PRACTICE TESTS
for
PHYSICAL SETTING
REGENTS PHYSICS

STUDENTS

The purpose of this book is to give you an aid to review for the Physical Setting/ Physics Regents exam, or your school physics exam. You will find answers and explanations to the questions from four previous exams. Take your time in going through each exam. Try to answer each question on your own before checking the answer and the accompanying explanation. Concentrate on those that you have trouble with. Do not wait until the last minute to start your review. Start well before the Regents exam and do 20 to 25 questions at a sitting. By the time you finish the four exams in this booklet, you should have a good understanding of the wording and types of questions to expect on the Regents, or school physics exam.

Good luck on the exam.

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PHYSICAL SETTING
REGENTS
PHYSICS

Published by
TOPICAL REVIEW BOOK COMPANY
P. O. Box 328
Onsted, MI 49265-0328
1-800-847-0854

EXAM **PAGE**

June 2016
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 in the space provided.**

1. Which quantity is a vector?
(1) power (2) kinetic energy (3) speed (4) weight 1_____

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 2_____

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

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 4_____

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 5_____

6. Sound waves are described as
(1) mechanical and transverse
(2) mechanical and longitudinal
(3) electromagnetic and transverse
(4) electromagnetic and longitudinal 6_____

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 (3) 3.2×10^{-4} N

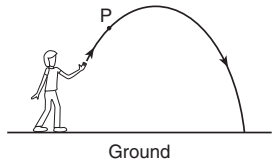
(2) 2.0×10^{-5} N (4) 4.0×10^{-5} N 7_____

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 (3) 3.0 kg • m/s

(2) 2.0 kg • m/s (4) 5.0 kg • m/s 8_____

9. The diagram 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*?

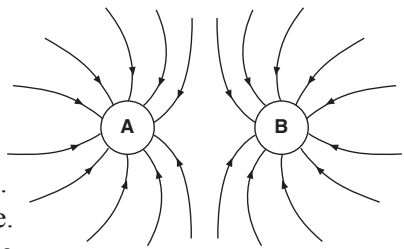


(1) (2) (3) (4) 9_____

10. A magnetic field would be produced by a beam of

(1) x rays (2) gamma rays (3) protons (4) neutron 10____

11. The diagram 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. 11____

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 12____

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 13____

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) 2*PE* (3) $\frac{PE}{2}$ (4) 4*PE* 14____

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 15____

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 (3) phase of the wave
(2) amplitude of the wave (4) distance traveled through the medium
16____

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 17____

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 18____

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 (3) longer period
(2) higher speed (4) higher frequency 19____

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 (3) both energy and matter
(2) matter, only (4) neither energy nor matter 20____

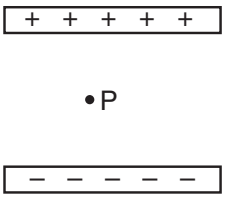
21. The time required to produce one cycle of a wave is known as the wave's
(1) amplitude (2) frequency (3) period (4) wavelength 21____

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. 22____

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 23____

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 24____

25. In the diagram, 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 25____

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 26____

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 27____

28. According to the Standard Model of Particle Physics, a neutrino is a type of
(1) lepton (2) photon (3) meson (4) baryon 28____

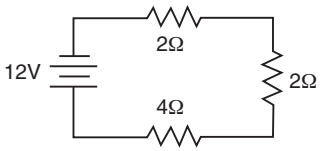
29. Which combination of quarks produces a neutral baryon?
(1) cts (2) dsb (3) uds (4) uct 29____

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 30____

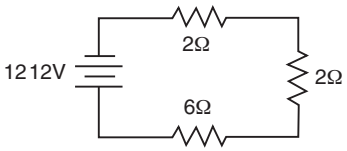
31. A ball is hit straight up with an initial speed of 28 meters per second. What is the speed of the ball 2.2 seconds after it is hit? [Neglect friction.]
(1) 4.3 m/s (2) 6.4 m/s (3) 22 m/s (4) 28 m/s 31____

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 (3) 1.50 eV
(2) 2.16×10^{-18} eV (4) 13.5 eV 32____

33. Which circuit has the largest equivalent resistance?



(1)



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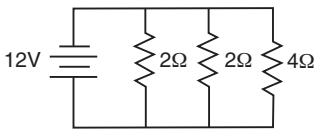

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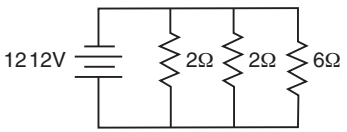


(4) 33____

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) 

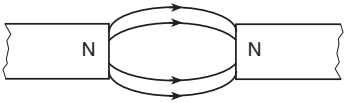
(2) 

(3) 

(4) 

34____

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



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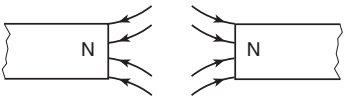

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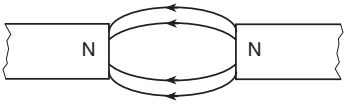

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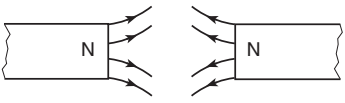


(4) 35____

Part B–1

Answer all questions in this part.

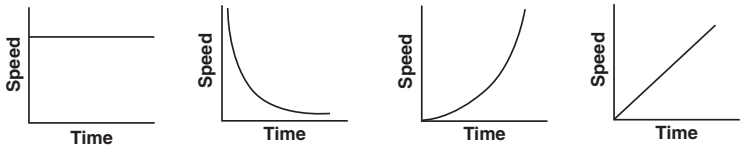
***Directions* (36–50): For *each* statement or question, choose the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2006 Edition Reference Tables for Physical Setting/Physics*.**

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

(1) diameter of an atom (3) length of a football field

(2) width of a student's finger (4) height of a schoolteacher 36____

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?



(1) (2) (3) (4) 37____

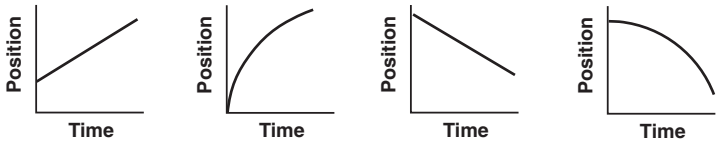
38. A hair dryer with a resistance of 9.6 ohms operates at 120 volts for 2.5 minutes. The total electrical energy used by the dryer during this time interval is

(1) 2.9×10^3 J (2) 3.8×10^3 J (3) 1.7×10^5 J (4) 2.3×10^5 J 38____

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 39____

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



(1) (2) (3) (4) 40____

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 41____

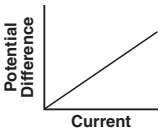
42. A 2700-ohm resistor in an electric circuit draws a current of 2.4 milliamperes. The total charge that passes through the resistor in 15 seconds is

(1) 1.6×10^{-4} C (2) 3.6×10^{-2} C (3) 1.6×10^{-1} C (4) 3.6×10^{1} C 42____

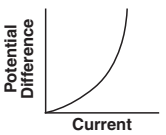
43. A 1000.–kilogram car traveling 20.0 meters per second east experiences an impulse of 2000. newton • seconds west. What is the final velocity of the car after the impulse has been applied?

(1) 18.0 m/s east (3) 20.5 m/s west
(2) 19.5 m/s east (4) 22.0 m/s west 43____

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?



(1)



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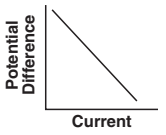
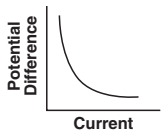


(3)



(4) 44____

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) $\frac{R}{2}$ (2) R (3) $2R$ (4) $4R$ 45____

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. 46____

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.]


(1)


(2)

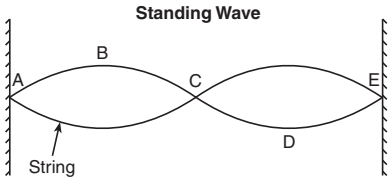

(3)


(4) 47____

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?

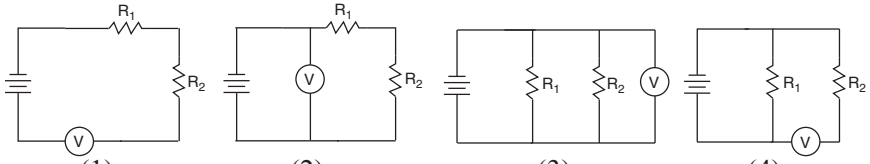
(1) 9.67×10^{-4} Hz (3) 1.03×10^{3} Hz
(2) 1.05×10^{2} Hz (4) 9.38×10^{8} Hz 48____

49. The diagram 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*



49____

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



50____

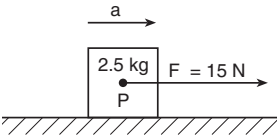
Part B–2

Answer all questions in this part.

***Directions* (51–65): Record your answers in the spaces provided. 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, diagram and on your knowledge of physics.

As represented in the diagram, 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.

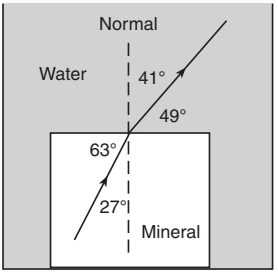


51–52. Calculate the magnitude of the net force acting on the box. [Show all work, including the equation and substitution with units.] [2]

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

Base your answers to questions 54 and 55 on the information and diagram 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.



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.

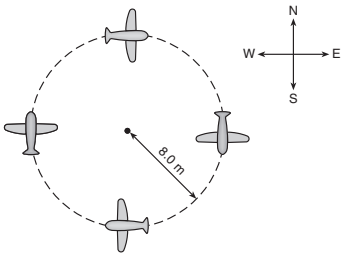
A ball is rolled twice across the same level laboratory table and allowed to roll off the table and strike the floor. In each trial, the time it takes the ball to travel from the edge of the table to the floor is accurately measured. [Neglect friction.]

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.

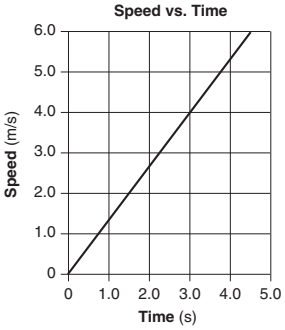


59–60. Calculate the speed of the airplane. [Show all work, including the equation and substitution with units.] [2]

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 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]

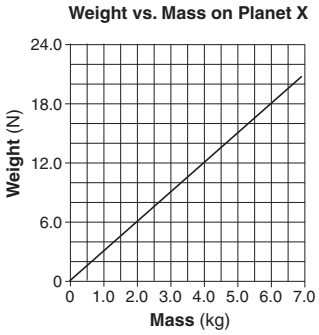
_____

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 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]

_____ m/s^2



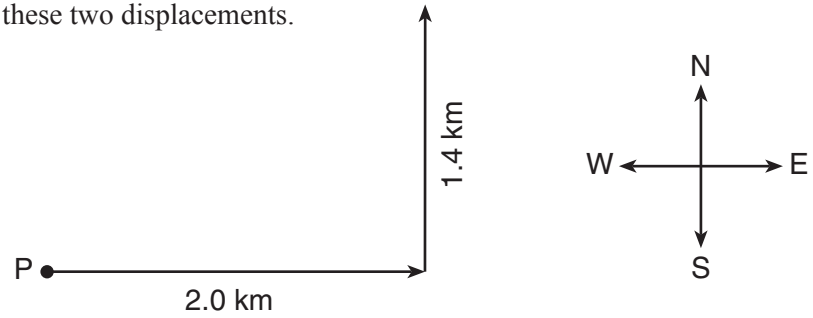
Part C

Answer all questions in this part.

***Directions* (66–85): Record your answers in the spaces provided. 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] 1.0 cm = _____km

67. On the diagram above, 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] _____ km

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 below. [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] _____ A

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]

_____ eV

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

_____ J

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]

_____

June 2017
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 in the space provided.**

1. A unit used for a vector quantity is
(1) watt (2) newton (3) kilogram (4) second 1_____

2. A displacement vector with a magnitude of 20. meters could have perpendicular components with magnitudes of
(1) 10. m and 10. m (3) 12 m and 16 m
(2) 12 m and 8.0 m (4) 16 m and 8.0 m 2_____

3. A hiker travels 1.0 kilometer south, turns and travels 3.0 kilometers west, and then turns and travels 3.0 kilometers north. What is the total distance traveled by the hiker?
(1) 3.2 km (2) 3.6 km (3) 5.0 km (4) 7.0 km 3_____

4. A car with an initial velocity of 16.0 meters per second east slows uniformly to 6.0 meters per second east in 4.0 seconds. What is the acceleration of the car during this 4.0-second interval?
(1) 2.5 m/s^2 west (3) 4.0 m/s^2 west
(2) 2.5 m/s^2 east (4) 4.0 m/s^2 east 4_____

5. On the surface of planet *X*, a body with a mass of 10. kilograms weighs 40. newtons. The magnitude of the acceleration due to gravity on the surface of planet *X* is
(1) 4.0×10^3 m/s^2 (2) 4.0×10^2 m/s^2 (3) 9.8 m/s^2 (4) 4.0 m/s^2 5_____

6. A car traveling in a straight line at an initial speed of 8.0 meters per second accelerates uniformly to a speed of 14 meters per second over a distance of 44 meters. What is the magnitude of the acceleration of the car?
(1) 0.41 m/s^2 (2) 1.5 m/s^2 (3) 3.0 m/s^2 (4) 2.2 m/s^2 6_____

7. An object starts from rest and falls freely for 40. meters near the surface of planet *P*. If the time of fall is 4.0 seconds, what is the magnitude of the acceleration due to gravity on planet *P*?
(1) 0 m/s^2 (2) 1.3 m/s^2 (3) 5.0 m/s^2 (4) 10. m/s^2 7_____

PHYSICAL SETTING

PHYSICS

ANSWERS AND EXPLANATIONS

A Physics Reference Table (RT) is quoted throughout this section. The Physics Reference Table can be found in the back of this booklet.

June 2016
Part A

1. 4 By definition a vector is a quantity possessing both magnitude (size) and direction. Only weight has both magnitude and direction. The rest are scalar quantities which possess magnitude only.

2. 2 The mass of an object is constant. Therefore the mass of the astronaut on the Moon is the same as on the Earth. The astronauts weight would be different since it depends upon the acceleration of gravity, which is different on the Moon than on the Earth.

3. 4 The definition of equilibrium is the state of an object which is either at rest or moving with a constant velocity. The condition for equilibrium is that the sum of all forces acting on the object is zero.

4. 1 Inertia is a quantitative measure of the mass of an object. Increasing the mass of an object increases the inertia of the object.

5. 3 This is an application of Newton's Third Law of Motion, which states that for every action there is an equal on opposite reaction. If the horse exerts a 60. N force on the cart, the cart exerts a 60. N force on the horse in the opposite direction.

6. 2 Sound waves are mechanical waves since they are the result of vibration of particles. Since the particles vibrate at a right angle to the direction of wave propagation, they are transverse waves.

7. 2 Under Electricity, find the equation $F_e = kq_1q_2/r^2$. This shows that the electric force varies inversely with the square of the distance between the particles. If the distance between the particles is doubled, the force becomes one-fourth as great. See 4d under Helpful Hints for Physics in the back of this book.

8. 1 Find the equation $p_{before} = p_{after}$ under Mechanics. Using the east direction as the positive direction and west as the negative direction, the total momentum of the system before the collision is
(+3.0 km•m/s) + (–2.0 kg•m/s) = 1.0 kg•m/s.

9. 2 The direction of the force of friction is opposite the direction of motion of an object.

10. 3 A magnetic field is produced by the motion of charged particles. Of the given choices, only the proton has an electric charge.

11. 3 By definition, the direction of an electric line of force in an electric field is from a positive charge to a negative charge. Since the field lines are directed toward the particles, both must be negative.

12. 2 Under Mechanics, find the equation $W = Fd$. The total work done is $W = (20\text{ N})(5\text{ m}) = 100\text{ J}$.

13. 2 Find the equation $W = \Delta E_T$. Since the object is on a horizontal surface, there is no change in the potential energy of the object. The work done on the object therefore increases the kinetic energy of the object.

14. 2 Find the equation $\Delta PE = mg\Delta h$. Since g and Δh are the same for both objects, the potential energy of the two objects depends only upon their masses. Since the mass of B is twice that of A, its potential energy is twice that of A.

15. 3 Under Mechanics, find the equation $KE = \frac{1}{2}\, mv^2$. The kinetic energy of the skier is $KE = \frac{1}{2}(55\text{ kg})(9.0\text{ m/s})^2 = 2.2 \times 10^3\text{ kg•m/s}^2 = 2.2 \times 10^3\text{ J}$.

16. 1 Under Waves, find the equation $n = c/v$. Solving for v, $v = c/n$. Since the value of c is constant, the speed of light depends upon the index of refraction of that medium. See the table of Absolute Indices of Refraction.

17. 3 Under Mechanics, find the equation $P = W/t$. The power of the motor is $P = (480\text{ J})/(5.0\text{ s}) = 96\text{ J/s} = 96\text{ W}$.

18. 3 Find the equation $P = F\overline{v}$ under Mechanics. Solving for $\overline{v}$, $\overline{v} = P/F = (5.8 \times 10^4\text{ W})/(2.1 \times 10^4\text{ N}) = 2.8\text{ m/s}$.

19. 4 The Doppler Effect is change in the observed frequency of a wave caused by relative motion between the source of the wave and the receiver of the wave. If the distance between the source and the receiver if decreasing, a wave of higher frequency is observed.

20. 1 A light wave is an electromagnetic wave and carries only energy.

21. 3 By definition, the time needed to produce one cycle of a wave is called the period of the wave.

22. 4 A magnetic field is produced by the motion of charged particles. The current in the wire is electrons moving through the wire.

23. 2 Under Waves, find the equations $n = c/v$ and $v = f\lambda$. From the table Absolute Indices of Refraction, the index of refraction of Lucite is 1.50. Using the first equation, determine the speed of light in Lucite. Solving for v, $v = c/n$ (the value of c is on the List of Physical Constants) $= (3.00 \times 10^8\text{ m/s})/(1.50) = 2.00 \times 10^8\text{ m/s}$. The frequency of the light does not change as it enters the Lucite. Using the second equation, solve for the wavelength of the light in Lucite. Solving for λ, $\lambda = v/f = (2.00 \times 10^8\text{ m/s})/(5.09 \times 10^{14}\text{ Hz}) = 3.93 \times 10^{-7}\text{ m}$. Using the table Prefixes for Powers of 10, 1 nanometer (nm) $= 10^{-9}$ m. Converting to nm, $3.93 \times 10^{-7}\text{ m} \times (1\text{ nm})/(1 \times 10^{-9}\text{ m}) = 3.93 \times 10^2\text{ nm} = 393\text{ nm}$.