Physics 2nd Semester Test Review Packet

Name___*KEY*___

Circular Motion

1. Define:

rotation — to turn about an axis. Axis part of the object.

revolution — to move in a circular or curving course.

linear speed — straight speed. $s = \frac{d}{t}$

rotational speed — meas. # of circles/time. RPM's. Equal for all parts of the circle. Spinning cd

2. What is linear speed called when something moves in a circle? tangential velocity

3. When you whirl a can at the end of a string in a circular path, what is the direction of the force that acts on the can?
inward, towards center

4. What is the equation for acceleration for uniform circular motion? $a_c = \frac{v_t^2}{r}$ (m/s^2)

5. What is the equation for Centripetal force? $F_c = ma_c$ or $F_c = \frac{m \cdot v_t^2}{r}$ (N)

6. Calculate the tangential velocity of an object traveling in a circle with a period of 6s and a radius of 4m?

$$v_t = \frac{2\pi r}{t} = \frac{2\pi(4m)}{6\,sec} = \boxed{4.19\ m/s}$$

7. The moon revolves in its orbit at a distance of 3.84 x 10⁸ meters from the center of the Earth. The mass of the Earth is 5.98 x 10²⁴ kilograms. What is the tangential velocity of the moon in its orbit?

$$v_t = \sqrt{\frac{Gm}{r}} \quad \sqrt{\frac{(6.67 \times 10^{-11})(5.98 \times 10^{24})}{3.84 \times 10^8}} = \boxed{1020\ m/s}$$

a. If the moon were farther from the Earth, would its tangential velocity increase, decrease, or remain constant? Why?

decrease... inverse rel. $v_t \sim \frac{1}{r}$

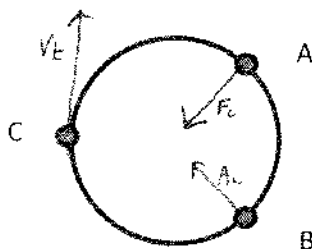b. If the moon were more massive, would its tangential velocity increase, decrease, or remain constant? Why?

remain constant... only mass that matters is center mass

8. In the diagram at the right, draw vector arrows that indicate the following for an object that is moving in a clockwise circle.

a. the net force at point A

b. The acceleration at point B

c. The velocity at point C

9. Define:

force Push or Pull. $F = ma$

torque Force that causes rotation $T = F_\perp \cdot d$

What are the units of force? Newtons (N)

What are the units of torque? Newton-meters (N-m)

10. In terms of center of gravity, support base, and torque, why can't you stand with your heels and back to the wall and then bend over to touch your toes without falling over?
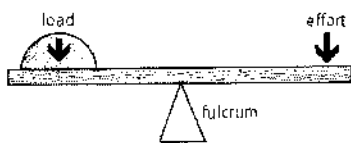
CG extends beyond your support base applying a torque which causes you to fall over.

11. Calculate the torque produced by a 50-N perpendicular force at the end of a 0.2-m-long wrench.

$T = F_\perp \cdot d$ $50N \cdot 0.2m = \boxed{10 \ N\text{-}m}$

a. Calculate the torque produced by the same 50-N force when a pipe extends the length of the wrench to 0.5 m. $T = F_\perp \cdot d$ $50N \cdot 0.5m = \boxed{25 \ N\text{-}m}$

load   effort   fulcrum   12. If a 200-g mass is placed 30 cm from the fulcrum, where should a 500-g mass be placed so that the system balances?

$T_1 = T_2$

$200g \cdot 30cm = 500g \cdot x$

$\boxed{d = 12 cm}$

Universal Gravitation

13. Why did Newton think that a force must act on the moon?

Because its falling around the Earth

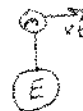14. What did Newton conclude about the force that pulls apples to the ground and the force that holds the moon in orbit? Same force... gravity

15. If the moon falls, why doesn't it get closer to Earth?

It has sufficient tangential velocity to keep falling around the Earth

16. Define tangential velocity?

Velocity that is at right angles to the radius... tangent

17. Since the planets are pulled to the sun by gravitational attraction, why don't they simply crash into the sun?

V_t

18. What did Newton say about Universal Gravitation?

Everything that has mass also has gravity ... universal.

19. What is the equation to calculate the force of gravity between two objects?

$F_g = \dfrac{G m_1 m_2}{d^2}$

20. What are the units? N

21. What does the very small value of the gravitational constant G (in standard units) tell us about the strength of gravitational forces?   Weak $\llcorner\ 6.67 \times 10^{-11}$

22. How is the force of gravity affected when distances between two objects is doubled? $F_g = \frac{1}{2^2}$: $F_g = \frac{1}{4}$

a. Tripled? $F_g = \frac{1}{3^2}$ so $F_g = \frac{1}{9}$

b. Why does this occur? Include a formula to support your answer.

$F_g = \frac{G m_1 m_2}{d^2}$ Inverse relationship
                              $F_g \downarrow - d \uparrow$ $F_g = \frac{1}{d^2}$

23. If the gravitational force of the sun on the planets suddenly disappeared, in what kind of paths would the planets move?   straight on, tangent to the sun.

24. Two bowling balls each have a mass of 6.8 kg. They are located next to each other with their centers .218 m apart. What gravitational force do they exert on each other?

$F_g = \frac{G m_1 m_2}{d^2}$ $\frac{6.67 \times 10^{-11} \cdot (6.8)^2}{(.218)^2}$ = $\boxed{6.5 \times 10^{-8} N}$

Gravitational Interactions

25. Upon what quantities does the acceleration of gravity on the surfaces of various planets depend?
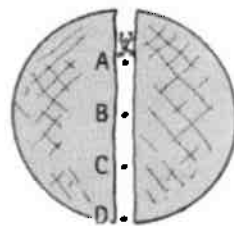
$Ag = \frac{G \cdot m}{r^2}$ mass + radius

26. How does the gravitational field surrounding Earth vary with increasing distance?

$\uparrow$ dist — $\downarrow$ F_g

27. Where is your weight greatest- at the surface of the Earth, deep below the surface, or above the surface? $\llcorner$ greatest

28. Why would your weight be less if you were deep beneath Earth's surface?   gravitational pull is less because of the surrounding mass

29. Where in an elliptical orbit is the speed of a satellite maximum? Where is it minimum? - farthest from planet
                              $\llcorner$ closest to
                                  planet

30. This question reviews several concepts of mechanics. A satellite travels the elliptical path as shown below. At which of the positions A through D does the satellite experience the maximum:

 a gravitational force?   A

b. Speed? A

c. Kinetic energy? A

d. Gravitational potential energy? C

e. Acceleration? A
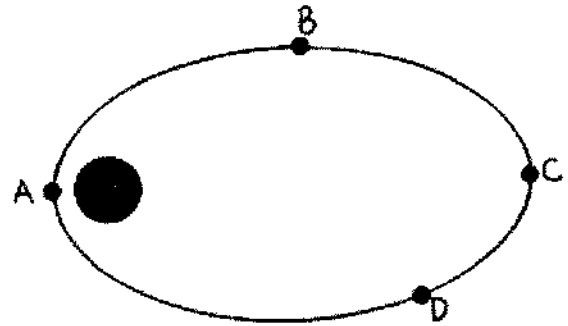
Waves

31. Label and distinguish among these different parts of a wave: amplitude, crest, trough, and wavelength.
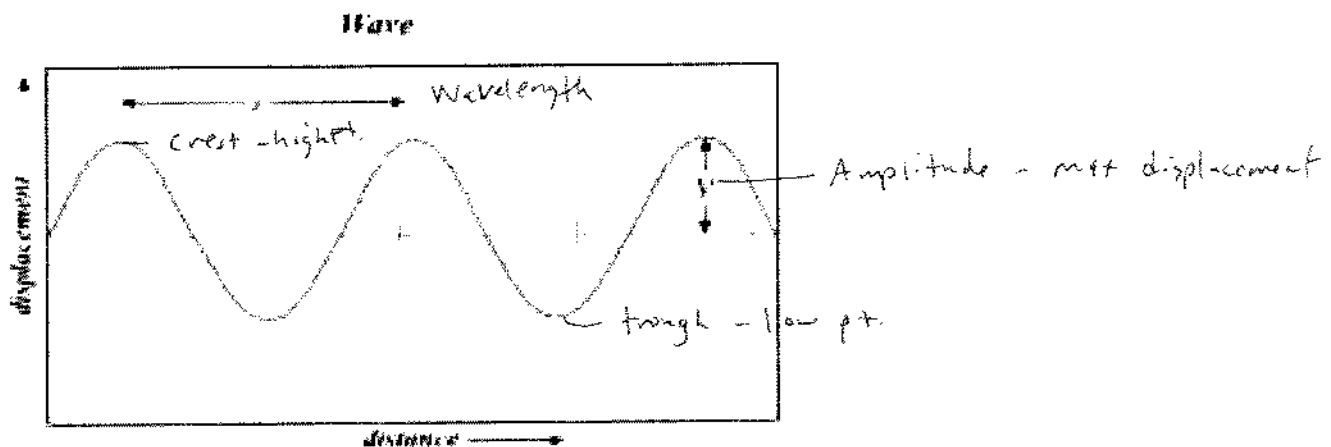
32. What is the frequency if the time in the drawing represents 2 seconds? 2.5 waves / 2 sec. = $\boxed{1.25 \text{ Hz}}$

a. What is the period? $T = \frac{1}{f} = \frac{1}{1.25} = \boxed{.8 \text{ sec}}$

33. Distinguish between the period and the frequency of a vibration or a wave. How do they relate to one another?
time for a complete wave → waves/second   inverse rel.
(sec)   (Hz) $T = \frac{1}{f}$ $f = \frac{1}{T}$

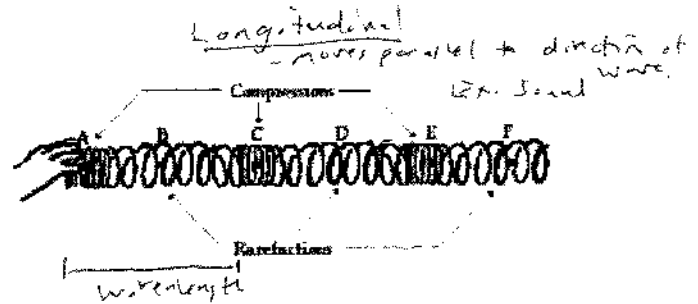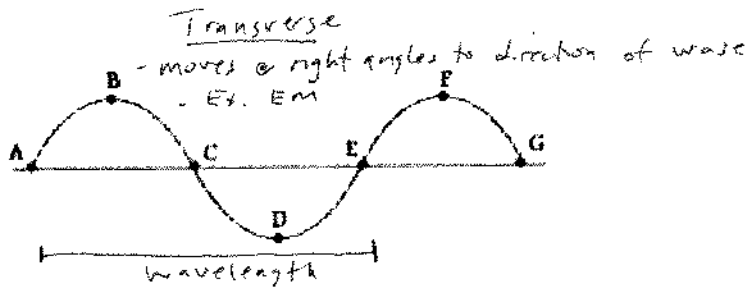34. Does the medium in which a wave travels move along with the wave itself? Defend your answer.
No, energy moves.

35. How does the speed of a wave relate to its wavelength and frequency?
$v = f\lambda$

36. As the frequency of sound is increased, does the wavelength increase or decrease? Give an example. Two musical instruments.
At given velocity, if freq ↑, then λ ↓

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37. Distinguish between a transverse wave and a longitudinal wave. Indicate the interval(s) which represents one full wavelength on both types of waves.

Transverse
- moves @ right angles to direction of wave
- Ex. EM

Longitudinal
- moves parallel to direction of wave
- Ex. Sound

38. New York's 300-m high Citicorp tower oscillates in the wind with a period of 6.80 s. Calculate its frequency of vibration.

$$F = \frac{1}{T} = \frac{1}{6.8 sec} = \boxed{.15 Hz}$$

39. Calculate the speed of waves in a puddle that are 0.15 m apart and made by tapping the water surface twice each second.

$$V = f\lambda \qquad 2 Hz \cdot .15m = \boxed{.3 \, m/s}$$

40. What is the source of all sounds?   vibration caused by a force.

41. How does pitch relate to frequency?   Directly

42. What is the average frequency range of a young person's hearing?   20 - 20,000 Hz.

43. Define:
   infrasonic $< 20 Hz$
   ultrasonic sound $> 20,000 Hz$
   compressions high pressure, regions of a longitudinal wave
   rarefactions low pressure
   Constructive interference Reinforcement, in phase. Crests overlap.
   Destructive interference Cancellation, out of phase. Crest of 1 wave overlaps w/ trough of another wave.

44. How are compressions and rarefactions produced?   vibration — sound wave (longitudinal wave)

45. Light can travel through a vacuum, as is evidenced when you see the sun or the moon. Can sound travel through a vacuum also? Explain why or why not.   NO, need a medium for particles to vibrate

46. Why does sound travel faster in solids and liquids than in gases?   particles closer together to transfer v.

47. What is the wavelength, in meters, of the sound produced by a tuning fork that has a frequency of 320 Hz? The temperature of the air is 15 °C.

$$V_{air} = 331 + .6 \times T_c$$
$$= 331 + (.6 \times 15)$$
$$v = 340 \, m/s$$

$$v = f\lambda$$
$$340 \, m/s = 320 Hz \cdot \lambda$$
$$\boxed{\lambda = 1.06 m}$$

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48. Sound waves travel at approximately 340 m/s. What is the wavelength of a sound with a frequency of 20 Hz (the lowest note we can hear as a sound)?

$$v = f \lambda$$
$$340 = 20 \cdot \lambda$$
$$\boxed{\lambda = 17\,m}$$

a. What is the wavelength of a sound with a frequency of 20 kHz (the highest note we can hear)?

$$v = f \lambda$$
$$340 = 20,000\,Hz \cdot \lambda$$
$$\boxed{\lambda = .017\,m}$$

49. Suppose you wish to produce a sound wave that has a wavelength of 1 m in room temperature air. What would its frequency be?

$$v = f \lambda$$
$$340 = f \cdot 1\,m$$
$$\boxed{f = 340\,Hz}$$

Light and Color

50. List the types of electromagnetic waves in order from the lowest frequencies to the highest frequencies.

Radio - Microwaves - Infrared - Visible - UV - X-rays - Gamma

51. What do all of these waves have in common?

EM waves, travel @ 3×10^8 m/s, transverse

52. What are their differences?

Freq & wavelengths

53. What is the source of electromagnetic waves?

vibrating electrons

54. What is the speed of electromagnetic waves?

3×10^8 m/s

55. What is a red shift from a star, and how does it provide evidence for the big band?

Indicating longer wavelengths (red) which means moving away... expanding Universe

56. How do the frequencies of infrared, visible, and ultraviolet light compare?

↑ in freq. from infrared - visible - uv

57. Different bells and tuning forks have their own natural vibrations and emit their own tones when struck. How is this analogous to light?

Categories to light (EM spectrum) has diff. freq. as do diff. tuning forks/bells

58. An infrared wave has a wavelength of 7.1 x 10-7 m. What is its frequency?

$$v = f \lambda \qquad 3\times10^8 \tfrac{m}{s} = f \cdot 7.1\times10^{-7}\,m$$
$$\boxed{f = 4.23 \times 10^{14}\,Hz}$$

59. What is the wavelength of a 512 Hz sound wave traveling at 345 m/s in air?

$$v = f \lambda \qquad 345 = 512\,Hz \cdot \lambda$$
$$\boxed{\lambda = .67\,m}$$

60. What evidence can you cite to support the idea that light can travel through a vacuum?

EM waves don't require a medium   Particle theory of light... photons!
Ex. communication thru space.

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61. List the order of the colors in the spectrum. *ROYGBIV*

a. What is the low energy end? *Reds*

b. What is the high energy end? *Blues*

62. What colors of spots are lit on a television tube to give it full color? *R G B*

63. What colors of ink are used to print full-color pictures in books and magazines? *C M Y*

64. Bart uses a helium-neon laser to align his telescope. The laser emits red light with a wavelength of 633 nm. What is the wavelength of the helium-neon laser in meters?

$$\frac{633 \ nm}{1} \cdot \frac{10^{-9} m}{1 \ nm} = \boxed{6.33 \times 10^{-7} \ m}$$

a. How much energy is given off by each photon of laser light?

$$E = \frac{h \cdot c}{\lambda} \qquad \frac{6.63 \times 10^{-34} \cdot 3 \times 10^8}{6.33 \times 10^{-7}} = \boxed{3.14 \times 10^{-19} \ J}$$

65. The KRRO broadcasts at 103.7 MHz (FM). What is the frequency of the KRRO's broadcast in Hz?

$$\frac{103.7 \ mHz}{1} \cdot \frac{10^6 \ Hz}{1 \ mHz} = \boxed{103,700,000 \ Hz}$$

a. Calculate the wavelength of the KRRO's broadcast.

$$v = f \lambda \qquad 3 \times 10^8 = 103,700,000 \cdot \lambda \qquad \boxed{\lambda = 2.89 \ m}$$

66. Name one property that reinforces the particle nature of light. *light is made up of photons.*

67. Name one property that reinforces the wave nature of light. *constructive / destructive interference.*

68. A pendulum makes exactly 40 vibrations in 20.0s. What is it's period?

$$Freq = vibes/sec. \qquad \frac{40}{20} = 2 Hz \qquad T = \frac{1}{f} = \boxed{\frac{1}{2} \ sec}$$

69. A wave has a time period of 0.005 seconds. What would the frequency be in Hertz?

$$f = \frac{1}{T} = \frac{1}{.005} = \boxed{200 \ Hz}$$

Electrostatics

70. Which force- gravitational or (electrical) repels as well as attracts?

71. Gravitational forces depend on the property called mass. What comparable property underlines electrical forces?
Charge

72. How do protons and electrons differ in their charge?
+   −

73. How do like charges behave? *repel*

74. How do unlike charges behave? *attract*

75. How is Coulomb's law similar to Newton's law of gravitation? $F_e = \dfrac{kq_1 q_2}{d^2}$ vs. $F_g = \dfrac{Gm_1 m_2}{d^2}$

76. In a grain elevator on Farmer Judd's farm, kernels of grain become electrically charged while falling through the elevator. One kernel of grain is charged with $+2.0 \times 10^{-16}$ C, while another holds $+5.0 \times 10^{-16}$ C. Calculate the electrostatic force between the kernels when they are separated by .05 m.

$$F_e = \frac{kq_1 q_2}{d^2} \qquad \frac{(9 \times 10^9)(2 \times 10^{-16})(5 \times 10^{-16})}{(.05)^2} = 3.6 \times 10^{-19} N \quad repel$$

77. Why are metals good conductors?

mobile e^-

78. Why are materials such as rubber, glass and plastic good insulators?

e^- are not mobile

Electricity

79. Define and give units:

electric current - Flow of e^- (A)

ampere - unit for electric current (Amps)

voltage - push on e^- (V)

resistance - opposition to the flow of e^- (Ohms Ω)

work = energy (J)

power rate at which work is done. $P = IV$ (Watts W)

energy = power · time   Kilowatt · hours (kwh)

80. What is Ohm's law? $I = \dfrac{V}{R}$ or $V = IR$

81. If the resistance of a circuit remains constant while the voltage across the circuit decreases to half its former value, what change occurs in the current?

$$I = \frac{V}{R} \qquad so \qquad \frac{V \cdot \frac{1}{2}}{R \; const} = I \; must \; go \; down \; by \; \frac{1}{2}$$

82. Which of these is a unit of power and which is a unit of electrical energy: a watt, a kilowatt, and a kilowatt-hour?

P   P   E

83. How many amperes flow through a 60-watt bulb when 120 volts are impressed across it?

$P = IV$ $60 W = I \cdot 120 V$

$$I = .5 A$$

8

84. A motor with an operating resistance of 32 ohms is connected to a voltage source. The current I the circuit is 3.8 A. What is the voltage of the source?

$V = IR$ $3.8A \cdot 32\Omega = \boxed{121.6 V}$

85. How much current moves through your fingers (resistance: 1200 ohms) if you touch them to the terminals of a 6-volt battery?

$I = \dfrac{V}{R}$ $\dfrac{6V}{1200\Omega} = \boxed{.005 A}$

86. Calculate the resistance of the filament in a lightbulb that carries 0.4 A when 3.0 V is impressed across it.

$V = IR$ $R = \dfrac{V}{I}$ $\dfrac{3V}{0.4 A} = \boxed{7.5 \Omega}$

87. Calculate the current in a 140-W electric blanket connected to a 120-V outlet.

$P = IV$ $\dfrac{140 W}{120V} = \boxed{1.17 A}$

88. How much voltage is required to make 2 amperes flow through a resistance of 8 ohms?

$V = IR$ $2 \cdot 8 = \boxed{16 V}$

89. An 8 amp electric heater operates on a 120V outlet. What is the power of the device?

$P = IV$ $8A \cdot 120V = \boxed{960 W}$

   a. Calculate the energy used for 4 hours.

   $E = P \cdot t$ $.960 KW \cdot 4 hrs = \boxed{3.84 \ KWh}$

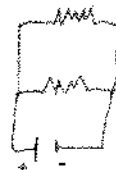 $\dfrac{960 W}{1} \cdot \dfrac{1 KW}{1000 W} = .960 KW$

   b. Calculate the cost to operate the electric heater if the cost per kilowatt-hour is 8 cents.

   $\$ = E \cdot rate$ $3.84 KWh \cdot (.08) = \boxed{31 ¢}$

90. Distinguish between a series circuit and a parallel circuit?

single pathway   multiple pathways

a. Draw a schematic for each.

91. If three lamps are connected in a series to a 6 volt battery, how many volts are impressed across each lamp?

2 Volts.   Voltage shared in series circuit.

92. If three lamps are connected in parallel to a 6-volt battery, how many volts are impressed across each lamp?

6 volts.   Get full voltage in parallel circuit.

93. In which case will there be more current in each of three lamps— if they are connected to the same battery in series or parallel? *Parallel* $\downarrow R - \uparrow I$

a. In which case will there be more voltage across each lamp?
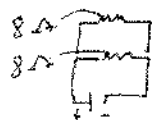*Parallel. Get full voltage / lamp.*

94. What happens to the total circuit resistance when more devices are added to a series circuit? To a parallel circuit?
Series — $R \uparrow$. Parallel — $R \downarrow$.

95. What is the total resistance of a pair of 8-ohm resistors in series? In parallel? Draw a schematic diagram of each.

Series $R_T = R_1 + R_2$ $\quad 8 + 8 = 16\,\Omega$

Parallel $R_T = \frac{1}{R_1} + \frac{1}{R_2}$ $\quad \frac{1}{8} + \frac{1}{8} = \frac{1}{4} = \frac{4}{1} = 4\,\Omega$

96. Why does the total circuit resistance decrease when more devices are added to a parallel circuit?
More pathways (branches) so less resistance

Electromagnetism

97. What is a magnetic domain? *Region of aligned atoms.*

98. Why do some pieces of iron behave as magnets, while other pieces of iron do not?
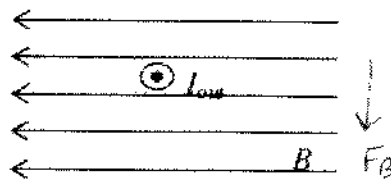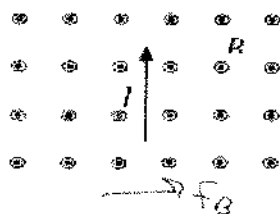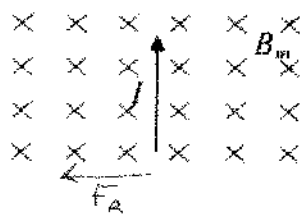*↳ magnetic domains are aligned.*

99. Why will dropping or heating a magnet weaken it?
Magnetic domains become randomized.

100. What is the right hand rule used for?
3D view of F_B, I, B

101. For each situation below, a current carrying wire runs through a magnetic field. Draw and label the direction of the magnetic force exerted on the wire.

102. A 6.0 V battery is connected to a wire of length .15 m and resistance of .10 Ω. Calculate the current flowing through the wire.

$I = \frac{V}{R}$ $\quad \frac{6\,V}{.10\,\Omega} = \boxed{60\,A}$

a) If the magnetic field is .025 T, calculate the magnetic force exerted on the wire.

$F_B = I \cdot L \cdot B$ $\quad 60\,A \times .15\,m \times .025\,T = \boxed{.225\,N}$

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103. A magnet moved into a coil of wire will induce voltage in the coil. What is the effect of moving a magnet into a coil with more loops? ↑ current

104. Define electromagnetic induction. Generation of a current by a Δ magnetic field.

105. What is a generator? mechanical energy to electrical energy

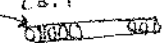106. What is a motor? electrical energy to mechanical energy

107. What would be needed to build each? coil of wire, magnets

108. A motor is characterized by three main ingredients: magnetic field, moving charges, and magnetic force. What are the three main ingredients that characterize a generator? magnet   wire
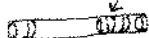same

109. How can a change in voltage in a coil of wire (the primary) be transferred to a neighboring coil of wire (the secondary) without physical contact? Combines electromagnetism + electromagnetic induction.
(elec - mag. field)   (Δ magnetic field - elec.)
changing

110. What does a step-up transformer step up—voltage, current, or energy?

111. How does the relative number of turns on the primary and the secondary coil in a transformer affect the step-up or step-down voltage factor?

more in the primary coil

$$\frac{Primary\ voltage}{\#\ of\ primary\ turns} = \frac{Secondary\ voltage}{\#\ of\ sec.\ turns}$$

more in the secondary coil

112. If the number of secondary turns is 10 times the number of primary turns, and the input voltage to the primary is 6 volts, how many volts will be induced in the secondary coil?

$$\frac{V_P}{T_P} = \frac{V_s}{T_s} \qquad \frac{6V}{1} = \frac{V_s}{10} \qquad = \boxed{V_s = 60V}$$

Nuclear Fusion

113. What is nuclear fusion? Energy is generated by fusing $H \rightarrow He$.

114. What is the mass that is created during a nuclear fusion turned into? Energy

115. Where does nuclear fusion occur in a star? core

116. Where do stars come from? Nebula - dust + gas

117. What is the most common element found in a star? Second most common?

H   He

118. What does the red shift tell us about the universe?

expanding

119. What is the Big Bang Theory?

Universe began as a single point + has been expanding ever since

120. What causes movement within the mantle?

Convection currents

121. How does the Earth generate internal thermal energy?

radioactive decay

122. Put the layers of the Earth in the correct order: mantle, inner core, crust outer core.

inner core
outer core
mantle