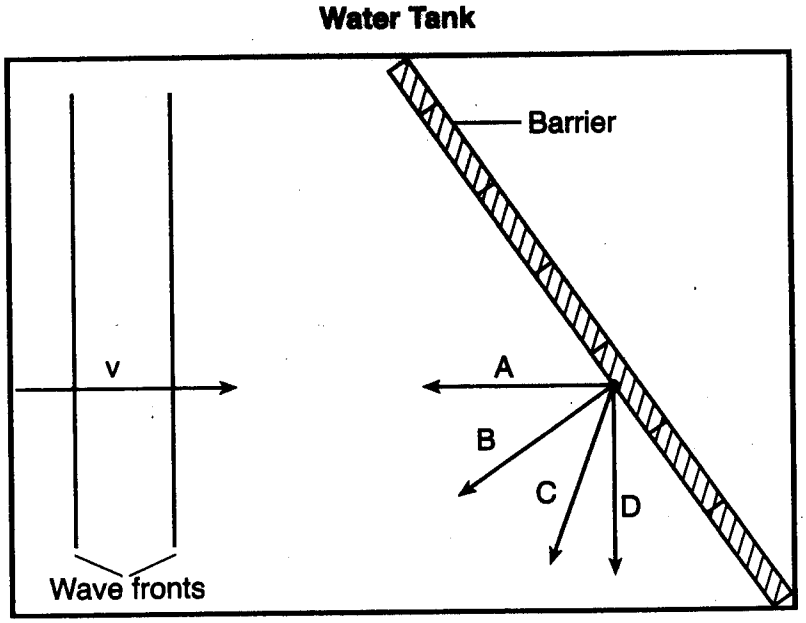
Waves, Light, & Modern
June 2011

Name_____

30 credits of 85 Possible
(35% of test)

16 The diagram below represents a view from above of a tank of water in which parallel wave fronts are traveling toward a barrier.



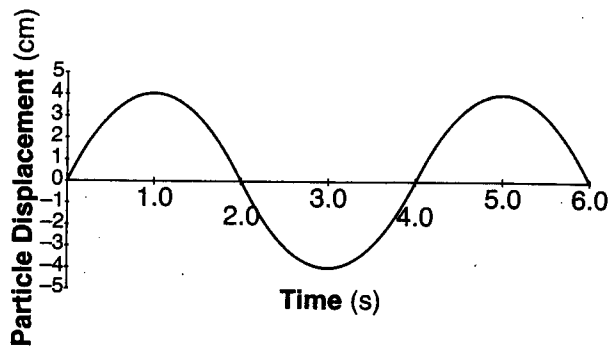
Which arrow represents the direction of travel for the wave fronts after being reflected from the barrier?

(1) *A*
(2) *B*
(3) *C*
(4) *D*

25 A pulse traveled the length of a stretched spring. The pulse transferred

(1) energy, only
(2) mass, only
(3) both energy and mass
(4) neither energy nor mass

26 The graph below represents the displacement of a particle in a medium over a period of time.



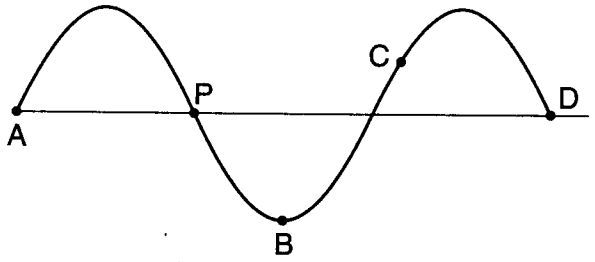
The amplitude of the wave is

(1) 4.0 s
(2) 6.0 s
(3) 8 cm
(4) 4 cm

27 What is the period of a water wave if 4.0 complete waves pass a fixed point in 10. seconds?

(1) 0.25 s
(2) 0.40 s
(3) 2.5 s
(4) 4.0 s

28 The diagram below represents a periodic wave.



Which point on the wave is 90° out of phase with point *P*?

(1) *A*
(2) *B*
(3) *C*
(4) *D*

29 What is the wavelength of a 256-hertz sound wave in air at STP?

(1) 1.17×10^{6} m
(2) 1.29 m
(3) 0.773 m
(4) 8.53×10^{-7} m

30 What is the minimum total energy released when an electron and its antiparticle (positron) annihilate each other?

(1) 1.64×10^{-13} J
(2) 8.20×10^{-14} J
(3) 5.47×10^{-22} J
(4) 2.73×10^{-22} J

31 Which statement correctly describes one characteristic of a sound wave?

(1) A sound wave can travel through a vacuum.
(2) A sound wave is a transverse wave.
(3) The amount of energy a sound wave transmits is directly related to the wave's amplitude.
(4) The amount of energy a sound wave transmits is inversely related to the wave's frequency.

32 A 256-hertz vibrating tuning fork is brought near a nonvibrating 256-hertz tuning fork. The second tuning fork begins to vibrate. Which phenomenon causes the nonvibrating tuning fork to begin to vibrate?

(1) resistance
(2) resonance
(3) refraction
(4) reflection

33 Astronauts traveling toward Earth in a fast-moving spacecraft receive a radio signal from an antenna on Earth. Compared to the frequency and wavelength of the radio signal emitted from the antenna, the radio signal received by the astronauts has a

(1) lower frequency and a shorter wavelength
(2) lower frequency and a longer wavelength
(3) higher frequency and a shorter wavelength
(4) higher frequency and a longer wavelength

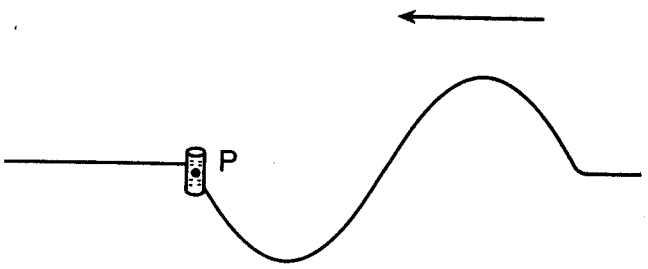
34 On the atomic level, energy and matter exhibit the characteristics of

(1) particles, only
(2) waves, only
(3) neither particles nor waves
(4) both particles and waves

35 Which particles are *not* affected by the strong force?

(1) hadrons
(2) protons
(3) neutrons
(4) electrons

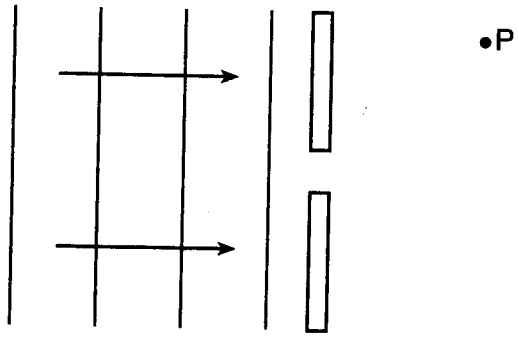
46 The diagram below represents a transverse water wave propagating toward the left. A cork is floating on the water's surface at point *P*.



In which direction will the cork move as the wave passes point *P*?

(1) up, then down, then up
(2) down, then up, then down
(3) left, then right, then left
(4) right, then left, then right

47 The diagram below shows a series of wave fronts approaching an opening in a barrier. Point *P* is located on the opposite side of the barrier.



The wave fronts reach point *P* as a result of

(1) resonance
(2) refraction
(3) reflection
(4) diffraction

48 The diagram below represents a standing wave.

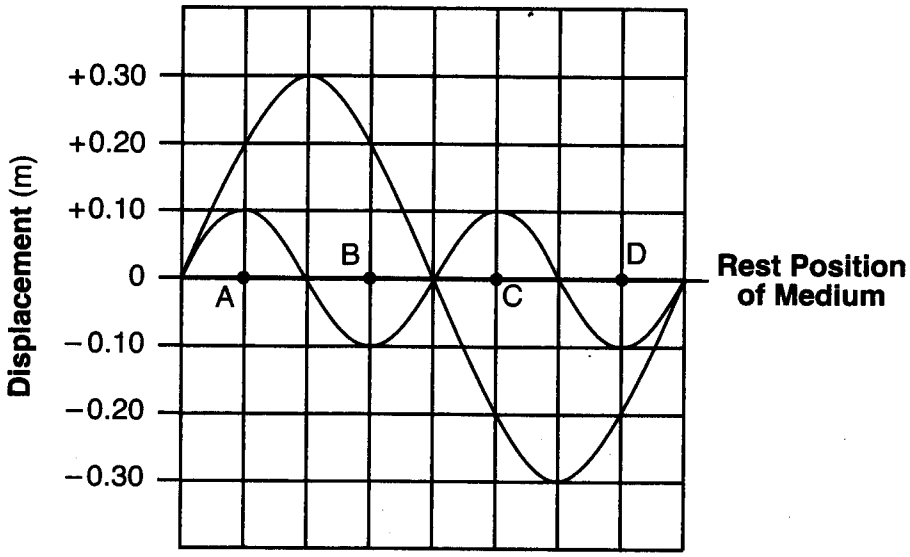
The number of nodes and antinodes shown in the diagram is

(1) 4 nodes and 5 antinodes
(2) 5 nodes and 6 antinodes
(3) 6 nodes and 5 antinodes
(4) 6 nodes and 10 antinodes

49 A deuterium nucleus consists of one proton and one neutron. The quark composition of a deuterium nucleus is

(1) 2 up quarks and 2 down quarks
(2) 2 up quarks and 4 down quarks
(3) 3 up quarks and 3 down quarks
(4) 4 up quarks and 2 down quarks

50 The diagram below shows two waves traveling in the same medium. Points *A*, *B*, *C*, and *D* are located along the rest position of the medium. The waves interfere to produce a resultant wave.



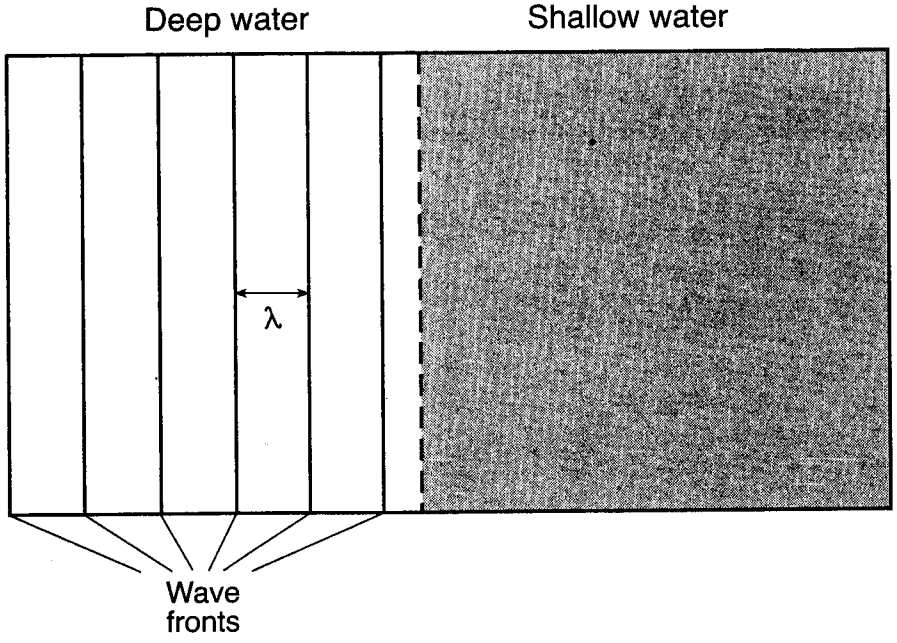
The superposition of the waves produces the greatest positive displacement of the medium from its rest position at point

(1) *A*
(2) *B*
(3) *C*
(4) *D*

62–63 An electromagnetic wave of wavelength 5.89×10^{-7} meter traveling through air is incident on an interface with corn oil. Calculate the wavelength of the electromagnetic wave in corn oil. [Show all work, including the equation and substitution with units.] [2]

64 The energy required to separate the 3 protons and 4 neutrons in the nucleus of a lithium atom is 39.3 megaelectronvolts. Determine the mass equivalent of this energy, in universal mass units. [1]

65 A wave generator having a constant frequency produces parallel wave fronts in a tank of water of two different depths. The diagram below represents the wave fronts in the deep water.



As the wave travels from the deep water into the shallow water, the speed of the waves decreases. On the diagram *in your answer booklet*, use a straightedge to draw *at least three* lines to represent the wave fronts, with appropriate spacing, in the shallow water. [1]

Base your answers to questions 77 through 80 on the information below.

A photon with a wavelength of 2.29×10^{-7} meter strikes a mercury atom in the ground state.

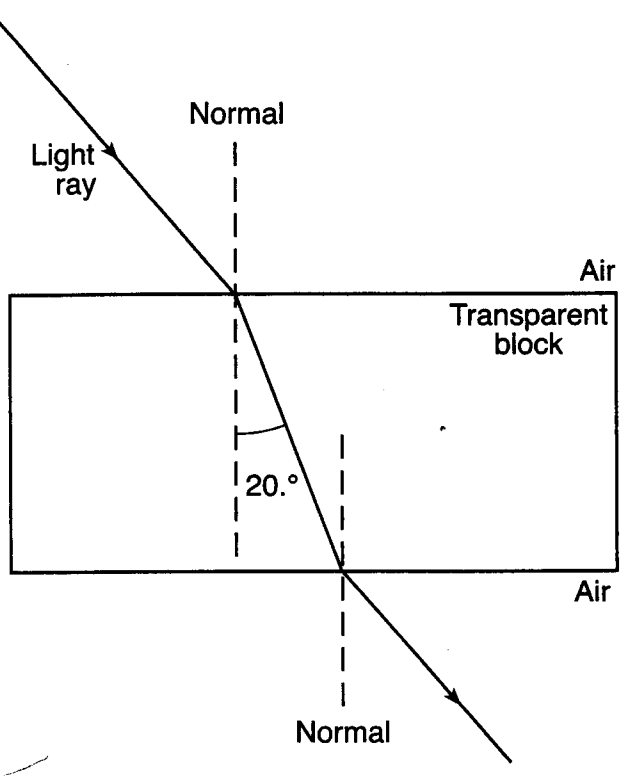
77–78 Calculate the energy, in joules, of this photon. [Show all work, including the equation and substitution with units.] [2]

79 Determine the energy, in electronvolts, of this photon. [1]

80 Based on your answer to question 79, state if this photon can be absorbed by the mercury atom. Explain your answer. [1]

Base your answers to questions 81 through 85 on the information below.

A ray of monochromatic light ($f = 5.09 \times 10^{14}$ Hz) passes through air and a rectangular transparent block, as shown in the diagram below.



81 Using a protractor, determine the angle of incidence of the light ray as it enters the transparent block from air. [1]

82–83 Calculate the absolute index of refraction for the medium of the transparent block. [Show all work, including the equation and substitution with units.] [2]

84–85 Calculate the speed of the light ray in the transparent block. [Show all work, including the equation and substitution with units.] [2]

Answers
light and Waves
June 2011

16 - 3
25 - 1
26 - 4
27 - 3
28 - 2
29 - 2
30 - 1
31 - 3
32 - 2
33 - 3
34 - 4
35 - 4
46 - 2
47 - 4
48 - 3
49 - 3
50 - 1

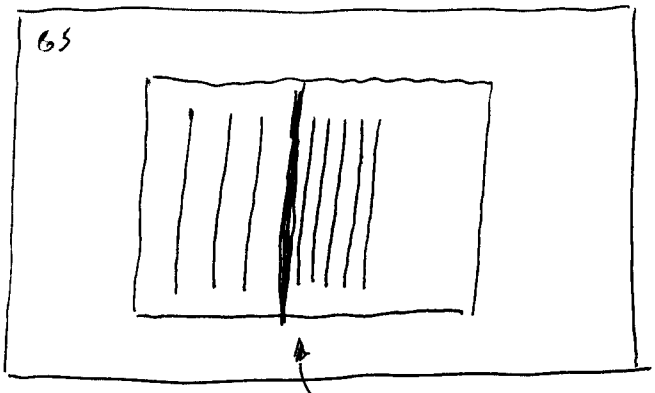
62 - 63

$$\frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2}$$

$$\frac{1.47}{1} = \frac{5.89 \times 10^{-7}\,m}{\lambda_2}$$

$\lambda_2 = 4 \times 10^{-7}\,m$

65



Waves get closer because speed goes down

77 - 78

$$E_{photon} = \frac{hc}{\lambda}$$

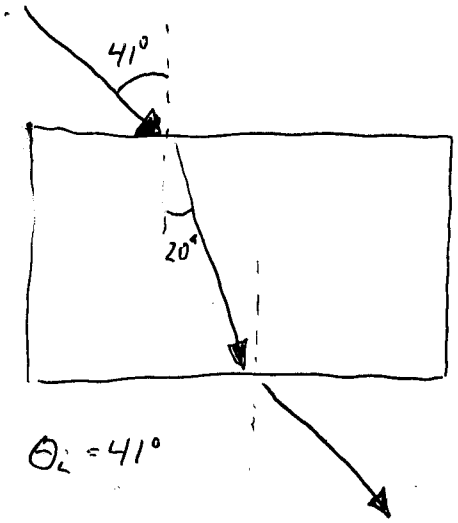
$$= \frac{6.63 \times 10^{-34}\,J \cdot s \left(3 \times 10^{8}\,m/s\right)}{2.29 \times 10^{-7}\,m}$$

$E = 8.7 \times 10^{-19}\,J$

79

$$\frac{8.7 \times 10^{-19}}{1.6 \times 10^{-19}} = 5.43\,ev$$

80 - Can be absorbed it has exact difference between a & d



81) - $\theta_i = 41°$

82 - 83) $n_1 \sin\theta_i = n_2 \sin\theta_r \Rightarrow 1 \sin 41° = n_2 \sin 20°$

$n_2 = 1.9$

84) $n = \frac{c}{v}$ $\quad 1.9 = \frac{3 \times 10^{8}\,m/s}{v}$ $\quad v = 1.6 \times 10^{8}\,m/s$