronic strobes. Because the light from an electronic flash travels much shorter distances underwater, you can be sure that the backgrounds in most of your shots will likely be green or blue if you are deeper than 25' or so. If you want the proper colors of your subject to be accurately captured, you'll have to use flash.

Section 9.8 Vehicle Crash Photography

11. **Before a major accident scene can be photographed, safety issues have to be addressed. What are they**? The first responsibility of a law enforcement officer has to be to protect the accident scene itself so that no further accidents can occur. Even when cones, flares, and charley-horse barricades have been put out to divert traffic, cars will still drive into your scene. Prepare for the worst and wear a good reflective vest to remain visible under all conditions. After the accident has been protected, the responsibility to render aid to the injured becomes paramount.

12. **The immediate accident scene cannot be isolated from its surroundings. How does this apply to the photographic documentation of a major accident**? It is important to understand that the cause of the accident might not be within close proximity of the accident. It might have issues that started the whole thing a block, two blocks away. Because of that it is important to photograph the scene and then go out and bring it in. Photograph the street signs, speed limits, weather conditions, water on the road, loose gravel on the roadway, etc., anything that might have had an influence on this incident. Were the traffic signals working, is the view of the roadway hindered by anything like trees. Are the street signs being blocked by trees or building overhangs, etc. You also need to make sure that you photograph the accident from the view point of the drivers as well as the witnesses. Could your view be greatly reduced if you were sitting in a lower vehicle, or a semi. Could the witnesses really see the scene as they described it from their vantage point.

13. **How should the vehicles involved in a major accident be photographed**? Midrange photographs of each vehicle must be taken to show them in relation to the fixed features of the accident scene itself. They should be photographed parallel to the roadway edge and perpendicular to it. They should be photographed in relationship to each other. Complete exterior photographs should also be done, as well as the damaged areas, and undamaged areas. Make sure to show all of the tires, license plates, VIN's paint transfer, and vehicle lamp filaments. Show the interior of the vehicle including all of the pedals and safety equipment. Speedometer dials, detached or missing vehicle parts, an overhead view of the vehicle if you can as well as an undercarriage shot. All of this should be done prior to moving the vehicles out of the roadway if possible.

14. **How can photography document the wounds and injuries to the occupants of the vehicles in major accidents**? At times, the only way to position the occupants of a vehicle within the vehicle before the accident is to match the patterns of the personal injuries suffered during the vehicle to areas on the interior of the vehicle. An example of this would be seatbelt burns on shoulders, steering wheel bruises on the stomach/chest of the driver. Damage to the windshield and corresponding bruising/scratches to the forehead of the occupants. Detailed photographic documentation of all these types of evidence may prevent the need for difficult and lengthy investigations later.

15. **Large accident scenes can be lit by the painting with light technique during the nighttime. Discuss two other photography techniques sometimes used for large, dimly lit accident scenes**. If distracting color tints are located on the scene due to lighting conditions, and painting with light is not an option you can turn your camera to its black and white setting and photograph the scene

that way. The second method would be to use time exposures. A precondition to obtaining a well-exposed image was the absence of bright ambient lights too close to the scene of interest. You can also use the Aperture priority setting on the camera and allow the camera to decide when enough light has been let into expose the scene. You will have to make sure there is no bright lights around the scene though, or meter in the darkest area of the scene to have the photograph exposed correctly.

Chapter 10: Digital Imaging Technologies

- **Airbrushing:** Developed in 1879 by Abner Peeler. Patented by Charles Burdick 1893. A technique for blending colors such as adding shadows by applying ink or paint with a sprayer. This technique provides the ability to hide signs that an image has been manipulated.
- 1969 John Cohen exhibited more than 40 special effect techniques that he devised on the basis of photographing projected images years before computer manipulation ever existed.
- **Film Recorder**: A hardware device, similar to laser projector, which writes computer graphic files onto analog film.
- Not only are we facing questions about the integrity of the original digital image, we are facing challenges about our ability to identify if and where computer enhancements are made. Even our personal integrity is being called into question.
- **Pixels**: An abbreviation for picture element, which is the smallest element of a digital image.
- **Metadata:** The data contained within an image file that describe how and when the image was captured, as well as information including date, time, file size, enhancement history and other date. These data elements are then stored as part of the image file in a collection of data fields called the file header.
- **Rule of Thumb 10.1:** Most image editing and viewing programs provide the ability to display EXIF camera data when processing the image. There are, however, still some image editing programs that overwrite or simply ignore the existence of EXIF data when the image file is resaved after editing. Hence, it is imperative to always maintain and preserve the integrity of the original digital images.
- **EXIF:** The most common header format used today (Exchangeable Image File Format) header. In fact, EXIF has become the standard for storing camera information, thus providing interoperability between digital cameras and image processing programs. EXIF data has also proven to be very useful because photographers with digital cameras do not have to worry about recording the settings they used when taking the image on a photo log. When a photograph is taken, the image data together with the information about the device and the image capture, including but not limited to the camera, make, model, and serial number, and all the camera settings used are stored with the image.
- **Lossy Compression**: A technique for reducing the file size of a digital image. When the compressed image is decompressed, the missing information cannot be reproduced exactly as it was captured. It is interpolated. (JPEG)
- **Lossless Compression**: A type of compression that ensures that the original image information can be recreated exactly as it was captured. (RAW or TIFF).
- Adobe Photoshop is one of the oldest, most widely used, and most widely accepted image processing tools available today.
- **Process:** The steps involved in improving the perceived quality of the image or preparing the image for printing.
- **Digital Image**: The process of creating an electronic recording in a two-dimensional form of a physical object, such as a person, place or thing.

- **Digital Evidence**: Evidence, such as latent prints and impressions, which can only be recorded or collected by photography when the image itself is not recoverable. Also, electronic files that give rise to the cause of action, such as child pornography, audit trails in the case of computer hackers, and images of computer hard drives, cell phones, and PDA's that are seized during the investigation of a crime.
- Regardless of whether you are dealing with digital images or digital evidence, nothing is more easily damaged, corrupted, or erased than electronic data. Therefore, you must be able to prove beyond a reasonable doubt that the digital image or digital evidence is truce, accurate, and reliable and that it has not been significantly modified in any way since you acquired it.
- Dpi and ppi are not interchangeable. There terms have totally separate and distinct meanings.
- The most commonly used and misunderstood terms in the digital world are:
    - **Bits:** The smallest element used by a computer or a digital camera. It can have only one of two values: One or Zero.
    - **Bytes:** A measurement of computer data that consists of 8 bits.
    - **Pixels:** Are square, continuous tones, and each pixel represents a unique color value.
    - **Dots:** Are irregular in shape, use white space to simulate a specific color value, and use multiple dots to represent a single pixel color value.
- **Rule of Thumb 10.2:** Dots, on the other hand, are irregular in shape (the degree to which the dot bleeds or is absorbed into the paper depends on the quality and thickness of the paper as well as the absorption rate of the paper, heat and humidity in the room); dots use white space to simulate a specific color value; and multiple dots are used together to represent a single pixel color value.
- The density or the contrast between varying shades increase as the number of bits increases, which is important to know, because different digital capture devices capture light values from 10 bits to 16 bit grayscale and then resample those values to 8 bit grayscale so that the grayscale values can be displayed and adjusted.
- 8 bits equal 1 byte. Each picture element (also known as a pixel) has 1 byte for each color: red green and blue. Each byte allows us to represent up to 256 shades.
- **Monitor Resolution**: A measurement of the number of pixels, both width and height, that a monitor is capable of displaying.
- **Rule of Thumb 10.3:** In contrast, to see more of the actual detail contained within the digital image, zoom in on the image. Zooming into the image too much will cause the image to appear pixilated. For example, viewing an image with only 640 pixels X 480 pixels on a display with a resolution of 1024 X 768 will cause the image to appear pixilated… appear on the screen as large boxes.
- These display pixels are made up of a combination of red, green and blue lights.
- A combination of red, green, and blue lights coupled with the intensity of each individual light creates an optical illusion that causes your eye to perceive the specific color value of an image pixel contained with your digital image.
- Resolution by itself does not imply image quality or size because the same number of pixels can be displayed as a small area (zoomed out) or as a large area (zoomed in) on a monitor or printout.
- **Cluster of dots (or device dot cluster)**: The number of dots in a cluster that varies based on the number of inks, varying sizes of droplets, and number of nozzles per print head in your printer.

- When an image is printed, each pixel is made up of a cluster of dots.
- How do we convert pixels to dots? When an image is printed, each pixel is converted into a series of halftone dots. Each halftone dot is then converted into a series of device dot clusters based on the available ink colors used by the printer, the number of nozzles per print head, the size of droplets, and the type of paper used.
- Human eye, under optimal lighting conditions, can distinguish somewhere between 16 and 64 shades of gray in a range from black to white.
- By use of 8-bit grayscale, computers can distinguish 256 shades of gray between black and white, which is approximately 8 times greater than the ability of the human eye.
- Using 8 bits per color channel, there are 256 shades of red, 256 shades of blue, and 256 shades of green; the computer can render a total of 16,777,216 different color combinations for each pixel. Although 1365 possible color tones is nowhere close to the more than 16 million possible shades available.
- Dye sublimation printers **actually print pixels not dots**. The color value for each pixel represented is the buildup of the colors contained on the dye sub donor ribbon. Therefore, it represents an actual color value; it is not made up of dot clusters used in conjunction with white space on the paper. It is for this reason that dye sub printers are commonly referred to as **continuous tone printers**.
- **Bayer Pattern**: A pattern of color filters that overlays the imaging sensor's photoreceptors. Also commonly referred to as a mosaic pattern. Twice as many green filtered pixels than red or blue exist, because the human eye is more sensitive to green.
- Digital cameras and flatbed scanners use two very different techniques for assigning color values to each pixel. Digital cameras use a variation of the Bayer pattern in which each photo sensor collects only one grayscale value which is based on the density of light that strikes the photo receptor, which is filtered by a red, green or blue sensor. The resulting pixel color value is based on its receptor value together with the values of the eight surrounding neighbor sensors.
- **Rule of Thumb 10.4:** Capturing an area that is too large for the imaging sensor can create moire patterns, which occurs when multiple colors are "processed" by the camera's optics to create a single pixel value in a grid pattern. In some cases, it may be necessary to take an overall photograph of the entire area of interest and then take separate close-ups of individual areas within the area of interest to optimize image resolution.
- **Interpolated**: A mathematical process that creates missing pixels (when decompressions a JPEG file) or to improve perceived image quality by increasing the number of pixels within a given image. Digital cameras also use interpolation to create filtered color values on the basis of the Bayer pattern, which uses the filtered light density values of the neighboring sensors.
- Two major issues should be considered when deciding what device to use:
    - The desired resolution
    - The most accurate method for capturing color values
- By capturing a small area you minimize the area covered by each photoreceptor, which also means that you get better color management and have a greater opportunity to eliminate backgrounds.

- In digital imaging, resolution and color go hand in hand. The higher your resolution, the better your image quality, because resolution helps to maintain color values and keep them separated, and color values provide better image detail.
- When capturing a single fingerprint, palm print, or bite mark, you should set the lens at its closest focusing distance. Then move the camera as close to the object as possible, using the distance of the lens to the object as your primary method for focusing. This allows you to get as close to the image as possible, filling the entire frame with the object and ensuring the highest possible resolution for image capture. Then you can use the focus ring on the lens to fine tune the focus.
- The larger the area you must capture, the lower the resolution of the image. The more that you can fill the frame with the object, the higher your resolution will be.
- **Rule of Thumb 10.5:** If photographing large areas as segments for the purpose of capturing a high-resolution image for analysis, it is important to allow at least a 1" to 2" overlap in each segment. In addition, do not attempt to capture large areas such as footwear impressions, tire marks, or bloodstains with anything less than a 12-megapixel digital camera. And last but not least, do not capture a large area of interest using a camera JPG format and then hope to do any type of analysis or comparison with that image later.
- **Dynamic Range**: The sensitivity to the difference between the values of gray from pure black to pure white. Also referred to as density; there are 256 shades from black to white in an 8 bit grayscale image; there are 65,536 shades of gray between black and white in a 16 bit image.
- **Noise:** Unwanted artifacts within a digital image that affect image quality, such as dust or scratches.
- Many digital camera users further degrade image quality by use of compressed file formats such as JPEG to store larger volumes of pictures with limited storage space and use compressed file formats so the camera will operate faster. Unfortunately, high speed and image quality do not go hand in hand.
- Most digital cameras can save images in one or more of three primary image formats:
    - JPEG (Joint Photographic Expert Group)
    - RAW (camera raw(read unprocessed) sensor data)
    - TIF (Tagged Image File)
- **JPEG**: An image format that reduces the image file size, sacrificing image quality, so that the image does not require as much storage space. Compression removes features: relocates boundaries; alters size, shape and color of features, and reduces resolution differently for different locations in the same image.
- **Artifacts:** Disturbances within a digital image that affect image quality such as pixilation, dust, scratches, moiré patterns, printing distortions, or other imperfections that interfere with image quality.
- Every time you open a JPEG file and change even so much as one single pixel within the image and then resave the file, the entire image is recompressed. The image becomes more and more degraded with each successive resave.
- Once you discard the original information you cannot get the same information back. You merely get an interpretation of this information.

- **RAW:** One of the methods for storing images on a digital camera. RAW files are simply the unprocessed sensor data from a camera.
- **TIF:** Short for **Tagged Image File Format**. A non-compressed format used for storing digital images. Commonly referred to as the truest interpretation of an image, because the image can be reproduced exactly as it was captured and stored bit by bit.
- **Rule of Thumb 10.6:** The need for best possible image quality --- both capture and output --- should always prevail in any argument. However, the reality is that the argument for better images does not always win, and crime scene technicians, firearms examiners, latent print examiners, etc., have to deal with less than acceptable images. There really is no substitution for good photography and good image quality!
- Permissible digital image processing involves those techniques that enable us to visualize the image more clearly. The core of permissible processing is that
    - Nothing has been added to the original image
    - Nothing essential has been removed from the original image.
- Manipulations, however, do those things: they add data that was not originally there, and they take away data that was originally present.
- **Rule of Thumb 10.7:** Unfortunately, many people are skeptical and tend to believe the worst. Until digital image processing is as easily accepted in court as are traditional photographs, it is our job to make it easier to accept such processing.
- **Rule of Thumb 10.8:** A majority of digital cameras used by law enforcement officers in the field do not have the correct date and time settings, which can be problematic. In addition, the majority of law enforcement officers are not aware that the act of rotating an image to view it after the image is downloaded to a computer will cause the image to be identified as a "modified" image.
- **Rule of Thumb 10.9**: Using PDF creation Default Settings: "Standard," images with a resolution greater than 225 pixels per inch (ppi) are downsampled to only 150ppi, and the downsampled images are then compressed using standard jpg compression with only medium image quality, rendering images, in the PDF file unusable.

Chapter 10 – Review Questions – From Edition 2 of the Textbook

1. **Explain the components of a digital images**. Digital images can come from many sources. Digital cameras, scanners, video cameras. A digital image is typically considered to be a representation of a physical object.

2. **Explain what image quality means as it relates to a digital images**. Like printers, digital cameras cannot provide high speed and maximum image quality at the same time: One suffers at the expense of the other. If you want faster performance, you have to minimize the image quality and use compressed image files; if you want to have better image quality, you have to suffer the consequence of longer download times and larger files. Most digital cameras provide multiple image quality (compression) settings, such as fine, normal and basic. Depending on the processor speed, memory and software within the camera, some digital cameras actually compress images more than others. There is no such thing as a fast, high resolution totally lossless image quality.

3. **Explain the difference between dots per inch (dpi) and pixels per inch (ppi**).
    a. Dots per inch (dpi): Irregular in shape. Dots use white space to stimulate a specific color value; and multiple dots are used together to represent a single pixel color value.
    b. Pixels per inch (ppi): Are square in shape. They appear as a continuous tone; and each pixel represents a unique color value.

4. **Explain the differences between image resolution, monitor resolution, and printer resolution**.
    a. Printer Resolution: Even the printer (inkjet, laser, or dye sublimation) that we use can affect the quality of the image because of the different types of inks (dye vs pigment) and the different types of paper (plain, matte, and glossy). Most inkjet printers use multi-size dot technology together with multi-pass technology, where the color tonal value for each output pixel is created by multiple passes of the print head that sprays varying size ink droplets. Although we are still limited by the printer's rated dpi, image quality can be improved by choosing a printer with more ink colors, smaller picoliter droplets, and a higher nozzle count (per print cartridge). Because each printer has different printing techniques, the same image printed from the same computer can appear different simply because of different output devices. There are typically two resolution specifications: one for horizontal movement of the print head and one for the vertical movement of the paper as it moves through the printer and under the print head. The lower resolution value is always the vertical movement of the paper through the printer, which is why the image quality of the horizontal lines is typically better than vertical lines.
    b. Monitor Resolution:
    c. Image Resolution:

5. **Explain how pixels per inch are converted to dots per inch**. When an image is printed, each pixel is converted into a series of halftone dots. Each halftone dot is then converted into a series of device dot clusters based on the available ink colors used by the printer, the number of nozzles per print head, the size of droplets, and the type of paper used. While we do not have an equation we can use to calculate the exact dot-to-pixel ratio, we can, however, determine an approximate ratio of dots to pixels. This is only an approximate ratio because each printer manufacturer uses its own proprietary algorithm for different paper types, ink droplet sizes, nozzles per print head, different numbers of inks, and so forth.

6. **Identify and explain the differences between the image file formats used in digital cameras**.
    a. RAW: None of the actual sensor data is discarded during compression. RAW image files are actually data files that must be processed before they can even be viewed. Larger than JPEG, smaller than TIFF. Stored in their native 12 or 14 bit grayscale mode (4,096 and 16,384 tonal ranges respectively). Read only files. Cannot share easily because the RAW file formats are not standardized. Computer does all the processing rather than the computer.
    b. TIFF: Identified as the truest interpretation of an image. Most accurate and reliable method. Have multiple layers. Large files require vast storage amounts. Cannot be shared easily. Require more time to print.

c. JPEG: Provides the smallest file size. Images are processed inside the camera and do not have to be converted to open or view. Download fast. Can send in emails easily. They have a lower dynamic range (only 8 bits per color channel or 256 shades per color channel). When compressed actual sensor data is discarded. Every time it is opened and saved the file is processed, recompressed, and causes more loss.

7. **Explain the difference between lossy compression and lossless compression**.
   a. Lossy Compression, such as the compression inherent in a JPG format, discard actual picture information to create smaller file sizes. When these images are subsequently decompressed, displayed, and enhanced, artifacts are added into the image. This opens a huge door for attorneys to challenge both the quality of the image and the analysis of the image.
   b. Lossless compression: Tiff and RAW settings on the camera. No picture information is discarded or changed. When using a RAW or TIFF format option, all processing (assigning a red, green and blue color value; demosaicing; noise reduction; sharpening; etc.) is deferred until the image is opened using either the camera manufacturer's image processing software or Adobe Photoshop and only one bye of data (the light density value) is stored for each pixel. So, a RAW file from the same 6 megapixel camera would produce a RAW image file that is approximately 7.1 megabytes.

Explain the best practices for photographing evidence to maximize image quality. To capture an image with a digital camera at the highest possible resolution, you should fill the frame with the object and, if required a scale. A single photoreceptor must capture a larger area, using all the color values in the area covered by that single sensor and the light intensity to determine the resulting pixel value recorded by that photoreceptor. By capturing a smaller area, you minimize the area covered by each photoreceptor, which also means that you get better color management and have a greater opportunity to eliminate backgrounds. In addition to blending multiple color values as a single pixel value when you capture too large of an area with an imaging sensor, you can also create moiré patterns within an image when you capture too large of an area with a digital camera. In some cases, you may be required to take an overall photograph of the area of interest and then take separate close ups of individual areas within the area of interest to optimize image resolution. In digital imaging, resolution and color go hand in hand. The higher your resolution, the better your image quality because resolution helps to maintain color values and keep them separated, and color values provide better image detail. When capturing a small object, such as a latent print, you should set the lens for its closest focusing point. Then move the camera as close to the object as possible. Using the distance between the lens to the object as your primary method for focusing. Use a high resolution camera.

Chapter 11: Digital Image Processing of Evidentiary Photography

- **Rule of Thumb 11.1:** An expert witness is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion.
- Expert Witness is qualified as an expert by the following
    1) The expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in the issue
    2) The testimony is based on sufficient facts or data
    3) The testimony is the product of reliable principles and methods
    4) The expert has reliable applied the principles and methods to the facts of the case.
- **SOP: Standard Operating Procedure** – a document that describes the digital imaging process from the time the evidence is photographed at the scene until the processed digital image is presented in court.
- **Digital Image Manipulation**: Commonly accepted to mean "the altering of an image using software tools to produce an artificial image and create new meaning."
- **Rule of Thumb 11.2:** Law enforcement agencies are required to have a standard operating procedure (SOP) that describes the digital imaging process from the time the evidence is photographed at the scene until the processed digital image is presented in court.
- **Rule of Thumb 11.3:** It is highly recommended that multiple photographs be taken of each piece of evidence being processed.
- **Rule of Thumb 11.4:** If a digital image is to be used for analysis and comparison (such as a latent fingerprint or palm print, footwear impression, tire mark, tool mark, questioned document, bloodstain, firearm comparison, and gunshot residue), a scale must e included in the image.
- **Rule of Thumb 11.5:** When capturing an image digitally – whether using a digital camera or a flatbed scanner – it is imperative that the image be captured in color.
- **Connecticut v. Swinton**: Individual testifying did not have the knowledge about the technology as well as the process when photographs were enhanced.
- In many situations, the forensic analyst must use special processing techniques to see the evidence. Unfortunately, it is possible to use digital imaging technology to mislead, misrepresent, and confuse anyone looking at a digital image.
- Every digital image must be captured, processed, and managed in a manner to ensure that it will be admissible in the courtroom.
- **Scientific Working Group on Imaging Technology (SWGIT):** Guidelines that provide a foundation for adoption and acceptance of consistent standards, practices, and methodologies used throughout the law enforcement community. These guidelines do not provide a detailed requirement, however.
- Basic recommendations that have been widely accepted by the forensic community:
    - You must start with the best possible image
    - Preserve the original image
    - Enhancements done to copy
    - Must be able to authenticate both the original and enhanced image

  - Maintain enhancement history for digitally processed images
  - Have and follow an SOP
- Image should be captured in color.
- **Rule of Thumb 11.6:** The easiest way to distinguish between Category 1 and Category 2 images is that Category 1 images are used for demonstrative or illustrative purposes. Category 2 images, on the other hand, are used for "scientific analysis" and to reach a conclusion.
- SWGIT has defined two categories of digital images that are commonly used in the criminal justice system:
  - **Category 1**: Images that are considered to be documentation, not used for analysis. Can use JPG format. History not needed.
    - Adjusting brightness/contrast
    - Adjusting color balance
    - Adjusting hue and saturation
    - Adjusting white balance
    - Basic image sharpening or blurring
    - Cropping
    - Rotating
  - **Category 2**: Considered evidentiary in nature, and are typically used for analysis and comparison. RAW or TIF format. History must be retained.
    - Tonal range corrections
    - Color channel selection and subtraction
    - Fourier analysis (pattern identification and extraction)
    - Noise reduction
    - Advanced image sharpening
  - Original copies of all digital image must be preserved in their original file format.
  - Any processing must be performed on a copy (duplicate) of the original
  - Chain of custody must be maintained for all digital images (how looks at/access to etc).
  - You should never rename a photograph after it has been taken.
- **Enhancement:** Should be defined to allow only commonly accepted image processing techniques that improve the visualization (quality) of the image without adding or removing features (content) that were not present when the digital image was captured. Techniques that are used to alter the content should not be permitted.
- **Rule of Thumb 11.7:** At no time is it permissible to overwrite the original image file! For legal purposes, you must maintain the "original" electronic file so that it is available, if requested, for discover and/or court. Any processing performed on the digital image must be performed on a copy of the original.
- **Recommended Order of Enhancements**:
  - Calibrate (scale)
  - Evaluate the color information to isolate/remove background noise
  - Optional: Convert the image to grayscale.
  - Adjust tonal range and contrast

  - Fine-tune the image to eliminate noise or hot spots or sharpen the image
  - Duplicate the enhanced for subsequent processing on steps that are considered destructive
  - Rotate the image as necessary
  - Change the resolution (AFIS)
  - Crop the image (AFIS)
  - Save edited copy as a separate image. Do not overwrite the previously enhanced image or original.
- **When an image is rotated at any angle *other* than 90 degrees, two issues arise**:
  - The aspect ratio (the special relationship of the neighboring pixels to which each pixel is compared) of the object changes.
  - Pixel color values are interpolated, which means that color values that did not exist in the original image are created when the image is rotate.
    - These changes may not appear to make a difference in the analysis of the image, they can create challenges that must be dealt with during the image enhancement process.
- **Rule of Thumb 11.8:** In accordance with SWGIT guidelines, a detailed history of the enhancement process must be maintained for every Category 2 image.
- **Rule of Thumb 11.9:** The History Log cannot be printed from any version of Adobe Photoshop; however, it can be copied and pasted into a test-editing application place like Microsoft Word and then printed.
- **Rule of Thumb 11.10:** The History Log maintains a complete, detailed list of all processes performed on a digital image for all editing sessions, including the settings and parameters used for each process whereas the History window displays only the names of the steps that have been used during the current image-processing session.
- Rotating an image at any angle but a 90° multiple can change the aspect ratio (how far apart pixels are from other pixels) and/or the pixel color values (changing, removing, and even adding some colors that that were not in the original).

- **Rule of Thumb 11.11:** If it is necessary to rotate the image after all image processing has been completed successfully, use the Ruler Tool to create an axis through the image and then click on the Straighten layer button on the tool bar. Adobe Photoshop will automatically rotate image using the least destructive method of rotation (ie: less than 45 degrees). Then it may only be necessary to rotate the image 90 degrees clockwise or counterclockwise, which does not create artifacts, to complete the rotation process.
- When viewing a photo that is not at 100% size, the pixels must be condensed and resampled to make the photo smaller which can change spatial relationship and color.
- **Rule of Thumb 11.12:** There are type types of resampling: "upsampling" and "downsampling" Downsampling decreases the number of pixels in an image, whereas upsampling increases the number of pixels.

- **Rule of Thumb 11.13:** Almost all images must be downsampled for printing, in which case actual pixel values are discarded and the remaining pixel values go through a process called dithering where the pixel values are converted to a cluster of dots (creating an approximate color value of the pixels being printed from a mixture of the color values and dot sizes available in the printer).
- When choosing the depth (8 bits/channel or 16 bits/channel) use 8 bits if you feel the photo will not require much enhancement, and 16 bits if you feel that the image will require extra enhancement efforts.
- Enhanced digital images may be used if "nothing material or essential has been added to or removed from the original image."
- **Rule of Thumb 11.14:** The enhancement process should be defined to allow only commonly accepted image-processing techniques that improve the visualization (quality) of the image without adding or removing features (content) that were not present when the digital image was captured.
- Images acquired using flatbed scanners are captured as true, life-size images.
- All image calibration techniques use the same theory: They count the number of pixels from one known point on the scale to another known point on a scale (in other words, a measured distance.)
- When Calibrating (scaling) the cropping method provides addition (more accurate) information.
- **Rule of Thumb 11.15:** Images captured using digital cameras must be calibrated (scaled) for 1:1 life-size output because there is always a variable distance between the lens and the object.
- Color Channels and color filters do not remove objects from (or change the content of) an image. They are just blocking out colors.
- **Calculations Function**: Allows you to use the different brightness values for each pixel to produce a composite value for each pixel. This means you can neutralize background noise by blending one channel intensity for a pixel with the Channel intensity to suppress background noise.
- **Rule of Thumb 11.16:** When calibrating a digital image, measure from the center of the starting scale bar to the center of the ending scale bar regardless of which option is used for calibration.
- All digital cameras (except those cameras that use the Foveon imaging sensor) use a color filter array (CFA) consisting of red, green, and blue filters arranged in a pattern commonly referred to as a Bayer pattern. 50% green, 25% red, 25% blue filters.
- **Rule of Thumb 11.17:** One of the most important and accurate methods for ensuring color accuracy when converting camera RAW images is to include an ABFO Forensic grayscale ruler or a forensic ABRO ruler that includes an 18% grayscale value with the object when it is photographed.
- **Rule of Thumb 11.18:** The easiest way to decide between using 8 – and 16- bit depth during camera RAW conversion is to choose 8 Bits per Channel if the image is not a complex image and it will not require a great deal of processing; choose 16 Bits per Channel if the image is a complex image and will require additional processing.
- **Rule of Thumb 11.19:** Contrary to statements found on the internet, the use of color channels and color filters do not remove objects from an image or change the contents of an image.
- Be careful when using the Levels function to ensure that you do not clip pixel values in the image.
- **Rule of Thumb 11.20:** If used improperly, Levels can also be very destructive.
- **Rule of Thumb 11.21:** To identify pixel values that will be clipped when using Levels, press and hold the Alt key when moving the shadows slider as well as when moving the highlights slider.

- **Rule of Thumb 11.22:** Shadow/Highlights not only provides better control than Levels, but also provides more flexibility for adjusting contrast within one tonal range without affecting the contrast in another tonal range.
- **Rule of Thumb 11.23:** For best results when using Curves, select the value for the lightest (faintest) ridge and the value for furrows (background) and adjust contrast between those points.
- **State of Florida v. Victor Reyes (2003):** Challenged the use of the Burn and Dodge tools because there was no history of "what was done" with them on the image.
- **Rule of Thumb 11.24:** It is perfectly acceptable to use Burn and Doge as part of the enhancement process
- **Rule of Thumb 11.25:** There is one function in Adobe Photoshop that typically must be performed in conjunction with selecting an area of interest: feathering (also known as "blending").
- **Rule of Thumb 11.26:** There are no firm, fixed guidelines for determining the feather radius, and the method for determining the feather radius is different for processing different types of impression evidence (latent prints, tool marks, footwear, and tire marks) as well as questioned documents, trace evidence, and firearms (which is different for things such as serial number restoration, gunshot residue, casing and cartridge characteristics, and so forth).
- **Rule of Thumb 11.27:** Most commercially available ink-jet printers do not have noise reduction and auto sharpening filters built into the printer driver for producing images that appear to be clear. Therefore, the use of Dust and Scratches and Unsharp Mask is highly recommended and encouraged for maximum print quality.
- **Rule of Thumb 11.28:** Digital images should also be rotated once and only once! Images subject to multiple rotations are subjected to additional artifacts based upon the previous rotation artifacts, and that is never a good thing!

Chapter 12: Legal Issues Related to Photographs and Digital Images

- Criteria of photographs and Digital Images as Evidence
  1) To be admissible as evidence, an image must be **Relevant** to an issue being contested.
  2) The image must also tend to either prove or disprove a disputed or **Material** Issue.
  3) The image must also be "**Authentic**"
  4) The image must be established to be "a fair and accurate representation of its subject matter"
- All photographs offered in court as evidence are required to have the proper foundation laid before they can be accepted. By this someone will have to testify that the photograph is a **Fair and Accurate Representation of the Scene**
- Normally a photograph must be properly exposed for it to survive challenges in court. However, there are two exceptions to this rule.
  1) When a witness will testify as to what he or she saw in a dimply lit condition. If the photographer was attempting to capture the scene from the viewpoint of the witness
  2) When examination quality photographs are being taken, with the ultimate view of having the photographs serve as a standard for comparison with a known item of evidence, the photographer often "brackets" the exposures.
- Correct Color Accuracy must be captured or corrected before being offered in court as evidence
- Photographs should accurately portray the correct distance relationships present at the original scene to be admissible in court as evidence.
  1) Use the correct focal length
  2) It is essential that the distance in question be viewed with the photographer positioned so that they are equal distances from two items in question. This has been expressed as the photographer being perpendicular to the imaginary line drawn between the two items in question or the photographer forms an isosceles triangle with two items of interest, with the two items of interest equal distances from the photographer.
- It is essential that the range of what appears to be in focus, the depth of field, covers all the areas in the photograph that are important.
- When a photograph is needed to be used for comparison aspects a scale must be included.
- Authentic photograph consists of a fusion of two concepts
  1) Captured "As Found" with a few exceptions:
     A. Crime Scene Barrier tape
     B. Traffic cones
     C. Evidence collected before photographs for safety reasons
  2) Recreations – as long as no effort is made to suggest the photographs are of the original scene
- All the photographs taken at a crime scene may not later be admissible in court as evidence. Relevant evidence is any evidence that tends to prove or disprove any disputed fact in the case. No evidence can be admitted proving facts that are not at issue.
- The Purpose of Crime Scene Photographs
  1) To document a crime scene and evidence

2) To provide investigative leads
3) To refresh memory, substantiate testimony, and clarify understanding

- There is no consent required if photographs of a person are taken in a public place if used for law enforcement purposes. Even if the subject objects to having the photographs taken. This is not the case for commercial photographers who use the photographs to make a profit.
- Miranda Rights do not apply to photographs or other aspects of physical evidence
- It is illegal to trespass even to capture a photograph. A person's Reasonable Expectation of Privacy can be violated with the proper legal instrument: a search warrant.
- **Manipulation** involves either the addition of details that were not in the original image, or the deletion of essential details that were in the original image. Manipulations DO NOT belong in the courtroom.
- History of processed images should be maintained.
- A record should be kept of who processed the evidence with a standard chain of custody
- Detailed notes must be kept on the exact kind of advanced digital imaging processing that was done to the image.
- Only personnel properly trained to competency should be performing category 2 processes on evidence images.
- Original images should always be archived, and any processing should only be done to copies

Chapter 11 and 12 Review Questions

1. **Explain the potential legal challenges concerning the use of image editing technologies on forensic digital images**. Digital image manipulation is commonly accepted to mean "the altering of an image using software tools to produce an artificial image and create new meaning." Every digital image must be captured, processed, and managed in a manner to ensure that it will be admissible in court. Generally, the courts have held that the original, unedited photograph must be available and that it can be authenticated; and that if enhancement was involved, the changes were made to a copy of the original and that each step of the enhancement process is recorded so that the enhancement process could be repeated, if necessary. There is currently no specific case law in the US, Canada or the UK that deals directly with the issue of processing digital images from a specific camera or from a specific photo editing software application. The basic protocols set up by the forensic community are as follows:
    a. You must start with the best possible image
    b. You must preserve the original image (so that it can be shown in court).
    c. You must make enhancements to a copy (duplicate) of the original image.
    d. You must be able to authenticate both the original and the enhanced image to prove their authenticity and integrity.
    e. You must maintain an enhancement history for digitally processed images.
    f. You must have and follow a standard operating procedure (SOP) that defines the digital imaging process from the point a digital image is acquired until the image is presented in the courtroom.

2. **Describe how the History Log is enabled and explain how it can be accessed for a digital image processed with Adobe Photoshop**. By default, the History Log is disabled and must be enabled before it can be used. You can view the History Log at any time during the enhancement process to going to the File menu, then choosing File Info, then clicking on the History tab in the Fil Info dialog box. To enable the History Log in Adobe Photoshop, do the following:
    a. From the Edit menu, choose Preferences.
    b. The preferences dialog box will appear.
    c. Click in the check box to the left of History Log, and a green checkmark should appear in the box.
    d. By default, the metadata option is selected, but you should confirm that this option is selected.
    e. Then choose the Detailed option from the Edit Log Items drop down list.

3. **Describe the basic steps for digital image enhancement and identify the order in which those steps should be performed**.
    a. Calibrate (Scale) the image for accurate, life size output when enhancing a digital image for comparison.
    b. Evaluate the color information contained in the image to isolate and remove background noise, etc.,
    c. Optional: convert the image to grayscale (this step is typically used when processing impression evidence).
    d. Adjust tonal range and contrast.
    e. Fine-tune the image to eliminate noise or hot spots or sharpen the image.
    f. Save the enhanced image.
    g. Duplicate the enhanced image for subsequent processing for steps that are considered "destructive" in their nature.
    h. Change the resolution to meet the requirements for AFIS.
    i. Save the edited copy as a separate image, making sure not to overwrite the previously enhanced image.

4. **Define the legal principles that must be followed to ensure that digitally processed images may be accepted in court**. The rules of evidence adopted by many states, provide two primary legal principles for digital image processing. Processed (enhanced) digital images may be used if:
    a. Nothing material or essential has been added to the original images.
    b. Nothing material or essential has been removed from the original image.

5. **Explain what happens to images that are rotated any degree other than in 90 degree increments as well as describe the effects on image processing**. While these changes may not appear to make a difference in the analysis of a digital image, they can create challenges that must be dealt with during the image enhancement process. For example, when you remove background noise, adjust color balance, etc., the computer evaluates every pixel in the image whether you see it or not. So if you are trying to remove a color background from an image that has been rotated, you would have additional derivative color values to consider. Or, if you need to use a pattern removal filter to remove background noise, the pixel values for the noise and the ridge detail can become

commingled when you rotate the image, thus making it significantly more challenging to remove the background. When an image is rotated at any angle other than 90 degrees, two issues arise:

a. The aspect ratio (the spatial relationship of the neighboring pixels to which each pixel is compared) of the object changes.
b. Pixel color values are interpolated, which means that color values that did not exist in the original image are created when the image is rotated.

6. **Describe the primary methods used to remove multicolored backgrounds in Adobe Photoshop for forensic digital image processing**. In some instances, the background might be a single color and can be suppressed simply by choosing a single color channel. The channels in Adobe Photoshop act like color filters that can be affixed to the lens of the camera for black and white photography. Failure to convert a digital image to grayscale in which adjustments were made to a single color channel often provides some unusual results when the image is saved and reopened. When the image is reopened, all three color channels will be displayed.
    a. Hue and Saturation/Black and White: Will also allow you to isolate the darker/lighter areas and enhance them thereby taking out the background noise. Example would be a Pepsi can, red/blue colors. You can make both neutral and the print will be the only thing showing.
    b. Calculations: Each pixel in a digital image has a brightness value that is unique in each color channel. The calculations function allows you to use the different brightness values for each pixel to produce a composite value for each pixel.

7. **Describe the techniques used to adjust tonal range when processing forensic evidentiary digital images as well as the pros and cons of each technique**. This process typically involves the use of tools such as Levels, Shadows/Highlights, and Curves. There are also two other commands that you can use to adjust tonal range and contrast. Those commands include Exposure and Brightness and Contrast, as well as Burn and Dodge. Levels, Shadows/Highlights, Curves and Burn and Dodge deserve some explanation because these tools, if used improperly, can be destructive and lead to challenges in the courtroom.
    a. Levels: Can be destructive. You can "clip" color values with Levels if you move the shadow slider (the black triangle under the x-axis of the histogram) to the right past the first value on the left side of the histogram.
    b. Shadows/Highlights: Does not just darken or lighten an area within the image; it actually adjusts contrast by comparing the contrast of each pixel to the neighboring pixel values and then darkens or lightens an area based on whether you are adjusting the Shadows or the Highlights. It not only provides better control, but also provides more flexibility for adjusting contrast within one tonal range without affecting the contrast in another tonal range.

8. **Identify the differences between digital images captured with a digital camera and a flatbed scanner and the impact these differences have on digital image processing**. Objects scanned in will be life size and will not need to be calibrated, unless they are copies of an item and they were enlarged prior to being scanned. With photographs you will have to calibrate all of the photographs to a 1:1 size if you are planning to do a comparison. A scale will need to be in every photograph for this to take place.

SAMPLE TEST QUESTIONS

REMEMBER THESE ARE ONLY TO ASSIST AND HAVE NOT PROMISE TO BE ON THE TEST

Chapter 1 – History of Forensic Imaging

1. The word "photography" means:
    a. Taking pictures with light
    b. Writing with light
    c. Capturing light images
    d. Painting with light

2. Which of the following has been credited as being the inventor of photography in 1826 when he made the first known photograph?
    a. Roger Bacon
    b. Leonardo da Vinci
    c. Sir William Herschel
    d. Joseph Niepce

3. Which of the following was credited with coining the term "photography"?
    a. Sir John Frederick William Herschel
    b. Joseph Niepce
    c. Leonardo da Vinci
    d. Fox Talbot

4. Aime Laussedat us considered the developer of which of the following?
    a. Paper negative process
    b. Photogrammetry
    c. Wet plate process
    d. Daguerreotype

5. Stokes' Law, formulated by Sir George G. Stokes in 1852, is the fundamental theoretical basis of which of the following?
    a. Film photography
    b. Digital photography
    c. Fluorescent photography
    d. Photography of items in motion

6. Which of the following United States Supreme Court cases did the Court hold that photographs of a document were properly admitted in place of the original document?
    a. Luco v. U.S.
    b. U.S. v. Hobbs
    c. U.S. v. Gibson
    d. Maxwell v. U.S.

7. Crime scene photography dates back to:
    a. 1800
    b. 1853
    c. 1867
    d. 1901

8. Videotapes began to be used as evidence in what year?
    a. 1932
    b. 1945
    c. 1967
    d. 1975

9. Although some agencies like to keep a chain of custody after converting to digital photography, there is no legal requirement to do so at this time.
    a. True
    b. False

Chapter 2 – Composition and Cardinal Rules

1. The "primary Subject" of a photograph refers to a single object within the composition.
    a. True
    b. False

2. Sometimes the most effective exposure is an "incorrect" exposure.
    a. True
    b. False

3. The best means of optimizing crime scene photography is:
    a. Fill the frame
    b. Maximize depth of field
    c. Keep the film plane parallel
    d. All of the above

4. Which of the following refers to eliminating irrelevant subject matter in the photograph composition?
    a. Fill the frame
    b. Maximize depth of field
    c. Keep the film plane parallel
    d. All of the above

5. If it appears impossible to eliminate your shadow from the field of view, the best alternative is to:
    a. Use fill flash
    b. Adjust the aperture
    c. Fill the entire area with shadow
    d. Take the photo at a later time when the sun is in a better position.
6. The best way to "soften" a "hard" shadow created by an oblique flash is to:
    a. Position the flash at 90 degrees
    b. Bounce the flash from a reflective surface, such as white paper
    c. Move the item to an environment in which a flash is not needed
    d. Hard shadows are acceptable and should be left as is

7. Lens flare is the optical effect when the sun is directly in front of the camera and creates images of lens optical elements and the aperture opening on the film/sensor.
    a. True
    b. False

8. The use of a large aperture setting results in a large depth of field
    a. True
    b. False

9. Hyperfocal focus involves a finite background in the composition

a. True
b. False

10. Keeping the film plane parallel refers to keeping the length of the lens perpendicular to the subject
    a. True
    b. False

11. When taking midrange photographs, the photographer should for a right triangle with the subject and a fixed feature.
    a. True
    b. False

12. For close up comparison quality photographs, a diagonal view is appropriate to make sure the entire subject is in view.
    a. True
    b. False

Chapter 3 – Crime Scene Photography

1. The photographer must be the one to testify that an image is a fair and accurate representation of the scene in court.
    a. True
    b. False

2. It is suggested that the first frame of a series of photographs be:
    a. An overall view of the scene
    b. Photo identifier
    c. Transient evidence
    d. Any victim or suspect

3. Which of the following provides a log of specific variable data used to capture each individual photograph?
    a. Photo identifier
    b. Photo memo sheet
    c. Case report
    d. It is not necessary to record information related to individual photo variables

4. When a scale is used for close up photography, it is proper for it to show only distance markers.
    a. True
    b. False

5. If a scale is placed above the plane of the item of interest, it will be larger than the evidence and therefore inaccurate for examinations.
    a. True
    b. False

6. The natural perspective of a photograph is that which is taken when the photographer is standing at full height.
    a. True
    b. False

7. If a crime is committed indoors it is not necessary to take overall photographs of the building exterior since the exterior is irrelevant.
    a. True
    b. False

8. Diagonal views of building facades are the preferred perspective.
    a. True
    b. False

9. It is recommended that interior overall photographs be achieved with a view from each of the four corners of a room using a direct flash.
    a. True
    b. False

10. To the extent possible, midrange photographs should be taken from a natural perspective.
    a. True
    b. False

11. One image can be used as a midrange photograph for several items of evidence that are grouped relatively close together and will be related to the same fixed feature.
    a. True
    b. False

12. A natural perspective should be maintained for close up photographs.
    a. True
    b. False

13. What is the recommended minimum size equivalent for using a "normal" lens (no magnification) when taking close up photographs?
    a. A text book
    b. A nickel
    c. A business card
    d. An inch

14. Which aperture should be used when taking close up examination quality photographs?
    a. f/5.6
    b. f/11
    c. f/16
    d. f/22

15. Which of the following are the suggested types of close up photographs?
    a. In situ
    b. With a labeled scale in the same plane
    c. An altered close up
    d. All of the above
    e. A & B only

16. When an additional view of an item of evidence is necessary, it is best to leave the item on the same background on which it was photographed in situ.
    a. True
    b. False

17. It is not necessary to have the entire body included in the midrange photograph.
    - **a. True**
    - b. False

18. A 50 mm lens will most accurately depict the subject when taking a full-face photograph.
    - a. True
    - **b. False**

19. Once the body panorama photographs have been taken, the position of the victim can be altered and clothing moved in order to photo document wounds.
    - a. True
    - **b. False**

20. Because liquid blood is dark in color, it will not reflect more light than a "normal" scene.
    - a. True
    - **b. False**

21. The series of photographs to be taken is as follows: the body panorama, wound documentation, any victim identifiers, and any clues as to the postmortem interval.
    - **a. True**
    - b. False

22. Postmortem interval indicators include which of the following?
    - a. Rigor mortis
    - b. Livor mortis
    - c. Insect activity
    - **d. All of the above**
    - e. A & B only

23. Since the photographs are evidentiary in nature, a victim must allow photographs of their injuries to be taken.
    - a. True
    - **b. False**

24. It is recommended that the victim's face not be included within the same composition as sensitive body parts.
    - **a. True**
    - b. False

25. A crying victim in a photograph may be considered unduly prejudicial and not admitted during trial.
    - **a. True**
    - b. False

Chapter 4 – Basic Exposure (Nonflash) Concepts

1. An exposure stop will either quarter or quadruple the overall lighting from the original exposure.
    a. True
    b. False

2. Which of the following are variables that directly affect exposure:
    a. Shutter speed
    b. Aperture
    c. ISO settings
    d. Lighting
    e. All of the above
    f. A, B, and C only

3. The shutter in a single lens reflex camera is most frequently located in the camera body as opposed to within the lens.
    a. True
    b. False

4. The camera sensor is designed to focus light coming in through the lens.
    a. True
    b. False

5. A shutter speed setting of "15" means the shutter will be open for how long?
    a. 15 sec
    b. 30 sec
    c. 1/15 sec
    d. 1/7/5 sec

6. What is the difference between a shutter speed setting of 2" and 2?
    a. 2" means the photographer should be at least 2 inches from the subject; 2 is 2 feet
    b. 2" is 2 seconds; 2 is ½ second
    c. There is no difference; it's a camera manufacturer preference
    d. 2" is shorthand for 1/2000; 2 is 2 seconds

7. The "B" setting on the shutter speed dial is ideal when a very fast exposure time is needed.
    a. True
    b. False

8. The f-stop is related to:
    a. Shutter speed
    b. Aperture
    c. Flash
    d. Film plane

9. Given a 50mm lens and an f/8 setting, the diaphragm diameter will be:
    a. .16 cm
    b. 6.25 mm
    c. 6.25 cm
    d. 50 mm

10. Given a 50 mm lens and a 2.27 mm diameter diaphragm, the f-stop will be:
    a. f/4
    b. f/8
    c. f/15
    d. f/22

11. f-stops are fractions of the focal length of the lens that is being used.
    a. True
    b. False

12. Film speed changes result in 2-stop exposure differences
    a. True
    b. False

13. Digital sensors that are more sensitive and require less light are designated by the lower ISO numbers.
    a. True
    b. False

14. ISO stands for:
    a. International Society for Optics
    b. International Standards Organization
    c. International Organization for Standardization
    d. Imaging Standards Office

15. The best use of a faster ISO setting is when there is little ambient light and the aperture needs to be small to maximize the depth of field.
    a. True
    b. False

16. On a sunny day and for examination quality photographs, a rule of thumb is to use an ISO 400 setting.
    a. True
    b. False

17. In order to capture correct color in a photograph with a film camera, which of the following can be used?
    a. Morning sunlight
    b. Midday sunlight
    c. Electronic flash
    d. All of the above
    e. B & C only

18. Tungsten light will create what color tint in a photograph?
    a. Yellow
    b. Green
    c. Blue
    d. Red

19. What setting can be adjusted on a digital camera to correct color in various modes of ambient lighting?
    a. Shutter speed
    b. White balance
    c. Aperture
    d. ISO

20. If two areas of lighting extremes (for example, midday sunlight and shadow) need to be photographed together, a midrange exposure setting is the best solution.
    a. True
    b. False

21. If an exposure error is unavoidable it is best to underexpose film and overexpose digital images.
    a. True
    b. False

22. In order to eliminate blur from hand holding the camera:
    a. Use the highest shutter speed available
    b. Set the camera to shutter priority
    c. Use the shutter speed closest to the focal length of the lens, inverted into a fraction
    d. Brace the camera as tightly as possible

23. A faster shutter speed setting is the only option when trying to freeze motion in an image.
    a. True
    b. False

24. It is possible to eliminate rain and snow from an image with a slow shutter speed.
    a. True
    b. False

25. This theory states that for every photo opportunity there are multiple exposure combinations from which to choose.
    a. Theory of Multiplicity
    b. Theory of Alternate Exposures
    c. Coupling Theory
    d. Theory of Reciprocity

26. There are times when the theory of reciprocity does not work when operating a digital camera.
    a. True
    b. False

27. It has been determined that this percentage of light is reflected from a normal scene and therefore this percentage of gray is used to represent the normal scene when metering the camera.
    a. 12%
    b. 15%
    c. 18%
    d. 22%

28. The terms “normal” and “non-normal” scenes refer to the amount of light being reflected.
    a. True
    b. False

29. Which of the following can be metered in order to determine “proper” exposure in a “non-normal” scene?
    a. An area of green grass
    b. Newly laid asphalt
    c. Gray card
    d. All of the above
    e. None of the above
    f. A & C only

30. Program exposure mode (designated by “P”) selects the exposure settings on the basis of the light being read by the meter and is therefore the best choice when photographing crime scenes.
    a. True
    b. False

31. When the exposure control dial is set to “Tv”, the photographer selects the shutter speed and the camera automatically selects the required f/stop.
    a. True
    b. False

32. When the camera is set to either aperture priority or shutter priority, bracketing can be accomplished by adjusting the f/stop and shutter speed, respectively.
    a. True
    b. False

33. This "rule" recommends both an f/stop setting and a corresponding shutter speed for most outdoor photographic situations.
    a. f/11 sunny day rule
    b. f/16 sunny day rule
    c. f/22 overcast day rule
    d. f/16 overcast day rule

34. Which of the following are common uses of a UV filter?
    a. Lens protection
    b. To keep the sky in an image form being overexposed
    c. Recording images with an ALS
    d. All of the above
    e. A & B only

35. A polarizing filter is used to reduce or eliminate reflections from a surface.
    a. True
    b. False

36. The optimal angle at which to photograph images with a polarizing filter is:
    a. 28 degrees
    b. 34 degrees
    c. 40 degrees
    d. 45 degrees

37. A polarizing filter can be used when it is necessary to eliminate the reflection of the sun from a surface.
    a. True
    b. False

Chapter 5 – Focus, Depth of Field, and Lenses

1. This is the ability of the camera system to distinguish groups of alternating line pairs as the lines become increasingly thinner and they become increasingly closer together.
    a. **Resolution**
    b. Acutance
    c. Sharpness
    d. None of the above

2. 100 ISO black and white film has higher resolution than digital cameras.
    a. **True**
    b. False

3. Set by NIST, the maximum resolution for a fax of a 10 print card for examination is:
    a. 500 pixels per inch at 2:1
    b. **1000 pixels per inch at 1:1**
    c. 1500 pixels per inch at 1:2
    d. 250 pixels per inch at 1:1

4. It is sometimes necessary to take overlapping photographs in order to archive the best resolution.
    a. **True**
    b. False

5. This refers to the camera's ability to render a sharp edge of the subject as a sharp edge in the photograph.
    a. Resolution
    b. **Acutance**
    c. Sharpness
    d. All of the above

6. This is the concept that as long as the light reflected from a single point in space enters the lens and remains a circle rather than coming together at the sensor as a specific point, the image will be out of focus.
    a. Circles of light
    b. Circles of focus
    c. **Circles of confusion**
    d. Circles of images

7. This refers to an image being in focus:
    a. Resolution
    b. Acutance
    c. **Sharpness**
    d. None of the above

8. Manual focusing is the most appropriate technique when photographing a single item when assuming a diagonal point of view.
    a. True
    b. **False**

9. Auto focus is best used when:
    a. The photographer is inexperienced
    b. The option is available
    c. During day time photography
    d. **Where there is only one main subject in the field of view**

10. If an item is focused using a telephoto lens, it is necessary to re-focus the item if a different focal length is selected to photograph the same item.
    a. True
    b. **False**

11. Pre-focusing the camera involves focusing on an item the furthest from the camera in the field of view.
    a. True
    b. **False**

12. When composing an entire area as your primary subject, only the item of interest needs to be in focus.
    a. True
    b. **False**

13. When hyperfocal focusing, an f/4 can be selected and the camera can be focused on an item 60' away.
    a. True
    b. **False**

14. The rule of thirds is a guideline that states:
    a. **The depth of field extends 1/3 in front of the point of exact focus and 2/3 behind**
    b. The depth of field extends 2/3 in front of the point of exact focus and 1/3 behind
    c. The depth of field extends 1/3 in front of the point of exact focus, 1/3 through the point of exact focus, and 1/3 behind
    d. Any of the above can be true depending on the camera settings.

15. The rule of thirds will not apply to close up photography.
    a. **True**
    b. False

16. It is possible to focus for UV light using information provided by an IR adjustment indicator.
    a. **True**
    b. False

17. Which of the following on the camera corrects for the photographer's eye quality?
    a. Optical corrector
    b. **Diopter adjustment**
    c. Vision sensor
    d. There is nothing on a camera to correct the photographer's vision

18. What camera variables directly affect the depth of field range?
    a. f/stop selection
    b. lens selection
    c. Distance from camera to subject
    d. **All of the above**
    e. A & B only

19. The wider the aperture, the larger the depth of field.
    a. True
    b. **False**

20. "Normal" lenses will have a better depth of field than a telephoto lens.
    a. **True**
    b. False

21. Enhancing the depth of field when taking close up photographs of small items requires a change in f/stop.
    a. True
    b. **False**

22. The distance in millimeters between the optical center of a lens and the sensor when the camera is focused on infinity is:
    a. Depth of field
    b. Working distance
    c. **Focal length**
    d. None of the above

23. "Fast" and "slow" when used in terms of lenses refers to the lens speed.
    a. True
    b. **False**

24. Which of the following is considered a “normal” lens?
    a. 35mm
    b. **50mm**
    c. Macro lens
    d. Telephoto lens

25. Which of the following types of lenses will elongate the distance between the foreground and the background?
    a. **Wide angle**
    b. Telephoto
    c. 50mm
    d. Macro

26. Some digital cameras will have a focal length multiplier because:
    a. The lens is too short to properly capture the image
    b. The environment is too dark
    c. It will prevent camera shake when being hand-held
    d. **The digital sensor is smaller than the film negative equivalent**

27. The magnification of a telephoto lens can be calculated by dividing the focal length by 100.
    a. True
    b. **False**

28. For adequate magnification, it is recommended that a lens is used that has a focal length of 2mm per lens per foot of distance between the camera and the subject.
    a. **True**
    b. False

29. A wide-angle lens gives an increased depth of field; however, it should not be used for crime scene work.
    a. **True**
    b. False

30. Which of the following are options to magnify small objects to fill the frame of the photograph?
    a. Macro lens
    b. Close up filters
    c. An extension tube
    d. **All of the above**

31. Which of the following is a defect in an image produced by a lens that reduces the resolution of the image?
    a. Diffraction
    b. Distraction
    c. Distortion
    d. **Aberration**

32. Which of the following is the bending of light when it strikes an edge causing a loss of resolution, a loss of edge sharpness, and a loss of clarity in an image?
    a. Distortion
    b. **Diffraction**
    c. Aberration
    d. Deflection

33. It is recommended that the two widest and two smallest apertures be used when taking examination quality photographs.
    a. True
    b. **False**

34. The area of light that is the result of the light bending around an opaque disk is called:
    a. **Poisson's spot**
    b. Newton's light
    c. Huygen's Wave Theory
    d. Airy Disk

35. When an image shows straight lines at the edges appearing to be bent outward, usually by using a wide-angle lens, the effect is referred to as:
    a. Diffraction
    b. **Barrel distortion**
    c. Pincushion distortion
    d. Fish-eye effect

36. Pincushion distortion is an effect of the use of a wide-angle lens.
    a. True
    b. **False**

Chapter 6 – Electronic Flash

1. The flash guide number is a means to discuss a flash unit's relative output power.
    - **a. True**
    - b. False

2. When using a flash, the proper f/stop can be calculated by dividing the distance between the photograph and the subject by the guide number.
    - a. True
    - **b. False**

3. Which of the following is the fastest shutter speed at which cameras should be set whenever an electronic flash is used?
    - a. Guide number
    - **b. Sync speed**
    - c. Flash speed
    - d. $1/125^{th}$ sec

4. In manual flash mode, the full power of the flash is used each time the flash is fired. Since the flash is used to photograph objects at different distances, the usual way to alter exposures is to change shutter speeds.
    - a. True
    - **b. False**

5. It is appropriate to follow the flash exposure recommendations when in manual mode when taking photographs outdoors.
    - a. True
    - **b. False**

6. When standing close to the intended target, the flash is better removed so it can be aimed more accurately.
    - **a. True**
    - b. False

7. Which of the following is a means of bracketing in the manual flash exposure mode?
    - a. Adjust the f/stop
    - b. Alter the intensity of the flash output
    - c. Move closer to the subject
    - **d. All of the above**
    - e. A & B only

8. Which of the following are ways of reducing the flash output?
    a. Place a finger in front of the flash
    b. Use multiple layers of handkerchiefs
    c. Bounce the flash from another surface
    d. All of the above
    e. A & C only

9. The inverse square law refers to the relationship between the distance light travels and its intensity at these distances; the intensity varying inversely by the square of the distance it travels.
    a. True
    b. False

10. f/stop numbers are exact increments that describe precisely a reduction of the light intensity by ½ at each stop and are derived from the inverse square law calculations.
    a. True
    b. False

11. The speed of light is:
    a. 186,000 miles per hour
    b. 186,000 meters per sec
    c. 186,000 meters per min
    d. 186,000 miles per second

12. When using a 120 guide number flash, the crime scene beyond 30 feet can be properly lit with an acceptable depth of field.
    a. True
    b. False

13. At what point does the flash shut off when in automatic mode?
    a. It is determined by the settings made by the photographer
    b. When 18% of the light is reflected from the surface of the scene
    c. Predetermined by the flash manufacturer
    d. When the shutter button is released

14. What is a negative aspect of the automatic flash exposure mode?
    a. The sensor can be fooled by the reflectivity of light and dark surfaces
    b. The photographer has no control of the flash
    c. In this mode the flash should not be removed from the camera
    d. It will not be as bright as when it is set to manual

15. The benefit of a dedicated flash unit is that the light is not read by the flash sensor but by the light meter in the camera body, improving exposure determinations.
    a. True
    b. False

16. When determining the amount of fill flash to highlight shadowed areas, it is recommended to set the flash equivalent to the ambient lighting in the scene.
    a. True
    b. False

17. Which flash mode is recommended when using fill-in flash?
    a. Automatic
    b. Designated flash
    c. Manual
    d. Any of the above

18. Direct lighting makes the depth and texture of three-dimensional images more evidence.
    a. True
    b. False

19. What is the purpose of using a reflector?
    a. Capture a reverse image of a 3D impression
    b. Bounce light to soften hard shadows
    c. Increase the depth of field
    d. Create oblique lighting

20. When photographing a three-dimensional impression, a scale should be placed on the surface next to the impression outline.
    a. True
    b. False

21. The closer the flash is to a footwear impression, the more evenly the impression will be lit from heel to toe.
    a. True
    b. False

22. When photographing snow prints, the best means of increasing contrast in the white on white impression is to:
    a. Dim the flash
    b. Oblique lighting
    c. Add color
    d. Snow prints should only be photographed “as is”

23. When photographing standard tire tracks, what segment length will typically represent one full rotation of the tire?
    a. 6 feet
    b. 6.5 feet
    c. 7 feet
    d. 7.5 feet

24. Better images will typically be produced if each arch of a bite mark is photographed separately due to the curvature of the area of skin.
    a. True
    b. False

25. Moving the flashlight across an area of skin with a bite mark with the shutter open will create a streak in the image.
    a. True
    b. False

26. The more perpendicular the flash is to the paper on which there is indented writing, the easier it is to visualize fine detail.
    a. True
    b. False

27. A negative dust print is one in which dust is removed from an already dust covered surface.
    a. True
    b. False

28. Additional dust falling onto a dust print over time eliminates the possibility of its recovery.
    a. True
    b. False

29. Elimination of the reflection or shadows created by a mirror in a scene can be accomplished with:
    a. Bounce flash
    b. Direct flash
    c. Oblique lighting
    d. Painting with light

30. It is necessary to adjust the camera exposure when bouncing the flash from an intermediate surface.
    a. True
    b. False

31. When bouncing the flash from the ceiling onto an item, the best area in which to do so is beyond the halfway point between the photographer and the item.
    a. True
    b. False

32. Which of the following is a technique to be used when a single flash would be inadequate for the size of a large, dimly lit scene?
    a. Bounce flash
    b. Reflectivity
    c. Painting with light
    d. Flash multiplier

33. Which of the following is a variable affecting the painting with light technique?
    a. Tripod
    b. Camera
    c. Flash
    d. All of the above

34. To which shutter speed should the camera be set when painting with light?
    a. Sync speed
    b. Bulb
    c. The fastest shutter speed available
    d. The shutter speed is not a variable that needs to be adjusted

35. In addition to painting with light, which of the following is an alternative to photographing a large, dimly lit scene?
    a. Timed exposures
    b. Setting the camera to shutter priority
    c. Setting the camera to aperture priority
    d. All of the above
    e. A & C only

Chapter 7 – Ultraviolet, Infrared, and Fluorescence

1. A nanometer is:
    a. One thousandth of a meter
    b. One millionth of a meter
    c. One 10 millionth of a meter
    d. One billionth of a meter

2. Visible light is in the 400-700 nm range on the electromagnetic spectrum. Immediately below the 400 nm range is what kind of light?
    a. Ultraviolet
    b. Infrared
    c. Gamma rays
    d. X rays

3. The conversion of absorbed light into a longer wavelength with lower intensity and different color is normally understood as:
    a. Reflection
    b. Absorption
    c. Transmission
    d. Fluorescence

4. Which exposure mode at f/11 is recommended to photograph fluorescence?
    a. Shutter priority
    b. Aperture priority
    c. Automatic
    d. Manual

5. This is the general term for a molecule's ability to emit light from causes other than heat.
    a. Luminescence
    b. Phosphorescence
    c. Fluorescence
    d. Incandescence

6. This is the term referring to the ability of some materials to retain some of the radiation they have absorbed from a stimulating light and then continue "glowing" after the stimulation has ceased.
    a. Luminescence
    b. Phosphorescence
    c. Fluorescence
    d. Incandescence

7. When searching a crime scene with an alternative light source emitting a blue light, what color filter should be used to see and photograph any fluorescence?
    a. Yellow
    b. Orange
    c. Red
    d. No filter is necessary

8. All potential DNA samples must be collected prior to the use of short wave UV light in equipment such as RUVIS.
    a. True
    b. False

9. Typical camera lenses transmit UV light.
    a. True
    b. False

10. An 18A filter
    a. Blocks all UV light while transmitting visible light
    b. Transmits UV light while blocking visible light

11. The most suitable application of reflected ultraviolet photography include which of the following?
    a. Ink differentiation
    b. Invisible deep muscle bruising
    c. Night time photography
    d. All of the above
    e. A & B Only

12. Long wave UV light can be used to visualize faint bloodstains or bloodstains difficult to see due to the surface color. These can be photographed with:
    a. Oblique lighting
    b. Normal exposure since this would be visible light photography
    c. Red filters
    d. Timed exposures

13. IR can be used to visualize which of the following types of evidence?
    a. Ink differentiation
    b. Visualizing gunshot residue
    c. Visualizing writing on burned documents
    d. All of the above

14. If a substrate transmits IR light, what effect does it have?
    a. The substance will darken
    b. The substance will lighten
    c. The substance will fluoresce
    d. The substance will seemingly disappear revealing whatever is beneath it

15. When you are photographing fluorescent evidence, the proper exposure is frequently 2 stops more than what the camera's exposure meter recommends.
    a. True
    b. False

16. In order to record the fluorescence of luminol and relate it to the remainder of the scene, it is recommended to photograph it with ISO 400, a 90 second exposure and:
    a. Oblique lighting
    b. Painting with light
    c. A brief bounce light towards the end of the exposure
    d. All that is needed for a proper exposure is ISO 400 and a 90 second shutter speed

17. It is necessary to continue spraying a bloodstain with luminol to maintain its fluorescence while photographing it.
    a. True
    b. False

Chapter 8 – Photogrammetry

No Questions at this time. I will add them as I develop them or find them from other sources.

Chapter 9 – Special Photography Situations

1. The first responsibility of a law enforcement officer at a major accident scene is to render aid to the injured.
    a. True
    b. False

2. Which of the following is considered a type of perishable evidence?
    a. Evidence subjected to inclement weather
    b. Items in the path of travel
    c. Evidence subject to physiological processes
    d. All of the above

3. If a vehicle is traveling at 60 mph, what distance does it travel in five seconds prior to an accident? As a result, documentation may need to begin at this distance or beyond.
    a. 140 feet
    b. 240 feet
    c. 340 feet
    d. 440 feet

4. Photographs of obstructions taken from the eye level of the photographer will be the most accurate when documenting an accident scene.
    a. True
    b. False

5. This type of tire mark is usually narrower than the actual tire and the marks exhibit striae diagonal to the outside edge of the tire mark
    a. Skid
    b. Scuff

6. When photographing an accident scene at night, the best photographs of tire marks can be obtained when shinning a spotlight on them from above.
    a. True
    b. False

7. It is necessary to only document exterior areas of the involved vehicles that exhibit damage.
    a. True
    b. False

8. If the vehicle has a license plate, it is not necessary to also document the VIN.

a. True
b. False

9. In a heavy front-end accident, documentation of the vehicle pedals should be obtained since it can be a means of establishing who the driver was.
a. True
b. False

10. Vehicle light bulb filaments can be documented and collected so that a determination can be made as to whether the lights were on or off at the time of the accident.
a. True
b. False

11. Vehicle accident injuries are random and therefore cannot be used to place occupants of the vehicle at the time of an accident.
a. True
b. False

12. Which of the following is a means of capturing accident scenes at night?
a. Pint with light
b. Timed exposures
c. Setting the camera to Av
d. All of the above

13. When conducting surveillance photography, the primary function of the shutter speed is to allow more light.
a. True
b. False

14. When taking surveillance photos it is recommended to use the highest ISO possible since it will produce the best quality photographs.
a. True
b. False

15. When conducting surveillance, the photographer can minimize the depth of field in order to blue an obstruction.
a. True
b. False

16. Which of the following is part of the technique to make an obstruction “disappear”?
a. Use the longest focal length lens available
b. Use the widest aperture available
c. Get as close to the obstruction as possible
d. All of the above

17. How much of the lens can be hidden behind an obstruction and still be capable of photographing a subject under surveillance?
    a. 10-15%
    b. 85-90%
    c. 50%
    d. 75%

18. Fast ISO film speeds and digital camera equivalents are able to provide proper exposures during nighttime surveillance photography.
    a. True
    b. False

19. Aerial photograph are those taken from the highest structure in the vicinity of the scene.
    a. True
    b. False

20. The best conditions in which to take aerial photographs from an aircraft are:
    a. Midday on overcast days
    b. Sunny days between 10 am and 2 pm
    c. Dusk
    d. Any of the above
    e. A & B

21. The minimum shutter speed when taking motion into consideration while conducting aerial photography with a 50mm lens is:
    a. 1/100
    b. 1/250
    c. 1/500
    d. 1/1000

22. Water is approximately how much denser than air?
    a. 100x
    b. 250x
    c. 400x
    d. 600x

23. Refraction, that is the bending of light rays as they pass from one medium to another, causes items underwater to appear approximately 25% closer than they really are. When focusing on the object, it is recommended to focus on where the object apparently is, not where it actually is.
    a. True
    b. False

24. When dealing with the effects of refraction while taking underwater photographs, lighting needs to be directed at the object's actual distance, not its apparent distance.
    - **a. True**
    - b. False

25. The best time to avoid the effects of water surface reflection when taking underwater photographs (desiring the least reflection so more ambient lighting is available) is midday when the water is choppy.
    - a. True
    - **b. False**

26. Which of the following is defined by reflections from underwater particles that produce bright spots when the flash and the prime subject matter? This phenomenon can be avoided by keeping the light source as far away from the camera as possible at a 45 degree angle.
    - a. Scatter
    - b. Refraction
    - **c. Backscatter**
    - d. None of the above

27. When taking underwater photographs the electronic flash should be kept beyond 4' of the subject.
    - a. True
    - **b. False**

Chapter 10 – Digital Imaging Technologies

1. Photographic manipulation was not possible until the advent of digital imaging.
    a. True
    b. False

2. If a defense attorney suggests that digital images can be altered easily and that the technology is unscientific and unreliable, the burden is on the prosecution to prove otherwise.
    a. True
    b. False

3. (Lossy/Lossless) compression of an image file discards actual picture information to create smaller file sizes.
    a. Lossy
    b. Lossless

4. Any image that requires analysis should be captured by use of a (lossy/lossless) compression scheme.
    a. Lossy
    b. Lossless

5. Image quality can be affected by:
    a. Type of printer
    b. Type of ink
    c. Type of paper
    d. All of the above

6. The terms digital image and digital evidence are interchangeable.
    a. True
    b. False

7. Which of the following is a source of digital images?
    a. Digital cameras
    b. Video cameras
    c. Scanners
    d. All of the above
    e. A & B only

8. If a fingerprint is developed on an item and neither the print nor the item can be collected, the image needs to be handled with the same care as the physical evidence itself.
    a. True
    b. False

9. Which of the following is a recognized category of images by SWGIT?
    a. Documentation images that record a time, place or event
    b. Arrest photographs such as mug shots
    c. Evidentiary images used for analysis and comparison
    d. All of the above
    e. A & C only

10. The terms dot per inch and pixels per inch are interchangeable when discussing digital imaging technologies.
    a. True
    b. False

11. A byte is made up of how many bits?
    a. 5
    b. 8
    c. 10
    d. 12

12. A digital image is composed of a series of _____, each having their own color value.
    a. Bits
    b. Bytes
    c. Pixels
    d. Dots

13. An exact ratio can be calculated of digital image pixels to display pixels to achieve the best quality.
    a. True
    b. False

14. When deciding what printer to use, which of the following needs to be considered?
    a. Average number of prints required
    b. What use the prints will have
    c. Size of the prints needed
    d. All of the above

15. Regardless of the type or model of printer used, the image quality will not be as good as traditional film based photographs used for latent print comparison.
    a. True
    b. False

16. Which of the following is the "actual factor" that determines the final output quality of the printer?
    - **a. Printer settings**
    - b. Dpi value
    - c. Ratio of dots to pixels
    - d. Camera pixels

17. A dye-sublimation printer is optimal for printing images that require analysis and comparison.
    - a. True
    - **b. False**

18. Which of the following, in addition to input and output, are elements of digital imaging?
    - a. Storage and management
    - b. Processing
    - c. Neither A nor B
    - **d. Both A & B**

19. Traditional film processing provides pictures with a lifespan longer than that of digital images.
    - a. True
    - **b. False**

20. Information is lost when producing electronic copies of digital images and the quality will therefore dissipate.
    - a. True
    - **b. False**

21. The first step in determining whether to use a flatbed scanner instead of a digital camera is:
    - a. Camera quality
    - b. Printer output
    - **c. Size of the object**
    - d. A scanner should never be used instead of a digital camera

22. To determine the maximum capture area for a particular digital camera, divide the effective pixel resolution of the camera by what number to achieve the minimum resolution to be compliant with the FBI NIST standard for latent prints?
    - a. 10
    - b. 100
    - **c. 1000**
    - d. 10000

23. The larger the area to be captured by a digital camera, the lower the resolution.
    - **a. True**
    - b. False

24. It is recommended to capture bloodstains, tire marks, and footwear impressions in segments with a 1-2" overlap then stitch the images together to create a single image.
    a. True
    b. False

25. It is recommended to capture large areas with a camera that is 12 megapixels or less with a JPG format.
    a. True
    b. False

26. Capturing images with a greater bit depth optimizes the ability to eliminate back grounds.
    a. True
    b. False

27. Unlike printers, digital cameras can provide high speed and maximum image quality at the same time.
    a. True
    b. False

28. Which of the following formats provides the smallest file size?
    a. JPG
    b. RAW
    c. TIF
    d. All are equal

29. The amount of detail lost and the artifacts produced cannot be predicted when dealing with JPG compression.
    a. True
    b. False

30. Lost detail with JPG compression is a result of pixel removal.
    a. True
    b. False

31. When enhancements are done to a file saved as JPG, the image becomes more and more degraded with every save.
    a. True
    b. False

32. JPG format is acceptable for digital images documenting a crime scene.
    a. True
    b. False

33. RAW files are smaller than non-compressed TIF files.
    - **a. True**
    - b. False

34. RAW image files must be processed with a file converter prior to being viewed.
    - **a. True**
    - b. False

35. Original RAW files cannot be altered.
    - **a. True**
    - b. False

36. TIF is the most reliable format when forensic analysis of the image is required.
    - **a. True**
    - b. False

37. Images that have been processed by removing essential items are permissible as long as it serves to make the image clearer for analysis.
    - a. True
    - **b. False**

38. Under existing rules of evidence, the main requirements for admissibility of a photograph into evidence are relevance and authentication.
    - **a. True**
    - b. False

39. Image storage and management are the most standardized components in the world of digital imaging.
    - a. True
    - **b. False**

40. Which Federal Rule of Evidence has guidelines regarding the use of computer based evidence (also referred to as the Swinton Six)?
    - a. 106
    - b. 402
    - c. 701
    - **d. 901**

Chapter 11 – Digital Image Processing of Evidentiary Photography

1. The Scientific Working Group on Imaging Technology puts forth requirements for capturing and enhancing digital images.
    a. True
    b. False

2. Enhancements can be done to the original image as long as all the steps of the process are documented.
    a. True
    b. False

3. When an image is captured digitally, it is imperative that the image is captured in color.
    a. True
    b. False

4. Standard operating procedures discussing enhancement and techniques are discoverable along with the image itself.
    a. True
    b. False

5. Those images described by SWGIT as "Category 2" can be acquired using JPG file format.
    a. True
    b. False

6. The steps given for the image enhancement process must be done in the order provided to ensure image integrity.
    a. True
    b. False

7. How many degrees can an image be rotated with no effect on the pixel values?
    a. 10
    b. 50
    c. 60
    d. 90

8. Down sampling an image so that more can be viewed on the computer monitor has not effect on the detail of the image.
    a. True
    b. False

9. Any digital cameras have a RAW file format option that must be used when capturing images for analysis.
    a. True
    b. False

10. Images captured using digital cameras are not calibrated for 1:1 life-size output because:
    a. Various cameras can be used
    b. Camera settings are variable
    c. Distance between the lens and the object is variable
    d. Some images are taken without a scale

11. Which of the following are attributes that make up the size of any digital image?
    a. Width
    b. Height
    c. Resolution
    d. All of the above
    e. A & B only

12. Images converted to grayscale require less space to store the image.
    a. True
    b. False

13. All digital cameras use a color filter array consisting of what three colors?
    a. Green, red, blue
    b. Red, blue, yellow
    c. Green, red, orange
    d. Red, orange, blue

14. When using the burning and dodging tool in Adobe Photoshop to enhance a latent print, always drag the ”brush” in the direction of the ridge flow.
    a. True
    b. False

15. How many ridges should be viewed within the circle of the “brush” tool when burning in and dodging in Photoshop?
    a. 2
    b. 5
    c. 10
    d. 25

16. Once an image has bene enhanced, the image can be compressed for saving.
    a. True
    b. False

17. Which of the following is recommended submission to AFIS?
    a. The original image
    b. The enhanced image
    c. A copy of the enhanced image
    d. Any of the above as long as it meets the resolution standards

18. It is a requirement to save the images that is submitted to AFIS.
    a. True
    b. False

Chapter 12 – Legal Issues Related to Photographs and Digital Images

No Questions at this time. I will add them as I develop them or find them from other sources.