The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
PHYSICS

Tuesday, June 24, 2025 — 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.

Base your answers to questions 1 and 2 on the information below and on your knowledge of physics.

A car, initially moving at 20.0 meters per second, travels 200. meters while accelerating uniformly to a speed of 30.0 meters per second.

1 The magnitude of the acceleration of the car is

(1) 0.0500 m/s^2
(2) 1.25 m/s^2
(3) 2.50 m/s^2
(4) 3.13 m/s^2

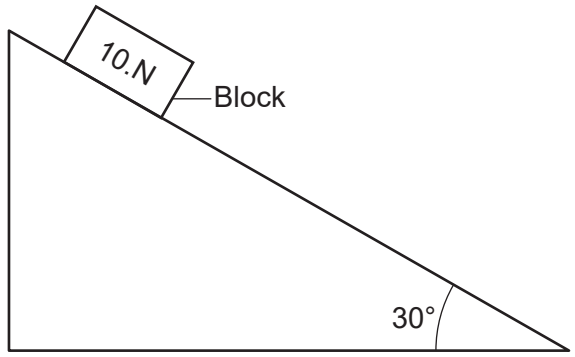
2 The time required for the car to travel the 200. meters is

(1) 6.67 s
(2) 8.00 s
(3) 10.0 s
(4) 20.0 s

3 A car traveling at 12 meters per second north accelerates in a straight line at 3.0 meters per second squared north for 4.0 seconds. How far north does the car travel during the 4.0 seconds it accelerates?

(1) 24 m
(2) 48 m
(3) 54 m
(4) 72 m

4 A block weighing 10. newtons rests on an inclined plane, as shown in the diagram below.



The magnitude of the component of the block's weight perpendicular to the plane is closest to

(1) 5.0 N
(2) 5.8 N
(3) 8.7 N
(4) 10. N

5 A sailor is near the top of a sailboat mast. The sailboat is traveling at a constant velocity of 5.0 meters per second west. The sailor drops a screwdriver that falls freely for 1.0 second before hitting the deck of the sailboat. [Neglect friction.]

Where does the screwdriver land?

(1) directly below the sailor
(2) 5.0 m behind the sailor
(3) 5.0 m in front of the sailor
(4) 49 m behind the sailor

6 A marble is projected horizontally from a fixed height above a level floor. If the marble is projected horizontally again from the same fixed height, but with twice the initial speed, its time of flight will be

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

7 Which animal has the greatest inertia?

(1) an 8.0-kg meerkat moving at 2 m/s
(2) a 350-kg zebra moving at 18 m/s
(3) a 190-kg lion moving at 0.5 m/s
(4) an 1800-kg hippopotamus at rest

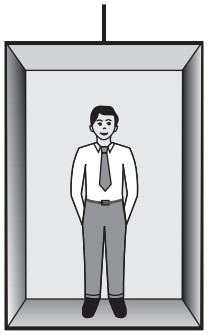
8 A cart is rolling along in a straight line on an inclined ramp. The cart is in equilibrium when it is rolling up or down the ramp with

(1) decreasing speed
(2) increasing speed
(3) constant acceleration
(4) constant speed

9 A 3.5-kilogram bowling ball and a 7.0-kilogram bowling ball are in free fall near the surface of Earth. Compared to the magnitude of the acceleration of the 3.5-kilogram ball, the magnitude of the acceleration of the 7.0-kg ball is

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

10 The diagram below represents a 600-newton student standing in an elevator.



The elevator floor exerts an upward force of 400 newtons on the student. The student has

(1) a constant velocity directed downward
(2) a constant velocity directed upward
(3) an acceleration directed downward
(4) an acceleration directed upward

11 One end of a spring is held stationary and a 40.-newton force applied to the free end of the spring elongates the spring 0.20 meter from its unstretched length. What is the magnitude of the total force required to stretch the spring 0.80 meter from its unstretched length if the spring's elastic limit has *not* been exceeded?

(1) 10. N
(2) 20. N
(3) 120 N
(4) 160 N

12 The engine of a toy train is traveling at constant speed on a horizontal, circular track. If the speed of the engine is doubled, the magnitude of the centripetal acceleration of the engine is

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

13 The strength of an electric field has a magnitude of 3.5×10^5 newtons per coulomb. What is the magnitude of the electrostatic force on a 5.3×10^{-6}-coulomb charge in this field?

(1) 1.5×10^{-11} N
(2) 1.9 N
(3) 19 N
(4) 6.6×10^{10} N

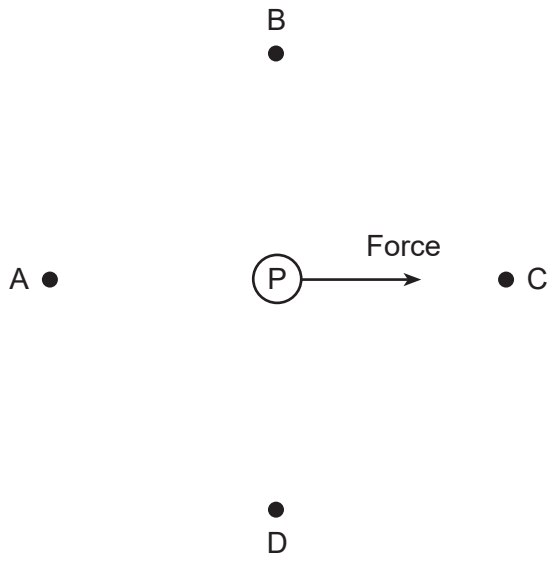
14 A car is traveling on a level highway at a speed of 15.0 meters per second. A braking force of magnitude 3.00×10^3 newtons brings the car to a stop in 10.0 seconds. The mass of the car is

(1) 1.50×10^3 kg
(2) 2.00×10^3 kg
(3) 3.00×10^3 kg
(4) 4.50×10^3 kg

15 A 5.00-kilogram cart traveling east at a speed of 15.0 meters per second collides with a 10.0 kilogram cart traveling west at a speed of 15.0 meters per second. The total momentum of the two-cart system after the collision is

(1) 75.0 kg • m/s west
(2) 75.0 kg • m/s east
(3) 225 kg • m/s west
(4) 225 kg • m/s east

16 In the diagram below, a force acts to the right on a proton, *P*, in an electric field.



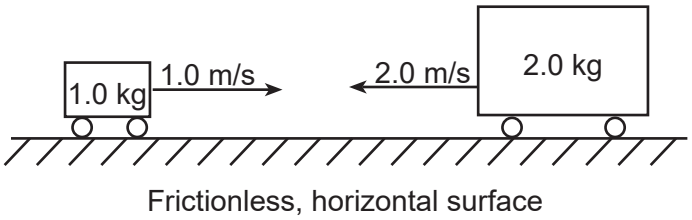
To produce this force, the direction of the electric field at the position of the proton is toward point

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

17 While investigating static electricity, a student notices a negatively charged plastic rod attracts a small piece of paper. The student correctly concludes the charge of the paper

(1) must be negative
(2) must be positive
(3) could be negative or neutral
(4) could be positive or neutral

18 The diagram below represents a 1.0-kilogram cart moving to the right at 1.0 meter per second that is about to collide head on with a 2.0-kilogram cart moving to the left at 2.0 meters per second. During the collision, the magnitude of the force exerted on the 1.0-kilogram cart by the 2.0-kilogram car is F.



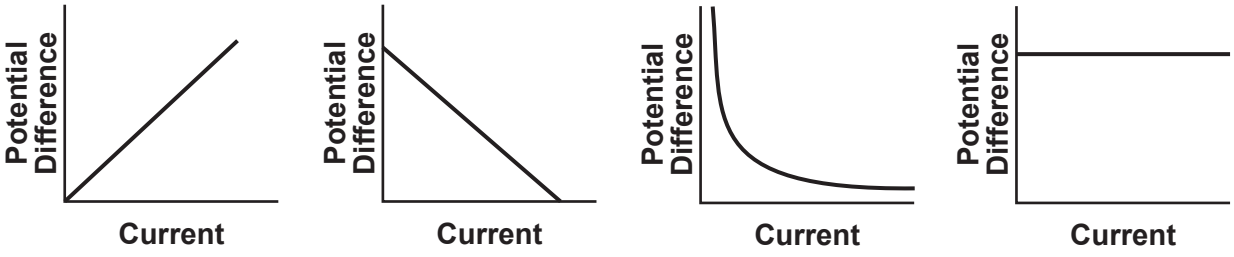
What is the magnitude of the force exerted on the 2.0-kilogram cart by the 1.0-kilogram cart during the collision?

(1) $F/4$
(2) $F/2$
(3) F
(4) $2F$

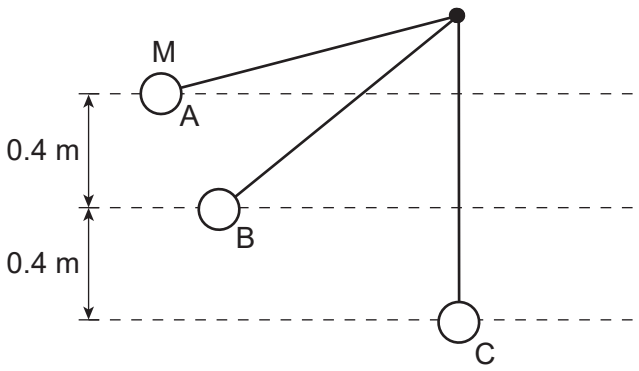
19 Sunlight shines on solar panels on the roof of a house. The panels are hooked up to the house's electrical system, which is used to operate a microwave oven that heats up a cup of coffee. What energy conversions are taking place in this entire process?

(1) electromagnetic → electrical → electromagnetic → thermal
(2) thermal → electromagnetic → nuclear → electrical
(3) mechanical → electrical → electromagnetic → chemical
(4) electromagnetic → thermal → mechanical → electrical

20 Which graph best represents the relationship between the potential difference across a resistor and the resulting current through the resistor, for a resistor that obeys Ohm's law?



21 As shown in the diagram of a pendulum below, mass M is released from rest at point A and allowed to swing through point B to point C. [Neglect friction.]



Compared to the kinetic energy of mass M at point B, the kinetic energy of mass M at point C is

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

22 A student, running at 6 meters per second, slides to rest on a horizontal floor. As the student slides, the internal energy of the student-floor system

(1) decreases and the student's kinetic energy decreases
(2) increases and the student's kinetic energy decreases
(3) decreases and the student's kinetic energy remains the same
(4) increases and the student's kinetic energy remains the same

23 Which object will most likely produce a magnetic field?

(1) a stationary neutral object
(2) a moving neutral object
(3) a stationary charged object
(4) a moving charged object

24 To *reduce* the electrical resistance of a copper wire, increase the wire's

(1) length
(2) temperature
(3) diameter
(4) resistivity

25 A potential difference of 12 volts is applied across a resistor for 60. seconds. A constant current of 0.10 ampere flows through the resistor during this time. What is the power of the resistor?

(1) 1.2 W
(2) 12 W
(3) 72 W
(4) 120 W

26 What type of waves are sound waves?

(1) longitudinal waves
(2) transverse waves
(3) electromagnetic waves
(4) ultraviolet waves

27 As waves travel through space, they transfer

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

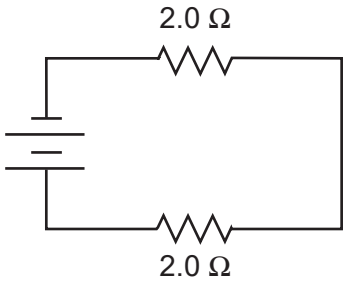
28 The frequency of an orange light wave is 4.85×10^{14} hertz. What is the wavelength of the wave in a vacuum?

(1) 1.00×10^{-7} m
(2) 4.82×10^{-7} m
(3) 5.96×10^{-7} m
(4) 6.19×10^{-7} m

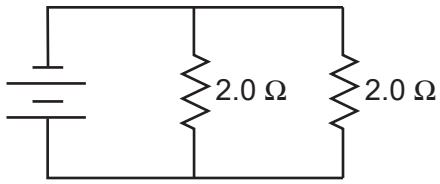
29 Which statement describes mechanical and electromagnetic waves?

(1) Mechanical waves all travel at the same speed in a vacuum, whereas the speeds of electromagnetic waves vary in a vacuum.
(2) Mechanical waves all have the same frequency, whereas electromagnetic waves all have the same period.
(3) Mechanical waves require a material medium through which to travel, whereas eletromagnetic waves can travel through a vacuum.
(4) Mechanical waves are transverse waves, whereas electromagnetic waves are longitudinal waves.

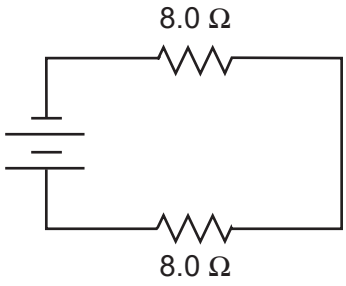
30 Which diagram represents a parallel circuit with an equivalent resistance of 4.0 ohms?



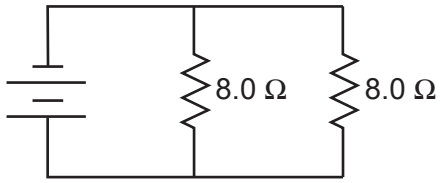
(1)



(3)

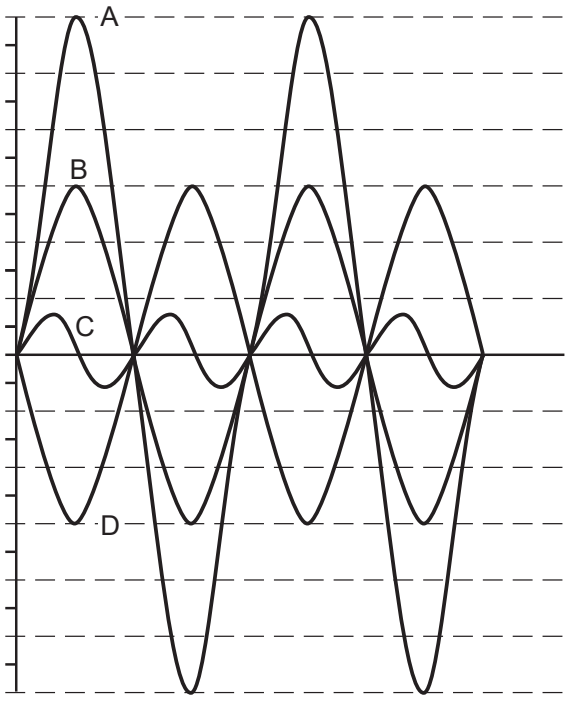


(2)



(4)

31 The diagram below shows four waves.



Which two waves, when superimposed, would produce complete destructive interference at every point along the waves?

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

32 A musician plays a flute by blowing across the opening in the mouth piece of the flute. This causes the air inside the flute to vibrate and produce sound waves. The phenomenon that causes the creation of these sound waves in a flute is

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

33 Compared to FM radio waves, AM radio waves

(1) travel faster in a vacuum
(2) travel slower in a vacuum
(3) have a higher frequency
(4) have a longer wavelength

34 A star approaches Earth. Compared to the frequency and wavelength of the light emitted by the star, the light detected by an observer on Earth would have a

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

35 A beam of electrons directed at a polycrystalline nickel target scatters to form a diffraction pattern on a detecting screen. The diffraction of electrons is an example of the

(1) particle nature of light
(2) Doppler effect
(3) action-reaction principle
(4) wave nature of matter

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.

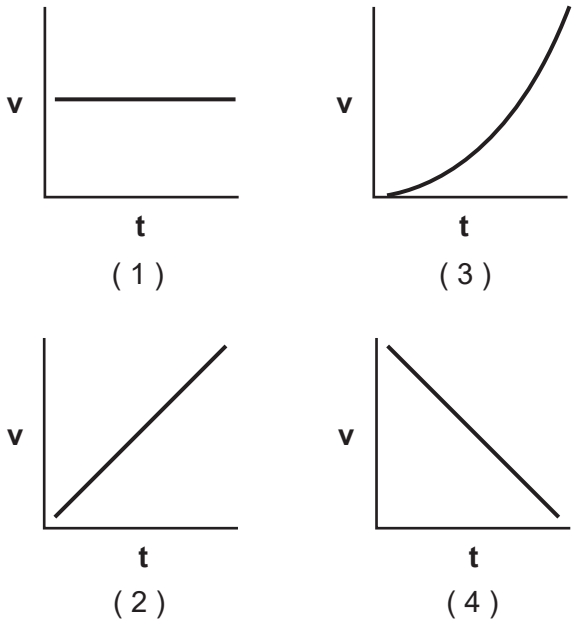
36 What is the approximate width of a typical five-passenger automobile?

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

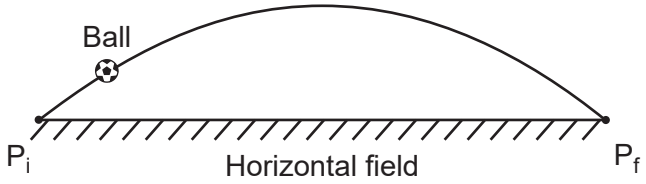
37 Two identical metal spheres with charges of +3.0 microcoulombs and –1.0 microcoulomb, respectively, are brought into contact and then separated. Which statement describes the electrostatic force between the spheres?

(1) It is attractive before contact and repulsive after contact.
(2) It is attractive both before contact and after contact.
(3) It is repulsive before contact and attractive after contact.
(4) It is repulsive both before contact and after contact.

38 Which graph best represents the relationship between velocity, v, and time, t, for an object moving with constant positive acceleration?



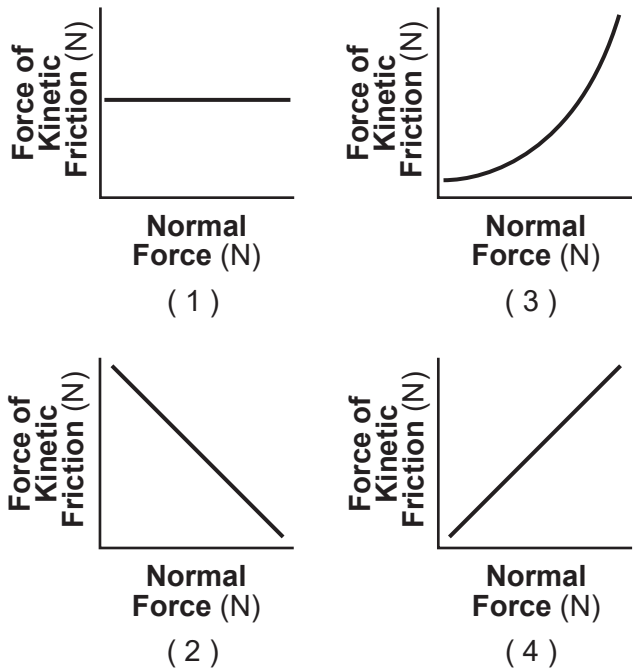
39 A soccer ball is kicked from point P_i at an angle above a horizontal field and lands on the field at point P_f. [Neglect friction.]



As the ball travels from P_i to P_f in air, the horizontal component of its velocity

(1) decreases, only
(2) increases, only
(3) decreases and then increases
(4) remains the same

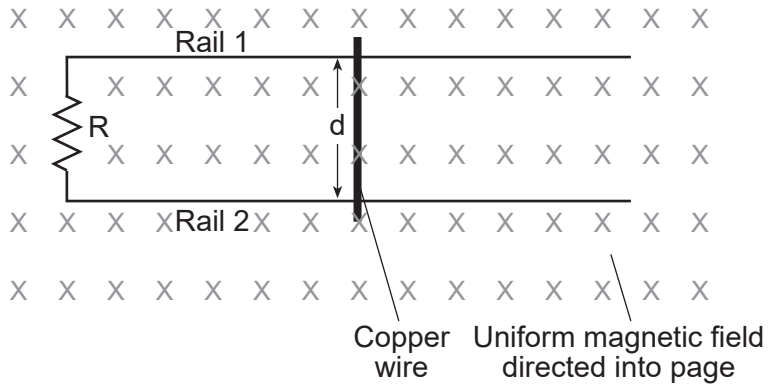
40 Which graph best represents the relationship between the forces of kinetic friction and the normal force exerted on wooden boxes of various weights as they are moved at constant velocity across a level, wooden floor?



41 A 75-kilogram student runs up a set of stairs a vertical distance of 13 meters in 25 seconds. The average power developed by the student is

(1) 3.0 W
(2) 39 W
(3) 380 W
(4) 9600 W

42 The diagram below represents an apparatus consisting of two conducting rails connected to a resistor, R, and a copper wire of length d, connected to each rail in a uniform magnetic field directed into the page.



Electrons will flow through resistor R if the copper wire is moving

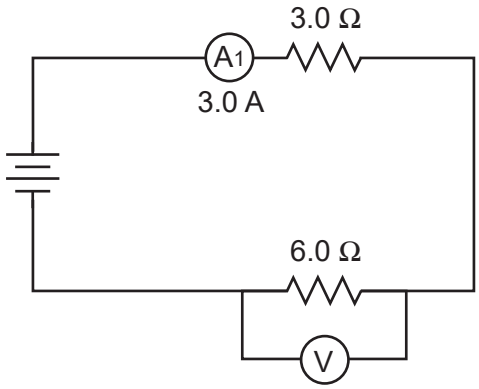
(1) to the right, only
(2) to the left, only
(3) either right or left
(4) neither right nor left

43 The current through an incandescent lamp is 0.500 ampere. The number of elementary charges that pass through the lamp in 5.00 seconds is

(1) 8.00×10^{-20}
(2) 4.00×10^{-19}
(3) 3.13×10^{18}
(4) 1.56×10^{19}

Base your answers to questions 44 and 45 on the information and diagram below and on your knowledge of physics.

The diagram below represents an electrical circuit. The reading of A_1 is 3.0 amperes.



44 The equivalent resistance of the circuit is

(1) 0.5 Ω
(2) 2.0 Ω
(3) 3.0 Ω
(4) 9.0 Ω

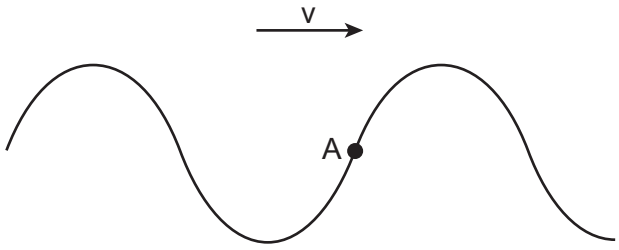
45 Compared to the potential difference across the 6-ohm resistor, the potential difference across the 3-ohm resistor is

(1) the same
(2) twice as much
(3) one half as much
(4) one quarter as much

46 Which expression is a unit of work?

(1) $\frac{V^2 \cdot s}{\Omega}$
(2) $\frac{V^2}{\Omega}$
(3) $\frac{kg \cdot m}{s^2}$
(4) $\frac{kg \cdot m^3}{s^3}$

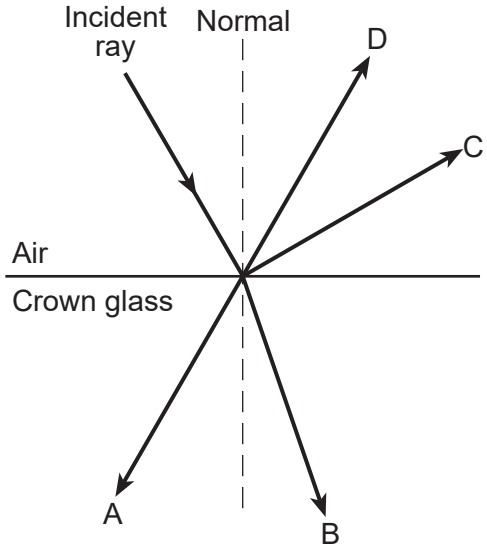
47 The diagram below represents a wave propagating to the right through a uniform medium. Point *A* represents a particle of the medium.



At the instant shown, the particle at point *A* is moving

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

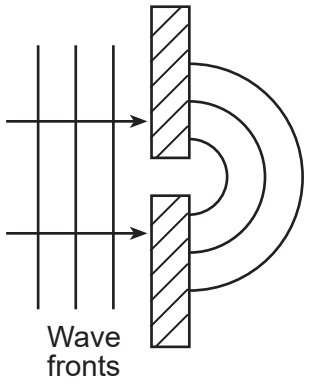
48 A ray traveling through air strikes a boundary with crown glass as shown.



Which path would the reflected ray take?

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

49 The diagram below shows wave fronts going through an opening and spreading into the area behind the barrier.



Which wave phenomenon is represented in the diagram?

(1) resonance
(2) Doppler effect
(3) diffraction
(4) reflection

50 What occurs as an electron in a mercury atom moves from energy level b to energy level a?

(1) a photon is emitted with an energy of 4.64 J
(2) a photon is absorbed with an energy of 4.64 J
(3) a photon is emitted with an energy of 7.42×10^{-19} J
(4) a photon is absorbed with an energy of 7.42×10^{-19} J

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 below and on your knowledge of physics.

A 750-watt toaster is operating at 120 volts and is being used to heat a blueberry bagel for 2.5 minutes.

51 Determine the resistance of the toaster. [1]

52–53 Calculate the total amount of electrical energy consumed by the toaster during the heating of the bagel. [Show all work, including the equation and substitution with units.] [2]

54 In a linear accelerator, a proton is accelerated from rest through a potential difference of 4.40×10^6 volts. Determine the total kinetic energy, in joules, gained by this proton as it travels through this linear accelerator. [1]

55–56 Calculate the resistance of a 0.050-meter-long copper wire having a cross-sectional area of 5.73×10^{-10} meter squared at 20°C. [Show all work, including the equation and substitution with units.] [2]

57–58 During a football game, player *A*, a 70.0-kilogram football player, attempts to prevent player *B*, a 90.0-kilogram player, from scoring a touchdown. Player *B* is running toward player *A* at a constant speed of 6.50 meters per second. Calculate the speed of player *A* such that the magnitude of the momentum of player *A* is equal to the magnitude of the momentum of player *B*. [Show all work, including the equation and substitution with units.] [2]

59–60 A photon has a wavelength of 5.03×10^{-7} meter. Calculate the energy of this photon. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 61 and 62 on the information below and on your knowledge of physics.

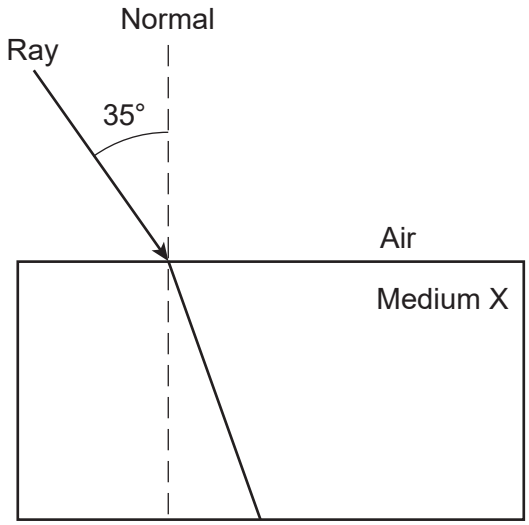
A 53-newton box on a horizontal surface is pulled toward the right by a horizontal force of 27 newtons. The force of friction exerted on the box by the surface has a magnitude of 16 newtons.

61 On the diagram *in your answer booklet*, use a scale of 1.0 cm = 10. N and start at point *P* to construct a vector representing the normal force exerted on the box by the floor. [1]

62 Determine the magnitude of the net force acting on the box. [1]

Base your answers to questions 63 through 65 on the information and diagram below and on your knowledge of physics.

A ray of monochromatic light ($f = 5.09 \times 10^{14}$ hertz) passes from air into a transparent medium, *X*, as shown in the diagram below.



63 Using a protractor, determine the angle of refraction in medium *X*, to the *nearest degree*. [1]

64–65 Calculate the absolute index of refraction of medium *X*. [Show all work, including the equation and substitution with units.] [2]

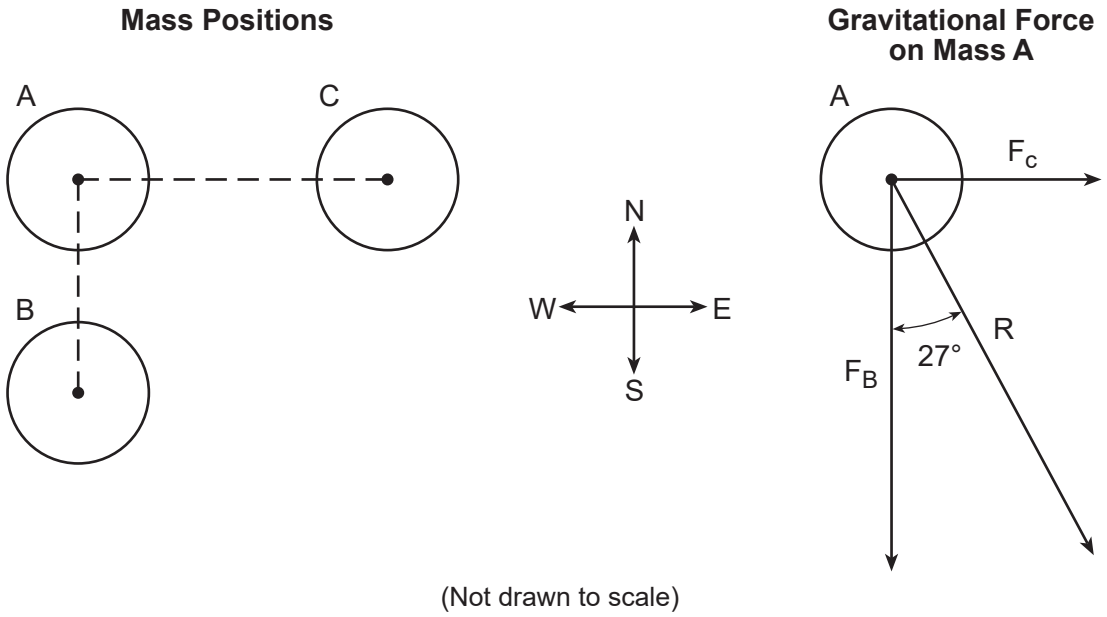
Part C

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

Three 4.0-kilogram spherical masses, *A*, *B*, and *C*, are positioned as shown below. Mass *B* and mass *C* exert gravitational forces on mass *A*. The gravitational force, F_B, exerted by mass *B* on mass *A* is 5.08×10^{-10} newton south. The resultant gravitational force, *R*, exerted on mass *A* is 5.74×10^{-10} newton at 27° east of south.



(Not drawn to scale)

66–67 Calculate the distance separating the centers of masses *A* and *B*. [Show all work, including the equation and substitution with units.] [2]

68 Mass *A* is removed and a 7.0-kilogram mass is placed at the same position. Compare the magnitude of the resultant gravitational force on the 7.0-kilogram mass with the magnitude of the original resultant gravitational force, *R*. [1]

Base your answers to questions 69 through 73 on the information and data table below and on your knowledge of physics.

An electric train with a mass of 2.8 kilograms moves from rest down a long, straight track. The table shows the train's momentum during the first 4.0 seconds of its trip.

Data Table

Time (s)	**Momentum** (kg • m/s)
0.0	0.0
0.5	2.1
1.0	4.2
1.5	6.3
2.0	8.4
2.5	11.0
3.0	13.0
3.5	15.0
4.0	18.0

Using information from the data table, construct a graph *in your answer booklet*, following the directions below.

69 Plot the momentum versus time for the first 4.0 seconds of the train's trip. [1]

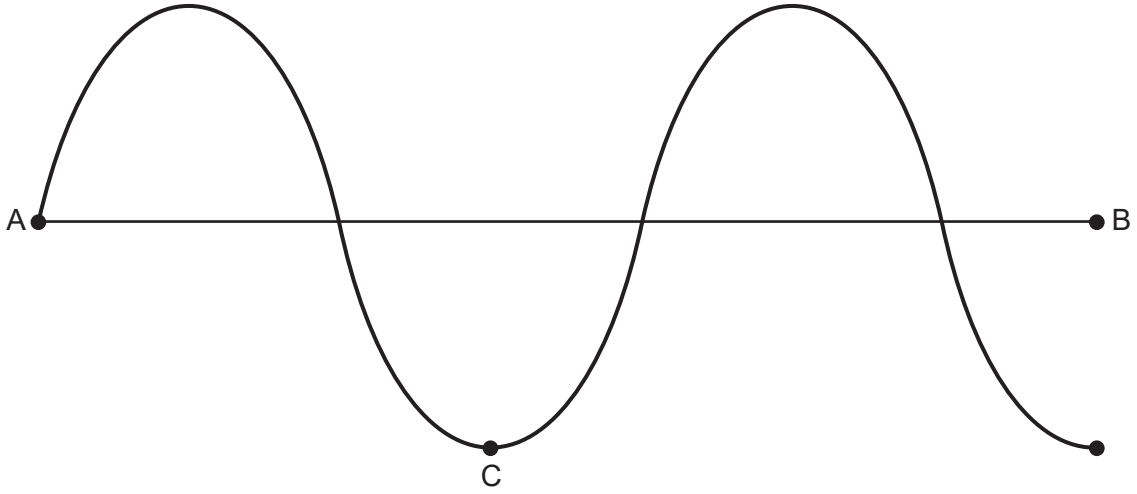
70 Draw a best-fit line, using a straight edge, to represent the relationship between momentum and time. [1]

71 Using your best-fit line, determine the average force that acted upon the train. [1]

72–73 Calculate the magnitude of the average acceleration of the train. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 74 through 77 on the information and diagram below and on your knowledge of physics.

The diagram below represents a medium as a periodic wave passes through it, traveling to the right. The wave requires 2.0 seconds to travel from point *A* to point *B*. The scale used in the diagram is 1.0 centimeter = 0.10 meter.



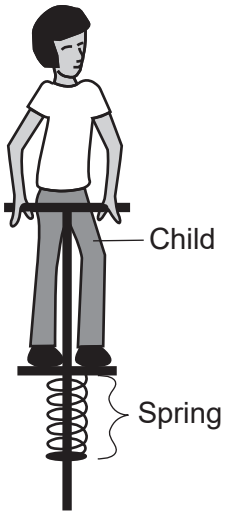
74 Determine the wavelength of the wave in meters. [1]

75–76 Calculate the speed of the wave in meters per second. [Show all work, including the equation and substitution with units.] [2]

77 On the diagram *in your answer booklet*, place an **X** on the wave at a position that is 180° out of phase with point *C*. [1]

Base your answers to questions 78 through 82 on the information and diagram below and on your knowledge of physics.

A pogo stick is a popular children's toy with a spring on the bottom. When a 51.0-kilogram child stands at rest on a pogo stick, the spring is compressed 0.15 meter.



78 Determine the magnitude of the weight of the child in newtons. [1]

79–80 Calculate the spring constant of the spring on the pogo stick. [Show all work, including the equation and substitution with units.] [2]

81-82 Calculate the total energy stored in the pogo stick's spring when the child's weight has compressed the spring 0.15 meter. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 83 through 85 on the information below and on your knowledge of physics.

Scientists at the CERN Large Hadron Collider discovered a new subatomic particle. It is called the X_b particle and is composed of one down quark, one strange quark, and one bottom quark. The mass of the X_b particle is approximately 5950 MeV.

83 Determine both the sign and the magnitude of the charge of the X_b particle, in elementary charges. [1]

84 Identify the fundamental force that holds the quarks together in the X_b particle. [1]

85 Determine the mass of the X_b particle, in universal mass units. [1]

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