

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

PHYSICAL SETTING
PHYSICS

Wednesday, June 17, 2015 — 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.

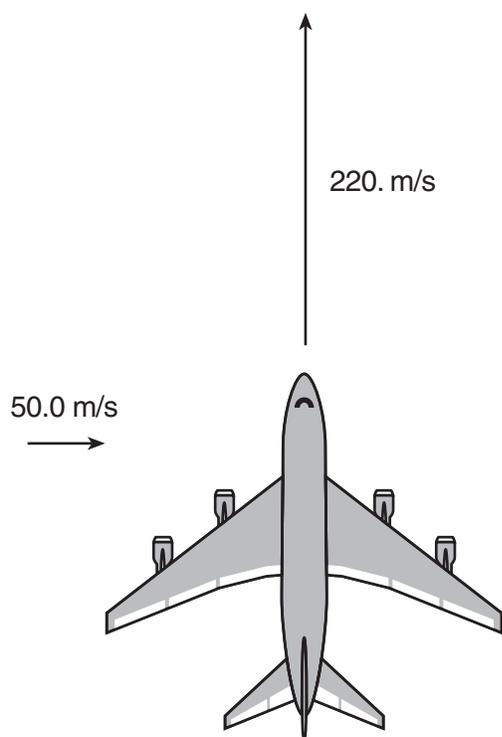
1 Which quantities are scalar?

- (1) speed and work
- (2) velocity and force
- (3) distance and acceleration
- (4) momentum and power

2 A 3.00-kilogram mass is thrown vertically upward with an initial speed of 9.80 meters per second. What is the maximum height this object will reach? [Neglect friction.]

- (1) 1.00 m
- (2) 4.90 m
- (3) 9.80 m
- (4) 19.6 m

3 An airplane traveling north at 220. meters per second encounters a 50.0-meters-per-second crosswind from west to east, as represented in the diagram below.



What is the resultant speed of the plane?

- (1) 170. m/s
- (2) 214 m/s
- (3) 226 m/s
- (4) 270. m/s

4 A 160.-kilogram space vehicle is traveling along a straight line at a constant speed of 800. meters per second. The magnitude of the net force on the space vehicle is

- (1) 0 N
- (2) 1.60×10^2 N
- (3) 8.00×10^2 N
- (4) 1.28×10^5 N

5 A student throws a 5.0-newton ball straight up. What is the net force on the ball at its maximum height?

- (1) 0.0 N
- (2) 5.0 N, up
- (3) 5.0 N, down
- (4) 9.8 N, down

6 A vertical spring has a spring constant of 100. newtons per meter. When an object is attached to the bottom of the spring, the spring changes from its unstretched length of 0.50 meter to a length of 0.65 meter. The magnitude of the weight of the attached object is

- (1) 1.1 N
- (2) 15 N
- (3) 50. N
- (4) 65 N

7 A 1.5-kilogram cart initially moves at 2.0 meters per second. It is brought to rest by a constant net force in 0.30 second. What is the magnitude of the net force?

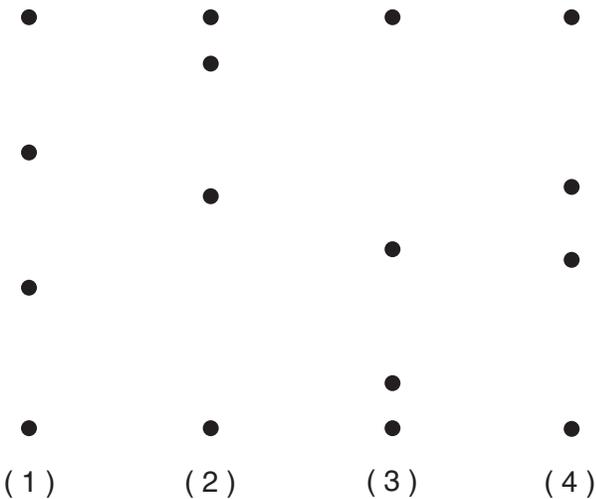
- (1) 0.40 N
- (2) 0.90 N
- (3) 10. N
- (4) 15 N

8 Which characteristic of a light wave must increase as the light wave passes from glass into air?

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

- 9 As a 5.0×10^2 -newton basketball player jumps from the floor up toward the basket, the magnitude of the force of her feet on the floor is 1.0×10^3 newtons. As she jumps, the magnitude of the force of the floor on her feet is
- (1) 5.0×10^2 N (3) 1.5×10^3 N
 (2) 1.0×10^3 N (4) 5.0×10^5 N
- 10 A 0.0600-kilogram ball traveling at 60.0 meters per second hits a concrete wall. What speed must a 0.0100-kilogram bullet have in order to hit the wall with the same magnitude of momentum as the ball?
- (1) 3.60 m/s (3) 360. m/s
 (2) 6.00 m/s (4) 600. m/s
- 11 The Hubble telescope's orbit is 5.6×10^5 meters above Earth's surface. The telescope has a mass of 1.1×10^4 kilograms. Earth exerts a gravitational force of 9.1×10^4 newtons on the telescope. The magnitude of Earth's gravitational field strength at this location is
- (1) 1.5×10^{-20} N/kg (3) 8.3 N/kg
 (2) 0.12 N/kg (4) 9.8 N/kg
- 12 When two point charges are a distance d apart, the magnitude of the electrostatic force between them is F . If the distance between the point charges is increased to $3d$, the magnitude of the electrostatic force between the two charges will be
- (1) $\frac{1}{9}F$ (3) $2F$
 (2) $\frac{1}{3}F$ (4) $4F$
- 13 A radio operating at 3.0 volts and a constant temperature draws a current of 1.8×10^{-4} ampere. What is the resistance of the radio circuit?
- (1) $1.7 \times 10^4 \Omega$ (3) $5.4 \times 10^{-4} \Omega$
 (2) $3.0 \times 10^1 \Omega$ (4) $6.0 \times 10^{-5} \Omega$
- 14 Which energy transformation occurs in an operating electric motor?
- (1) electrical \rightarrow mechanical
 (2) mechanical \rightarrow electrical
 (3) chemical \rightarrow electrical
 (4) electrical \rightarrow chemical
- 15 A block slides across a rough, horizontal tabletop. As the block comes to rest, there is an increase in the block-tabletop system's
- (1) gravitational potential energy
 (2) elastic potential energy
 (3) kinetic energy
 (4) internal (thermal) energy
- 16 How much work is required to move an electron through a potential difference of 3.00 volts?
- (1) 5.33×10^{-20} J (3) 3.00 J
 (2) 4.80×10^{-19} J (4) 1.88×10^{19} J
- 17 During a laboratory experiment, a student finds that at 20° Celsius, a 6.0-meter length of copper wire has a resistance of 1.3 ohms. The cross-sectional area of this wire is
- (1) 7.9×10^{-8} m² (3) 4.6×10^0 m²
 (2) 1.1×10^{-7} m² (4) 1.3×10^7 m²
- 18 A net charge of 5.0 coulombs passes a point on a conductor in 0.050 second. The average current is
- (1) 8.0×10^{-8} A (3) 2.5×10^{-1} A
 (2) 1.0×10^{-2} A (4) 1.0×10^2 A
- 19 If several resistors are connected in series in an electric circuit, the potential difference across each resistor
- (1) varies directly with its resistance
 (2) varies inversely with its resistance
 (3) varies inversely with the square of its resistance
 (4) is independent of its resistance
- 20 The amplitude of a sound wave is most closely related to the sound's
- (1) speed (3) loudness
 (2) wavelength (4) pitch
- 21 A duck floating on a lake oscillates up and down 5.0 times during a 10.-second interval as a periodic wave passes by. What is the frequency of the duck's oscillations?
- (1) 0.10 Hz (3) 2.0 Hz
 (2) 0.50 Hz (4) 50. Hz

22 Which diagram best represents the position of a ball, at equal time intervals, as it falls freely from rest near Earth's surface?



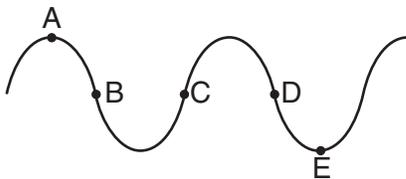
23 A gamma ray and a microwave traveling in a vacuum have the same

- (1) frequency (3) speed
 (2) period (4) wavelength

24 A student produces a wave in a long spring by vibrating its end. As the frequency of the vibration is doubled, the wavelength in the spring is

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

25 Which two points on the wave shown in the diagram below are in phase with each other?



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

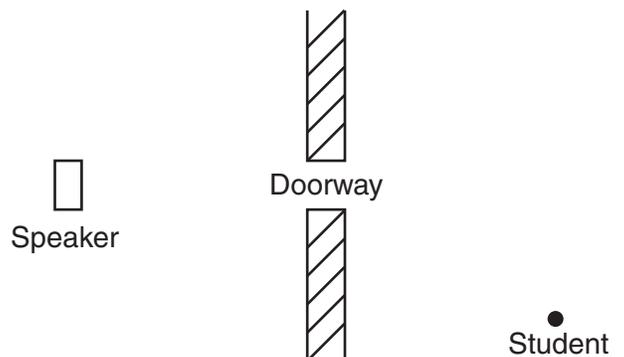
26 As a longitudinal wave moves through a medium, the particles of the medium

- (1) vibrate parallel to the direction of the wave's propagation
 (2) vibrate perpendicular to the direction of the wave's propagation
 (3) are transferred in the direction of the wave's motion, only
 (4) are stationary

27 Wind blowing across suspended power lines may cause the power lines to vibrate at their natural frequency. This often produces audible sound waves. This phenomenon, often called an Aeolian harp, is an example of

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

28 A student listens to music from a speaker in an adjoining room, as represented in the diagram below.



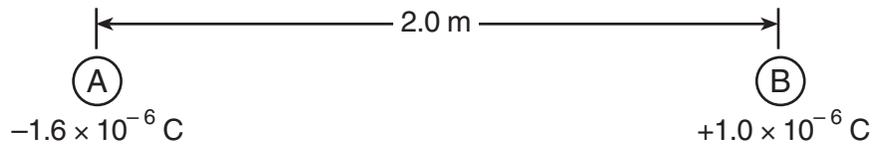
She notices that she does not have to be directly in front of the doorway to hear the music. This spreading of sound waves beyond the doorway is an example of

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

29 What is the minimum energy required to ionize a hydrogen atom in the $n = 3$ state?

- (1) 0.00 eV (3) 1.51 eV
 (2) 0.66 eV (4) 12.09 eV

Base your answers to questions 30 and 31 on the diagram below and on your knowledge of physics. The diagram represents two small, charged, identical metal spheres, *A* and *B* that are separated by a distance of 2.0 meters.



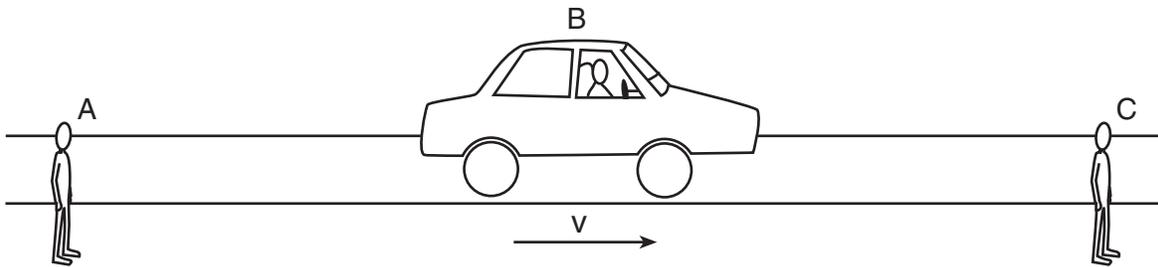
30 What is the magnitude of the electrostatic force exerted by sphere *A* on sphere *B*?

- (1) $7.2 \times 10^{-3} \text{ N}$ (3) $8.0 \times 10^{-13} \text{ N}$
 (2) $3.6 \times 10^{-3} \text{ N}$ (4) $4.0 \times 10^{-13} \text{ N}$

31 If the two spheres were touched together and then separated, the charge on sphere *A* would be

- (1) $-3.0 \times 10^{-7} \text{ C}$ (3) $-1.3 \times 10^{-6} \text{ C}$
 (2) $-6.0 \times 10^{-7} \text{ C}$ (4) $-2.6 \times 10^{-6} \text{ C}$

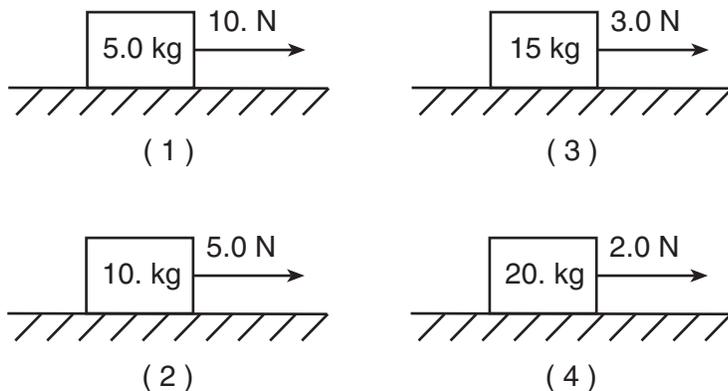
32 The horn of a moving vehicle produces a sound of constant frequency. Two stationary observers, *A* and *C*, and the vehicle's driver, *B*, positioned as represented in the diagram below, hear the sound of the horn.



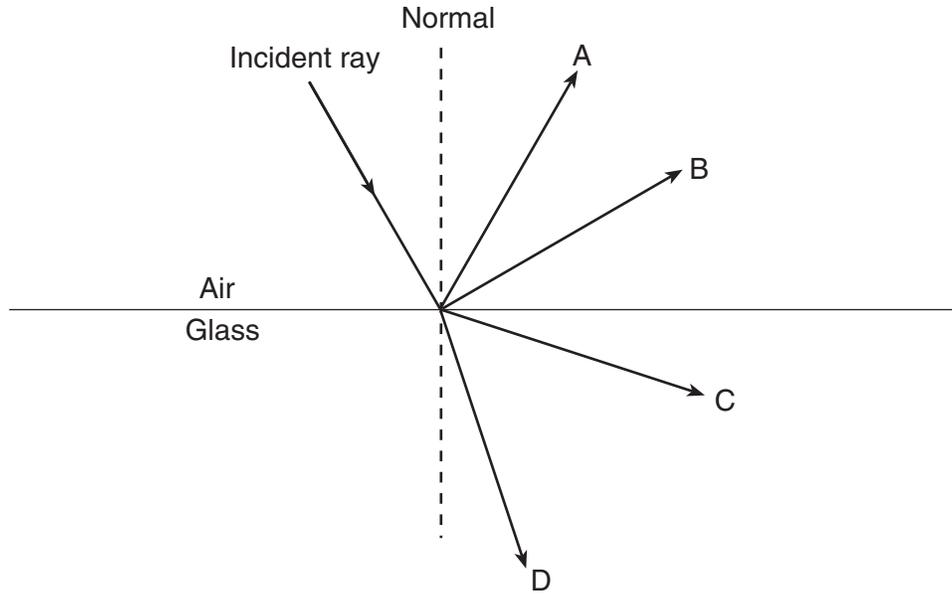
Compared to the frequency of the sound of the horn heard by driver *B*, the frequency heard by observer *A* is

- (1) lower and the frequency heard by observer *C* is lower
 (2) lower and the frequency heard by observer *C* is higher
 (3) higher and the frequency heard by observer *C* is lower
 (4) higher and the frequency heard by observer *C* is higher

33 A different force is applied to each of four different blocks on a frictionless, horizontal surface. In which diagram does the block have the greatest inertia 2.0 seconds after starting from rest?



34 The diagram below shows a ray of monochromatic light incident on a boundary between air and glass.



Which ray best represents the path of the reflected light ray?

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

35 Two pulses approach each other in the same medium. The diagram below represents the displacements caused by each pulse.



Which diagram best represents the resultant displacement of the medium as the pulses pass through each other?

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

Part B-1

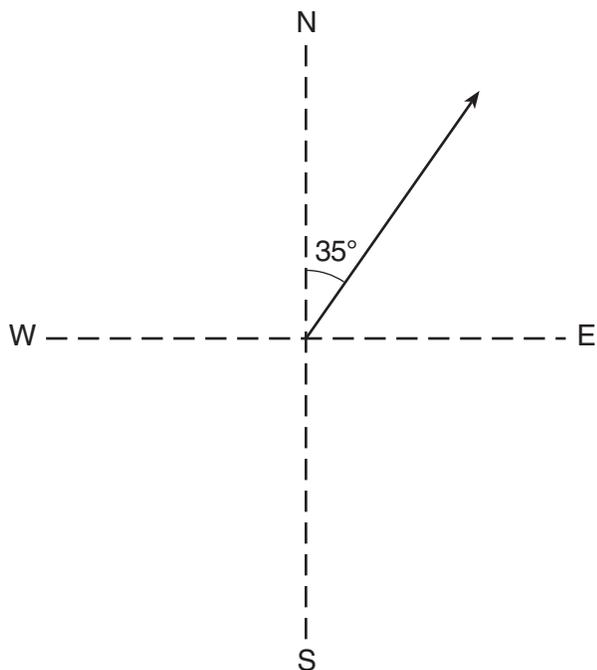
Answer all questions in this part.

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 The diameter of an automobile tire is closest to

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

37 The vector diagram below represents the velocity of a car traveling 24 meters per second 35° east of north.



What is the magnitude of the component of the car's velocity that is directed eastward?

- (1) 14 m/s (3) 29 m/s
 (2) 20. m/s (4) 42 m/s

38 Without air resistance, a kicked ball would reach a maximum height of 6.7 meters and land 38 meters away. With air resistance, the ball would travel

- (1) 6.7 m vertically and more than 38 m horizontally
 (2) 38 m horizontally and less than 6.7 m vertically
 (3) more than 6.7 m vertically and less than 38 m horizontally
 (4) less than 38 m horizontally and less than 6.7 m vertically

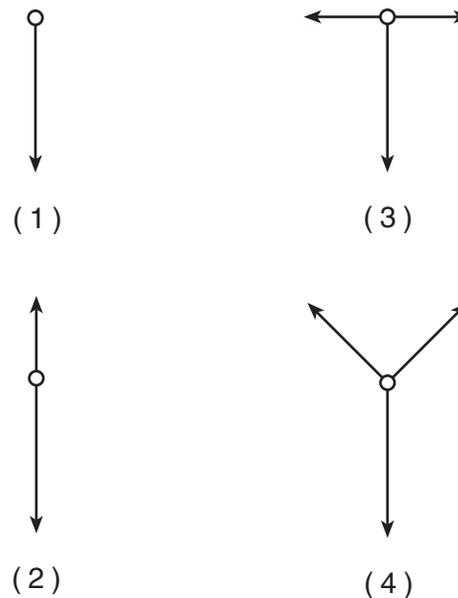
39 A car is moving with a constant speed of 20. meters per second. What total distance does the car travel in 2.0 minutes?

- (1) 10. m (3) 1200 m
 (2) 40. m (4) 2400 m

40 A car, initially traveling at 15 meters per second north, accelerates to 25 meters per second north in 4.0 seconds. The magnitude of the average acceleration is

- (1) 2.5 m/s^2 (3) $10. \text{ m/s}^2$
 (2) 6.3 m/s^2 (4) $20. \text{ m/s}^2$

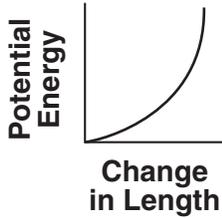
41 An object is in equilibrium. Which force vector diagram could represent the force(s) acting on the object?



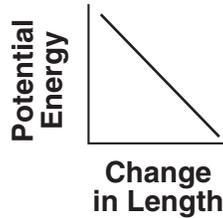
42 Which combination of fundamental units can be used to express the amount of work done on an object?

- (1) $\text{kg}\cdot\text{m/s}$ (3) $\text{kg}\cdot\text{m}^2/\text{s}^2$
 (2) $\text{kg}\cdot\text{m/s}^2$ (4) $\text{kg}\cdot\text{m}^2/\text{s}^3$

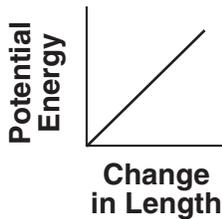
43 Which graph best represents the relationship between the potential energy stored in a spring and the change in the spring's length from its equilibrium position?



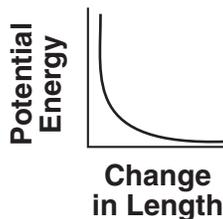
(1)



(3)



(2)



(4)

44 An electric motor has a rating of 4.0×10^2 watts. How much time will it take for this motor to lift a 50.-kilogram mass a vertical distance of 8.0 meters? [Assume 100% efficiency.]

- (1) 0.98 s (3) 98 s
 (2) 9.8 s (4) 980 s

45 A compressed spring in a toy is used to launch a 5.00-gram ball. If the ball leaves the toy with an initial horizontal speed of 5.00 meters per second, the minimum amount of potential energy stored in the compressed spring was

- (1) 0.0125 J (3) 0.0625 J
 (2) 0.0250 J (4) 0.125 J

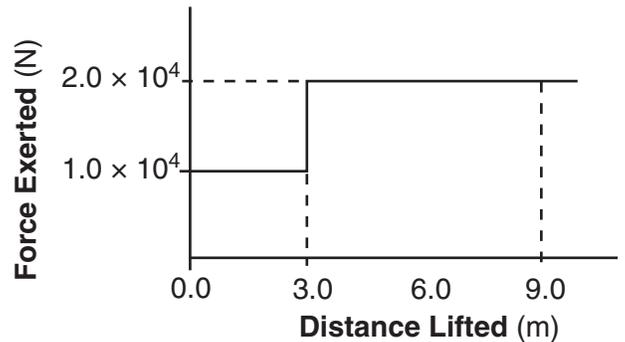
46 A ray of yellow light ($f = 5.09 \times 10^{14}$ Hz) travels at a speed of 2.04×10^8 meters per second in

- (1) ethyl alcohol (3) Lucite
 (2) water (4) glycerol

47 A blue-light photon has a wavelength of 4.80×10^{-7} meter. What is the energy of the photon?

- (1) 1.86×10^{22} J (3) 4.14×10^{-19} J
 (2) 1.44×10^2 J (4) 3.18×10^{-26} J

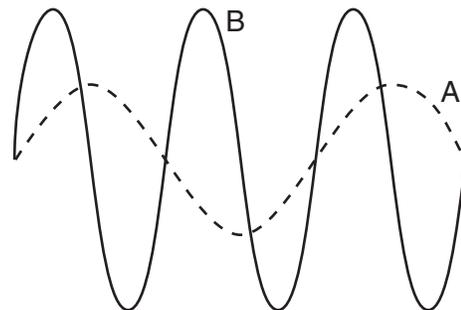
48 The graph below represents the relationship between the force exerted on an elevator and the distance the elevator is lifted.



How much total work is done by the force in lifting the elevator from 0.0 m to 9.0 m?

- (1) 9.0×10^4 J (3) 1.5×10^5 J
 (2) 1.2×10^5 J (4) 1.8×10^5 J

49 The diagram below shows waves A and B in the same medium.



Compared to wave A, wave B has

- (1) twice the amplitude and twice the wavelength
 (2) twice the amplitude and half the wavelength
 (3) the same amplitude and half the wavelength
 (4) half the amplitude and the same wavelength

50 What is the quark composition of a proton?

- (1) uud (3) csb
 (2) udd (4) uds

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*.

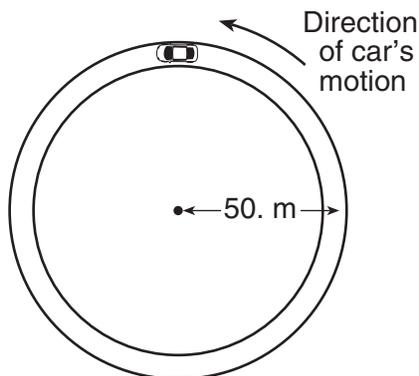
51–52 Calculate the minimum power output of an electric motor that lifts a 1.30×10^4 -newton elevator car vertically upward at a constant speed of 1.50 meters per second. [Show all work, including the equation and substitution with units.] [2]

53–54 A microwave oven emits a microwave with a wavelength of 2.00×10^{-2} meter in air. Calculate the frequency of the microwave. [Show all work, including the equation and substitution with units.] [2]

55–56 Calculate the energy equivalent in joules of the mass of a proton. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 57 through 59 on the information and diagram below and on your knowledge of physics.

A 1.5×10^3 -kilogram car is driven at a constant speed of 12 meters per second counterclockwise around a horizontal circular track having a radius of 50. meters, as represented below.



Track, as Viewed from Above

57 On the diagram *in your answer booklet*, draw an arrow to indicate the direction of the velocity of the car when it is at the position shown. Start the arrow on the car. [1]

58–59 Calculate the magnitude of the centripetal acceleration of the car. [Show all work, including the equation and substitution with units.] [2]

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

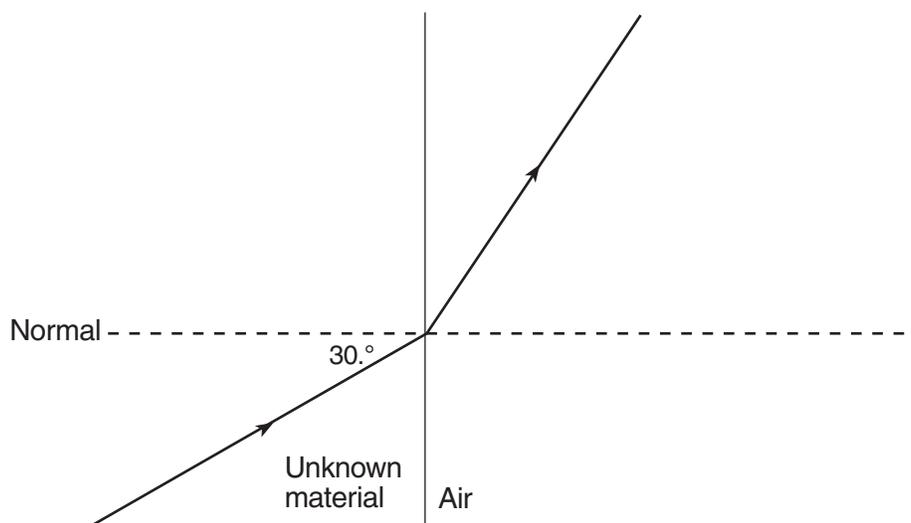
A football is thrown at an angle of $30.^\circ$ above the horizontal. The magnitude of the horizontal component of the ball's initial velocity is 13.0 meters per second. The magnitude of the vertical component of the ball's initial velocity is 7.5 meters per second. [Neglect friction.]

60 On the axes *in your answer booklet*, draw a graph representing the relationship between the horizontal displacement of the football and the time the football is in the air. [1]

61–62 The football is caught at the same height from which it is thrown. Calculate the total time the football was in the air. [Show all work, including the equation and substitution with units.] [2]

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

A ray of light ($f = 5.09 \times 10^{14}$ Hz) traveling through a block of an unknown material, passes at an angle of incidence of $30.^\circ$ into air, as shown in the diagram below.



63 Use a protractor to determine the angle of refraction of the light ray as it passes from the unknown material into air. [1]

64–65 Calculate the index of refraction of the unknown material. [Show all work, including the equation and substitution with units.] [2]

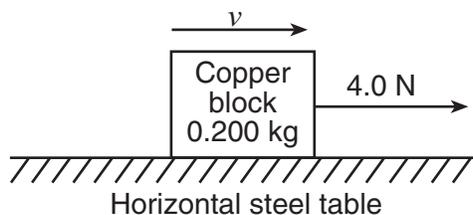
Part C

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 70 on the information below and on your knowledge of physics.

The diagram below represents a 4.0-newton force applied to a 0.200-kilogram copper block sliding to the right on a horizontal steel table.



66 Determine the weight of the block. [1]

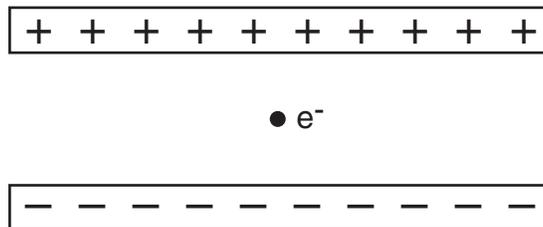
67–68 Calculate the magnitude of the force of friction acting on the moving block. [Show all work, including the equation and substitution with units.] [2]

69 Determine the magnitude of the net force acting on the moving block. [1]

70 Describe what happens to the magnitude of the velocity of the block as the block slides across the table. [1]

Base your answers to questions 71 through 75 on the information and diagram below and on your knowledge of physics.

Two conducting parallel plates 5.0×10^{-3} meter apart are charged with a 12-volt potential difference. An electron is located midway between the plates. The magnitude of the electrostatic force on the electron is 3.8×10^{-16} newton.



71 On the diagram *in your answer booklet*, draw *at least three* field lines to represent the direction of the electric field in the space between the charged plates. [1]

72 Identify the direction of the electrostatic force that the electric field exerts on the electron. [1]

73–74 Calculate the magnitude of the electric field strength between the plates, in newtons per coulomb. [Show all work, including the equation and substitution with units.] [2]

75 Describe what happens to the magnitude of the net electrostatic force on the electron as the electron is moved toward the positive plate. [1]

Base your answers to questions 76 through 80 on the information below and on your knowledge of physics.

An electron in a mercury atom changes from energy level *b* to a higher energy level when the atom absorbs a single photon with an energy of 3.06 electronvolts.

76 Determine the letter that identifies the energy level to which the electron jumped when the mercury atom absorbed the photon. [1]

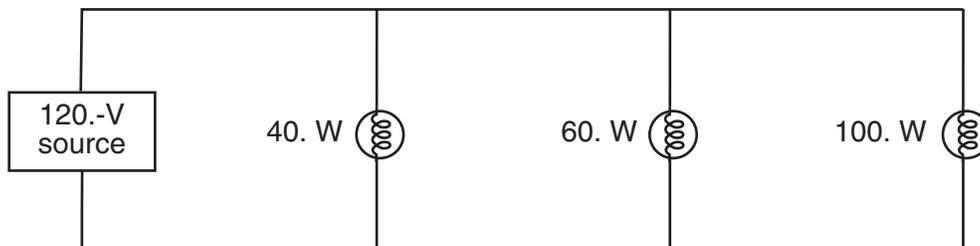
77 Determine the energy of the photon, in joules. [1]

78–79 Calculate the frequency of the photon. [Show all work, including the equation and substitution with units.] [2]

80 Classify the photon as one of the types of electromagnetic radiation listed in the electromagnetic spectrum. [1]

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

Three lamps are connected in parallel to a 120.-volt source of potential difference, as represented below.



81–82 Calculate the resistance of the 40.-watt lamp. [Show all work, including the equation and substitution with units.] [2]

83 Describe what change, if any, would occur in the power dissipated by the 100.-watt lamp if the 60.-watt lamp were to burn out. [1]

84 Describe what change, if any, would occur in the equivalent resistance of the circuit if the 60.-watt lamp were to burn out. [1]

85 The circuit is disassembled. The same three lamps are then connected in series with each other and the source. Compare the equivalent resistance of this series circuit to the equivalent resistance of the parallel circuit. [1]
