The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
PHYSICS

Wednesday, June 15, 2011 — 1:15 to 4:15 p.m., only

The answers to *all* questions in this examination are to be written in your separate answer booklet. Be sure to fill in the heading on the front of your answer booklet.

You are to answer all questions in all parts of this examination according to the directions provided in the examination booklet. All work 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 in the answer booklet.

When you have completed the examination, you must sign the statement printed on the first page of your answer booklet, 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 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.

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

DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN.

Part A

Answer all questions in this part.

Directions (1–35): For *each* statement or question, write in your answer booklet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

1 Scalar is to vector as

(1) speed is to velocity
(2) displacement is to distance
(3) displacement is to velocity
(4) speed is to distance

2 If a car accelerates uniformly from rest to 15 meters per second over a distance of 100. meters, the magnitude of the car's acceleration is

(1) 0.15 m/s^2
(2) 1.1 m/s^2
(3) 2.3 m/s^2
(4) 6.7 m/s^2

3 An object accelerates uniformly from 3.0 meters per second east to 8.0 meters per second east in 2.0 seconds. What is the magnitude of the acceleration of the object?

(1) 2.5 m/s^2
(2) 5.0 m/s^2
(3) 5.5 m/s^2
(4) 11 m/s^2

4 A rock is dropped from a bridge. What happens to the magnitude of the acceleration and the speed of the rock as it falls? [Neglect friction.]

(1) Both acceleration and speed increase.
(2) Both acceleration and speed remain the same.
(3) Acceleration increases and speed decreases.
(4) Acceleration remains the same and speed increases.

5 A soccer ball kicked on a level field has an initial vertical velocity component of 15.0 meters per second. Assuming the ball lands at the same height from which it was kicked, what is the total time the ball is in the air? [Neglect friction.]

(1) 0.654 s
(2) 1.53 s
(3) 3.06 s
(4) 6.12 s

6 A student is standing in an elevator that is accelerating downward. The force that the student exerts on the floor of the elevator must be

(1) less than the weight of the student when at rest
(2) greater than the weight of the student when at rest
(3) less than the force of the floor on the student
(4) greater than the force of the floor on the student

7 The magnitude of the centripetal force acting on an object traveling in a horizontal, circular path will *decrease* if the

(1) radius of the path is increased
(2) mass of the object is increased
(3) direction of motion of the object is reversed
(4) speed of the object is increased

8 The centripetal force acting on the space shuttle as it orbits Earth is equal to the shuttle's

(1) inertia
(2) momentum
(3) velocity
(4) weight

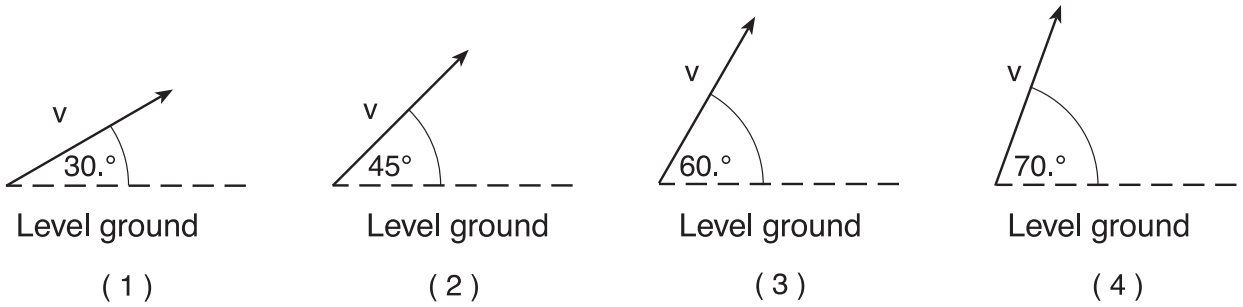
9 As a box is pushed 30. meters across a horizontal floor by a constant horizontal force of 25 newtons, the kinetic energy of the box increases by 300. joules. How much total internal energy is produced during this process?

(1) 150 J
(2) 250 J
(3) 450 J
(4) 750 J

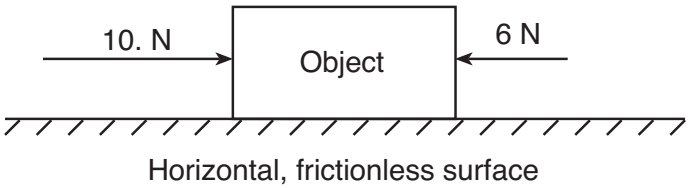
10 What is the power output of an electric motor that lifts a 2.0-kilogram block 15 meters vertically in 6.0 seconds?

(1) 5.0 J
(2) 5.0 W
(3) 49 J
(4) 49 W

11 Four identical projectiles are launched with the same initial speed, v, but at various angles above the level ground. Which diagram represents the initial velocity of the projectile that will have the largest total horizontal displacement? [Neglect air resistance.]



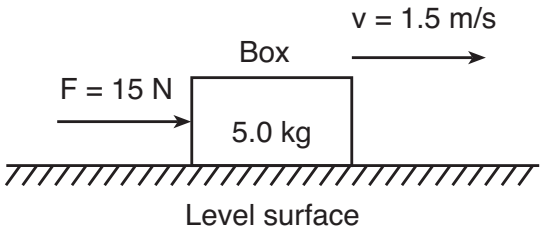
12 Two forces act concurrently on an object on a horizontal, frictionless surface, as shown in the diagram below.



What additional force, when applied to the object, will establish equilibrium?

(1) 16 N toward the right
(2) 16 N toward the left
(3) 4 N toward the right
(4) 4 N toward the left

13 As shown in the diagram below, an open box and its contents have a combined mass of 5.0 kilograms. A horizontal force of 15 newtons is required to push the box at a constant speed of 1.5 meters per second across a level surface.



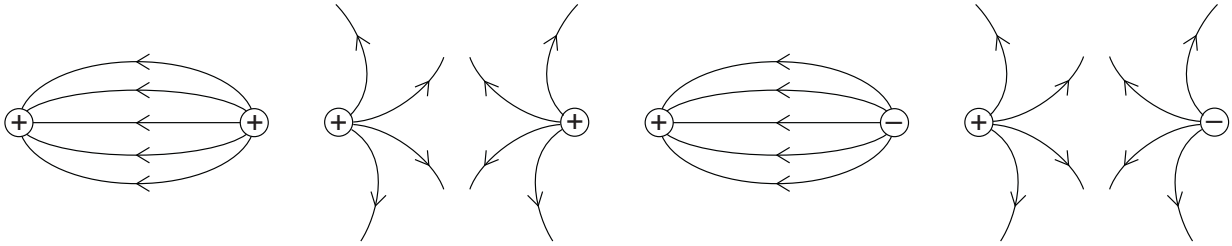
The inertia of the box and its contents increases if there is an increase in the

(1) speed of the box
(2) mass of the contents of the box
(3) magnitude of the horizontal force applied to the box
(4) coefficient of kinetic friction between the box and the level surface

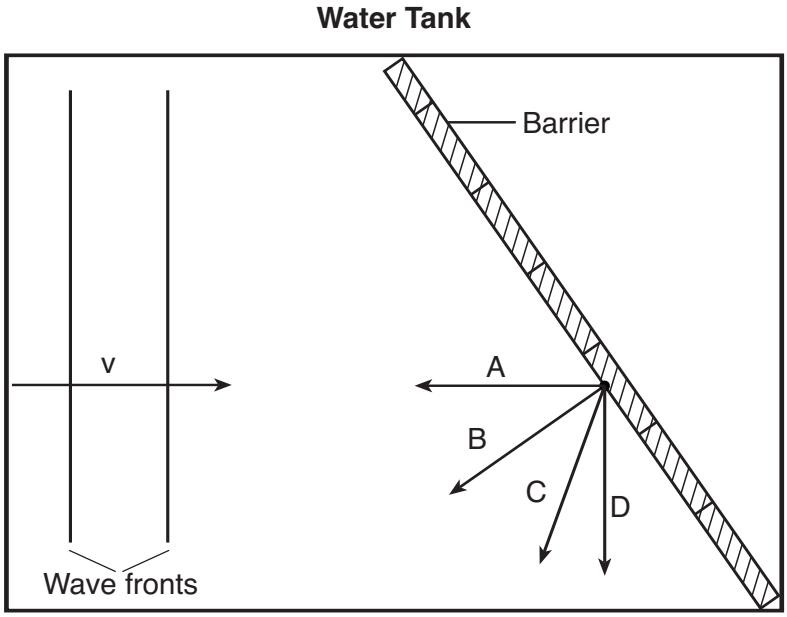
14 Which statement describes the kinetic energy and total mechanical energy of a block as it is pulled at constant speed up an incline?

(1) Kinetic energy decreases and total mechanical energy increases.
(2) Kinetic energy decreases and total mechanical energy remains the same.
(3) Kinetic energy remains the same and total mechanical energy increases.
(4) Kinetic energy remains the same and total mechanical energy remains the same.

15 Which diagram represents the electric field lines between two small electrically charged spheres?



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

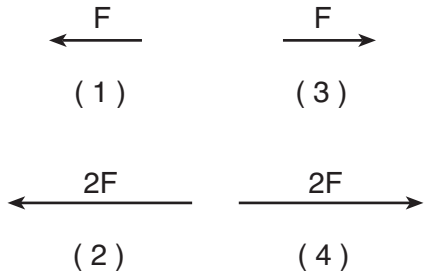


Which arrow represents the direction of travel for the wave fronts after being reflected from the barrier?

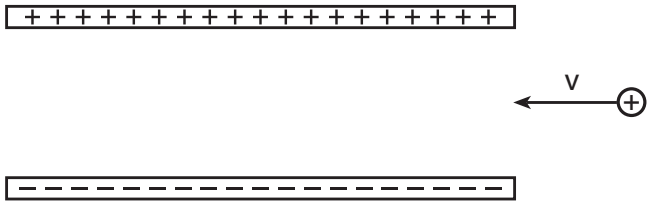
(1) *A*
(2) *B*
(3) *C*
(4) *D*

17 Two metal spheres, *A* and *B*, possess charges of 1.0 microcoulomb and 2.0 microcoulombs, respectively. In the diagram below, arrow *F* represents the electrostatic force exerted on sphere *B* by sphere *A*.

Which arrow represents the magnitude and direction of the electrostatic force exerted on sphere *A* by sphere *B*?



18 The diagram below represents a positively charged particle about to enter the electric field between two oppositely charged parallel plates.



The electric field will deflect the particle

(1) into the page
(2) out of the page
(3) toward the top of the page
(4) toward the bottom of the page

19 What is the total amount of work required to move a proton through a potential difference of 100. volts?

(1) 1.60×10^{-21} J
(2) 1.60×10^{-17} J
(3) 1.00×10^{2} J
(4) 6.25×10^{20} J

20 What is the current through a wire if 240 coulombs of charge pass through the wire in 2.0 minutes?

(1) 120 A
(2) 2.0 A
(3) 0.50 A
(4) 0.0083 A

21 An electric circuit consists of a variable resistor connected to a source of constant potential difference. If the resistance of the resistor is doubled, the current through the resistor is

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

22 Circuit *A* has four 3.0-ohm resistors connected in series with a 24-volt battery, and circuit *B* has two 3.0-ohm resistors connected in series with a 24-volt battery. Compared to the total potential drop across circuit *A*, the total potential drop across circuit *B* is

(1) one-half as great
(2) twice as great
(3) the same
(4) four times as great

23 How much total energy is dissipated in 10. seconds in a 4.0-ohm resistor with a current of 0.50 ampere?

(1) 2.5 J
(2) 5.0 J
(3) 10. J
(4) 20. J

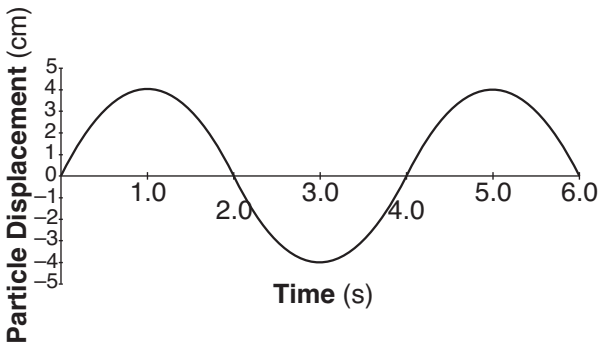
24 Moving a length of copper wire through a magnetic field may cause the wire to have a

(1) potential difference across it
(2) lower temperature
(3) lower resistivity
(4) higher resistance

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.



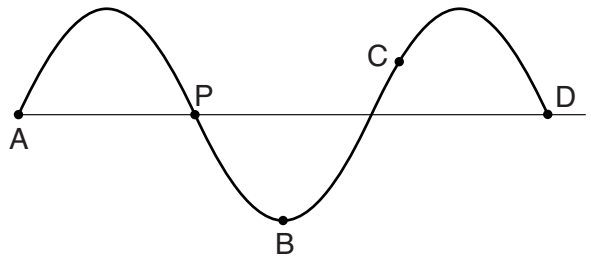
The amplitude of the wave is

(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

Part B–1

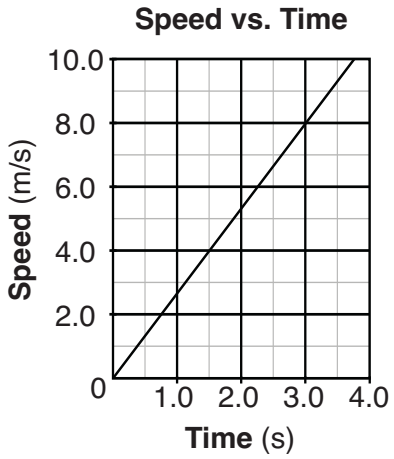
Answer all questions in this part.

Directions (36–50): For *each* statement or question, write in your answer booklet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

36 What is the approximate diameter of an inflated basketball?

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

37 The graph below shows the relationship between the speed and elapsed time for an object falling freely from rest near the surface of a planet.



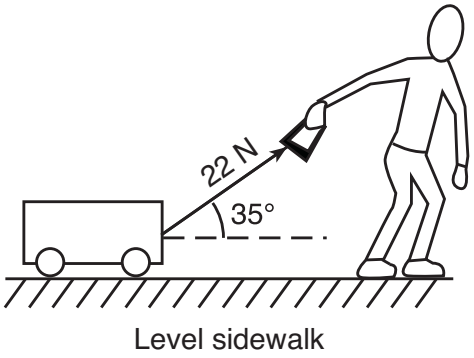
What is the total distance the object falls during the first 3.0 seconds?

(1) 12 m
(2) 24 m
(3) 44 m
(4) 72 m

38 A 75-kilogram hockey player is skating across the ice at a speed of 6.0 meters per second. What is the magnitude of the average force required to stop the player in 0.65 second?

(1) 120 N
(2) 290 N
(3) 690 N
(4) 920 N

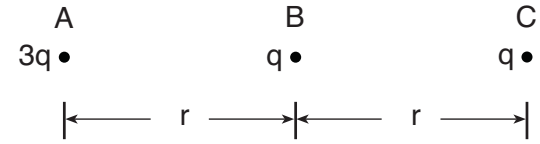
39 A child pulls a wagon at a constant velocity along a level sidewalk. The child does this by applying a 22-newton force to the wagon handle, which is inclined at 35° to the sidewalk as shown below.



What is the magnitude of the force of friction on the wagon?

(1) 11 N
(2) 13 N
(3) 18 N
(4) 22 N

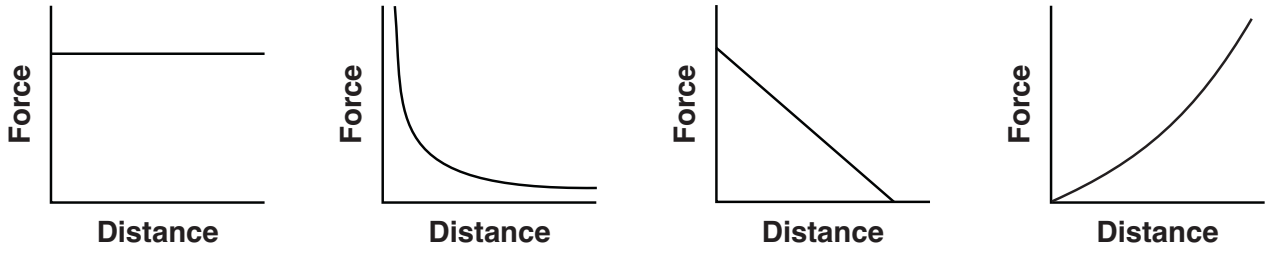
40 The diagram below shows the arrangement of three small spheres, *A*, *B*, and *C*, having charges of $3q$, q, and q, respectively. Spheres *A* and *C* are located distance *r* from sphere *B*.



Compared to the magnitude of the electrostatic force exerted by sphere *B* on sphere *C*, the magnitude of the electrostatic force exerted by sphere *A* on sphere *C* is

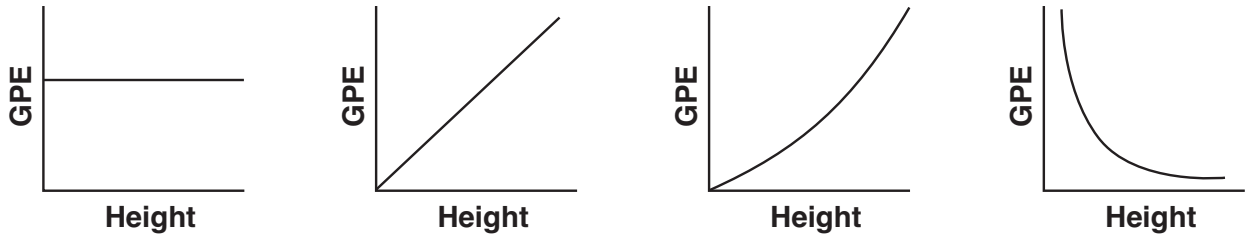
(1) the same
(2) twice as great
(3) $\frac{3}{4}$ as great
(4) $\frac{3}{2}$ as great

41 A space probe is launched into space from Earth's surface. Which graph represents the relationship between the magnitude of the gravitational force exerted on Earth by the space probe and the distance between the space probe and the center of Earth?



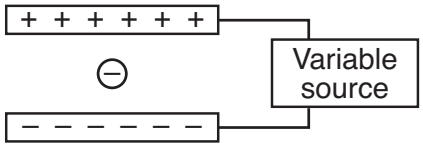
(1) (2) (3) (4)

42 Which graph represents the relationship between the gravitational potential energy *(GPE)* of an object near the surface of Earth and its height above the surface of Earth?

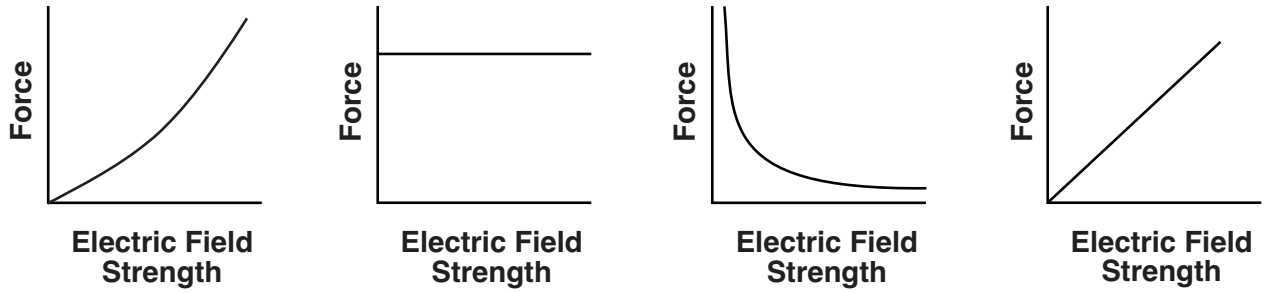


(1) (2) (3) (4)

43 Two parallel metal plates are connected to a variable source of potential difference. When the potential difference of the source is increased, the magnitude of the electric field strength between the plates increases. The diagram below shows an electron located between the plates.

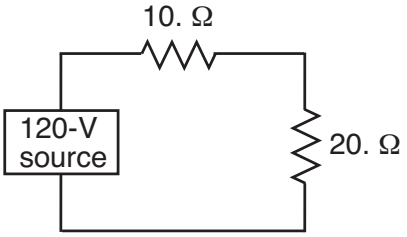


Which graph represents the relationship between the magnitude of the electrostatic force on the electron and the magnitude of the electric field strength between the plates?



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

44 The diagram below represents a circuit consisting of two resistors connected to a source of potential difference.



What is the current through the 20.-ohm resistor?

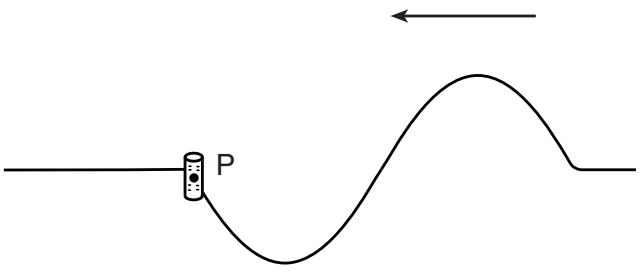
(1) 0.25 A
(2) 6.0 A
(3) 12 A
(4) 4.0 A

45 The diagram below shows the magnetic field lines between two magnetic poles, *A* and *B*.

Which statement describes the polarity of magnetic poles *A* and *B*?

(1) *A* is a north pole and *B* is a south pole.
(2) *A* is a south pole and *B* is a north pole.
(3) Both *A* and *B* are north poles.
(4) Both *A* and *B* are south poles.

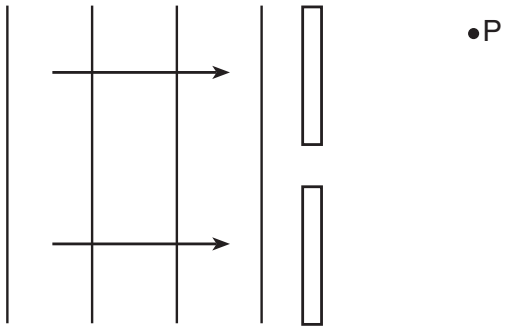
46 The diagram below represents a transverse water wave propagating toward the left. A cork is floating on the water's surface at point *P*.



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.

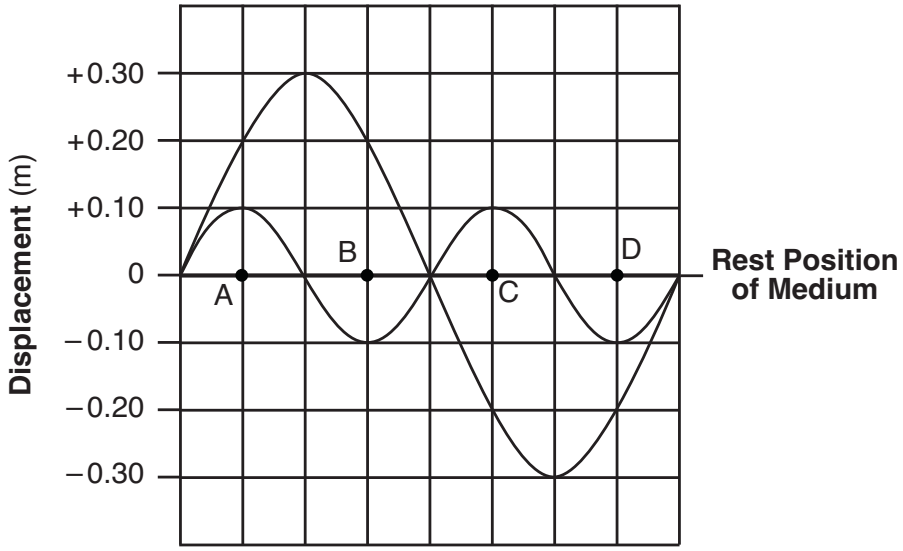
The number of nodes and antinodes shown in the diagram is

(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*

Part B–2

Answer all questions in this part.

Directions (51–65): Record your answers in the spaces provided in your answer booklet.

51–52 A 0.50-kilogram frog is at rest on the bank surrounding a pond of water. As the frog leaps from the bank, the magnitude of the acceleration of the frog is 3.0 meters per second^2. Calculate the magnitude of the net force exerted on the frog as it leaps. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 53 through 55 on the information below.

A student and the waxed skis he is wearing have a combined weight of 850 newtons. The skier travels down a snow-covered hill and then glides to the east across a snow-covered, horizontal surface.

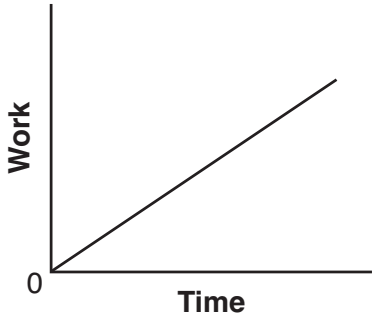
53 Determine the magnitude of the normal force exerted by the snow on the skis as the skier glides across the horizontal surface. [1]

54–55 Calculate the magnitude of the force of friction acting on the skis as the skier glides across the snow-covered, horizontal surface. [Show all work, including the equation and substitution with units.] [2]

56–57 Calculate the kinetic energy of a particle with a mass of 3.34×10^{-27} kilogram and a speed of 2.89×10^5 meters per second. [Show all work, including the equation and substitution with units.] [2]

58 A simple circuit consists of a 100.-ohm resistor connected to a battery. A 25-ohm resistor is to be connected in the circuit. Determine the *smallest* equivalent resistance possible when both resistors are connected to the battery. [1]

59 The graph below represents the relationship between the work done by a person and time.



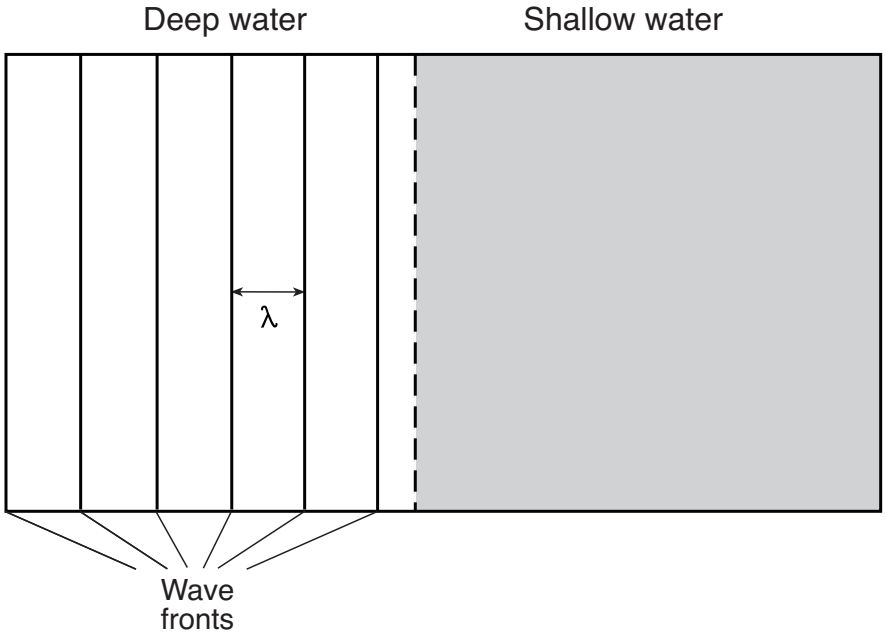
Identify the physical quantity represented by the slope of the graph. [1]

60–61 The heating element in an automobile window has a resistance of 1.2 ohms when operated at 12 volts. Calculate the power dissipated in the heating element. [Show all work, including the equation and substitution with units.] [2]

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]

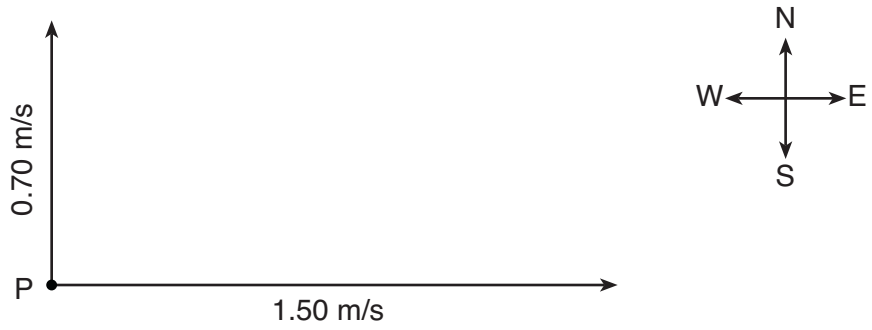
Part C

Answer all questions in this part.

Directions (66–85): Record your answers in the spaces provided in your answer booklet.

Base your answers to questions 66 through 69 on the information and diagram below.

A model airplane heads due east at 1.50 meters per second, while the wind blows due north at 0.70 meter per second. The scaled diagram below represents these vector quantities.



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

67 On the diagram *in your answer booklet*, use a protractor and a ruler to construct a vector to represent the resultant velocity of the airplane. Label the vector *R*. [1]

68 Determine the magnitude of the resultant velocity. [1]

69 Determine the angle between north and the resultant velocity. [1]

Base your answers to questions 70 through 73 on the information below.

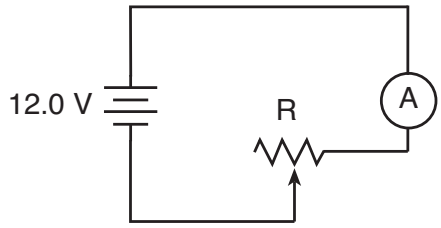
A vertically hung spring has a spring constant of 150. newtons per meter. A 2.00-kilogram mass is suspended from the spring and allowed to come to rest.

70–71 Calculate the elongation of the spring produced by the suspended 2.00-kilogram mass. [Show all work, including the equation and substitution with units.] [2]

72–73 Calculate the total elastic potential energy stored in the spring due to the suspended 2.00-kilogram mass. [Show all work, including the equation and substitution with units.] [2]

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

A circuit contains a 12.0-volt battery, an ammeter, a variable resistor, and connecting wires of negligible resistance, as shown below.



The variable resistor is a nichrome wire, maintained at 20.°C. The length of the nichrome wire may be varied from 10.0 centimeters to 90.0 centimeters. The ammeter reads 2.00 amperes when the length of the wire is 10.0 centimeters.

74 Determine the resistance of the 10.0-centimeter length of nichrome wire. [1]

75–76 Calculate the cross-sectional area of the nichrome wire. [Show all work, including the equation and substitution with units.] [2]

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.

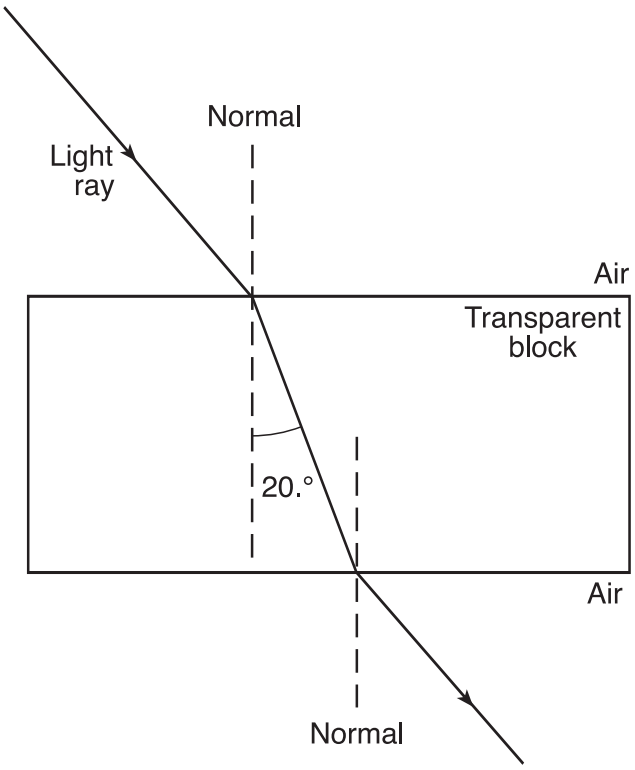
77–78 Calculate the energy, in joules, of this photon. [Show all work, including the equation and substitution with units.] [2]

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 × 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]

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