The University of the State of New York
REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
PHYSICS

Tuesday, June 21, 2016 — 1:15 to 4:15 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 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, 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 quantity is a vector?

(1) power
(2) kinetic energy
(3) speed
(4) weight

2 A 65.0-kilogram astronaut weighs 638 newtons at the surface of Earth. What is the mass of the astronaut at the surface of the Moon, where the acceleration due to gravity is 1.62 meters per second squared?

(1) 10.7 kg
(2) 65.0 kg
(3) 105 N
(4) 638 N

3 When the sum of all the forces acting on a block on an inclined plane is zero, the block

(1) must be at rest
(2) must be accelerating
(3) may be slowing down
(4) may be moving at constant speed

4 The greatest increase in the inertia of an object would be produced by increasing the

(1) mass of the object from 1.0 kg to 2.0 kg
(2) net force applied to the object from 1.0 N to 2.0 N
(3) time that a net force is applied to the object from 1.0 s to 2.0 s
(4) speed of the object from 1.0 m/s to 2.0 m/s

5 A 100.-kilogram cart accelerates at 0.50 meter per second squared west as a horse exerts a force of 60. newtons west on the cart. What is the magnitude of the force that the cart exerts on the horse?

(1) 10. N
(2) 50. N
(3) 60. N
(4) 110 N

6 Sound waves are described as

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

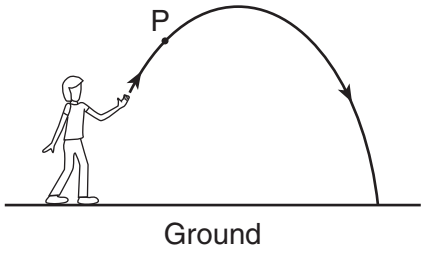
7 An electrical force of 8.0×10^{-5} newton exists between two point charges, q_1 and q_2. If the distance between the charges is doubled, the new electrical force between the charges will be

(1) 1.6×10^{-4} N
(2) 2.0×10^{-5} N
(3) 3.2×10^{-4} N
(4) 4.0×10^{-5} N

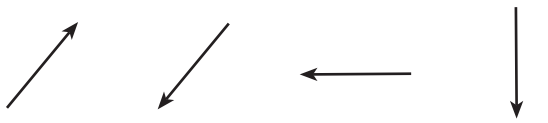
8 A blue lab cart is traveling west on a track when it collides with and sticks to a red lab cart traveling east. The magnitude of the momentum of the blue cart before the collision is 2.0 kilogram • meters per second, and the magnitude of the momentum of the red cart before the collision is 3.0 kilogram • meters per second. The magnitude of the total momentum of the two carts after the collision is

(1) 1.0 kg • m/s
(2) 2.0 kg • m/s
(3) 3.0 kg • m/s
(4) 5.0 kg • m/s

9 The diagram below represents the path of a thrown ball through the air.



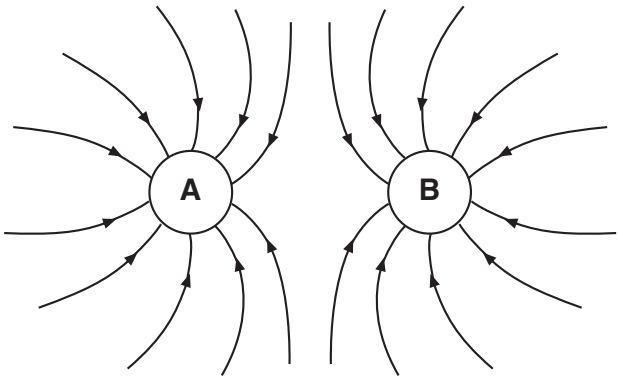
Which arrow best represents the direction in which friction acts on the ball at point *P*?



10 A magnetic field would be produced by a beam of

(1) x rays
(2) gamma rays
(3) protons
(4) neutrons

11 The diagram below represents the electric field in the region of two small charged spheres, *A* and *B*.



What is the sign of the net charge on *A* and *B*?

(1) *A* is positive and *B* is positive.
(2) *A* is positive and *B* is negative.
(3) *A* is negative and *B* is negative.
(4) *A* is negative and *B* is positive.

12 A horizontal force of 20 newtons eastward causes a 10-kilogram box to have a displacement of 5 meters eastward. The total work done on the box by the 20-newton force is

(1) 40 J
(2) 100 J
(3) 200 J
(4) 1000 J

13 A block initially at rest on a horizontal, frictionless surface is accelerated by a constant horizontal force of 5.0 newtons. If 15 joules of work is done on the block by this force while accelerating it, the kinetic energy of the block increases by

(1) 3.0 J
(2) 15 J
(3) 20. J
(4) 75 J

14 Two objects, *A* and *B*, are held one meter above the horizontal ground. The mass of *B* is twice as great as the mass of *A*. If *PE* is the gravitational potential energy of *A* relative to the ground, then the gravitational potential energy of *B* relative to the ground is

(1) PE
(2) $2PE$
(3) $\frac{PE}{2}$
(4) $4PE$

15 What is the kinetic energy of a 55-kilogram skier traveling at 9.0 meters per second?

(1) 2.5×10^2 J
(2) 5.0×10^2 J
(3) 2.2×10^3 J
(4) 4.9×10^3 J

16 A 5.09×10^{14}-hertz electromagnetic wave is traveling through a transparent medium. The main factor that determines the speed of this wave is the

(1) nature of the medium
(2) amplitude of the wave
(3) phase of the wave
(4) distance traveled through the medium

17 A motor does a total of 480 joules of work in 5.0 seconds to lift a 12-kilogram block to the top of a ramp. The average power developed by the motor is

(1) 8.0 W
(2) 40. W
(3) 96 W
(4) 2400 W

18 A 5.8×10^4-watt elevator motor can lift a total weight of 2.1×10^4 newtons with a maximum constant speed of

(1) 0.28 m/s
(2) 0.36 m/s
(3) 2.8 m/s
(4) 3.6 m/s

19 A stationary police officer directs radio waves emitted by a radar gun at a vehicle moving toward the officer. Compared to the emitted radio waves, the radio waves reflected from the vehicle and received by the radar gun have a

(1) longer wavelength
(2) higher speed
(3) longer period
(4) higher frequency

20 A light wave strikes the Moon and reflects toward Earth. As the light wave travels from the Moon toward Earth, the wave carries

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

21 The time required to produce one cycle of a wave is known as the wave's

(1) amplitude
(2) frequency
(3) period
(4) wavelength

22 A magnetic compass is placed near an insulated copper wire. When the wire is connected to a battery and a current is created, the compass needle moves and changes its position. Which is the best explanation for the production of a force that causes the needle to move?

(1) The copper wire magnetizes the compass needle and exerts the force on the compass needle.
(2) The compass needle magnetizes the copper wire and exerts the force on the compass needle.
(3) The insulation on the wire becomes charged, which exerts the force on the compass needle.
(4) The current in the wire produces a magnetic field that exerts the force on the compass needle.

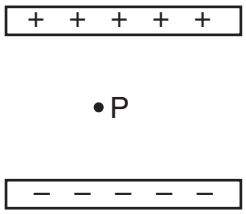
23 A beam of monochromatic light ($f = 5.09 \times 10^{14}$ Hz) has a wavelength of 589 nanometers in air. What is the wavelength of this light in Lucite?

(1) 150 nm
(2) 393 nm
(3) 589 nm
(4) 884 nm

24 If the amplitude of a sound wave is increased, there is an increase in the sound's

(1) loudness
(2) pitch
(3) velocity
(4) wavelength

25 In the diagram below, point P is located in the electric field between two oppositely charged parallel plates.



Compared to the magnitude and direction of the electrostatic force on an electron placed at point P, the electrostatic force on a proton placed at point P has

(1) the same magnitude and the same direction
(2) the same magnitude, but the opposite direction
(3) a greater magnitude, but the same direction
(4) a greater magnitude and the opposite direction

26 The effect produced when two or more sound waves pass through the same point simultaneously is called

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

27 A gamma ray photon and a microwave photon are traveling in a vacuum. Compared to the wavelength and energy of the gamma ray photon, the microwave photon has a

(1) shorter wavelength and less energy
(2) shorter wavelength and more energy
(3) longer wavelength and less energy
(4) longer wavelength and more energy

28 According to the Standard Model of Particle Physics, a neutrino is a type of

(1) lepton
(2) photon
(3) meson
(4) baryon

29 Which combination of quarks produces a neutral baryon?

(1) cts
(2) dsb
(3) uds
(4) uct

30 When 2.0×10^{-16} kilogram of matter is converted into energy, how much energy is released?

(1) 1.8×10^{-1} J
(2) 1.8×10^{1} J
(3) 6.0×10^{-32} J
(4) 6.0×10^{-8} J

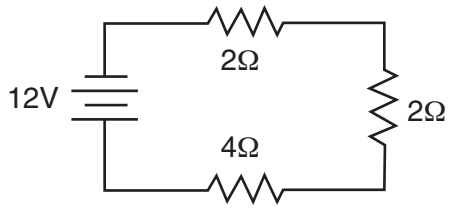
31 A ball is hit straight up with an initial speed of 28 meters per second. What is the speed of the ball 2.2 seconds after it is hit? [Neglect friction.]

(1) 4.3 m/s
(2) 6.4 m/s
(3) 22 m/s
(4) 28 m/s

32 A particle with a charge of 3.00 elementary charges moves through a potential difference of 4.50 volts. What is the change in electrical potential energy of the particle?

(1) 1.07×10^{-19} eV
(2) 2.16×10^{-18} eV
(3) 1.50 eV
(4) 13.5 eV

33 Which circuit has the largest equivalent resistance?



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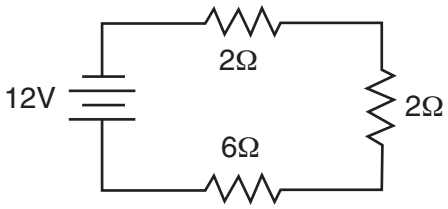

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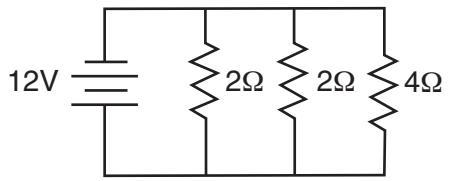

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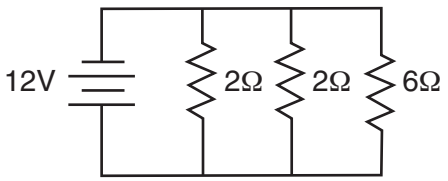
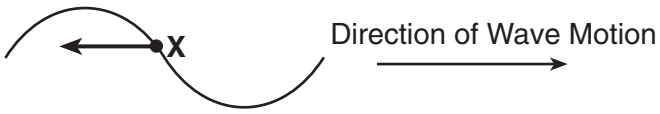


(4)

34 A transverse wave is moving toward the right in a uniform medium. Point *X* represents a particle of the uniform medium. Which diagram represents the direction of the motion of particle *X* at the instant shown?

(1)



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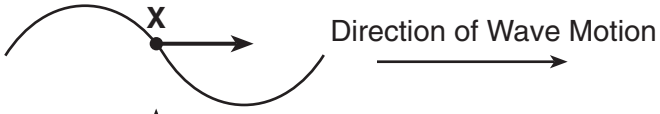

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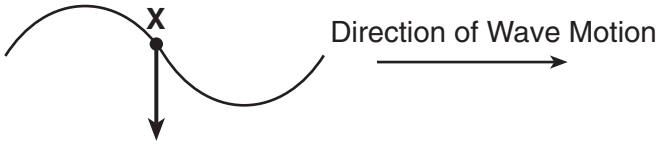
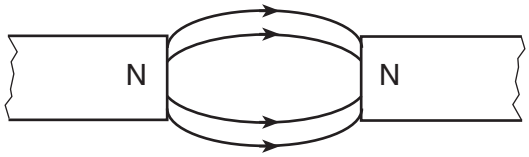
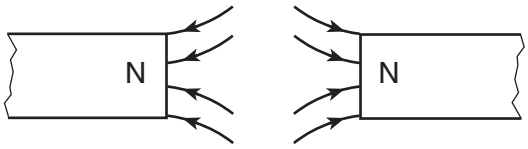


35 Which diagram represents magnetic field lines between two north magnetic poles?



(1)



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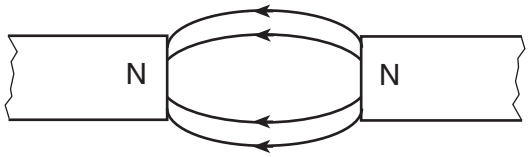

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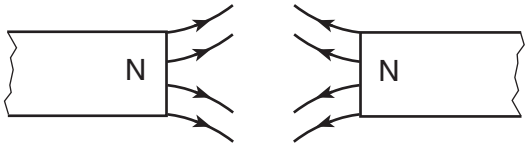


(4)

Part B–1

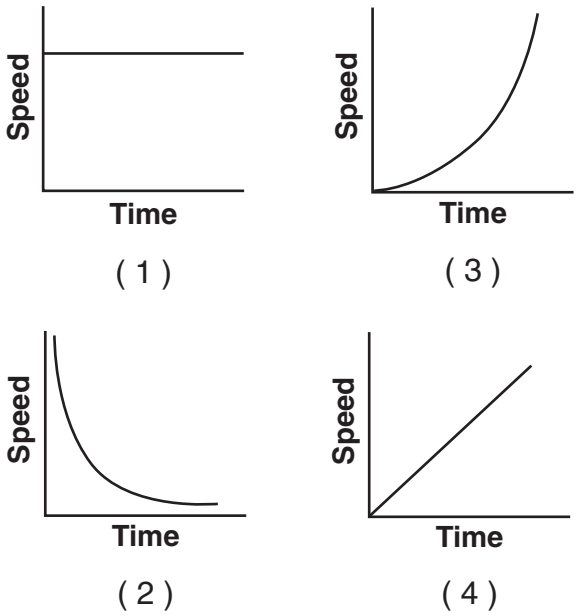
Answer all questions in this part.

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 Which measurement is closest to 1×10^{-2} meter?

(1) diameter of an atom
(2) width of a student's finger
(3) length of a football field
(4) height of a schoolteacher

37 Which graph represents the relationship between the speed of a freely falling object and the time of fall of the object near Earth's surface?



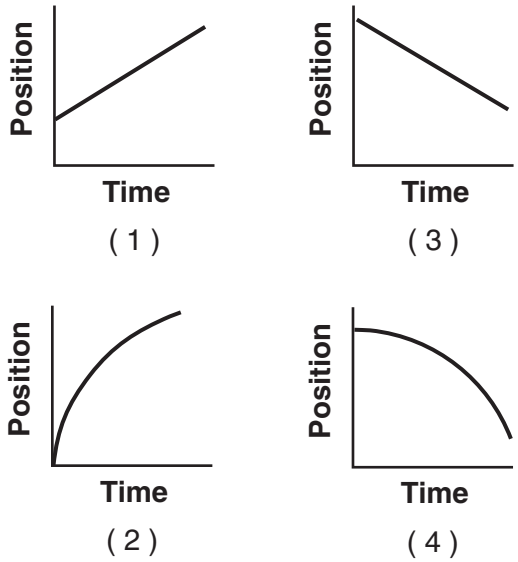
38 A hair dryer with a resistance of 9.6 ohms operates at 120 volts for 2.5 minutes. The total electrical energy used by the dryer during this time interval is

(1) 2.9×10^3 J
(2) 3.8×10^3 J
(3) 1.7×10^5 J
(4) 2.3×10^5 J

39 A box weighing 46 newtons rests on an incline that makes an angle of 25° with the horizontal. What is the magnitude of the component of the box's weight perpendicular to the incline?

(1) 19 N
(2) 21 N
(3) 42 N
(4) 46 N

40 Which graph represents the motion of an object traveling with a positive velocity and a negative acceleration?



41 Car *A*, moving in a straight line at a constant speed of 20. meters per second, is initially 200 meters behind car *B*, moving in the same straight line at a constant speed of 15 meters per second. How far must car *A* travel from this initial position before it catches up with car *B*?

(1) 200 m
(2) 400 m
(3) 800 m
(4) 1000 m

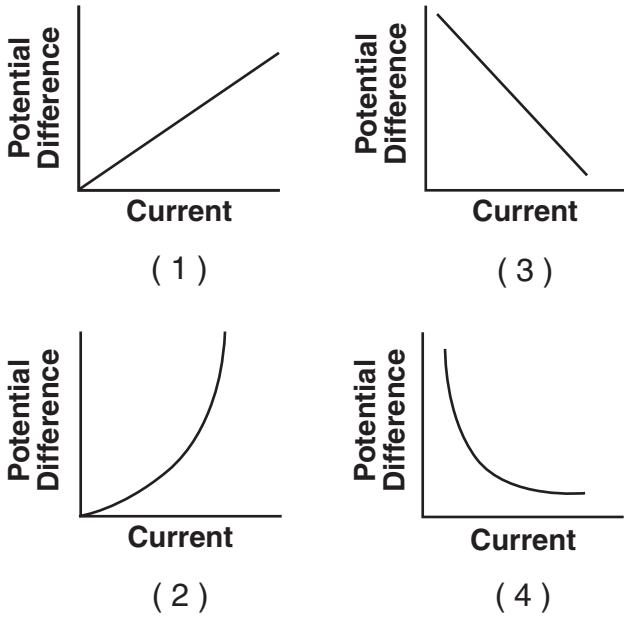
42 A 2700-ohm resistor in an electric circuit draws a current of 2.4 milliamperes. The total charge that passes through the resistor in 15 seconds is

(1) 1.6×10^{-4} C
(2) 3.6×10^{-2} C
(3) 1.6×10^{-1} C
(4) 3.6×10^{1} C

43 A 1000.–kilogram car traveling 20.0 meters per second east experiences an impulse of 2000. newton • seconds west. What is the final velocity of the car after the impulse has been applied?

(1) 18.0 m/s east
(2) 19.5 m/s east
(3) 20.5 m/s west
(4) 22.0 m/s west

44 Which graph represents the relationship between the potential difference applied to a copper wire and the resulting current in the wire at constant temperature?



45 A tungsten wire has resistance R at 20°C. A second tungsten wire at 20°C has twice the length and half the cross-sectional area of the first wire. In terms of R, the resistance of the second wire is

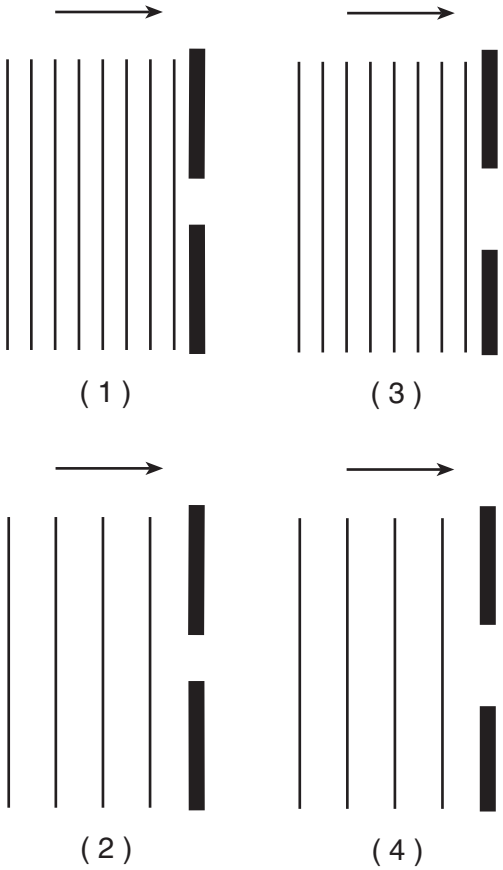
(1) $\frac{R}{2}$ (3) $2R$

(2) R (4) $4R$

46 After an incandescent lamp is turned on, the temperature of its filament rapidly increases from room temperature to its operating temperature. As the temperature of the filament increases, what happens to the resistance of the filament and the current through the filament?

(1) The resistance increases and the current decreases.
(2) The resistance increases and the current increases.
(3) The resistance decreases and the current decreases.
(4) The resistance decreases and the current increases.

47 Parallel wave fronts are incident on an opening in a barrier. Which diagram shows the configuration of wave fronts and barrier opening that will result in the greatest diffraction of the waves passing through the opening? [Assume all diagrams are drawn to the same scale.]

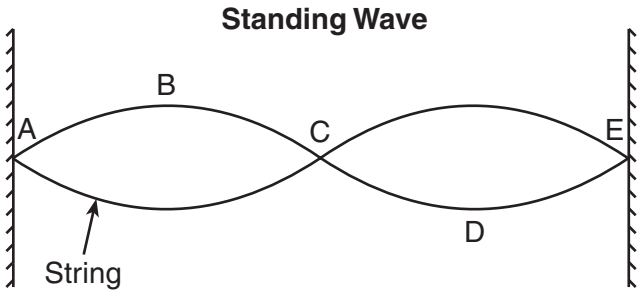


48 A singer demonstrated that she could shatter a crystal glass by singing a note with a wavelength of 0.320 meter in air at STP. What was the natural frequency of the glass?

(1) 9.67×10^{-4} Hz (3) 1.03×10^{3} Hz

(2) 1.05×10^{2} Hz (4) 9.38×10^{8} Hz

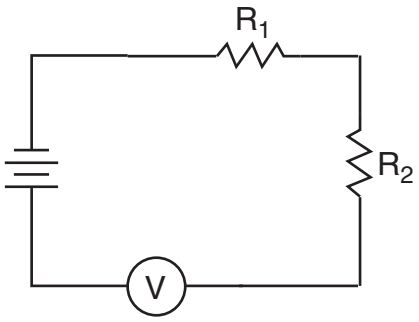
49 The diagram below represents a standing wave in a string.



Maximum constructive interference occurs at the

(1) antinodes *A*, *C*, and *E*
(2) nodes *A*, *C*, and *E*
(3) antinodes *B* and *D*
(4) nodes *B* and *D*

50 Which circuit diagram represents voltmeter *V* connected correctly to measure the potential difference across resistor R_2?



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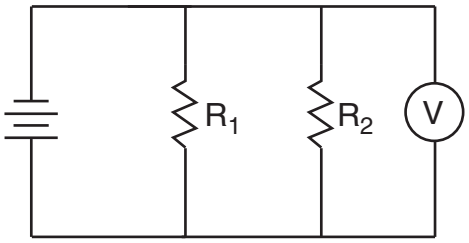

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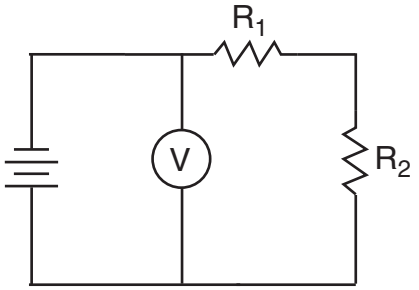

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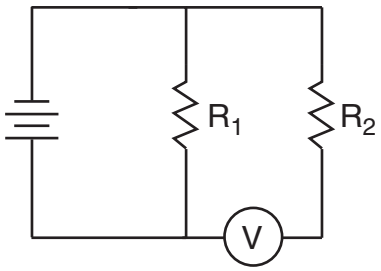


(4)

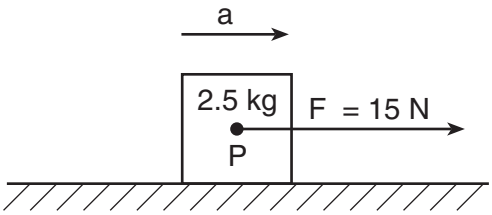
Part B–2

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 53 on the information and diagram below and on your knowledge of physics.

As represented in the diagram below, a constant 15-newton force, F, is applied to a 2.5-kilogram box, accelerating the box to the right at 2.0 meters per second squared across a rough horizontal surface.

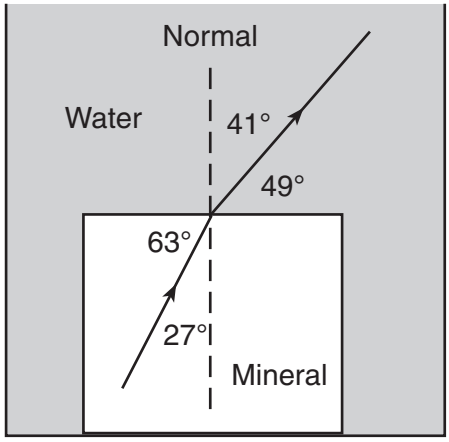


51–52 Calculate the magnitude of the net force acting on the box. [Show all work, including the equation and substitution with units.] [2]

53 Determine the magnitude of the force of friction on the box. [1]

Base your answers to questions 54 and 55 on the information and diagram below and on your knowledge of physics.

A ray of light ($f = 5.09 \times 10^{14}$ Hz) is traveling through a mineral sample that is submerged in water. The ray refracts as it enters the water, as shown in the diagram below.



54–55 Calculate the absolute index of refraction of the mineral. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 56 through 58 on the information below and on your knowledge of physics.

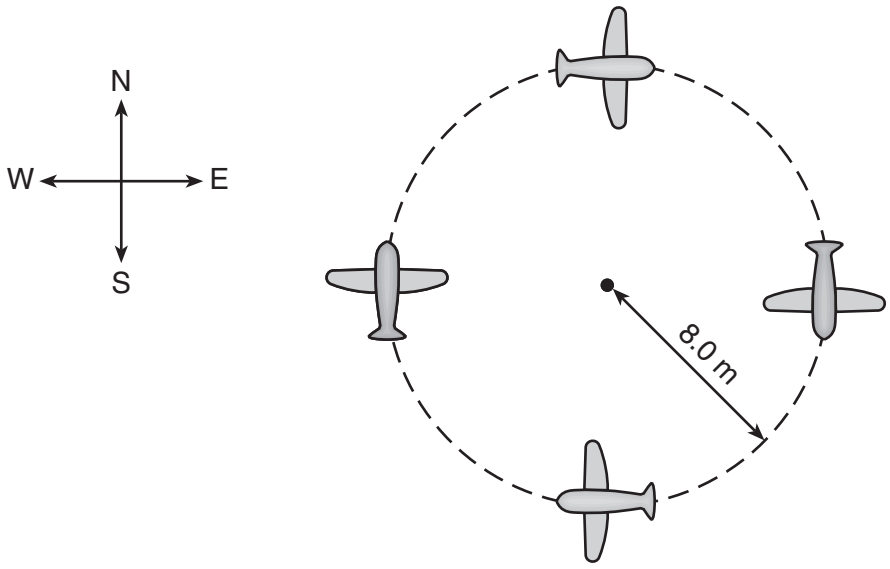
A ball is rolled twice across the same level laboratory table and allowed to roll off the table and strike the floor. In each trial, the time it takes the ball to travel from the edge of the table to the floor is accurately measured. [Neglect friction.]

56–57 In trial *A*, the ball is traveling at 2.50 meters per second when it reaches the edge of the table. The ball strikes the floor 0.391 second after rolling off the edge of the table. Calculate the height of the table. [Show all work, including the equation and substitution with units.] [2]

58 In trial *B*, the ball is traveling at 5.00 meters per second when it reaches the edge of the table. Compare the time it took the ball to reach the floor in trial *B* to the time it took the ball to reach the floor in trial *A*. [1]

Base your answers to questions 59 through 61 on the information and diagram below and on your knowledge of physics.

A toy airplane flies clockwise at a constant speed in a horizontal circle of radius 8.0 meters. The magnitude of the acceleration of the airplane is 25 meters per second squared. The diagram shows the path of the airplane as it travels around the circle.

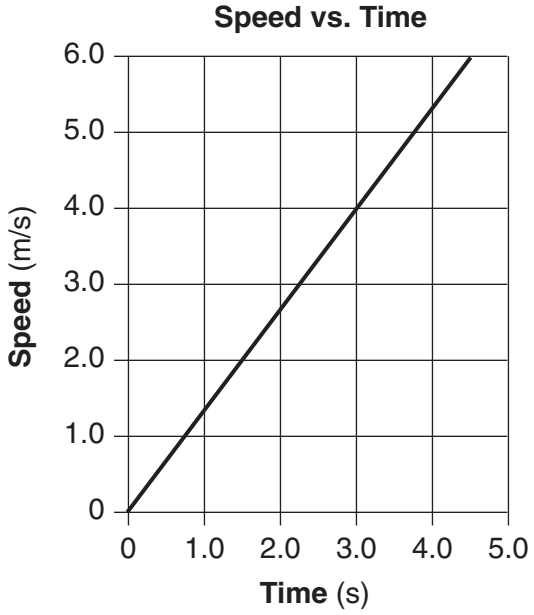


59–60 Calculate the speed of the airplane. [Show all work, including the equation and substitution with units.] [2]

61 State the direction of the velocity of the airplane at the instant the acceleration of the airplane is southward. [1]

Base your answers to questions 62 through 64 on the information and graph below and on your knowledge of physics.

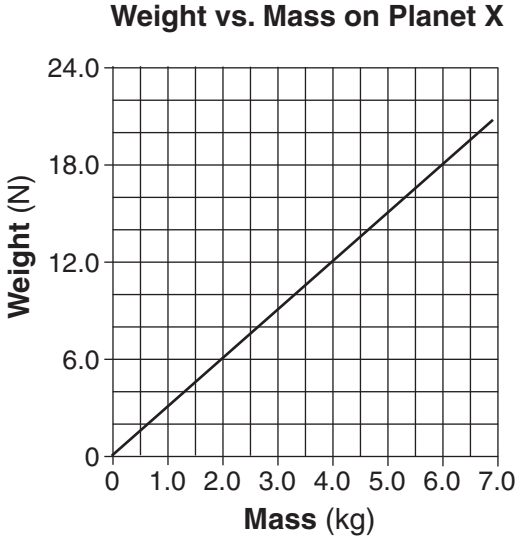
The graph below represents the speed of a marble rolling down a straight incline as a function of time.



62 What quantity is represented by the slope of the graph? [1]

63–64 Calculate the distance the marble travels during the first 3.0 seconds. [Show all work, including the equation and substitution with units.] [2]

65 The graph below represents the relationship between weight and mass for objects on the surface of planet *X*.



Determine the acceleration due to gravity on the surface of planet *X*. [1]

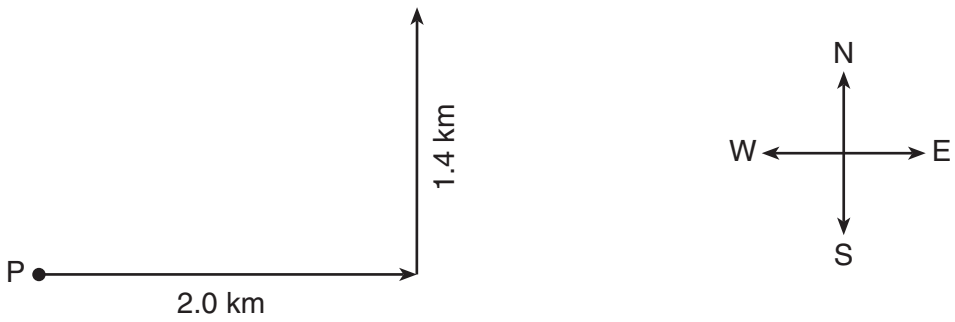
Part C

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 69 on the information and vector diagram below and on your knowledge of physics.

A hiker starts at point *P* and walks 2.0 kilometers due east and then 1.4 kilometers due north. The vectors in the diagram below represent these two displacements.



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

67 On the diagram *in your answer booklet,* use a ruler to construct the vector representing the hiker's resultant displacement. [1]

68 Determine the magnitude of the hiker's resultant displacement. [1]

69 Using a protractor, determine the angle between east and the hiker's resultant displacement. [1]

Base your answers to questions 70 through 74 on the information and diagram below and on your knowledge of physics.

A jack-in-the-box is a toy in which a figure in an open box is pushed down, compressing a spring. The lid of the box is then closed. When the box is opened, the figure is pushed up by the spring. The spring in the toy is compressed 0.070 meter by using a downward force of 12.0 newtons.

70–71 Calculate the spring constant of the spring. [Show all work, including the equation and substitution with units.] [2]

72–73 Calculate the total amount of elastic potential energy stored in the spring when it is compressed. [Show all work, including the equation and substitution with units.] [2]

74 Identify *one* form of energy to which the elastic potential energy of the spring is converted when the figure is pushed up by the spring. [1]

Base your answers to questions 75 through 80 on the information below and on your knowledge of physics.

A 12-volt battery causes 0.60 ampere to flow through a circuit that contains a lamp and a resistor connected in parallel. The lamp is operating at 6.0 watts.

75 Using the circuit symbols shown on the *Reference Tables for Physical Setting/Physics,* draw a diagram of the circuit in the space provided *in your answer booklet.* [1]

76–77 Calculate the current through the lamp. [Show all work, including the equation and substitution with units.] [2]

78 Determine the current in the resistor. [1]

79–80 Calculate the resistance of the resistor. [Show all work, including the equation and substitution with units.] [2]

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

The Great Nebula in the constellation Orion consists primarily of excited hydrogen gas. The electrons in the atoms of excited hydrogen have been raised to higher energy levels. When these atoms release energy, a frequent electron transition is from the excited $n = 3$ energy level to the $n = 2$ energy level, which gives the nebula one of its characteristic colors.

81 Determine the energy, in electronvolts, of an emitted photon when an electron transition from $n = 3$ to $n = 2$ occurs. [1]

82 Determine the energy of this emitted photon in joules. [1]

83–84 Calculate the frequency of the emitted photon. [Show all work, including the equation and substitution with units.] [2]

85 Identify the color of light associated with this photon. [1]

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