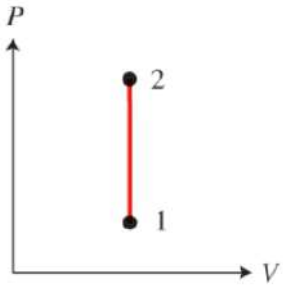
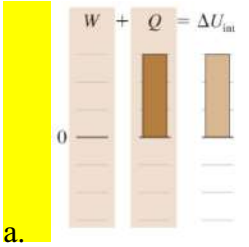
General Physics II/ University Physics II
Spring 2020 Practice Final Exam

1. We have two containers of gas. Container 1 has N particles, is at a temperature T and has an internal energy of U_{int}. Container 2 has the same number of particles, the same temperature and the same internal energy as Container 1. The two containers are put next to each other and the separating walls in between the two are removed, effectively combining the two containers into one large container. The gases are given time to mix. Which of the following is true about the gas in the new, combined container?
   a. The internal energy of the gas within the new container is U_{int} because the average energy per gas molecule remains the same
   b. The internal energy of the gas within the new container is $2U_{int}$ because average energy per gas molecule is now greater than before
   c. The internal energy of the gas within the new container is $2U_{int}$ because total internal energy contained within the new container is greater than the total energy in either of the previous individual containers
   d. The internal energy of the gas within the new container is $\frac{1}{2}\ U_{int}$ because total internal energy contained within this container is now spread out over double the number of particles compared to each of the previous individual containers

2. Which of the following energy bar charts corresponds to the process shown in the P-V graph below?



a.


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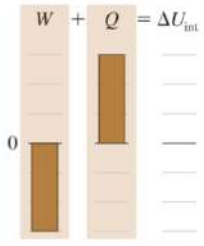

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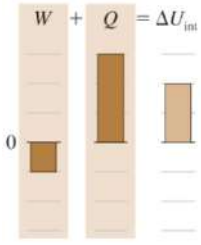

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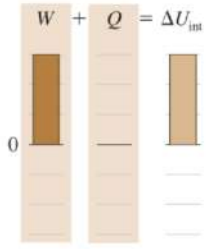
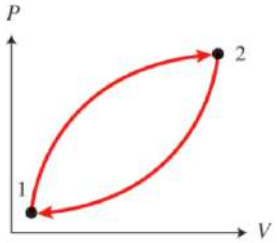


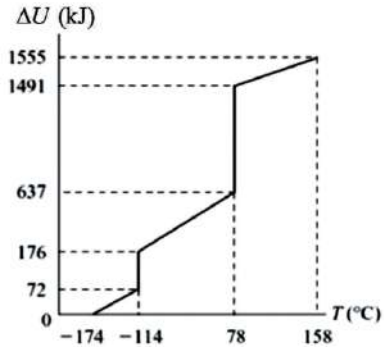
3. The specific heat of water is 4200 J/(kg·°C). Which of the following statements is true?
   a. One kilogram of water stores 4200 J of energy when its temperature is 1 °C.
   b. If you add 4200 J to water, its temperature will increase by 1 °C.
   c. If you add 42,000 J to 10 kg of water, its temperature will increase by 100 °C.
   d. To boil 1 kg of water you need to add 4200 J of energy

4. One night, a meteorite crashes in your back yard. Startled, you run outside. Even standing 5 ft away from the glowing rock you can feel its warmth on your skin. Mesmerized by it, you get closer and touch it with your palm and immediately retract your hand because you were burned. The two main heating mechanisms you experienced in order were:
   a. Conduction then radiation
   b. Radiation then conduction
   c. Convection then radiation
   d. Radiation then convection

5. Gas in a closed container undergoes a cyclic process from state 1 to state 2 and then back to state 1 as shown in the figure below. Describe the processes 1-2 and 2-1 qualitatively using the concepts of work, heating, and internal energy. (a) What happened to the thermal energy of the gas as it went from 1 to 2 and then from 2 to 1? What is the net change in the internal energy after the gas returned to state 1? (b) On the P-versus-V graph, show the magnitude of the work that was done on the gas by the environment during process 1-2 and during process 2-1. (c) Was the total work done on the gas positive, negative, or zero during the entire process 1-2-1? (d) Discuss the heating of the gas during process 1-2 and then 2-1. Was the total heating of the gas positive, negative, or zero during the whole process 1-2-1?



6. Energy provided through heating causes the internal energy of 1.0 kg of some material to change from a solid at to a gas at as shown in the graph below. What is the latent heat of fusion for this material?

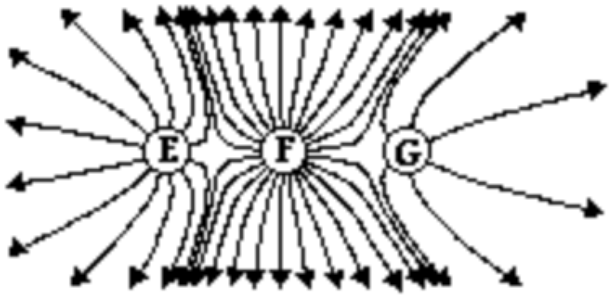


   a. 2.4 kJ/(kg)
   b. 2.4 k J/(kg·°C)
   c. 854 kJ/(kg)
   d. 854 kJ/(kg·°C)
   e. 1.2 kJ/(kg·°C)

7. You have 5 coins in front of you. Each coin can have either its head or its tail pointing up. Of the two configurations *(0 Heads, 5 Tails)* and *(3 Heads, 2 Tails)* which configuration has the highest entropy?
   a. *(0 Heads, 5 Tails)* because that is the microstate with the most macrostates
   b. *(0 Heads, 5 Tails)* because that is the microstate with the least macrostates
   c. *(0 Heads, 5 Tails)* because that is the macrostate with the most microstates
   d. *(3 Heads, 2 Tails)* because that is the macrostate with the least microstates
   e. *(3 Heads, 2 Tails)* because that is the macrostate with the most microstates
   f. *(3 Heads, 2 Tails)* because that is the microstate with the most macrostates

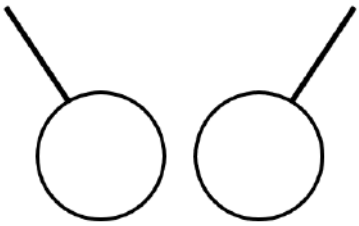
8. Water is heated on a stove. Which of the following temperature changes results in the greatest change in entropy?
   a. from 10°C to 20°C
   b. from 45°C to 55°C
   c. from 80°C to 90°C
   d. none of the above because they all have the same entropy change

9. Three charges and their electric field lines are shown below. Consider the following statements:
   I. Charge G exerts no force on Charge E
   II. The force that charge F exerts on charge E is greater than the force charge E exerts on charge F
   III. F has the largest magnitude of charge followed by E and then by G



Which of the above statements is true?
   a. Only I and III are true
   b. Only II and III are true
   c. I, II and II are all true
   d. Only III is true

10. Two ping pong balls are brought close to each other and attract one another as shown below. Which of the following claims can we make about the electrical charges of the ping pong balls?



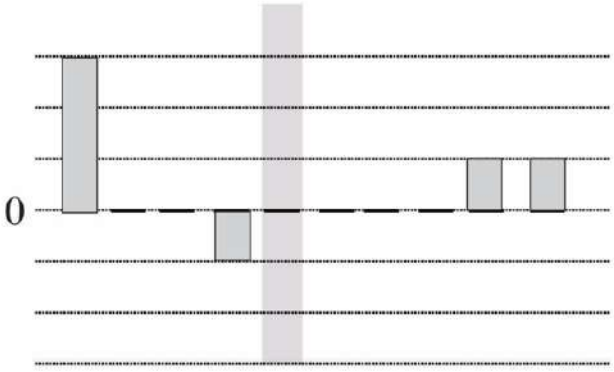
   a. The two ping pong balls have opposite electrical charges
   b. The two ping pong balls have the same electrical charge
   c. Only one of the ping pong balls has an electrical charge
   d. At least one of the ping pong balls has an electrical charge

11. When separated by a distance *d*, two positively charged point like objects A and B exert a force of magnitude *F* on each other. If you reduce the charge of A to half of its original value and the charge of B to one-fourth of its original value, what must the new distance be to keep the magnitude of the force they exert on each other the same?
   a. 0.354 R
   b. 2.83 R
   c. 0.125 R
   d. 8 R

12. Charge A is fixed in position while Charge B is brought close to Charge A. During the process, the *value* of the electric potential energy of the system consisting of A and B increases. What statement can we definitely make about the charges?
    a. Both charges are positive
    b. Both charges are negative
    c. They are unlike charges
    d. They are like charges
    e. Charge A is positive and Charge B is negative
    f. Charge A is negative and Charge B is positive

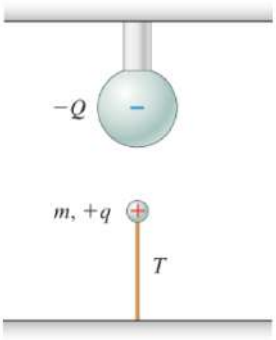
13. Which scenario corresponds to the following energy bar chart?

$$K_i+U_{gi}+U_{si}+U_{qi}+W=K_f+U_{gf}+U_{sf}+U_{qf}+\Delta U_{int}$$



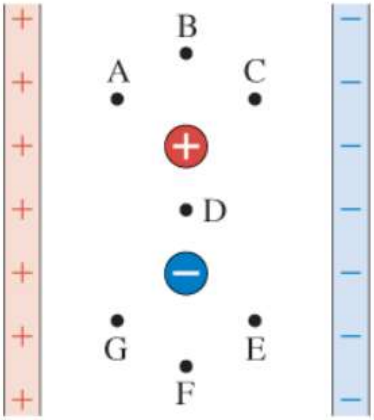
    a. A positively charged block slides on a rough table towards a positively charged wall and speeds up as it gets closer to the wall
    b. A positively charged block slides on a rough table towards a negatively charged wall and speeds up as it gets closer to the wall
    c. A positively charged block slides on a rough table towards a negatively charged wall and comes to a stop once it gets closer to the wall
    d. A positively charged block slides on a rough table towards a positively charged wall and comes to a stop once it gets closer to the wall

14. A small metal ball with positive charge +q and mass m is attached to a very light string, as shown in the figure. A larger metal ball with negative charge −Q is securely held on a plastic rod to the ceiling. Write an expression for the magnitude of the force T that the string exerts on the ball. Define any other quantities used in your expression.

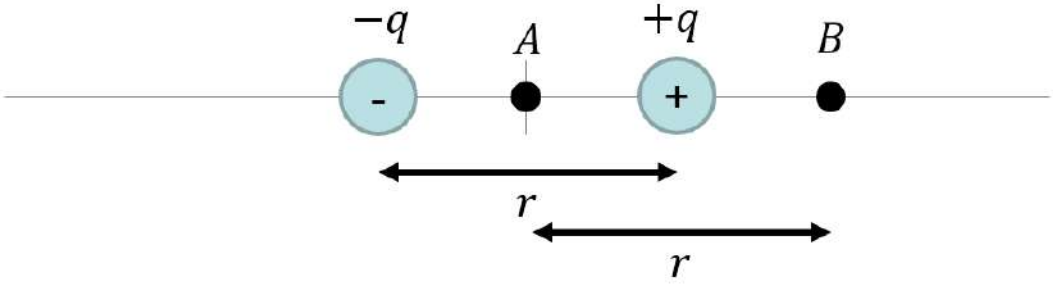


15. Assume the only forces in this situation are electric forces. A small negatively charged object is moving towards the left and slowing down. What is the direction of the E-field around the charged object?
    a. Left
    b. Right
    c. Depends on the sign and position of the source charge producing the electric field
    d. Cannot be determined from the information given

16. An electric dipole is placed between the oppositely charged plates as shown in figure. At which of the marked points could the net E-field be zero? Choose all possible answers.



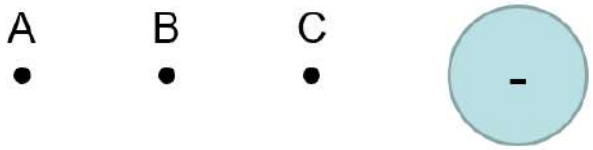
17. Two charged objects with charges $+q$ and $-q$ respectively are separated by a distance r, as shown in the figures below. At which point is the magnitude of the net E-field greater?



    a. A and it points to the right
    b. A and it points to the left
    c. B and it points to the right
    d. B and it points to the left
    e. The magnitude is the same at A and B but they point in opposite directions
    f. The magnitude is the same at A and B but they point in opposite directions

18. **(University Physics only)** A tiny positively charged ball is surrounded by three imaginary spheres of radius *r*, *2R* and *3R*. Which sphere has the greatest magnitude of electric flux through them?
    a. The sphere with radius *r*
    b. The sphere with radius *2R*
    c. The sphere with radius *3R*
    d. All three sphere have the same amount of electric flux passing through them

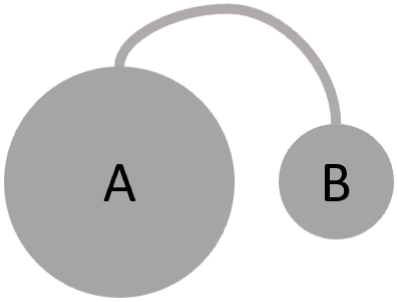
19. Which of the following is true about the electrical potential at each of the three positions shown?



    a. $V_A > V_B > V_C$
    b. $V_C > V_B > V_A$
    c. $V_A = V_B = V_C$
    d. The ranking depends on the sign of the test charge we place at the points

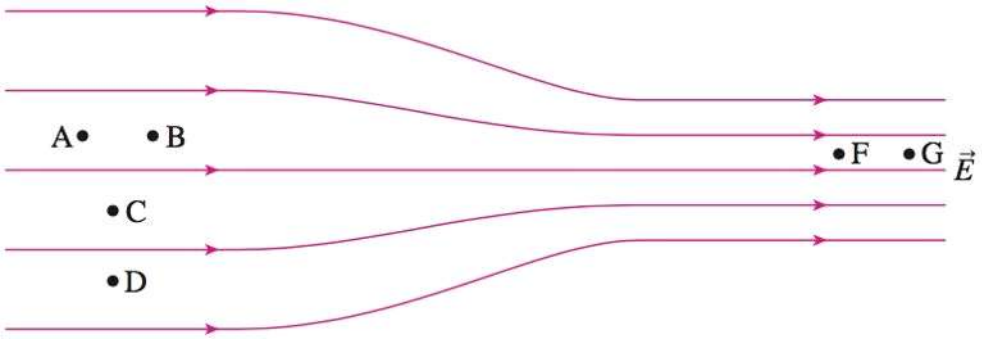
20. Your friend Nilbog tells you that the potential at a certain point A in space is -30V and another point nearby, B, has a potential of -50V. Choose all statements that are true. (assume no gravitational potential energy in the system)
    a. If you hold a small ball of +1C and bring it from A to B at constant speed, you have to do 20J of work on the ball
    b. If you hold a small ball of +1C and bring it from A to be at constant speed, the ball will do 20J of work on you
    c. If you hold a small ball of -1C and bring it from A to B at constant speed, you have to do 20J of work on the ball
    d. If you hold a small ball of -1C and bring it from A to be at constant speed, the ball will do 20J of work on you

21. Two metal balls, A with a radius of 0.3 m and B with a radius of 0.1 m, are connected to one another by a conducting wire. The initial charge on ball B is -10 nC. For which initial charge on ball A will **electrons** flow from A to B?



a. -30nC
b. -40nC
c. -20nC

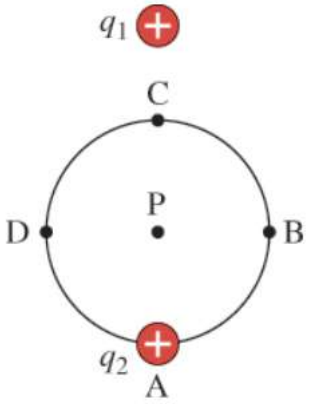
22. Which of the following correctly ranks the magnitudes of the electric potential at points A to G from largest to smallest?



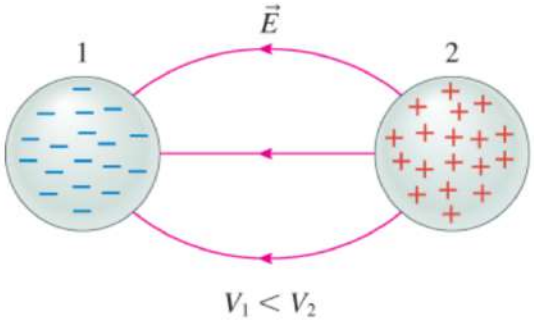
a. $V_A > V_C = V_D > V_B > V_F > V_G$
b. $V_A = V_C = V_D = V_B > V_F = V_G$
c. $V_A > V_C > V_D > V_B > V_F > V_G$
d. $V_A = V_C > V_D > V_B > V_F = V_G$

23. Two -3.0×10^{-9}C charged point-like objects are separated by 0.20 m. Determine the potential (assuming zero volts at infinity) at a point (a) halfway between the objects and (b) 0.20 m to the side of one of the objects (and 0.40 m from the other) along a line joining them.

24. While a sphere with positive charge q_1 remains fixed, a second sphere with positive charge q_2 is successively placed at the points A, B, C and D. Rank (a) the magnitudes of the E-field at point P and (b) the V-field values at P for the four positions of the second sphere.



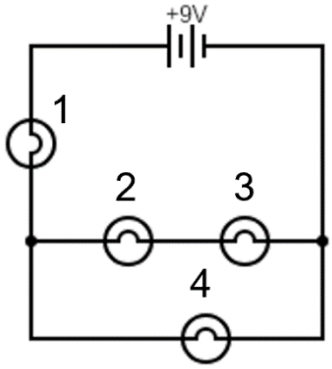
25. The two spheres of a Wimshurst generator are charged as shown in the diagram below. When they are brough close enough that they can discharge, which of the following best describes the discharging process?



a. Electrons flow from 1 to 2.
b. Electrons flow from 2 to 1.
c. Protons flow from 1 to 2.
d. Protons flow from 2 to 1.

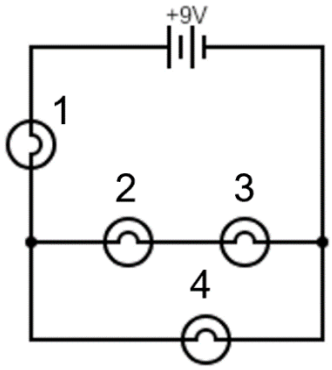
26. One common analogy physicists use to think about electrical current and charge flow is **water flowing down a hill in a stream**. In this analogy, which feature of the water system corresponds to the **lightbulb**?
a. The water itself
b. A mill being turned by the water as it flows
c. A pump which returns water from the bottom of the hill to the top
d. The height of the hill
e. The bed of the stream (an indentation through which water can flow)

27. The circuit below has 4 identical lightbulbs. Rank the current passing through each bulb.



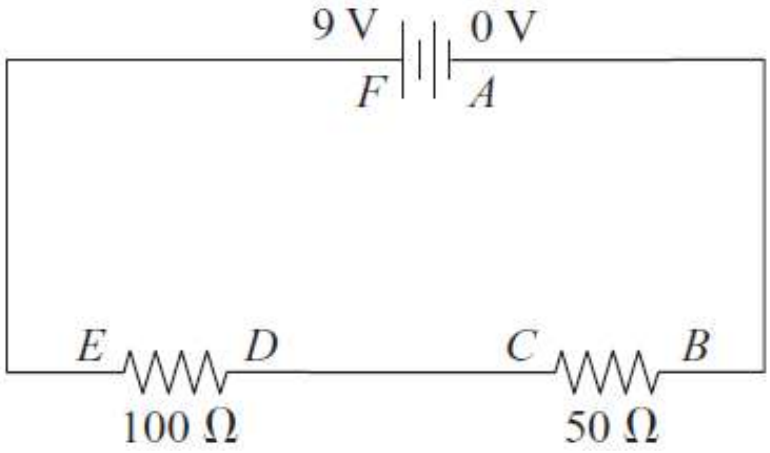
a. $I_1 > I_2 > I_3 > I_4$
b. $I_1 > I_4 = I_2 > I_3$
c. $I_1 > I_4 > I_2 = I_3$
d. $I_4 > I_1 > I_2 = I_3$

28. The circuit below has 4 identical lightbulbs. Rank the potential difference across each bulb.

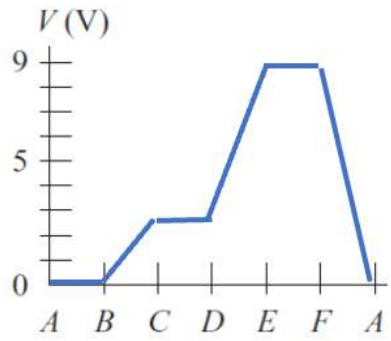


a. $V_1 > V_2 > V_3 > V_4$
b. $V_1 > V_4 = V_2 > V_3$
c. $V_1 > V_4 > V_2 = V_3$
d. $V_4 > V_1 > V_2 = V_3$

29. Determine the current through the circuit below, then select the correct graph of the potential at locations A-F.



a.



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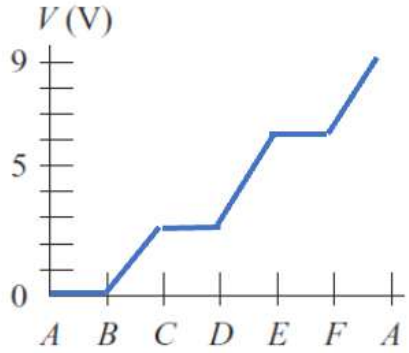
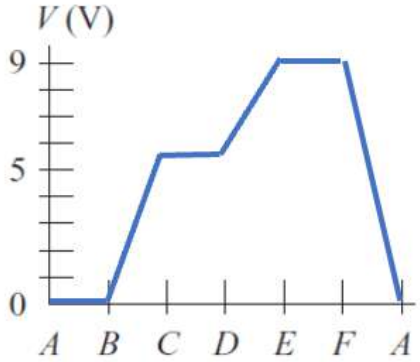


c.



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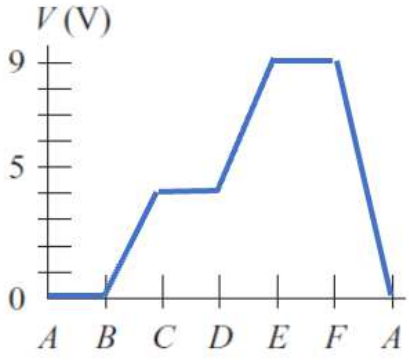
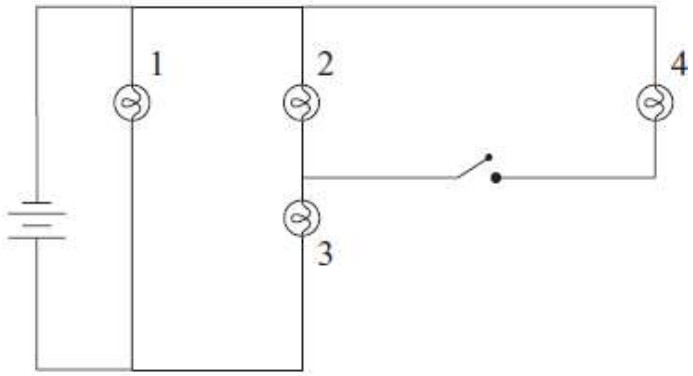


30. The circuit below has four identical lightbulbs. Describe how the brightness of the bulbs will change when the switch is closed.



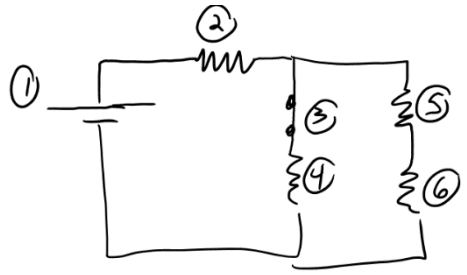
a. Bulb 4, bulb 3, and bulb 1 will get brighter; bulb 2 will get dimmer
b. Bulb 4, bulb 3, and bulb 1 will get brighter; bulb 2 will stay the same
c. Bulb 4 will get brighter; bulb 2 will get dimmer; bulb 1 and bulb 3 will stay the same
d. Bulb 4 and bulb 3 will get brighter; bulb 2 will get dimmer; bulb 1 will stay the same

31. You have a circuit consisting of a variety of elements including a 9-V battery, a switch, and several resistors. You measure current through different circuit elements and the potential difference across them (each element has a corresponding voltmeter and ammeter reading). The results are in the table below.

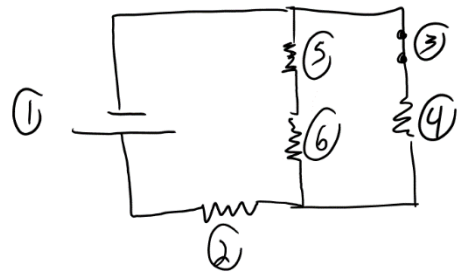
Element	Ammeter Reading	Voltmeter Reading
1	0.54 A	9 V
2	0.54 A	5.4 V
3	0.36 A	0 V
4	0.36 A	3.6 V
5	0.18 A	1.8 V
6	0.18 A	1.8 V

From which of the following circuits could these measurements have been taken?

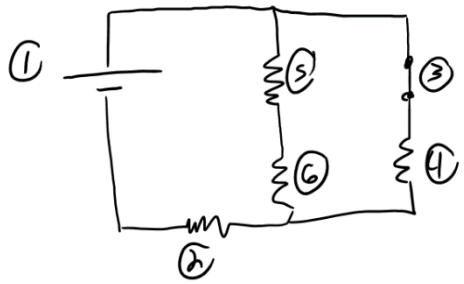
a.



b.

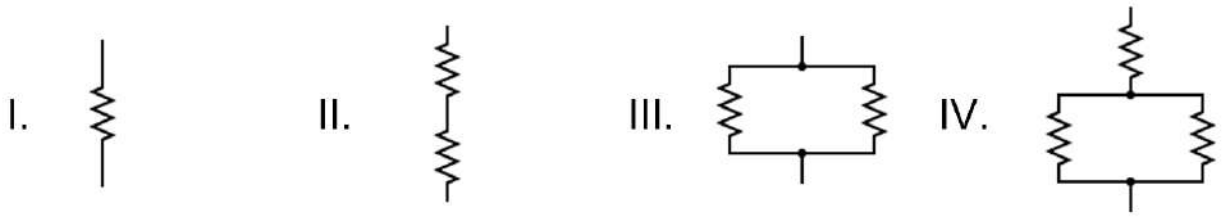


c.



d. All of the above

32. The following circuit segments are composed of identical resistors. Rank the equivalent resistance of each segment from highest to lowest:

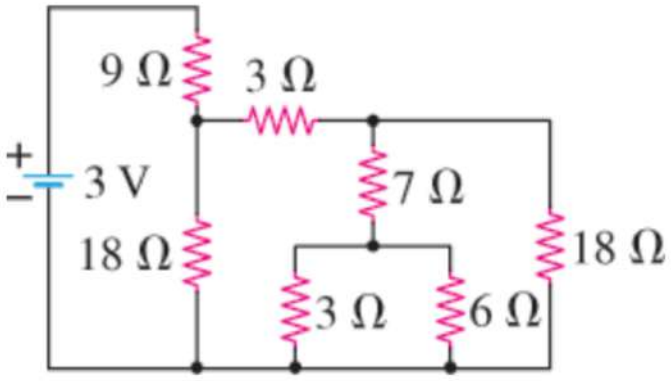


a. I > II > II > IV
b. IV > II > III > I
c. II > IV > III > I
d. II > IV > I > III

33. Which of the following would happen if the separation between the plates of a charged parallel-plate capacitor were increased **after the capacitor has been disconnected from a battery**?

e. The potential difference across the capacitor will increase.
f. The potential difference across the capacitor will decrease.
g. The amount of charge on each plate will increase.
h. The amount of charge on each plate will decrease.

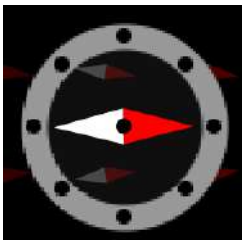
34. Determine the equivalent resistance of the resistors in the circuit below and the current through the battery.



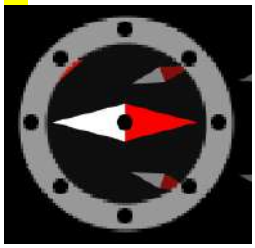
i. 10 Ω; 0.30 A
j. 15 Ω; 0.20 A
k. 20 Ω; 0.30 A
l. 25 Ω; 0.20 A

35. A compass is moved around a bar magnet. Which picture below indicates the compass's orientation at the location marked below (to the right of the bar magnet).

a.



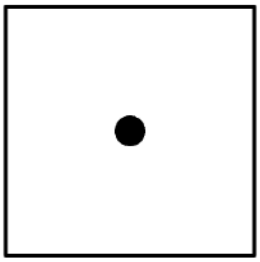
b.



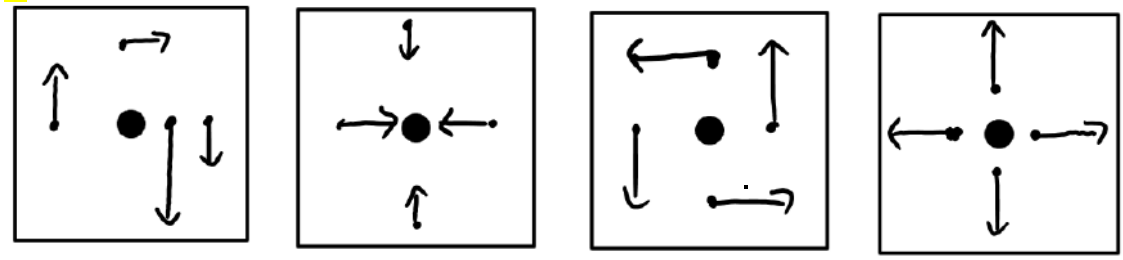
c.

d.

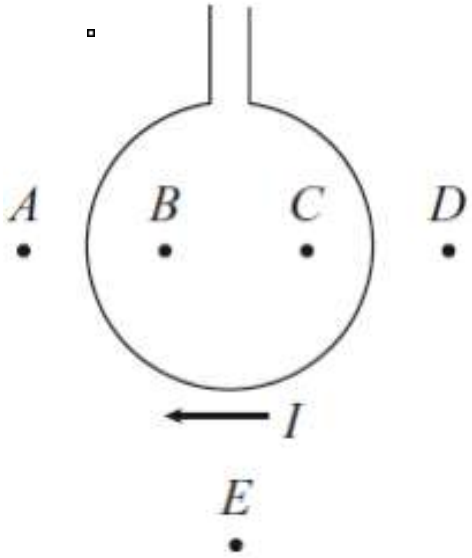
36. The picture below shows a current carrying wire oriented perpendicular to the page. Assume the current is moving into the page. Sketch 4 $\vec{B}$-field vectors around the wire.



a. b. c. d.

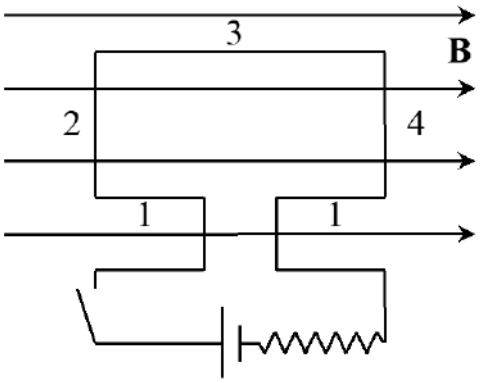


37. Current runs through the loop as indicated in the image below. Determine the direction of the magnetic field at location C.



a. Into the page
b. Out of the page
c. To the right
d. To the left
e. Up
f. Down

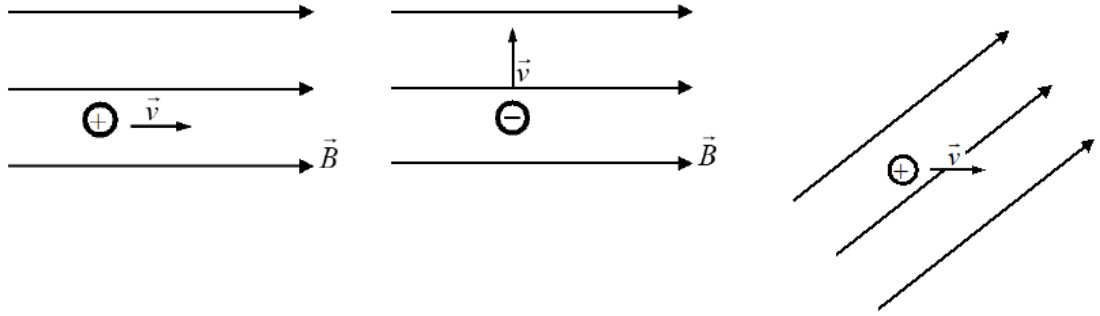
38. For the circuit drawn below, determine the direction of the force exerted by the external magnetic field on each side of the loop when the switch is closed.



e. Side 1: F = up ; side 2: out of the page; side 3: F = down; side 4: into the page
f. Side 1: F = down ; side 2: into the page; side 3: F = up; side 4: out of the page
g. Side 1: F = 0 ; side 2: out of the page; side 3: F = 0; side 4: into the page
h. Side 1: F = 0 ; side 2: into the page; side 3: F = 0; side 4: out of the page

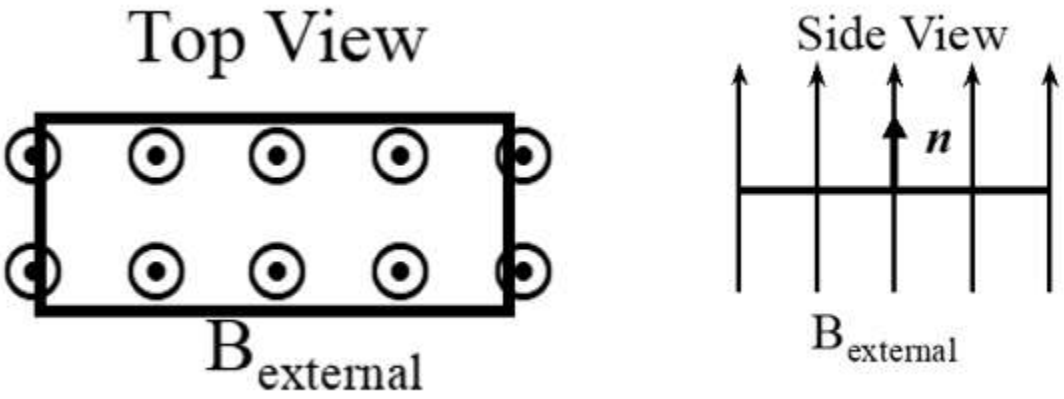
39. Objects with the same magnitude charge move through external B-fields of the same strength. Rank the magnitudes of the force exerted on the moving charged objects for the three scenarios.

I. II. III.



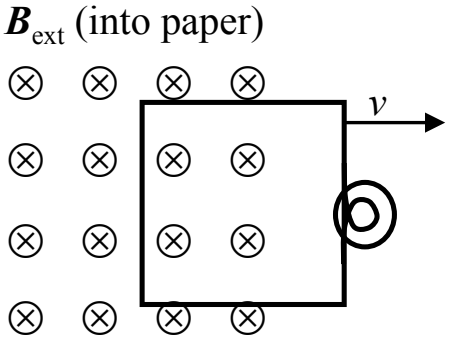
a. I > II > III
b. I = II > III
c. II > III > I
d. II > I > III
e. III > II > I

40. A loop of wire is in an external magnetic field, as shown below. What can be done to increase the flux passing through the loop?



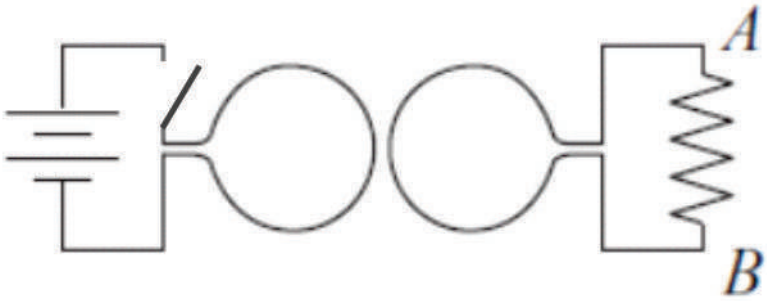
a. Move the loop to the right.
b. Move the loop vertically up (in the direction of the B-field).
c. Decrease the area of the loop.
d. Rotate the loop by 45 degrees.
e. None of the above.

41. A loop of wire with a lightbulb (no battery) moves through an external B-field as shown below. Determine the direction of the induced B-field and the direction of the induced current in the loop as it moves to the right.



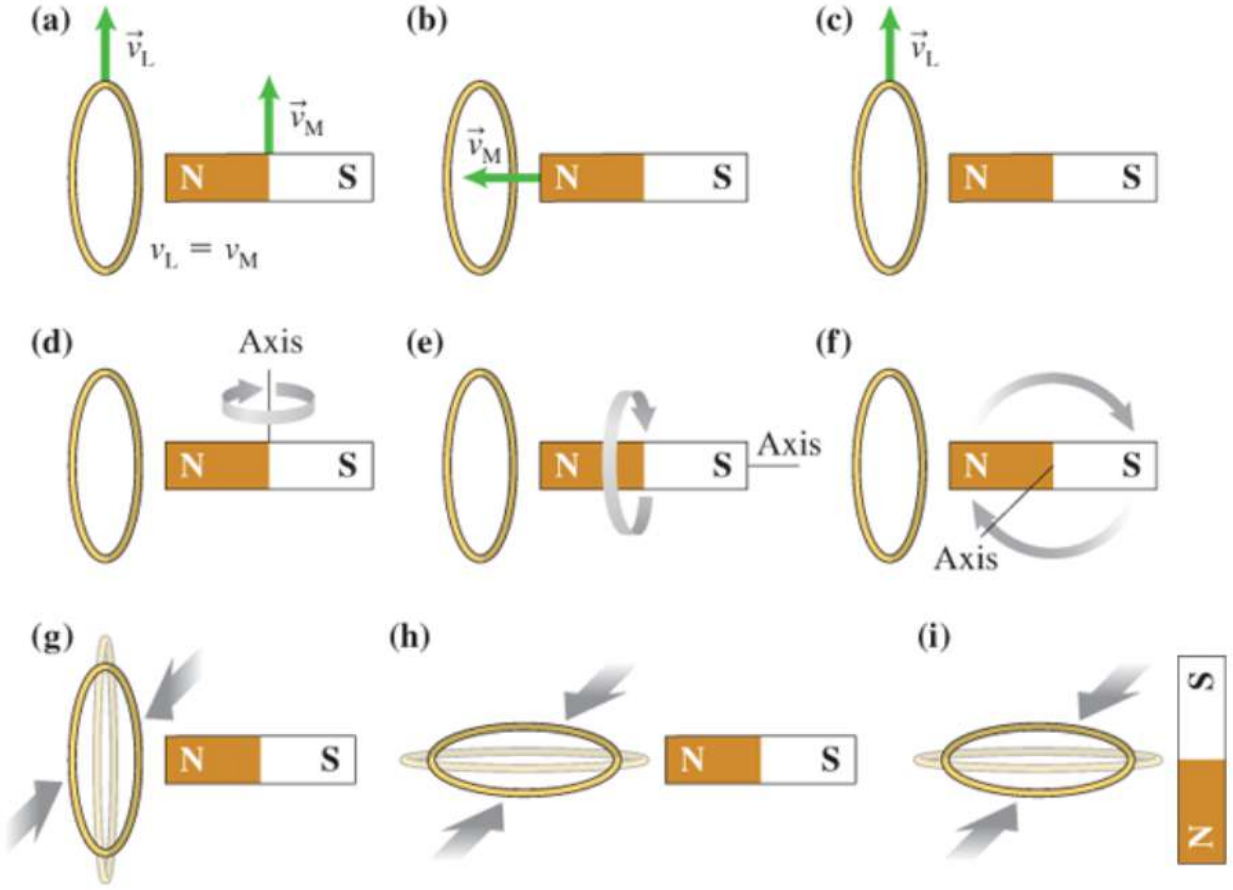
a. Induced B-field: Into the page; Induced current: clockwise
b. Induced B-field: Into the page; Induced current: counter clockwise
c. Induced B-field: Out of the page; Induced current: clockwise
d. Induced B-field: Out of the page; Induced current: counter clockwise

42. The figure below shows a circuit on the left and a loop of wire on the right. When the switch is first closed in the circuit on the left, determine the direction of the current induced in the loop on the right.



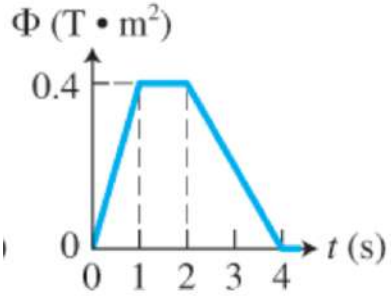
a. Across the resistor from A to B
b. Across the resistor from B to A
c. No current is induced

43. In which of the experiments with a loop and a bar magnet shown below is an electric current induced in the loop at the instant shown in the figures? In experiments (d) to (f), the magnet rotates around the given axis; in (g) to (i), the loop collapses as indicated by the arrows.



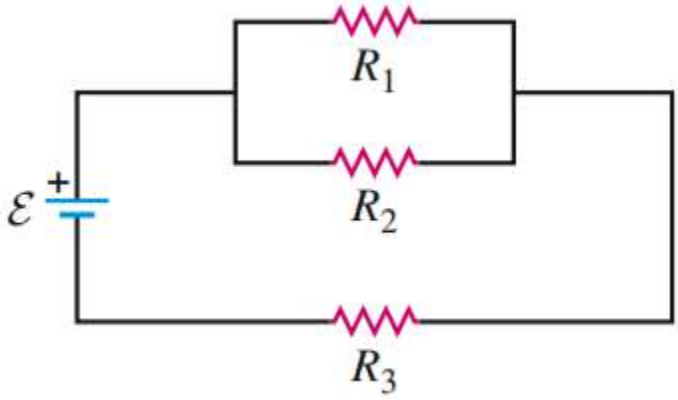
Answer: b, c, d, f, g, i

44. The magnetic flux through a coil is changing as shown in the figure below. At which times is the magnitude of the induced current through the coil the greatest?



a. 0-1 s
b. 0-2 s
c. 1-2 s
d. 2-4 s

45. In the circuit below, $R_1 = 3.00\ \Omega$, $R_2 = 6.00\ \Omega$, and $R_3 = 5.00\ \Omega$. The battery has negligible internal resistance. The current I_2 through R_2 is 4.00 A. (a) What are the currents I_1 and I_3? (b) What is the potential difference across the battery?



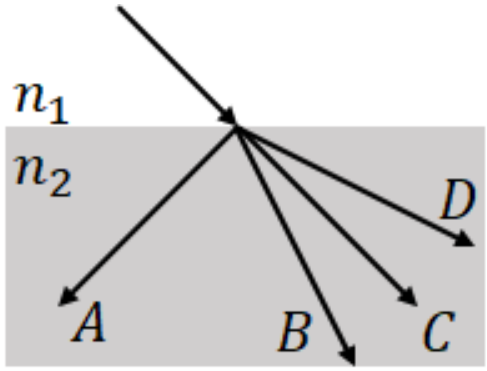
46. You fix a point-like light source 3.0 m away from a large screen and hold a basketball 1.0 m away from the screen so that the line connecting the center of the light source and the center of the basketball is perpendicular to the screen. You observe a shadow of the basketball on the screen. Select **two** correct statements.
    a. Moving the light source away from the screen will produce a larger shadow.
    b. Moving the basketball closer to the screen will produce a smaller shadow.
    c. Moving the basketball and the light source away from the screen (while keeping the distance between the light source and the basketball fixed) will not change the size of the shadow.
    d. Moving the light source up will result in moving the shadow down.
    e. Moving the basketball up will result in moving the shadow down.

47. A light ray travels through air and then passes through a rectangular glass block. It exits
    a. parallel to the original direction.

b. bent toward the normal line.
c. along the identical path that it entered the block.
d. bent away from the normal.

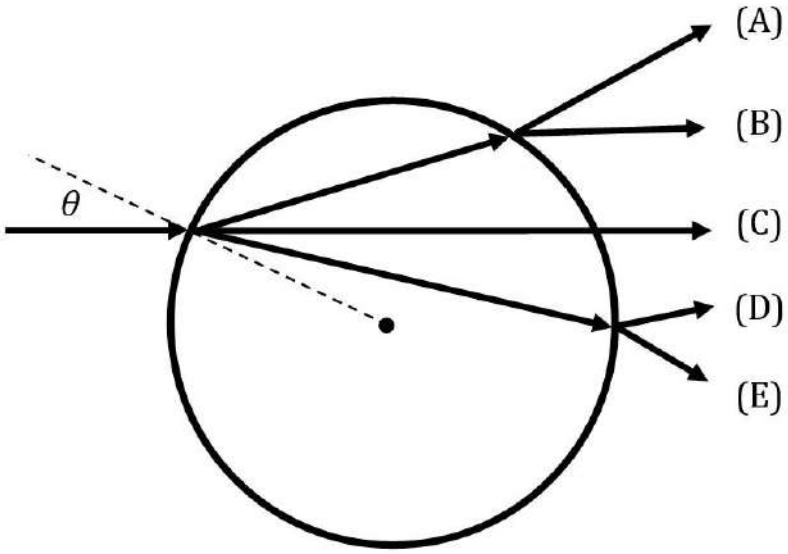
48. We can observe total internal reflection when light travels
a. From air to glass.
b. From water to glass.
c. From glass to water.
d. From air to water to glass.

49. A light ray is incident from a medium of refractive index n_1 to a medium of refractive index n_2, in which $n_1 < n_2$. Which of the subsequent paths shown below will the light follow?



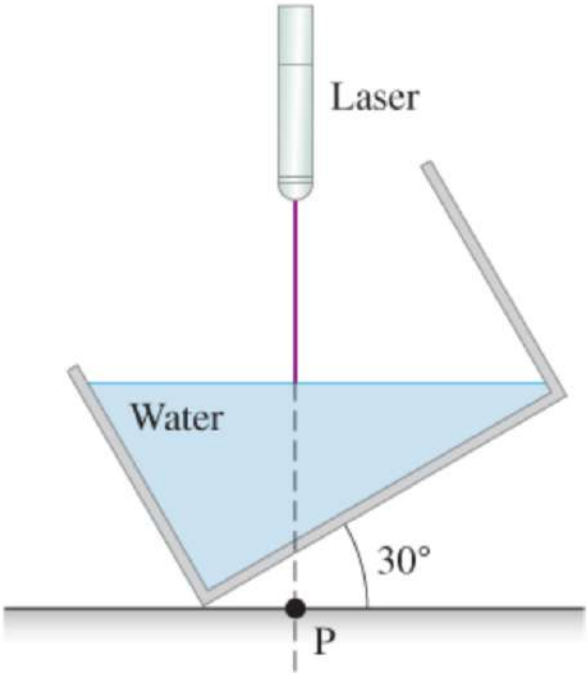
a. A
b. B
c. C
d. D

50. A light ray traveling through a piece of glass strikes a spherical air bubble at an angle of incidence θ, as shown below. Which path is possible? Select all that apply



a. A
b. B
c. C
d. D
e. E

51. You point a laser beam perpendicularly to the surface of water in a glass aquarium that is tilted at 30º and point P lies directly under the laser (see figure below). Where will you observe the laser beam hitting the table? Ignore any effects of the glass on the beam path.



a. At point P
b. To the right of point P
c. To the left of point P
d. The laser beam will not hit the table because it will undergo total internal reflection

52. A beam of light passes from glass with refractive index 1.58 into water with a refractive index 1.33. The angle of the refracted ray in water is 58º. Draw a sketch of the situation showing the interface between the media, the normal line, the incident ray, the reflected ray, the refracted ray, and the angles of these rays relative to the normal line.

53. A plane mirror produces an image of an object that is which of the following?
a. Real and the same size
b. Real and smaller
c. Virtual and the same size
d. Virtual and smaller

54. The focal length of a glass lens in air is 10 cm. When the lens is submerged in water, what is its new focal length?
a. Less than 10 cm
b. 10 cm
c. More than 10 cm
d. Not enough information to answer

55. Which of the following changes will result in decreasing the focal length of a concave mirror?
    a. Increase the radius of curvature of the mirror.
    b. Decrease the radius of curvature of the mirror.
    c. Immerse the mirror in water.
    d. Reduce the diameter of the mirror without changing the curvature.

56. Suppose you wanted to start a fire using a mirror to focus sunlight. Which of the following statements is most accurate?
    a. It would be best to use a plane mirror.
    b. It would be best to use a convex mirror.
    c. It would be best to use a concave mirror with the object to be ignited positioned at the center of curvature of the mirror.
    d. It would be best to use a concave mirror with the object to be ignited positioned halfway between the mirror and its center of curvature.

57. An object is placed to the left of a spherical mirror, in front of the mirror. If the image of the object is formed on the right side of the mirror, which of the following statements must be true? Select all answers that apply.
    a. The image is upright, and the mirror must be convex
    b. The image is inverted and real, and the mirror must be convex
    c. The image is upright, and the mirror must be concave
    d. The image is upright and virtual
    e. The mirror could be either concave or convex

58. You wish to order a mirror for shaving or makeup. The mirror should produce an image that is upright and magnified by a factor of 2.0 when held 15 cm from your face. What type and focal length mirror should you order? Support your answer with mathematics and a carefully drawn ray diagram.

59. To photograph a landscape 2.0 km wide from a height of 5.0 km, Joe uses an aerial camera with a lens of 0.40-m focal length. What is the width of the image on the detector surface?

60. Make a rough graph of image distance versus object distance for a convex lens with a focal length of 20cm as the object distance varies from infinity to zero.

61. What does the resolution limit of an optical system depend on? Choose all answers that are correct.
    a. The wavelength of light
    b. The diameter of the aperture
    c. The distance to the object being viewed
    d. The distance from the aperture to the light detectors

62. You shine a green laser beam $(\lambda = 530\text{nm})$ on a double slit apparatus and observe the interference pattern produced on a screen. Which of the following changes to the experiment (keeping the other parameters constant) could increase the total distance between each bright spot in the pattern? Select all that are correct.
    a. Increasing the distance between the slits
    b. Decreasing the distance between the slits
    c. Using a red laser $(\lambda = 650\text{nm})$
    d. Using a blue laser $(\lambda = 450\text{nm})$
    e. Increasing the distance between the laser and the slits
    f. Decreasing the distance between the laser and the slits
    g. Increasing the distance between the slits and the screen
    h. Decreasing the distance between the slits and the screen

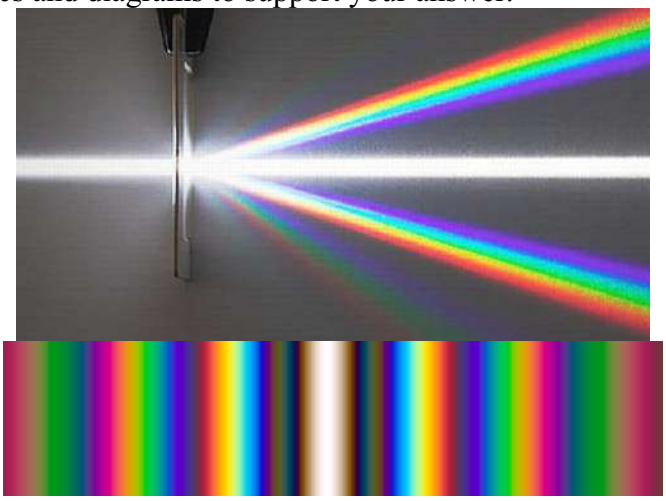
63. A double-slit diffraction experiment is set up so that an interference pattern of bright and dark fringes appears on a screen. Now, a sheet of glass is placed in front of one of the slits. The thickness of the glass is such that the light coming from the two slits is exactly ***out of phase*** upon being emitted. What will happen to the resulting pattern on the screen?
    a. The screen will be completely dark
    b. The screen will show one bright band along the central axis only
    c. The screen will show the same pattern, but with the bright and dark spots in opposite locations
    d. The screen will show only two bright spots, separated by a central dark spot

64. If the refractive index of a material is 2, this means that light travels
    a. 2 times as fast in air as it does in vacuum
    b. 2 times as fast in the material as it does in air
    c. 2 times as fast vacuum as it does in the material
    d. 2 times as fast in the material as it does in vacuum

65. In a double-slit interference experiment you are asked to use light of different wavelengths and determine the separation between adjacent bright spots. You observe that this separation is greatest when you illuminate the double slit with
    a. Blue light
    b. Green light
    c. Yellow light
    d. Red light
    e. The separation is the same for all wavelengths

66. In a single-slit diffraction experiment, the width of the slit through which light passes is reduced. What happens to the width of the central bright spot in the resulting diffraction pattern?
    a. It stays the same
    b. It becomes narrower
    c. It becomes wider
    d. It is impossible to say without knowing the wavelength of light used in the experiment

67. White light passing through a single slit produces a white bright band at the center of the pattern on a screen and colored bands at the sides as seen in the pictures below. Explain. Use mathematics and diagrams to support your answer.



68. Red laser light is passed through a double slit apparatus and produces an interference pattern on a screen 1 meter away. (a) Sketch the pattern that is produced by this experiment. (b) Explain what will happen to this pattern if one of the slits is blocked.