MR. RAICZAK

PHYSICS - CAP

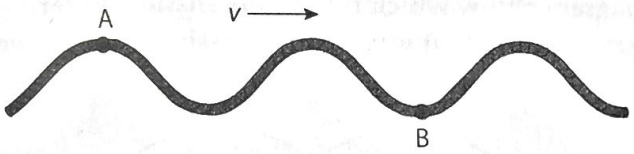
- USE ON-LINE RESOURCES
  - → COMPLETE TOPIC #5 REVIEW QUESTIONS
    - #1-111 p. 173-182

Directions

Review the Test-Taking Strategies section of this book. Then answer the following questions. Read each question carefully and answer with a correct choice or response.

Part A

1 A periodic wave travels through a rope, as shown in the diagram below.

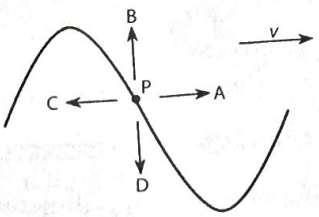


As the wave travels, what is transferred between points A and B?
(1) mass only
(2) energy only
(3) both mass and energy
(4) neither mass nor energy

2 In which wave type is the disturbance parallel to the direction of wave travel?
(1) torsional
(2) longitudinal
(3) transverse
(4) circular

3 A tuning fork oscillates with a frequency of 256 hertz after being struck by a rubber hammer. Which phrase best describes the sound waves produced by this oscillating tuning fork?
(1) electromagetic waves that require no medium for transmission
(2) electromagnetic waves that require a medium for transmission
(3) mechanical waves that require no medium for transmission
(4) mechanical waves that require a medium for transmission

4 The diagram below shows a transverse water wave moving in the direction shown by velocity vector v.



At the instant shown, a cork at point P on the water's surface is moving toward
(1) A
(2) B
(3) C
(4) D

5 The energy of a sound wave is most closely related to its
(1) period
(2) amplitude
(3) frequency
(4) wavelength

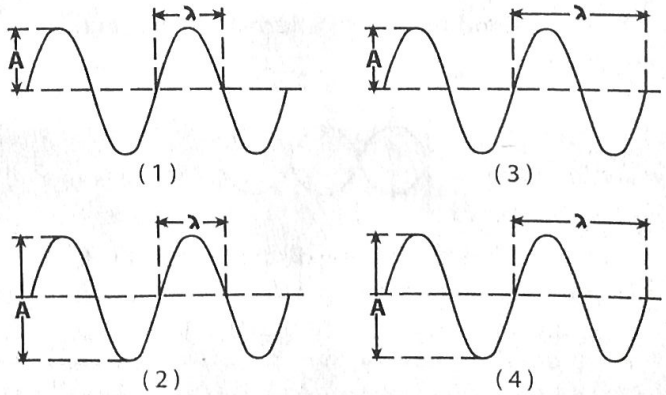
6 The product of a wave's frequency and its period is
(1) one
(2) its velocity
(3) its wavelength
(4) Planck's constant

7 What is the period of a wave with a frequency of 250 hertz?
(1) 1.2×10^{-3} s
(2) 2.5×10^{-3} s
(3) 9.0×10^{-3} s
(4) 4.0×10^{-3} s

8 The reciprocal of the frequency of a periodic wave is the wave's
(1) period
(2) amplitude
(3) intensity
(4) speed

9 Two points on a transverse wave that have the same magnitude of displacement from equilibrium are in phase if the points also have
(1) the same direction of displacement and the same direction of motion
(2) the same direction of displacement and the opposite direction of motion
(3) the opposite direction of displacement and the same direction of motion
(4) the opposite direction of displacement and the opposite direction of motion

10 Which wave diagram has *both* wavelength (λ) and amplitude (A) labeled correctly?



11 A source of sound waves approaches a stationary observer through a uniform medium. Compared to the frequency and wavelength of the emitted sound, the observer would detect waves with a
(1) higher frequency and shorter wavelength
(2) higher frequency and longer wavelength
(3) lower frequency and shorter wavelength
(4) lower frequency and longer wavelength

12 Which phenomenon is produced by two or more waves passing simultaneously through the same region?
(1) refraction
(2) diffraction
(3) interference
(4) reflection

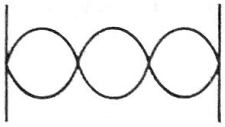
13 Maximum constructive interference between two waves of the same frequency could occur when their phase difference is
(1) 1λ (2) $\frac{\lambda}{2}$ (3) $\frac{3\lambda}{2}$ (4) $\frac{\lambda}{4}$

14 Which wave phenomenon could *not* be demonstrated with a single wave pulse?
(1) a standing wave
(2) diffraction
(3) reflection
(4) refraction

15 If two identical sound waves arriving at the same point are in phase, the resulting wave has
(1) an increase in speed
(2) an increase in frequency
(3) a larger amplitude
(4) a longer period

16 Standing waves are produced by the interference of two waves of the same
(1) frequency and amplitude, but opposite directions of travel
(2) frequency and direction of travel, but different amplitudes
(3) amplitude and direction of travel, but different frequencies
(4) frequency, amplitude, and direction of travel

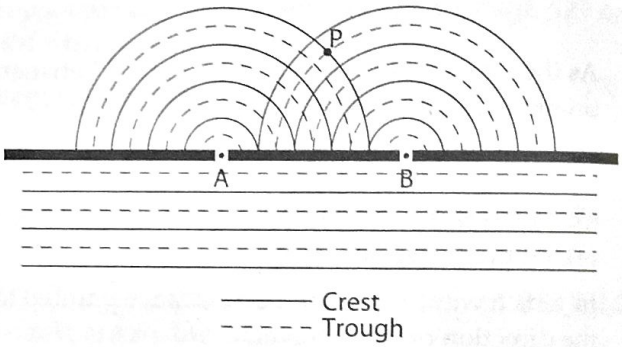
17 Two waves of the same wavelength λ interfere to form a standing wave pattern as shown in the diagram below.



What is the straight-line distance between consecutive nodes?
(1) 1λ (2) 2λ (3) $\frac{1}{2}\lambda$ (4) $\frac{1}{3}\lambda$

18 Two identical guitar strings are tuned to the same pitch. If one string is plucked, the other nearby string vibrates with the same frequency. This phenomenon is called
(1) resonance
(2) reflection
(3) refraction
(4) destructive interference

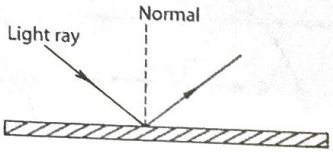
Base your answers to questions 19 and 20 on the diagram below which represents shallow water waves of constant wavelength passing through two small openings, A and B, in a barrier.



19 Compared to the length of path BP, the length of path AP is
(1) 1λ longer
(2) 2λ longer
(3) $\frac{1}{2}\lambda$ longer
(4) the same

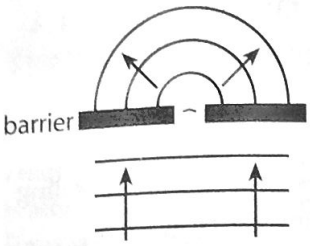
20 Which statement best describes the interference at point *P*?
(1) It is constructive, and causes a longer wavelength.
(2) It is constructive, and causes an increase in amplitude.
(3) It is destructive, and causes a shorter wavelength.
(4) It is destructive, and causes a decrease in amplitude.

21 The diagram below shows a light ray interacting with a barrier.

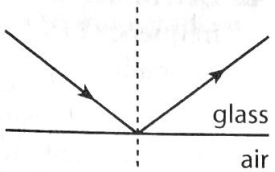


Which light phenomenon is illustrated?
(1) diffraction
(2) interference
(3) refraction
(4) reflection

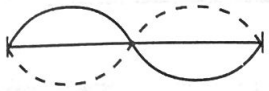
22 Which diagram best represents the phenomenon of diffraction?



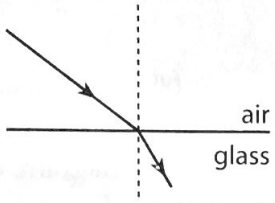
(1)



(3)



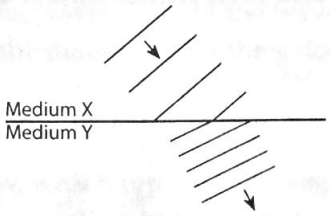
(2)



(4)

23 A ray of monochromatic light is incident on a plane mirror at an angle of 30.° The angle of reflection for the light ray is
(1) 15° (2) 30.° (3) 60.° (4) 90.°

24 The diagram below represents wave fronts traveling from medium X into medium Y.



All points on any one wave front shown must be
(1) traveling with the same speed
(2) traveling in the same medium
(3) in phase
(4) superposed

25 What is the approximate speed of light in alcohol?
(1) 1.4×10^8 m/s (3) 3.0×10^8 m/s
(2) 2.2×10^8 m/s (4) 4.4×10^8 m/s

26 What is the color of light with a frequency of 5.65×10^{14} hertz?
(1) green (2) red (3) violet (4) yellow

27 Which color of light has the lowest frequency?
(1) violet (2) green (3) yellow (4) red

28 Which waves are *not* electromagnetic?
(1) radio (3) light
(2) ultraviolet (4) sound

29 What is the speed of a radio wave in a vacuum?
(1) 0 m/s (3) 1.13×10^3 m/s
(2) 3.31×10^2 m/s (4) 3.00×10^8 m/s

30 Electromagnetic radiation is produced by
(1) an accelerating electron
(2) an accelerating neutron
(3) an electron at constant velocity
(4) a neutron at constant velocity

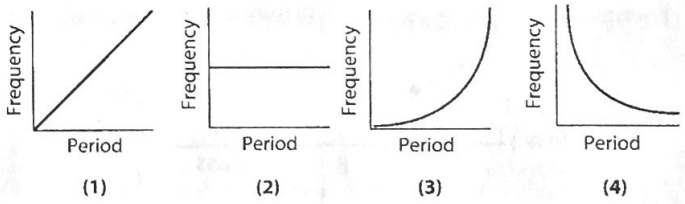
31 Which form of electromagnetic radiation has the shortest wavelength in air?
(1) ultraviolet (3) infrared
(2) visible (4) radio

32 How much time does it take light from a flash camera to reach a subject 6.0 meters across a room?
(1) 5.0×10^{-9} s (3) 5.0×10^{-8} s
(2) 2.0×10^{-8} s (4) 2.0×10^{-7} s

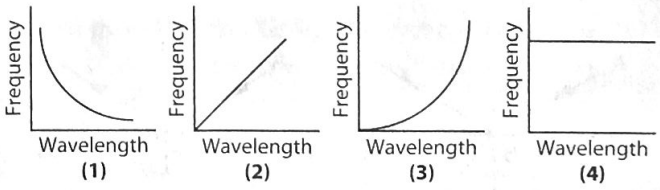
33 Electromagnetic radiation having a wavelength of 1.3×10^{-7} meter would be classified as
(1) infrared (3) blue
(2) orange (4) ultraviolet

Part B

34 Which graph best represents the relationship between the frequency and period of a wave?



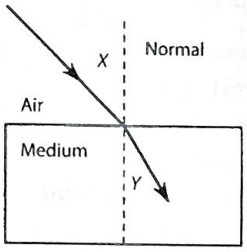
35 Which graph best represents the relationship between frequency and wavelength for microwaves in a vacuum?



36 If the period of a wave is doubled, its wavelength is
(1) halved (3) unchanged
(2) doubled (4) quartered

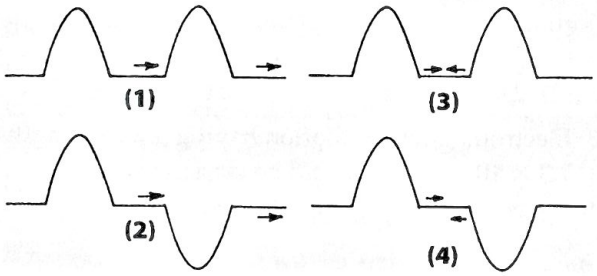
37 Periodic waves with a wavelength of 0.50 meter move with a speed of 0.30 meter per second in medium A. When the waves enter medium B, they travel at 0.15 meter per second. Calculate the wavelength of the waves in medium B. [2]

38 In the diagram below, a ray of light enters a transparent medium from air.

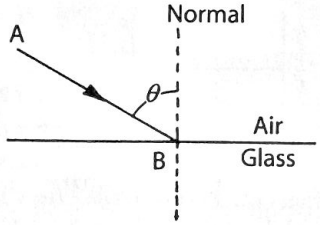


If angle X is 45° and angle Y is 30.°, what is the absolute index of refraction of the medium?

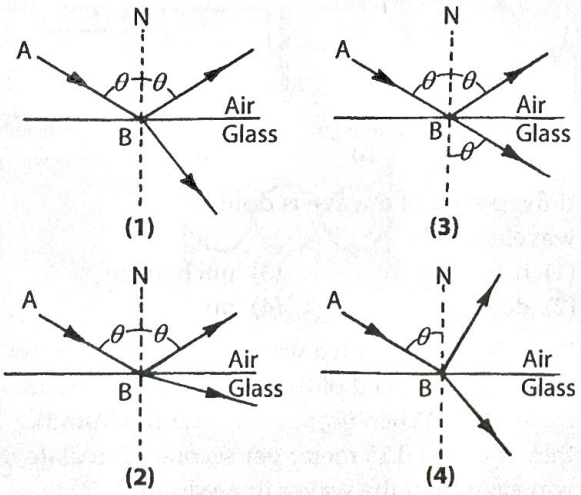
39 Which pair of moving pulses in a rope will produce destructive interference?



40 A ray of monochromatic light AB in air strikes a piece of glass at an incident angle θ, as shown in the diagram below.



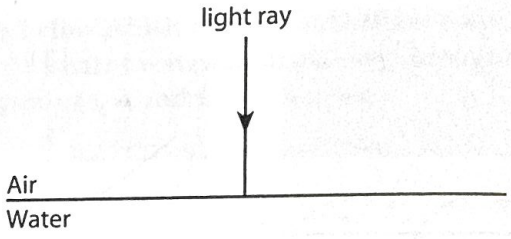
Which diagram best illustrates the ray's interaction with the glass?



41 Which expression represents a constant for light waves of different frequencies in a vacuum?
(1) $f\lambda$ (2) f/λ (3) λ/f (4) $f + \lambda$

42 Determine the wavelength of x rays with a frequency of 1.5×10^{18} hertz traveling in a vacuum. [1]

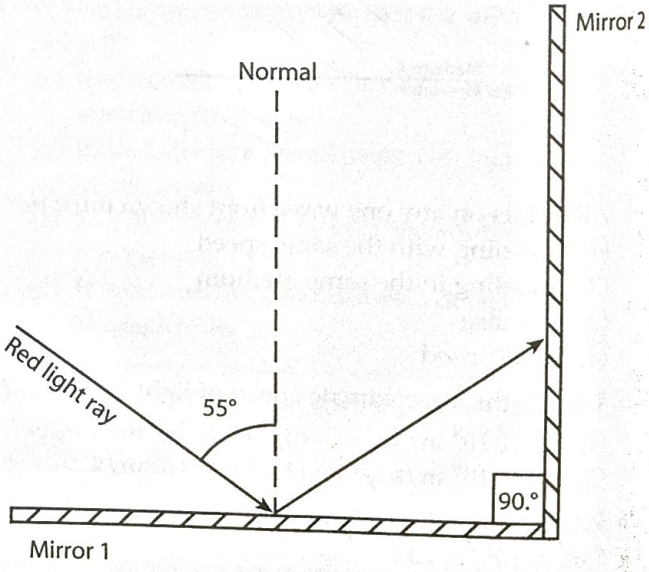
43 The diagram below shows a ray of light traveling in air incident on an air-water boundary.



On the diagram, draw the path of the ray in the water. [1]

44 Calculate the time required for light to travel a distance of 1.50×10^{11} meters. [2]

Base your answers to questions 45 and 46 on the information and diagram below. Two plane mirrors are positioned perpendicular to each other as shown. A ray of monochromatic red light is incident on mirror 1 at an angle of 55°. This ray is reflected from mirror 1 and then strikes mirror 2.

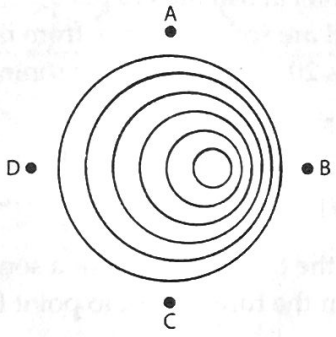


45 Determine the angle at which the ray is incident on mirror 2. [1]

46 On the diagram, use a protractor and a straightedge to draw the ray of light as it is reflected from mirror 2. [1]

47 Determine the speed of a ray of light ($f = 5.09 \times 10^{14}$ Hz) traveling through a block of sodium chloride. [1]

Base your answers to questions 48 through 51 on the diagram below, which represents the wave pattern produced by a vibrating source of constant frequency moving linearly in a shallow tank of water. The pattern is viewed from above and the lines represent crests.



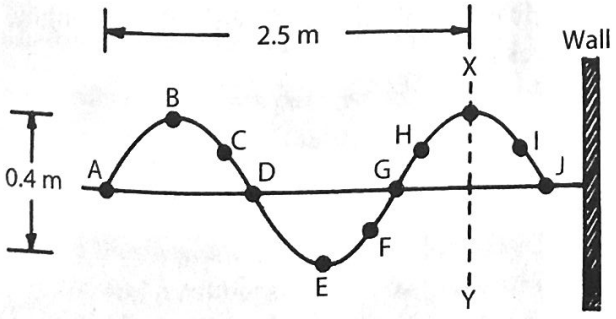
48 Towards which point is the source moving? [1]

49 What wave phenomenon is illustrated by the wave pattern? [1]

50 Compare the frequency of the waves observed at point B to the frequency of the waves observed at point D. [1]

51 Describe the wavelength of the waves observed at point D if the magnitude of the velocity of the source is increased. [1]

Base your answers to questions 52 through 58 on the diagram below, which represents a segment of a periodic wave traveling to the right in a steel spring. A crest passes line XY every 0.40 second.



52 What is the amplitude of the wave? [1]

53 What is the wavelength of the wave? [1]

54 How many cycles of the wave are shown? [1]

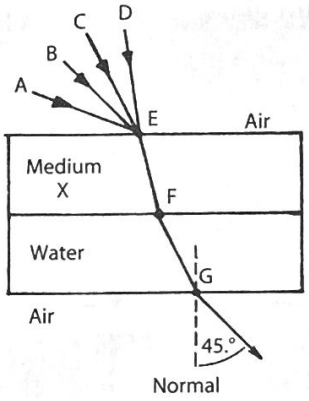
55 What is the frequency of the wave? [1]

56 Calculate the speed of the wave. [2]

57 Identify two points on the wave that are in phase. [1]

58 In which direction will point H move in the next instant of time? [1]

Base your answers to questions 59 through 64 on the diagram below, which represents two media with parallel surfaces in air and a ray of light ($f = 5.09 \times 10^{14}$ Hz) passing through them.



59 Calculate the approximate speed of the light in water. [2]

60 Calculate the angle of incidence in water, if the angle of refraction in air is 45°. [2]

61 Which line best represents the incident ray in air? [1]

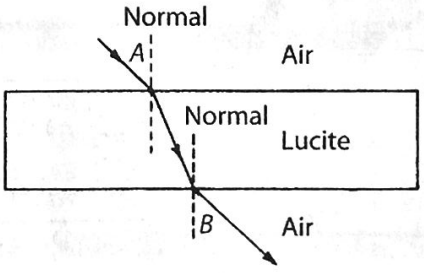
62 Compare the speed of light in water to the speed of light in medium X. [1]

63 Identify an absolute index of refraction for medium X that would make ray *EFG* a straight line. [1]

64 Calculate the wavelength of the light in water. [2]

Base your answers to questions 65 through 69 on the information and diagram below.

A ray of monochromatic light having a wavelength of 4.00×10^{-7} meter in air passes from air through Lucite and then into air again.



65 Calculate the frequency of the light in air. [2]

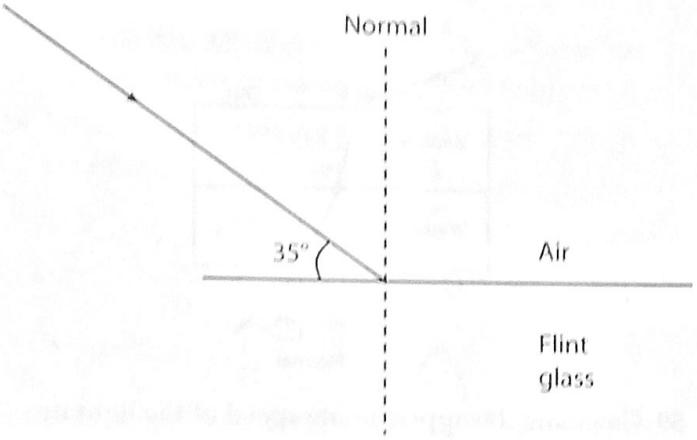
66 Identify the color of the light. [1]

67 Calculate the wavelength of the light in Lucite. [2]

68 Compare the measure of angle A to the measure of angle B. [1]

69 If angle A was increased, what would happen to the angle of refraction in the Lucite? [1]

Base your answers to questions 70 through 73 on the diagram below, which represents a ray of monochromatic light ($f = 5.09 \times 10^{14}$ Hz) in air incident on flint glass.



70 Determine the angle of incidence of the light ray in air. [1]

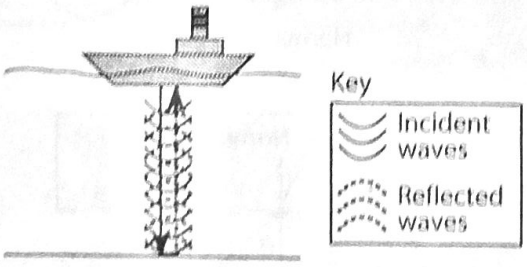
71 Calculate the angle of refraction of the light ray in the flint glass. [2]

72 Using a protractor and straightedge, draw the refracted ray on the diagram. [1]

73 What happens to the light from the incident ray that is *not* refracted or absorbed? [1]

Base your answers to questions 74 through 76 on the information and diagram below.

The sonar of a stationary ship sends a signal with a frequency of 5.0×10^3 hertz down through water. The speed of the signal is 1.5×10^3 meters per second. The echo from the bottom is detected 4.0 seconds later.



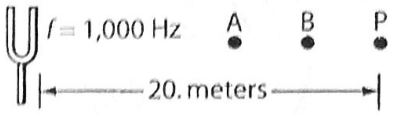
74 Calculate the wavelength of the sonar wave. [2]

75 Calculate the depth of the water under the ship. [2]

76 The echo is an example of which wave phenomenon? [1]

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

A vibrating 1000-hertz tuning fork produces sound waves that travel at 340 meters per second in air. Points A and B are some distance from the tuning fork. Point P is 20. meters from the tuning fork.



77 Calculate the time required for a sound wave to travel from the tuning fork to point P. [2]

78 Calculate the wavelength of the sound waves produced by the tuning fork. [2]

79 If the waves are in phase at point A and B, what is the minimum distance separating points A and B in terms of λ? [1]

80 If the vibrating tuning fork is accelerated toward point P, what happens to the frequency of the sound observed at P? [1]

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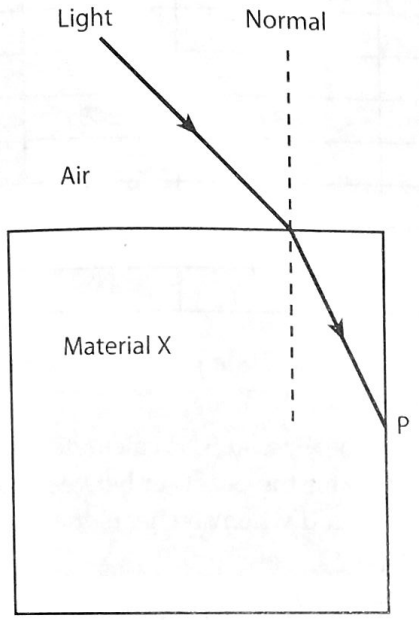
81 A sound wave has a wavelength of 5.5 meters as it travels through air at STP. Determine the wavelength of this sound in a medium where its speed is 1324 meters per second. [1]

82 Explain why, when a rapidly moving fire engine is coming toward you, the pitch of its siren sounds higher than it does when the fire engine is at rest. [1]

Base your answers to questions 83 and 84 on the information and diagram below.

A ray of light passes from air into a block of transparent material *X* as shown.



83 Measure the angles of incidence and refraction to the nearest degree for this light ray at the air into material *X* boundary and write your answers in the appropriate places on the diagram. [2]

84 The refracted light ray is reflected from the material *X*–air boundary at point *P*. Using a protractor and straightedge, on the diagram draw the reflected ray from point *P*. [1]

Part C

Base your answers to questions 85 through 92 on the following information, diagram, and data table.

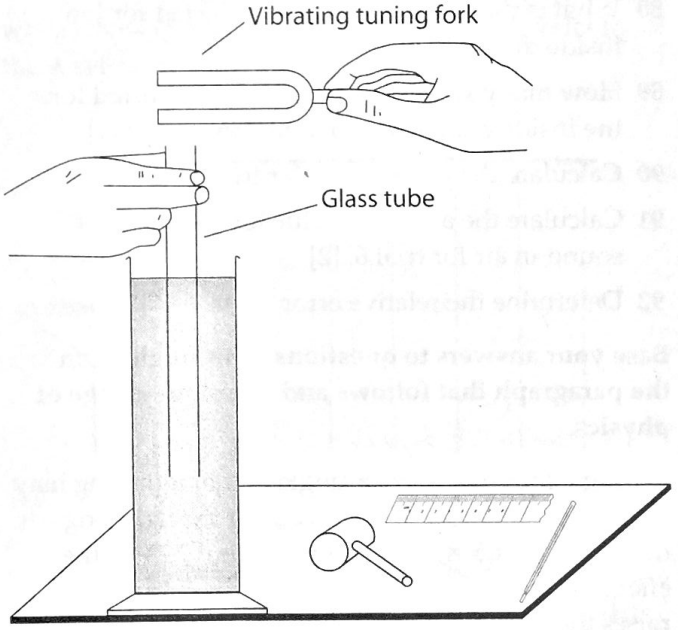
Seven pairs of students performed an experiment to determine the speed of sound in air in the classroom. The apparatus consisted of a tall cylinder nearly filled with water, a hollow glass tube, a 30-centimeter ruler, a Celsius thermometer, a tuning fork marked 512 hertz, and a rubber mallet. The glass tube was held vertically in the cylinder of water. After striking the tuning fork with the mallet, it was held over the open end of the tube as shown.

Keeping the vibrating fork just above the edge of the tube, the glass tube was slowly moved up and down in the water until the position was located where the sound was loudest. The length of the air column in the glass tube at this point was measured and recorded. The inside diameter of the tube and the temperature of the air inside the tube were also measured and recorded in the incomplete data table that follows. Each pair of students used the same tuning fork and all the data was collected within a 15-minute time interval.

Students were instructed to use the formula $\lambda = 4\ell + 1.6d$ to calculate the wavelength λ of the sound wave that was produced in the air column by the tuning fork. They were also told to use the formula

$$v = 331\sqrt{1 + \frac{T_C}{273}}$$

to determine the accepted value for v, the speed of sound in air in meters per second at a particular Celsius temperature T_C.



Data Table								
Trial	Length ℓ of air column (m)	Inside diameter d of tube (m)	Wavelength (m)	Frequency (Hz)	Temperature (°C)	Experimental speed of sound (m/s)	Accepted speed of sound, v (m/s)	Relative error (%)
1	0.163	0.032		512	21.5			
2	0.149	0.039		512	21.5			
3	0.150	0.037	0.659	512	20.5	337	343	
4	0.149	0.037		512	21.5			
5	0.152	0.040		512	21.8			
6	0.159	0.038	0.697	512	21.5			
7	0.152	0.040		512	21.8			

85 What type of wave was produced by the vibrating tuning fork? [1]

86 The loudest sound was produced when the natural frequency of the air in the column was the same as that of the vibrating tuning fork. What is the name of this wave phenomenon? [1]

87 What is the range of data collected for the length of the air column? [1]

88 What is the mean of the data collected for the inside diameter of the tube? [1]

89 How many significant digits were reported for the inside diameter of the tube in trial 5? [1]

90 Calculate the wavelength for trial 1. [2]

91 Calculate the accepted value for the speed of sound in air for trial 6. [2]

92 Determine the relative error for trial 3. [1]

Base your answers to questions 93 through 95 on the paragraph that follows and your knowledge of physics.

During a thunderstorm, a single bolt of lightning may develop 3.75 terawatts of power, but the lightning only lasts for 1.5×10^{-3} second. About 75% of the energy is dissipated as heat, which dramatically raises the temperature of the air in the lightning channel, causing the air to expand quickly. The movement creates sound waves that can be heard as thunder for distances up to 30. kilometers. An observer located 30. kilometers from the lightning strike sees the flash of lightning before hearing the clap of thunder.

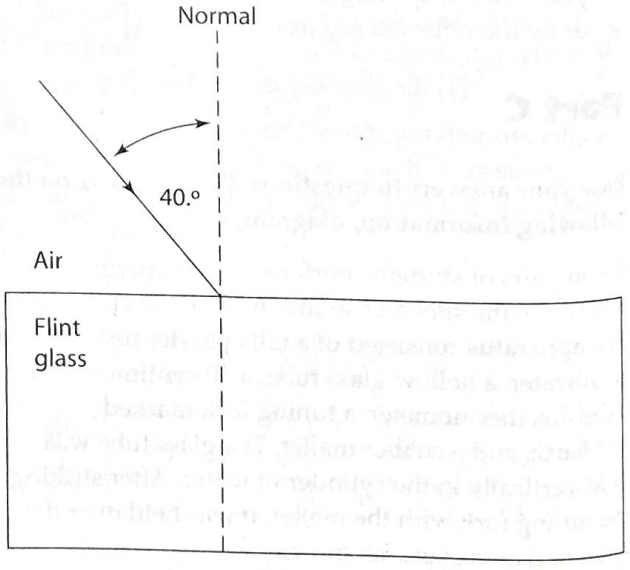
93 Express in scientific notation the power developed by the lightning bolt in watts. [1]

94 Calculate the energy in joules, the lightning bolt dissipates as heat. [2]

95 Assuming the air is at STP, calculate how much time elapses for the observer between the flash of lightning and when she hears the clap of thunder. [2]

Base your answers to questions 96 through 99 on the information and diagram below.

A ray of monochromatic light ($f = 5.09 \times 10^{14}$ Hz) is traveling in air. The ray is incident on the surface of a block of flint glass at an angle of 40.°, as shown. Part of the light is reflected at the air-glass interface and part is refracted in the glass.



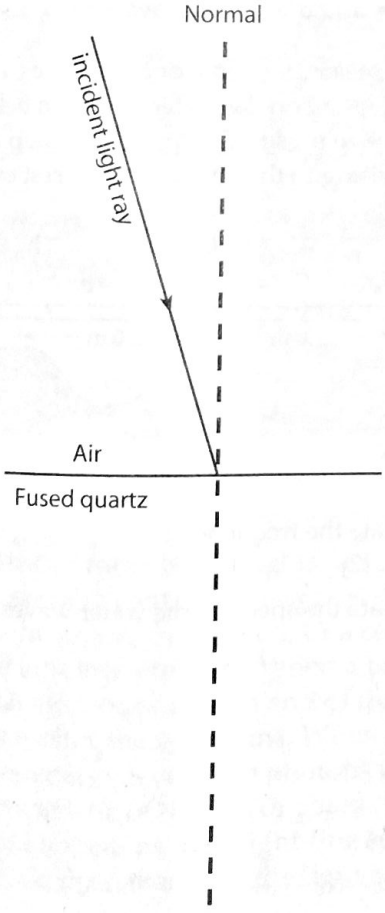
96 On the diagram, draw the reflected ray and label the angle of reflection with its measure in degrees. [2]

97 Calculate the angle of refraction in the flint glass to the nearest degree. [2]

98 On the diagram, draw the refracted ray. Label it "refracted ray." [1]

99 Calculate the wavelength of the light ray in flint glass. [2]

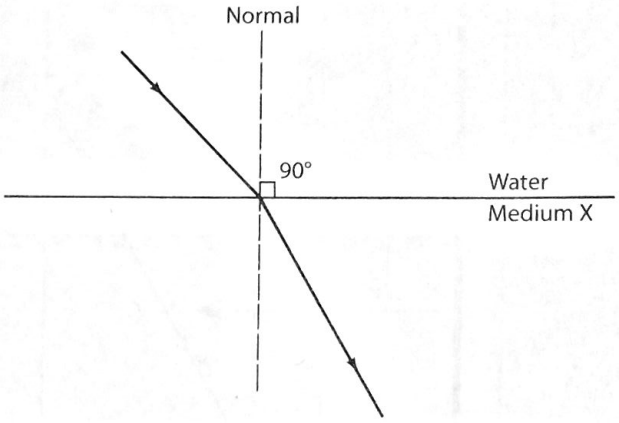
Base your answers to questions 100 and 101 on the diagram below, which shows a light ray ($f = 5.09 \times 10^{14}$ Hz) in air, incident on a boundary with fused quartz. At the boundary, part of the light is refracted and part of the light is reflected.



100 Calculate the angle of refraction of the incident light ray. [2]

101 Using a protractor and straightedge, construct the refracted light ray in the fused quartz on the diagram. [1]

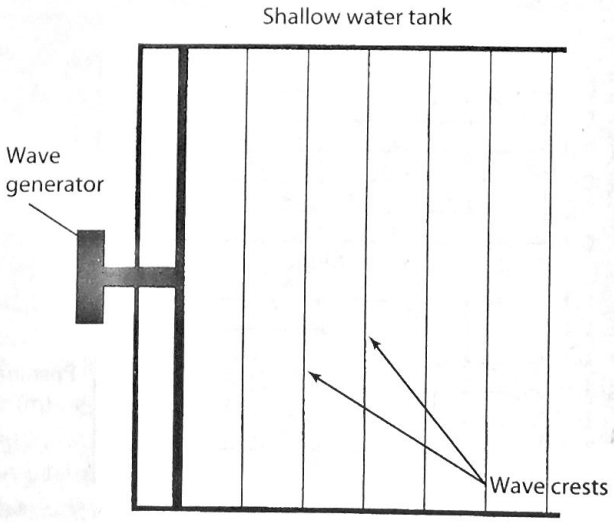
102 A ray of monochromatic light ($f = 5.09 \times 10^{14}$ Hz) is incident upon an interface of water and an unknown medium, X. The ray is refracted in medium X as shown in the diagram below.



Calculate the speed of light in medium X. [4]

Base your answers to questions 103 through 105 on the following information and diagram.

The diagram represents a wave generator having a constant frequency of 12 hertz and producing parallel wave fronts in a shallow tank of water. The velocity of the wave is v.

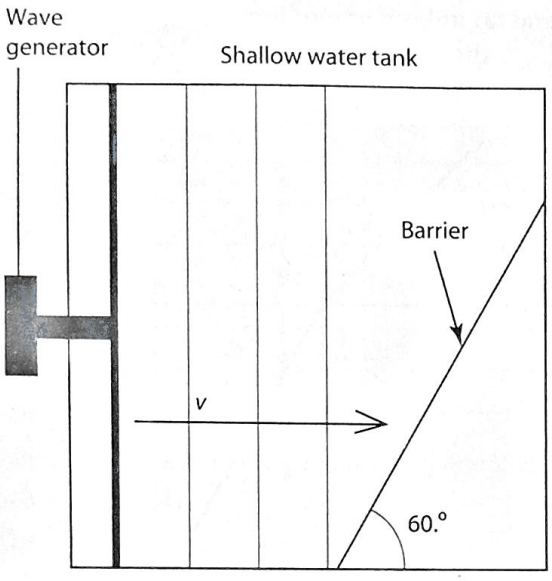


103 Determine the period of the waves. [1]

104 Using a ruler, measure the wavelength of the waves to the nearest tenth of a centimeter. [1]

105 Calculate the speed of the waves in the tank. [2]

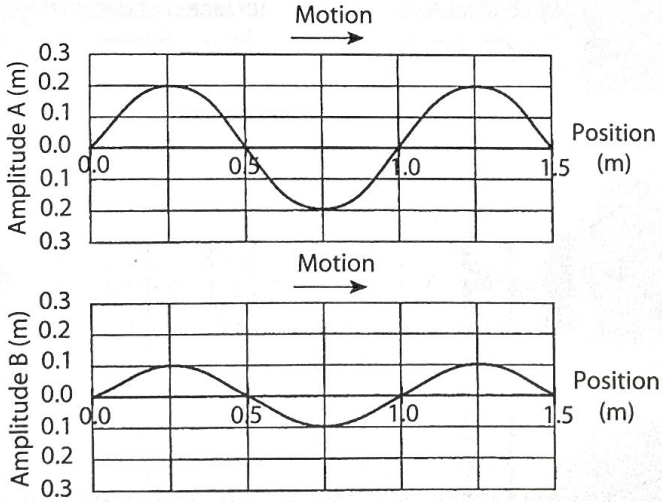
106 A barrier is placed in the tank as shown in the following diagram.



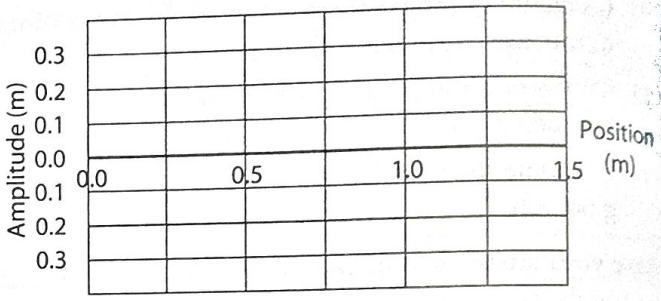
Use a protractor and a straight edge to construct an arrow to represent the direction of the velocity of the reflected waves. [1]

Base your answers to questions 107 through 109 on the information and diagram below.

Two waves, A and B, travel in the same direction in the same medium at the same time.



107 On the grid below draw the resultant wave produced by the superposition of waves A and B. [1]

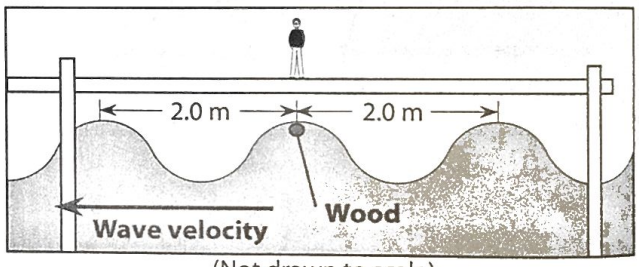


108 What is the amplitude of the resultant wave? [1]

109 What is the wavelength of the resultant wave? [1]

Base your answers to questions 110 and 111 on the information and diagram below.

A student standing on a dock observes a piece of wood floating on the water as shown below. As a water wave passes, the wood moves up and down, rising to the top of a wave crest every 5.0 seconds.



(Not drawn to scale)

110 Calculate the frequency of the passing water waves. [2]

111 Calculate the speed of the water waves. [2]