Large-Type Edition

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING

PHYSICS

Thursday, June 22, 2023 — 9:15 a.m. to 12:15 p.m., only

The possession or use of any communications device is strictly prohibited when taking this examination. If you have or use any communications device, no matter how briefly, your examination will be invalidated and no score will be calculated for you.

Answer all questions in all parts of this examination according to the directions provided in the examination booklet.

A separate answer sheet for Part A and Part B–1 has been provided to you. Follow the instructions from the proctor for completing the student information on your answer sheet. Record your answers to the Part A and Part B–1 multiple-choice questions on this separate answer sheet. Record your answers for the questions in Part B–2 and Part C in your separate answer booklet. Be sure to fill in the heading on the front of your answer booklet.

All answers in your answer booklet should be written in pen, except for graphs and drawings, which should be done in pencil. You may use scrap paper to work out the answers to the questions, but be sure to record all your answers on your separate answer sheet or in your answer booklet as directed.

When you have completed the examination, you must sign the statement printed on your separate answer sheet, indicating that you had no unlawful knowledge of the questions or answers prior to the examination and that you have neither given nor received assistance in answering any of the questions during the examination. Your answer sheet and answer booklet cannot be accepted if you fail to sign this declaration.

Notice. . .

A scientific or graphing calculator, a centimeter ruler, a protractor, and a copy of the *2006 Edition Reference Tables for Physical Setting/Physics*, which you may need to answer some questions in this examination, must be available for your use while taking this examination.

DO NOT START THIS EXAMINATION UNTIL THE SIGNAL IS GIVEN.

Part A

Answer all questions in this part.

Directions (1–35): For *each* statement or question, choose the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2006 Edition Reference Tables for Physical Setting/Physics.* Record your answers on your separate answer sheet.

1 Which pair of quantities are both scalar quantities?

(1) speed and mass
(2) speed and momentum
(3) momentum and displacement
(4) mass and displacement

2 In an attempt to get ketchup out of a bottle, a student takes off the cap, turns the bottle upside down, accelerates it downward, and then suddenly stops it. Ketchup is released from the open bottle because the ketchup doesn't stop moving when the bottle does. The ketchup leaving the bottle illustrates

(1) inertia
(2) resistivity
(3) resonance
(4) mass being converted to energy

3 The same net force is applied to object *A* and object *B*. The mass of *B* is three times greater than the mass of *A*. Compared to the acceleration of *A*, the acceleration of *B* is

(1) the same
(2) one-third as great
(3) three times as great
(4) one-ninth as great

4 What is the mass equivalent of 3.37×10^{-19} joule?

(1) 1.26×10^{-54} kg
(2) 3.74×10^{-36} kg
(3) 1.12×10^{-27} kg
(4) 5.08×10^{14} kg

5 Which object is in equilibrium?

(1) Earth orbiting the Sun
(2) a thrown baseball at its highest point above the ground
(3) a car moving at a constant speed in a straight line
(4) a bicycle skidding to a stop in a straight line

6 A race car travels around a flat circular track at constant speed. The net force on the car acts

(1) perpendicular to the car's velocity and toward the center of the circle
(2) perpendicular to the car's velocity and away from the center of the circle
(3) parallel to the car's velocity and in the same direction as the velocity
(4) parallel to the car's velocity and in the opposite direction as the velocity

7 An object is traveling in a horizontal, circular path at a constant speed. If the radius of the path were doubled while the speed remained constant, the centripetal acceleration would be

(1) quartered
(2) doubled
(3) halved
(4) quadrupled

8 A 600.-newton student pushes on a vertical wall for 20.0 seconds with a constant force having a magnitude of 100. newtons. What is the magnitude of the force that the wall exerts on the student?

(1) 0.00 N
(2) 5.00 N
(3) 100. N
(4) 600. N

9 An unbalanced force of 20. newtons is applied to a mass of 1.0×10^3 kilograms. After 10. seconds, the momentum of the mass will have changed by

(1) 2.0×10^2 kg•m/s
(2) 2.0×10^3 kg•m/s
(3) 1.0×10^4 kg•m/s
(4) 2.0×10^4 kg•m/s

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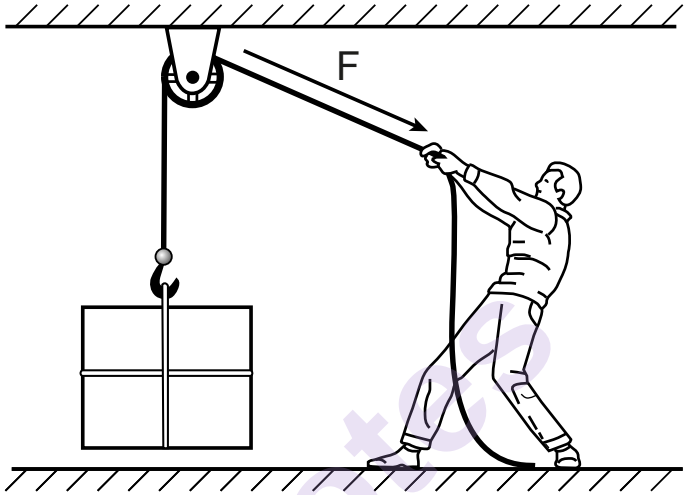
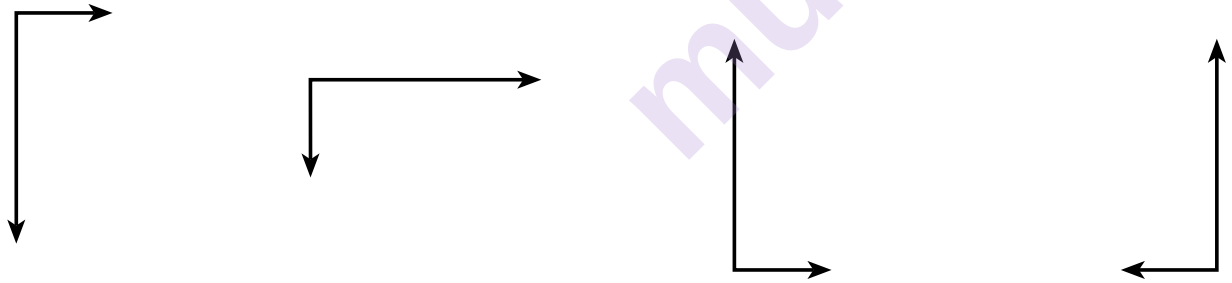
10 To lift a heavy block off the floor, a student pulls with force *F* on a rope that passes over a pulley, as shown in the diagram below.

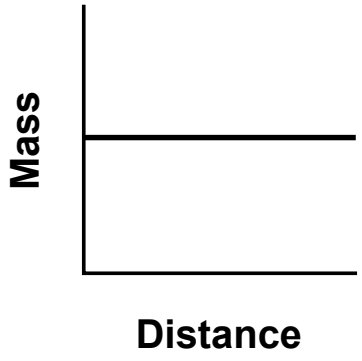


Which pair of vectors represents the perpendicular components of the force the student exerts on the rope?

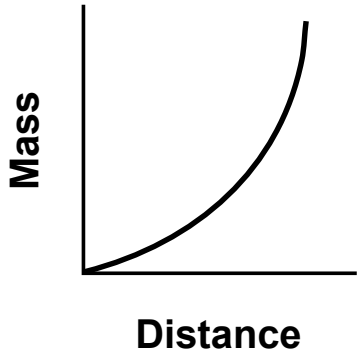


(1) (2) (3) (4)

11 Which graph best represents the relationship between the mass of an object and its distance from Earth's surface?



(1)



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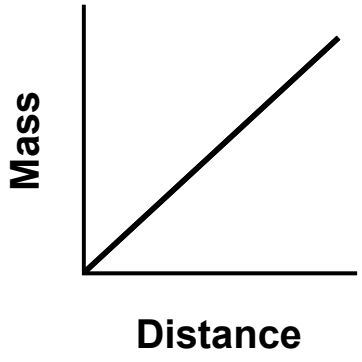

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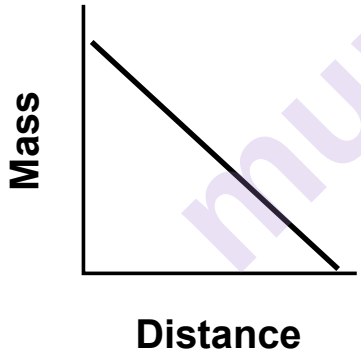
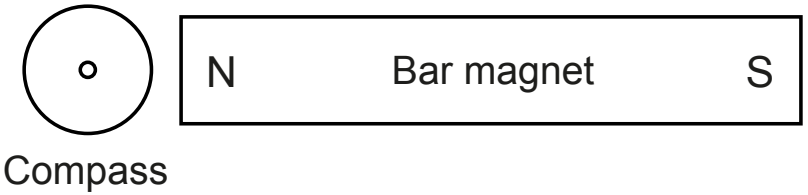
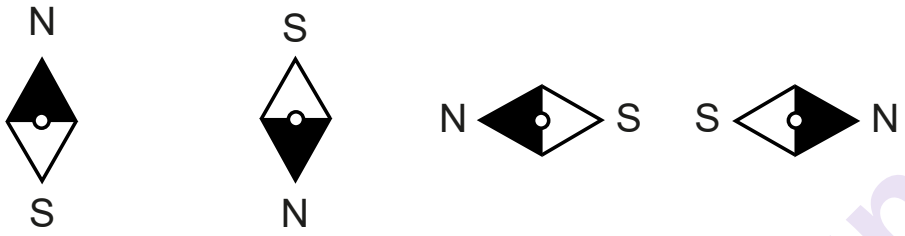


(4)

12 A compass is placed near a strong bar magnet as represented in the diagram below.



Which diagram best represents the direction of the compass needle?



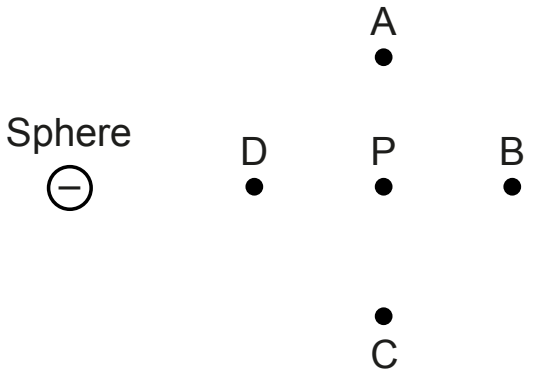
13 As Earth orbits the Sun in its elliptical orbit, the gravitational force between the Sun and Earth is

(1) always attractive
(2) attractive as the Sun and Earth get closer together and repulsive as the Sun and Earth get farther apart
(3) repulsive as the Sun and Earth get closer together and attractive as the Sun and Earth get farther apart
(4) always repulsive

14 Which unit is used to measure the work per unit charge required to move a charge in an electric field?

(1) ampere
(2) coulomb
(3) volt
(4) watt

15 The diagram below shows a negatively charged sphere and a point, *P*, located within the electric field produced by the charge on the sphere.



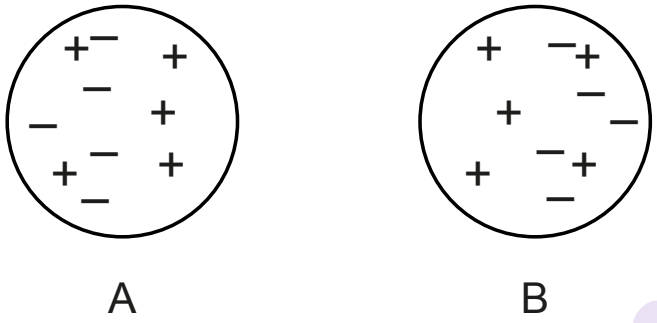
The direction of the electric field at point *P* is toward point

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

16 Two point charges, q_1 and q_2, are initially a distance, d, apart. Which change will cause the greatest increase in the electrostatic force between the two point charges, q_1 and q_2?

(1) double q_1
(2) halve q_2
(3) double d
(4) halve d

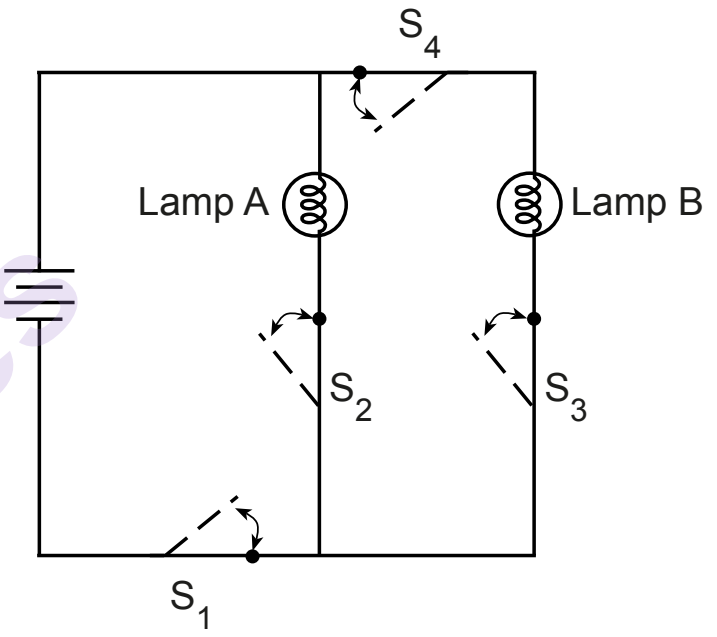
17 The diagram below represents two identical conducting spheres.



Which statement could be the correct explanation for the charge distribution on the spheres?

(1) A small positively charged object is located between sphere A and sphere B.
(2) A small negatively charged object is located between sphere A and sphere B.
(3) A small positively charged object is located to the right of sphere B.
(4) A small negatively charged object is located to the right of sphere B.

18 The diagram below represents a circuit containing a battery, two operating lamps, A and B, and four closed switches, S_1, S_2, S_3, and S_4.



Which switch, when opened, causes both lamps to turn off?

(1) S_1
(2) S_2
(3) S_3
(4) S_4

19 What is the resistance of a 100.-watt bulb when operating a potential difference of 120. volts?

(1) 1.20 Ω
(2) 100. Ω
(3) 120. Ω
(4) 144 Ω

20 The interaction that is most responsible for binding three quarks together in a proton is the

(1) strong force
(2) electromagnetic force
(3) weak force
(4) gravitational force

21 One example of a force doing work is the force exerted by

(1) Earth on a high diver falling toward a pool from a platform above
(2) a hook on an engine held stationary above a car
(3) a frictionless horizontal air hockey table on a puck moving across the table at a constant velocity
(4) a weightlifter on a barbell he holds motionless over his head

22 A ball falls freely from a rooftop to the street below. The ball starts from rest with 20. joules of gravitational potential energy with respect to the street. The total mechanical energy of the ball just before it hits the street is

(1) 0 J
(2) 5.0 J
(3) 10. J
(4) 20. J

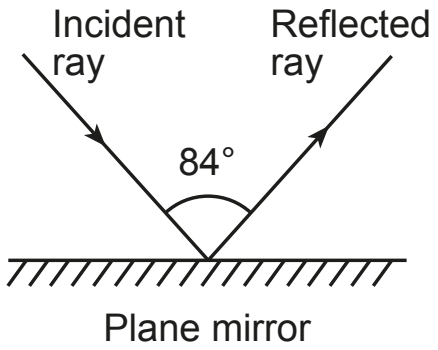
23 Which statement describes the gravitational potential energy (*PE*), kinetic energy (*KE*), and internal (thermal) energy (*Q*), of a wooden crate as it is pushed across a level classroom floor at constant speed?

(1) The *PE* decreases, *KE* remains the same, and *Q* decreases.
(2) The *PE* increases, *KE* increases, and *Q* decreases.
(3) The *PE* remains the same, *KE* decreases, and *Q* increases.
(4) The *PE* remains the same, *KE* remains the same, and *Q* increases.

24 The oscillation of electrons up and down a metal antenna produces waves. These waves are

(1) mechanical and longitudinal
(2) mechanical and transverse
(3) electromagnetic and transverse
(4) electromagnetic and longitudinal

25 The diagram below shows an incident light ray reflecting from a plane mirror.



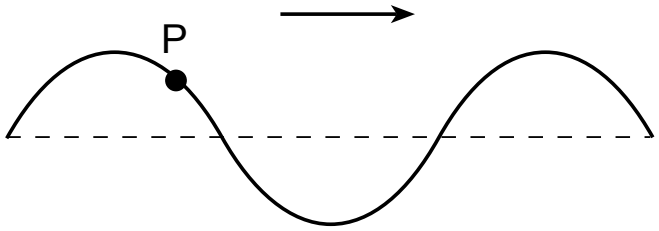
What is the angle of reflection?

(1) 96°
(2) 84°
(3) 48°
(4) 42°

26 A characteristic common to both sound waves and x rays is that they both

(1) travel fastest in a vacuum
(2) cause particles to vibrate in a direction parallel to the wave's direction of motion
(3) transmit energy without transmitting matter
(4) are mechanical

27 The diagram below represents a wave moving to the right through a rope.



Point *P* in the rope is moving toward the

(1) top of the page
(2) bottom of the page
(3) right
(4) left

28 What is the wavelength of a 300.-hertz sound wave in air at STP?

(1) 0.906 m
(2) 1.10 m
(3) 3.00×10^2 m
(4) 1.00×10^6 m

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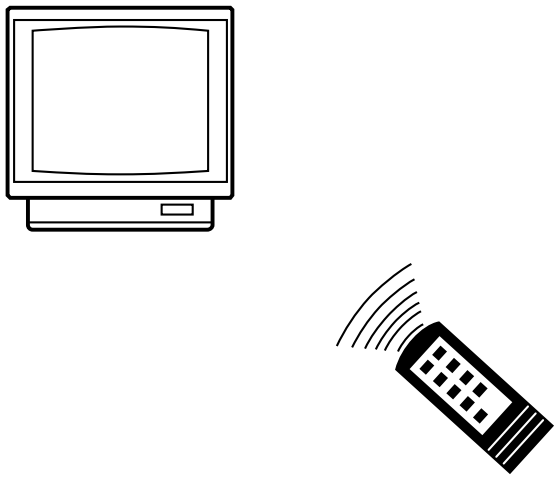
29 In the diagram below, a remote control is aimed at a television.



When the signal from the remote reaches the sensor on the television, the signal will most likely be

(1) neither reflected nor absorbed
(2) partially absorbed and partially reflected
(3) completely reflected
(4) completely absorbed

30 Compared to waves of blue light traveling in a vacuum, waves of red light traveling in a vacuum have

(1) a lower frequency and a lower speed
(2) a lower frequency and the same speed
(3) the same frequency and a lower speed
(4) the same frequency and the same speed

31 Earthquakes often cause buildings between twelve and forty stories high to vibrate at an amplitude high enough to be destructive. Buildings are often designed to absorb this vibrational energy that might cause them to vibrate at their natural frequency. This tendency for an earthquake to cause a building to vibrate at a large amplitude is an example of

(1) resonance
(2) the Doppler effect
(3) refraction
(4) diffraction

32 During the radioactive decay of a uranium-238 atom, a thorium-234 atom and an alpha particle are produced. During this process, there is conservation of

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

33 An antiproton has a charge of

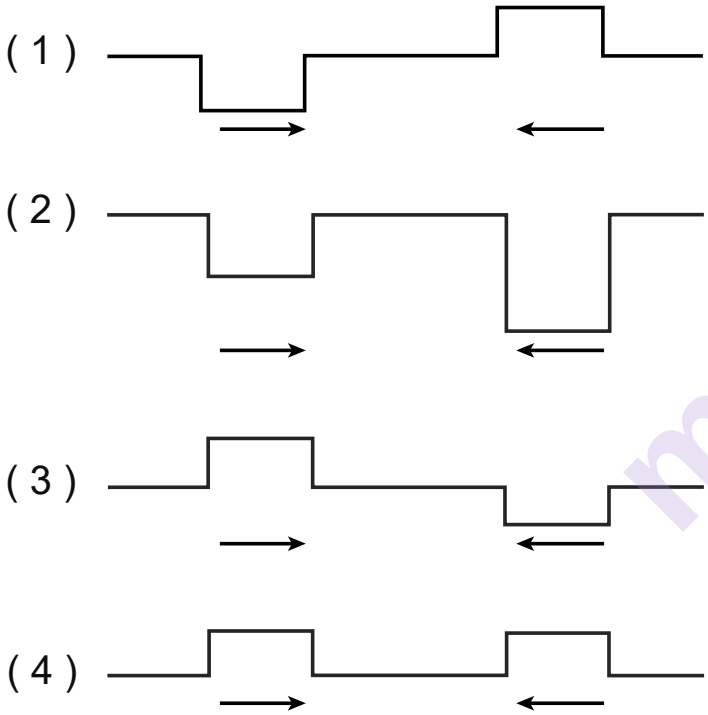
(1) $+1e$

(2) $+\frac{2}{3}e$

(3) 0

(4) $-1e$

34 Two pulses approach each other in the same medium. Which pair of pulses will result in the largest magnitude displacement of the medium as the pulses pass through each other?



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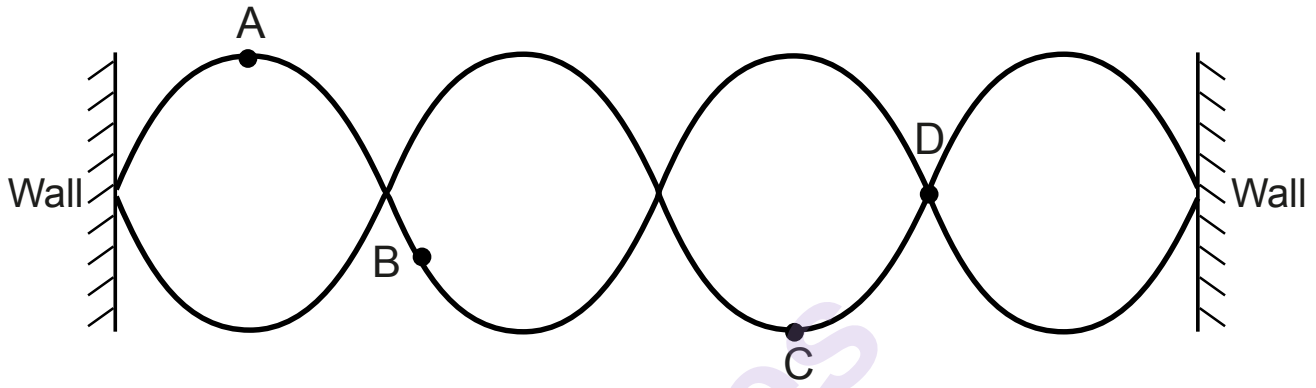
35 Two waves of the same wavelength interfere to form a standing wave pattern as represented in the diagram below.



Which point on the diagram represents a node?

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

Part B–1

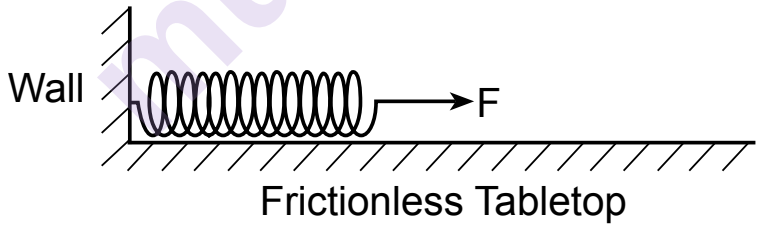
Answer all questions in this part.

Directions (36–50): For *each* statement or question, choose the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2006 Edition Reference Tables for Physical Setting/Physics*. Record your answers on your separate answer sheet.

36 A round dinner plate has a diameter closest to

(1) 2×10^{-2} m
(2) 2×10^{-1} m
(3) 2×10^{0} m
(4) 2×10^{1} m

37 Several springs are lying on frictionless tabletops with one end attached to a wall and a variable force F applied to the free end of each spring. The springs have different spring constants, k. The diagram below shows the setup for one of the springs.



The elongation of the springs produced by force F depends

(1) directly on both F and k
(2) directly on F and inversely on k
(3) inversely on F and directly on k
(4) inversely on both F and k

38 The table below shows the weight of four athletes (*A*, *B*, *C*, and *D*) and the time required for each athlete to run from the base of a hill to its top.

Athlete	**Weight** (N)	**Time** (s)
A	600.	11.8
B	650.	10.7
C	700.	10.8
D	750.	11.9

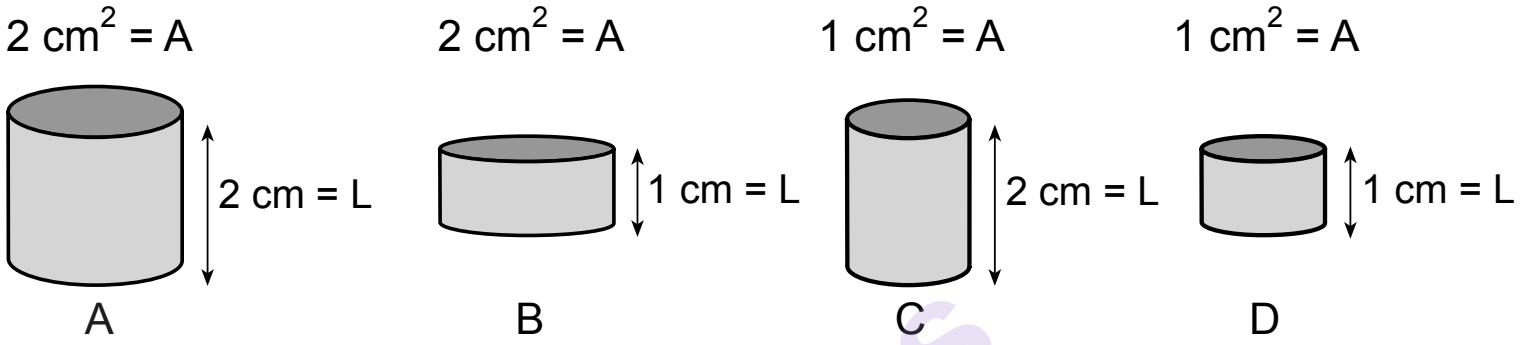
Which athlete ran up the hill with the greatest average power?

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

39 A copper wire carries 2.8 amperes of current. The total amount of charge that passes a point in the wire in 1.3 milliseconds is

(1) 4.6×10^{-4} C
(2) 3.6×10^{-3} C
(3) 3.6 C
(4) 2.2×10^{3} C

40 The diagram below represents four solid copper wire segments at 20°C with different lengths (L) and cross-sectional areas (A).



Which two segments have the same resistance?

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

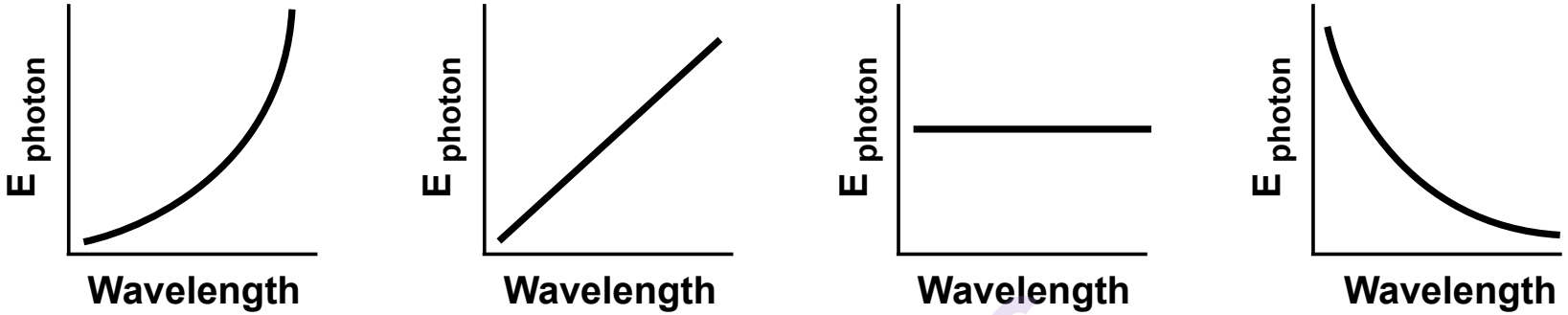
41 In substance X, a ray of light with a frequency of 5.09×10^{14} hertz has a speed of 2.04×10^{8} meters per second. Substance X could be

(1) diamond
(2) water
(3) zircon
(4) glycerol

42 Which could *not* be the charge on a particle?

(1) 3.2×10^{-19} C
(2) 4.5×10^{-19} C
(3) 4.8×10^{-19} C
(4) 6.4×10^{-19} C

43 Which graph best represents the relationship between photon energy (E_{photon}) and wavelength?



44 Light travels from air into another medium with an index of refraction of n. The light has a wavelength of 6.0×10^{-7} meter in the new medium. Which expression represents the wavelength of this light in air?

(1) $n(6.0 \times 10^{-7}\text{m})$

(2) $\dfrac{6.0 \times 10^{-7}\text{m}}{n}$

(3) $\dfrac{n}{6.0 \times 10^{-7}\text{m}}$

(4) $(6.0 \times 10^{-7}\text{m}) - n$

45 If 80. joules of electrical energy is dissipated by a 10.-ohm resistor in 2.0 seconds, the current in the resistor is

(1) 5.0 A

(2) 2.0 A

(3) 8.0 A

(4) 4.0 A

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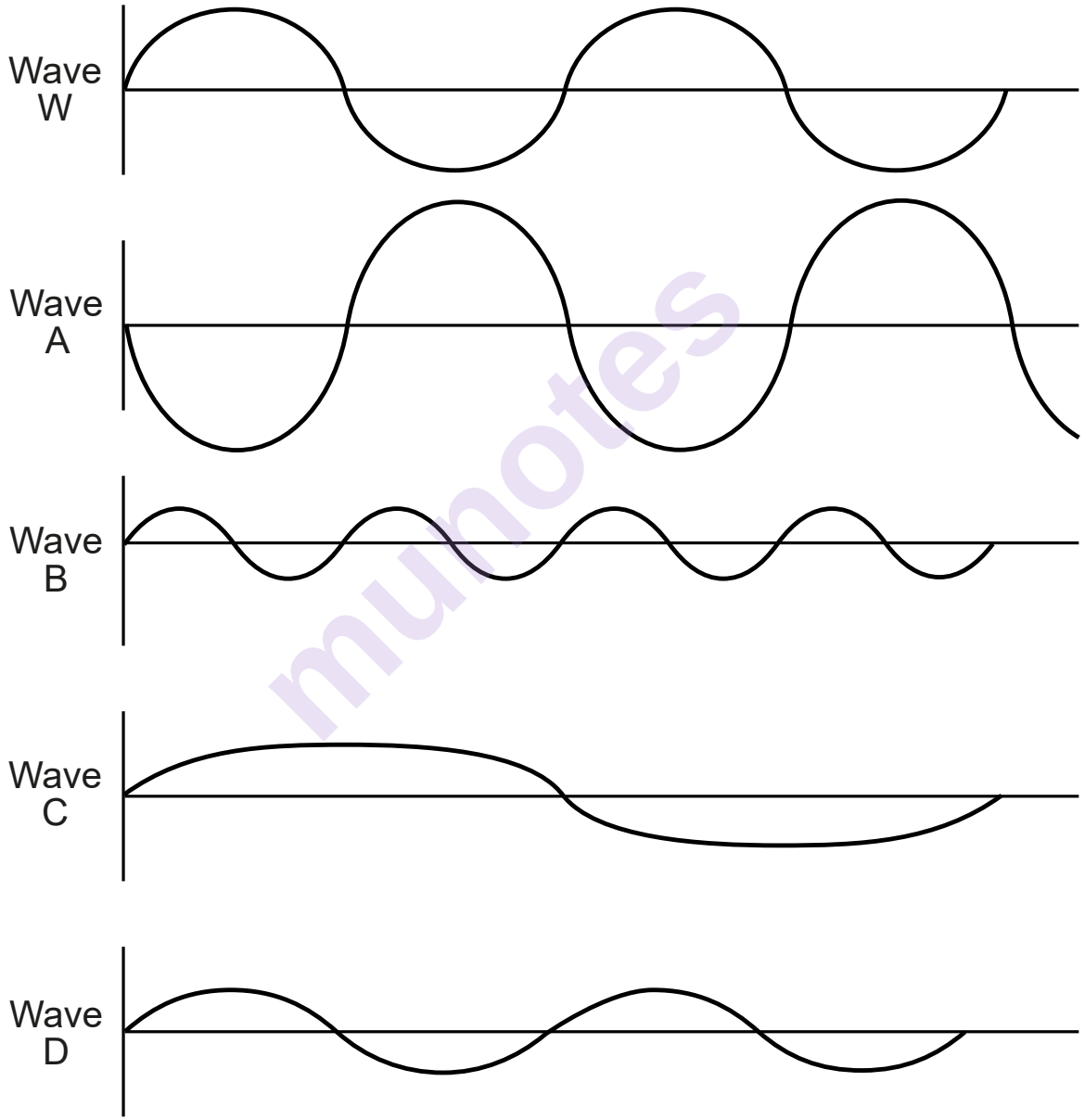
Base your answers to questions 46 and 47 on the diagrams below, and on your knowledge of physics. The diagrams represent waves *W*, *A*, *B*, *C*, and *D* traveling through the same uniform medium.



46 Which wave has a period that is twice that of wave *W*?

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

47 Which wave is always 180 degrees out of phase with wave *W*?

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

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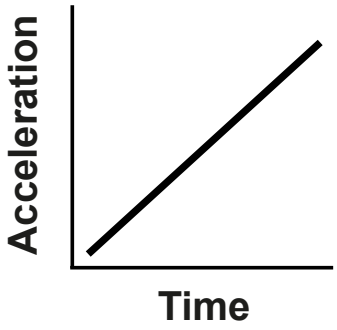
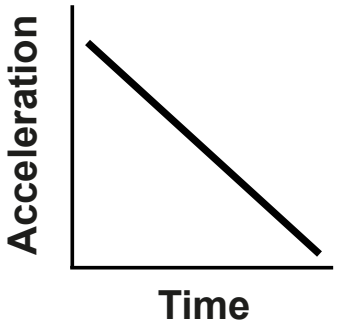
48 Which graph best represents the relationship between acceleration and time for a freely falling object as the object falls near the surface of Earth?



(1)



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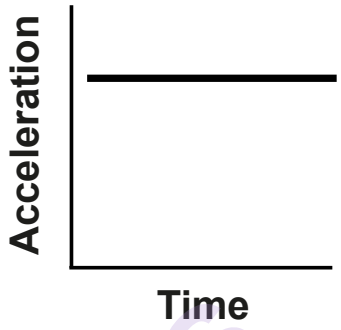

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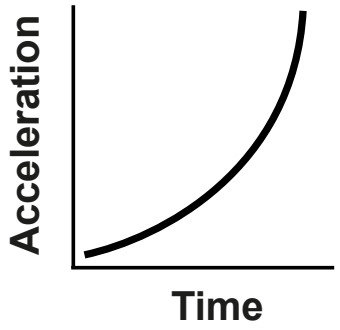
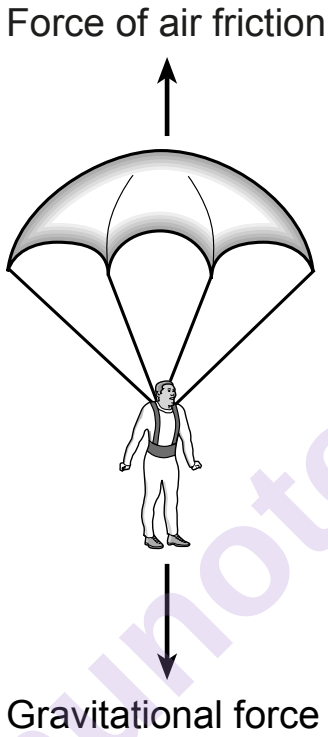


(4)

49 The diagram below represents the forces acting on a skydiver with his parachute.



The total mass of the skydiver with his parachute is 85.0 kilograms. If the magnitude of the gravitational force is 834 newtons, and the magnitude of the force of air friction is 652 newtons, the acceleration of the skydiver at the time shown is

(1) 2.14 m/s^2 up
(2) 2.14 m/s^2 down
(3) 7.67 m/s^2 up
(4) 9.81 m/s^2 down

50 A 15.0-gram air hockey puck sliding on a horizontal surface at a velocity of 7.00 meters per second north collides with a 15.0-gram air hockey puck traveling at a velocity of 8.00 meters per second south. The momentum of the system of pucks after the collision is

(1) 0.0150 kg•m/s north
(2) 0.0150 kg•m/s south
(3) 0.225 kg•m/s north
(4) 0.225 kg•m/s south

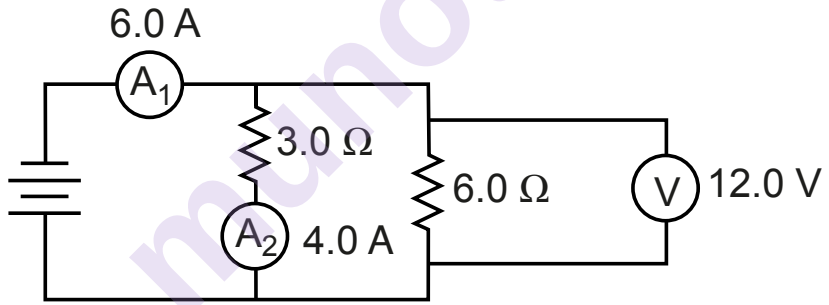
Part B–2

Answer all questions in this part.

Directions (51–65): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *2006 Edition Reference Tables for Physical Setting/Physics*.

Base your answers to questions 51 through 54 on the information and circuit diagram below and on your knowledge of physics.

An electric circuit contains a battery, a 3.0-ohm resistor, a 6.0-ohm resistor, and three meters. Ammeter A_1 reads 6.0 amperes, ammeter A_2 reads 4.0 amperes, and the voltmeter reads 12.0 volts.

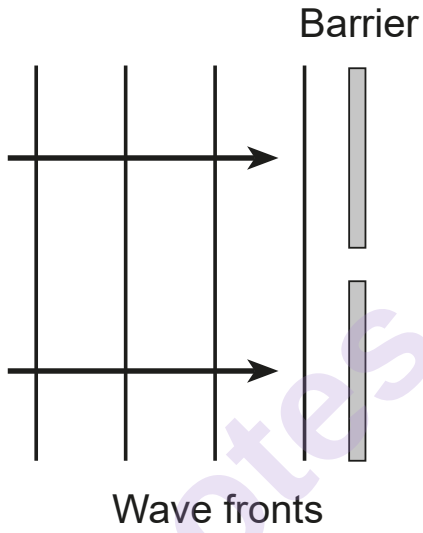


51 Determine the potential difference across the battery. [1]

52 Determine the current through the 6.0-ohm resistor. [1]

53–54 Calculate the equivalent resistance of the circuit. [Show all work, including the equation and substitution with units.] [2]

55 The diagram below shows parallel straight wave fronts approaching a rigid barrier that has a small opening in its center.



On the diagram *in your answer booklet*, draw *three* wave fronts after they have passed through the opening. [1]

Base your answers to questions 56 through 59 on the information below and on your knowledge of physics.

A projectile is launched from level ground with an initial vertical speed of 26 meters per second upward and an initial horizontal speed of 15 meters per second. [Neglect friction.]

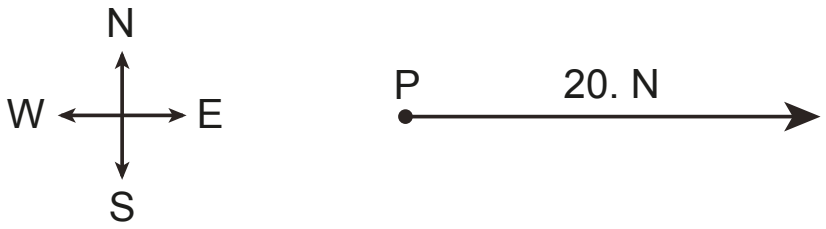
56–57 Calculate the total time the projectile is in the air before the projectile returns to the level ground. [Show all work, including the equation and substitution with units.] [2]

58 Determine the total horizontal distance the projectile travels before the projectile returns to the ground. [1]

59 Determine the angle above the horizontal at which the projectile is launched. [1]

Base your answers to question 60 through 62 on the information below and on your knowledge of physics.

A 20.-newton force due east and a 25-newton force due south act concurrently at point *P*. The diagram shows a vector drawn to scale representing the 20.-newton force due east.



60 Using a ruler, determine the scale used in the diagram. [1]

61 On the diagram in *your answer booklet*, use a metric ruler and the scale shown in the diagram to draw a vector to represent the 25 newton force due south acting at point *P*. Begin the vector at point P and label its magnitude in newtons. [1]

62 Determine the magnitude of the resultant force acting at point *P*. [1]

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63 Determine the amount of energy, in electronvolts, that must be absorbed by a hydrogen atom to excite the atom from the $n = 1$ energy level directly to the $n = 4$ energy level. [1]

64 Determine the sign and magnitude of the net charge, in coulombs, of a particle that has a quark composition of *bbb*. [1]

65 What type of electromagnetic radiation would contain photons each having an energy of 2.65×10^{-20} joule? [1]

Part C

Answer all questions in this part.

Directions (66–85): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *2006 Edition Reference Tables for Physical Setting/Physics*.

Base your answers to questions 66 through 70 on the information below and on your knowledge of physics.

A car, initially traveling at a velocity of 25 meters per second west, accelerates uniformly at a rate of 1.5 meters per second squared east for 6.0 seconds.

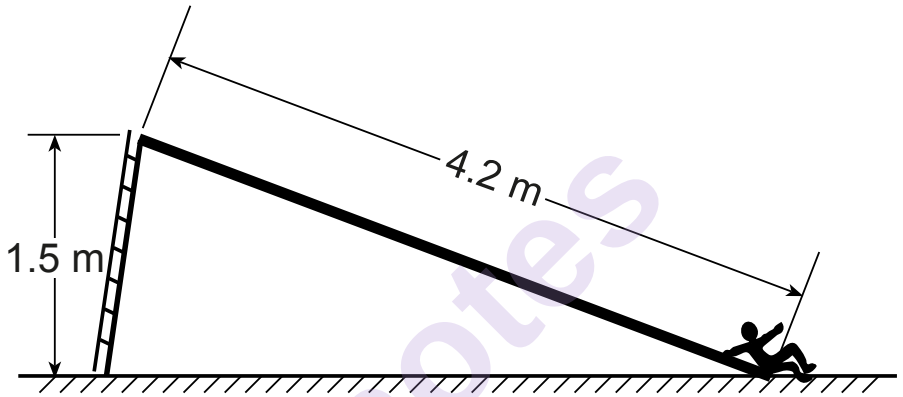
66–67 Calculate the magnitude of the car's velocity after the 6.0 seconds. [Show all work, including the equation and substitution with units.] [2]

68 Determine the direction of the car's velocity after the 6.0 seconds. [1]

69–70 Calculate the total distance traveled by the car during the 6.0 seconds. [Show all work, including the equation and substitution with units.] [2]

Base your answer to questions 71 through 76 on the information and diagram below and on your knowledge of physics.

Starting from rest at the top of the slide, a 40.-kilogram child accelerates uniformly along the surface of a 4.2-meter-long slide at a rate of 0.30 meter per second squared until she reaches the bottom of the slide.



71–72 Calculate the speed of the child at the instant she reaches the bottom of the slide. [Show all work, including the equation and substitution with units.] [2]

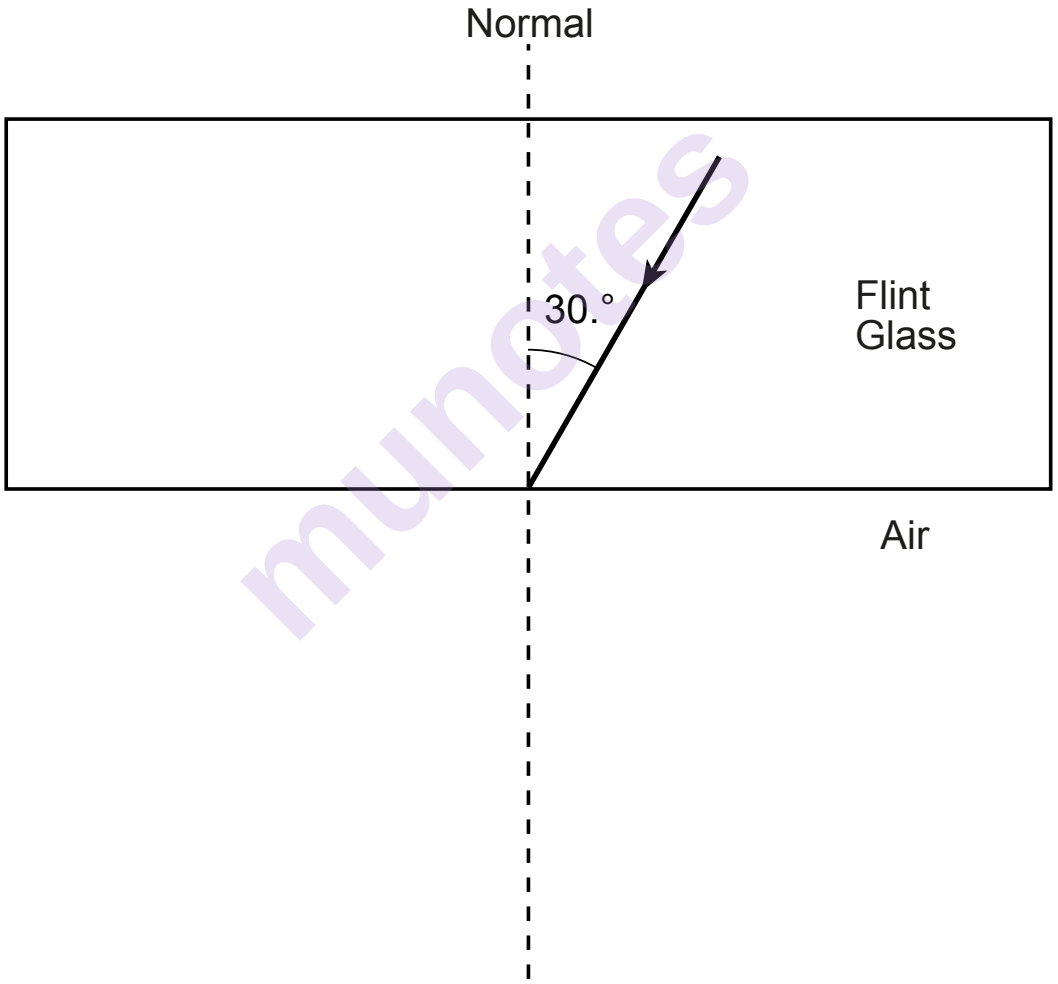
73–74 Calculate the child's kinetic energy at the bottom of the slide. [Show all work, including the equation and substitution with units.] [2]

75 Determine the total gravitational potential energy gained by the child when climbing 1.5 meters vertically from the bottom to the top of the slide. [1]

76 Determine the total amount of mechanical energy lost by the child–slide system as the child slides from the top to the bottom of the slide. [1]

Base your answer to questions 77 through 80 on the information and diagram below and on your knowledge of physics.

The diagram below represents a ray of light ($f = 5.09 \times 10^{14}$ Hz) in flint glass incident on air at an angle of incidence of 30.°.



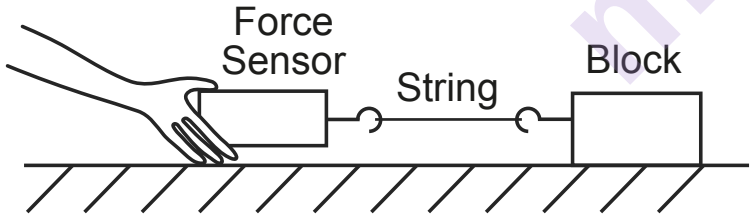
77–78 Calculate the angle of refraction of the light ray in the air. [Show all work, including the equation and substitution with units.] [2]

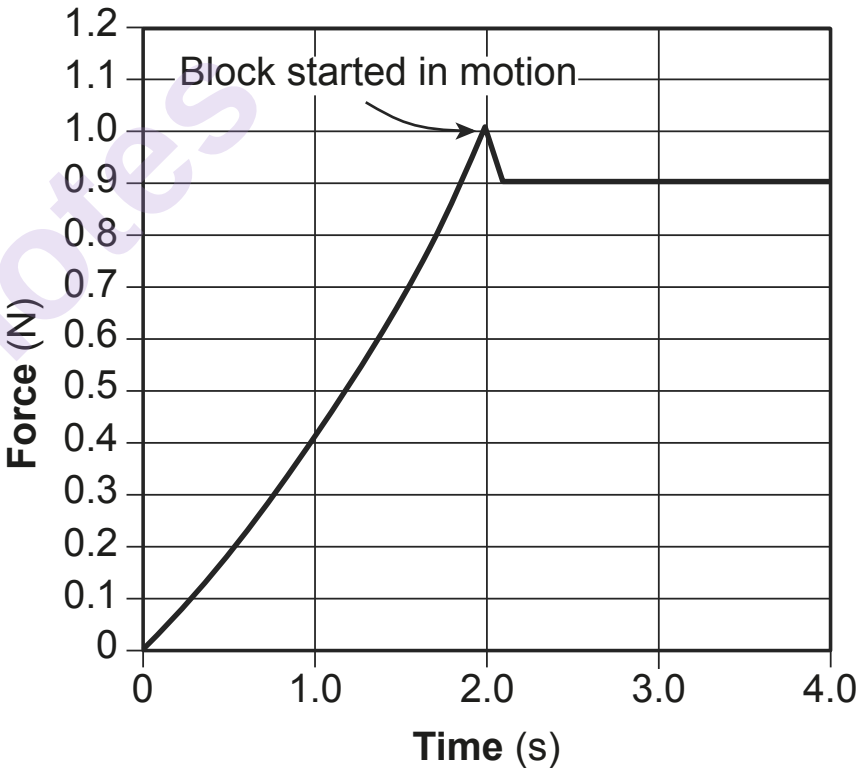
79 Using a protractor and a straightedge, draw the refracted light ray on the diagram *in your answer booklet*. [1]

80 State what happens to the wavelength of the light ray as the light ray passes into the air from the flint glass. [1]

Base your answers to questions 81 through 85 on the information, graph, and diagram below and on your knowledge of physics.

A student pulls a block weighing 2.0 newtons, resting on a horizontal laboratory table, with a string and force sensor. The sensor measures the force applied to the block when the block is at rest and when the block is moving. The force applied to the block is plotted against time on the graph.





81 Based on the graph, determine the force of kinetic friction acting on the block as it is pulled at constant velocity across the laboratory table. [1]

82–83 Calculate the coefficient of kinetic friction between the block and the laboratory table. [Show all work, including the equation and substitution with units.] [2]

84 At the instant the block begins to move, what happens to the value of the coefficient of friction? [1]

85 How would the coefficient of kinetic friction (μ) between the block and the laboratory table be affected if a 0.50-kilogram mass were placed on the block? [1]