

(This exam is **NOT** for any AP level students)

25 multiple choice questions per exam. Each of the 25 questions is worth 4 points.

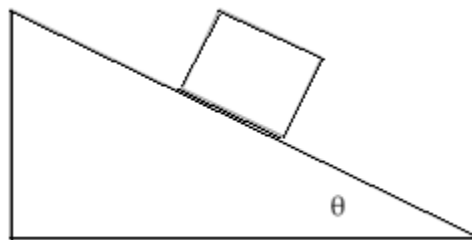
Directions: For each question or statement fill in the appropriate space on the answer sheet. Use the letter preceding the word, phrase, or quantity which best completes or answers the question.

Use: $g = 10. \text{ m/s}^2$ on Earth

1. A car travels 20.0 km northbound in 40.0 minutes, then 30.0 km westbound at 20 km/hour. The magnitude of the car's **average velocity** is

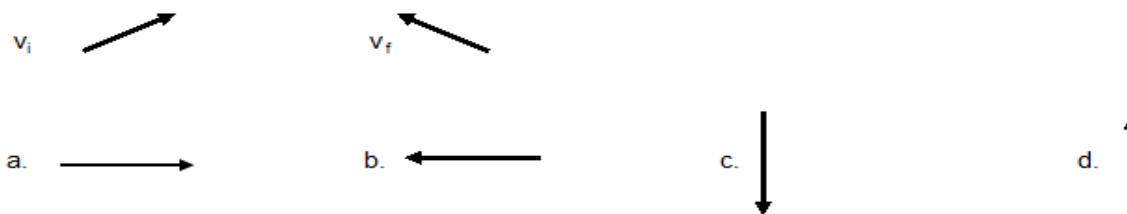
- a. 26.3 km/hr b. 23.1 km/hr c. 19.0 km/hr d. 16.6 km/hr

2. The diagram below shows a block at rest on a rough plane, inclined at an angle θ with the horizontal as shown. As the angle θ decreases, which one of the following is true?



- a. The component of the gravitational force on the block perpendicular to the plane decreases
b. The normal force on the block decreases
c. The static friction force on the block increases
d. The component of the gravitational force on the block parallel to the plane decreases

3. The initial velocity, v_i , and the final velocity, v_f , of a body are directed as shown. What is the direction of the **average acceleration** of the body?



4. Two objects, A and B are R meters apart and are attracted to each other with gravitational force F. If the mass of A is doubled, the mass of B is tripled, and the distance between them is quadrupled, the new force of gravitational attraction is _____.

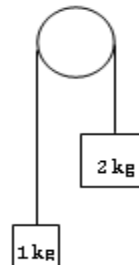
- a. $3F/8$ b. F c. $1.5 F$ d. $3 F$

5. A rock is dropped from rest from a very high cliff. Which is **not** true during the interval from $t = 3.0$ sec to $t = 4.0$ sec?

- a. The rock will speed up by 10 meters per second
b. The rock will fall an additional 45 meters
c. The magnitude of the rock's acceleration will remain at 10 m/s^2
d. The rock's displacement, velocity and acceleration are directed downward.

6. A momentary external force is applied to a stationary hockey puck, giving it an initial velocity of 10.0 m/s on a flat horizontal floor. The puck comes to a stop in 16.0 meters. The coefficient of kinetic friction between the puck and the floor is
- not able to be determined without knowing the mass of the puck.
 - 0.313
 - 0.250
 - 0.0313

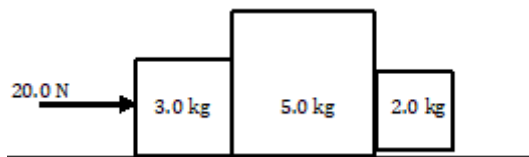
7. A 1.00 kg bag of nails and a 2.00 kg bag of rocks are attached to a “massless” string that is threaded through a “massless, frictionless” pulley as shown.



The tension in the string connecting the bags is

- 10.0 N
- 13.3 N
- 20.0 N
- 30.0 N

8. Three boxes are placed on a frictionless horizontal surface. A force of 20.0 N is applied to the 3.0 kg box on the left as shown.



With what force does the 5.0 kg mass push on the 2.0 kg mass?

- 20.0 N
- 10.0 N
- 5.0 N
- 4.0 N

Use the following information for problems 9 and 10.

A baseball is thrown toward a flat vertical wall that is located 18.0 meters to the right. The initial velocity of the ball is 15.0 m/s at 37 degrees above the horizontal.

9. At the top of the ball's trajectory,
- the velocity of the ball is zero
 - the acceleration of the ball is zero
 - the acceleration of the ball is non-zero and directed downward
 - the acceleration of the ball is non-zero and directed to the right
10. The time to reach the wall is ____ and the magnitude of the ball's velocity when it strikes the wall is ____.
- 1.5 seconds, 15.0 m/s
 - 1.5 seconds, 13.4 m/s
 - 1.2 seconds, 15.0 m/s
 - 1.2 seconds, 13.4 m/s

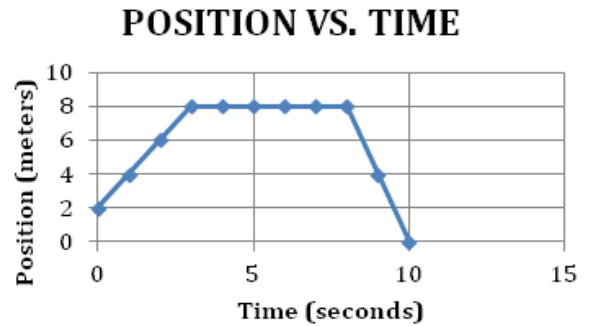
Use the following information for questions 11, 12 and 13.

A ball is thrown upward (straight up) into the air with an initial velocity 12.0 m/s and reaches a maximum height “H” in time “T”

11. What is the rock’s displacement at T/2?
a. 7.2 m b. 5.4 m c. 3.6 m d. 1.8 m
12. At maximum height, H, the velocity of the rock is _____ and its acceleration is _____.
a. negative, negative c. 0, negative
b. negative, 0 d. 0, 0
13. In order to reach height 2H, the rock would have had to be thrown upward with a speed of
a. 24.0 m/s b. 21.0 m/s c. 17.0 m/s d. 15.0 m/s

Use the following information for questions 14 and 15.

The motion of a mouse running along a wall is shown in the following graph.



14. The distance traveled by the mouse during the 10-second interval is
a. 2 m b. 6 m
c. 8 m d. 14 m
15. The average velocity of the mouse during the 10-second interval is
a. - 0.2 m/s c. 0 m/s
b. - 2.0 m/s d. 1.4 m/s

16. A car rounds an icy curve, banked at 37 degrees, with a 50-meter radius of curvature. If the coefficient of friction is negligible, the maximum speed of the car before it goes out of control is

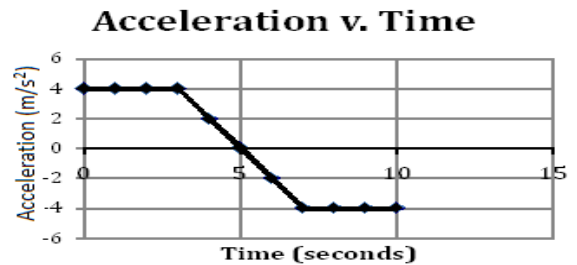
- a. 27.4 m/s b. 19.4 m/s c. 9.35 m/s
d. not able to be calculated without knowing the mass of the car

17. A 1.4 kg bucket of water is swung in a vertical circle of 1.6 meter radius. What is the minimum speed of the bucket of water at the top so that the water does not fall out?

- a. 4.0 m/s b. 8.0 m/s c. 12 m/s d. 16 m/s

Use the following information and graph for questions 18 and 19.

At t = 0 seconds, a car is moving at +20.0 m/s.



18. At t = 10 seconds, the velocity of the car is

- a. 16 m/s c. 36 m/s
b. 20 m/s d. 38 m/s

19. The maximum speed of the car during the 10 second interval shown in the graph is

- a. 24 m/s c. 36 m/s
b. 28 m/s d. 38 m/s

20. When a 20 kg scientific instrument is taken to the Moon, where the acceleration due to gravity is $1/6$ what it is on Earth, its mass and weight on the Moon are _____ and _____, respectively.

- a. 20 kg, 200 N
b. 3.3 kg, 33.3 N
c. 20 kg, 33.3 N
d. 3.3 kg, 200 N

21. A 20.0 kg cube is placed on a horizontal surface where the coefficient of kinetic friction is 0.05. Three horizontal forces are applied to the cube: 20.0 Newtons North, 10.0 Newtons South, and 20.0 Newtons East. The magnitude of the resulting acceleration of the cube due to the resultant force is _____.

- a. 22.4 m/s^2
b. 12.4 m/s^2
c. 2.24 m/s^2
d. 0.62 m/s^2

22. A 0.800 kg hockey puck is placed on the floor of a stationary merry-go-round, 4.0 meters from its center. The coefficients of static and kinetic friction between the puck and the floor are 0.40 and 0.20, respectively. The motor begins turning the merry-go-round. The maximum rotational speed of the merry-go-round to keep the puck in place on the floor is _____ revolutions per second.

- a. $0.707/(2\pi)$
b. $1/(2\pi)$
c. 1.0
d. 4.0

23. A golf ball is projected straight up from the ground and ascends to a maximum height of 5.0 meters. If instead, the golf ball is projected at an angle of 45 degrees above the horizontal, with the same initial speed, calculate the horizontal distance traveled by the ball.

- a. 5.0 m
b. 7.1 m
c. 10 m
d. 13 m

24. A motorcycle driver traveling at $V \text{ m/s}$, slams on his brakes, decelerates and comes to a stop in D meters. If the cycle had been traveling at $2V$ instead, how far would the cycle travel with the same deceleration?

- a. $1.4 D$
b. $2 D$
c. $4 D$
d. $2.8 D$

25. Freddie Fastlane, a newly licensed driver, often serves detention for arriving late to school. He is now late for work, exiting the student parking lot at a constant speed of 15 m/s . Waiting at an intersection, 100 meters ahead, is Sam Speedtrap, a dedicated member of the local police department. Just as Freddie passes Sam, it takes Sam 2.0 seconds to react (he has to put down his coffee cup) and put the patrol car into gear to follow Freddie. Sam's car accelerates from rest at 3.0 m/s^2 until it reaches a maximum speed of 21 m/s . He then continues at 21 m/s until Sam catches up to Freddie. How far does Sam travel until he catches up with Freddie?

- a. 312 m
b. 289 m
c. 213 m
d. 135 m

PHYSICS FORMULAE High School Physics 12-19-2017

| <u>MECHANICS</u> | <u>ELECTRICITY AND MAGNETISM</u> |
|--|---|
| $\bar{v} = \frac{\Delta x}{\Delta t}$ $\bar{a} = \frac{\Delta v}{\Delta t}$ $v_f = v_i + at$ $\Delta x = v_i t + \frac{1}{2} at^2$ $2a\Delta x = v_f^2 - v_i^2$ $\Sigma F = ma$ $W = mg$ $F_g = G \frac{m_1 m_2}{r^2}$ $p = mv$ $F\Delta t = m\Delta v$ $\mu = \frac{F_f}{F_N}$ | $F_e = k \frac{q_1 q_2}{r^2}$ $E = \frac{F}{q}$ $V = \frac{W}{q} = Ed$ $I = \frac{\Delta q}{\Delta t}$ $V = IR$ $P = VI = I^2 R = \frac{V^2}{R}$ <p style="text-align: center;"><u>SERIES CIRCUIT</u></p> $I_T = I_1 = I_2 = I_3 = \dots$ $V_T = V_1 + V_2 + V_3 + \dots$ $R_T = R_1 + R_2 + R_3 + \dots$ <p style="text-align: center;"><u>PARALLEL CIRCUITS</u></p> $I_T = I_1 + I_2 + I_3 + \dots$ $V_T = V_1 = V_2 = V_3 = \dots$ $R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots}$ |
| Δx = displacement (change of position) \bar{v} = average velocity \bar{a} = average acceleration v_i = initial velocity v_f = final velocity F = force F_f = force of friction F_N = normal force F_g = gravitational force G = Universal Gravitational Constant p = momentum μ = coefficient of friction r = distance between center of masses W = weight | E = electric field intensity I = electric current k = electrostatic constant $k = \frac{9 \times 10^9 \text{ Nm}^2}{\text{C}^2}$ $G = 6.67 \times 10^{-11} \frac{\text{Nm}^2}{\text{kg}^2}$ P = Power q = charge R = resistance V = electric potential difference W = Work Fundamental particle electron $e^{-1} = -1.60 \times 10^{-19} \text{ C}$ e mass $9.11 \times 10^{-31} \text{ kg}$ |

| | | | |
|---|---|---|--|
| <p style="text-align: center;"><u>ENERGY</u></p> $W = F\Delta x$ $P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t} = Fv$ $PE_g = mgh$ $KE = \frac{1}{2} mv^2$ $F = -kx$ $PE_s = \frac{1}{2} kx^2$ | h = height k = spring constant KE = kinetic energy PE_g = gravitational potential energy PE_s = potential energy stored in a spring P = power W = work x = change in spring length from the equilibrium position | <p style="text-align: center;"><u>MOTION IN 2-D</u></p> $a_c = \frac{v^2}{r}$ $F_c = m \frac{v^2}{r}$ $1 \text{ rev} = 2\pi \text{ rad} = 360^\circ$ $\tau = r \times F$ $L = I\omega$ $KE = \frac{1}{2} I\omega^2$ | a_c = centripetal acceleration F_c = centripetal force τ = Torque L = Angular Momentum I = Moment of Inertia ω = angular velocity |
|---|---|---|--|

High School PHYSICS FORMULAE 12-19-2017

HEAT ENERGY

$$Q = mc\Delta T$$

$$Q = mL_f$$

$$Q = mL_v$$

$$\Delta L = \alpha L_o \Delta T$$

c = specific heat

L_f = latent heat of fusion

L_v = latent heat of vaporization

Q = amount of heat

ΔT = change in temperature

α = coefficient of linear expansion

L_o = original length

$$c_{water} = 4186 \frac{J}{kg^\circ K}$$

1 cal = 4.184 joules

WAVE PHENOMENA

$$T = \frac{1}{f}$$

$$v = f\lambda \text{ OR } = v\lambda$$

$$n = \frac{c}{v}$$

$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$\lambda = \frac{xd}{L}$$

$$n \lambda = d \sin \theta$$

$$\sin \theta_c = \frac{1}{n}$$

c = speed of light in a vacuum

d = distance between slits

$f = \nu$ = frequency

L = distance from slit to screen

n = index of absolute refraction

T = period

v = speed

x = distance from central maximum to first-order maximum

λ = wavelength

θ = angle

θ_c = critical angle relative to air

GEOMETRIC OPTICS

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

$$\frac{h_i}{h_o} = -\frac{d_i}{d_o} = m$$

f = focal length

d_i = image distance

d_o = object distance

h_o = object size

h_i = image size

m = magnification

ELECTROMAGNETIC

APPLICATIONS

$F = Bqv$

$$F = BIL$$

$$V = BLv$$

$$\frac{N_p}{N_s} = \frac{V_p}{V_s}$$

$$V_p I_p = V_s I_s \text{ (ideal)}$$

$$\text{efficiency} = \frac{V_s I_s}{V_p I_p}$$

B = magnetic field strength

I_p = current in primary

I_s = current in secondary

N_p = number of turns in primary coil

N_s = number of turns in secondary coil

V_p = voltage of primary

V_s = voltage of secondary

L = length of conductor

V = electric potential difference

High School PHYSICS: Ivory Exam Corrections

Date: JANUARY 2018

High School PHYSICS -- For all Honors and college prep student.
25 multiple choice questions per exam.

This exam is NOT for any AP level students.

ANSWERS

| | | | | |
|-----|------|------|------|----------------------|
| 1 D | 6 B | 11 B | 16 B | 21 D All full credit |
| 2 D | 7 B | 12 C | 17 A | 22 B |
| 3 B | 8 D | 13 C | 18 B | 23 C |
| 4 A | 9 C | 14 D | 19 C | 24 C |
| 5 B | 10 B | 15 A | 20 C | 25 B |

2018 HS Physics Topics of Study

JANUARY: scalars, vectors, kinematics, projectiles, mass, Newton's laws, forces (mechanical, gravitational, frictional, centripetal),

FEBRUARY: impulse, linear momentum and its conservation, elastic and inelastic collisions, work, potential and kinetic energy and conservation of energy, power, simple harmonic motion of the simple pendulum and mass-spring systems, plus January Topics

MARCH: electric charges, fields and force, Coulomb's law, voltage sources and resistances, series/parallel networks, magnetism, plus January and February Topics.

APRIL: wave propagation, standing waves, sound, optics: light, index of refraction, color, lenses, mirrors, interference phenomena, plus January, February, and March Topics.

Dates for 2018 Season

Thursday January 11, 2018 Thursday February 8, 2018

Thursday March 8, 2018 Thursday April 12, 2018

All areas and schools must complete the April exam and mail in the results
by April 28th, 2018

New Jersey Science League

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phone # 908-213-8923 fax # 908-213-9391 email: newjssl@ptd.net

Web address: <http://entnet.com/~personal/njscil/html/>

What is to be mailed back to our office?

PLEASE RETURN THE AREA RECORD AND ALL TEAM MEMBER SCANTRONS
(ALL STUDENTS PLACING 1ST, 2ND, 3RD, AND 4TH).

If you return Scantrons of alternates, then label them as ALTERNATES.

Dates for 2019 Season

Thursday January 10, 2019 Thursday February 7, 2019

Thursday March 7, 2019 Thursday April 11, 2019

High School Physics Ivory Corrections

February 8, 2018

For all Honors and College Prep Students. This exam is NOT for any AP level students
25 multiple choice questions per exam. Each of the 25 questions is worth 4 points.

Directions: For each question or statement, fill in the appropriate space on the answer sheet. Use the letter preceding the word, phrase, or quantity which best completes or answers the question.

Use $g = 10.0 \text{ m/s}^2$ on Earth.

1. A 2000 kg truck, driven by an inattentive truck driver and traveling at 18 m/s to the East, collides with a stationary 1000 kg car waiting at a traffic light. The resulting velocity of the wreckage immediately after the completely inelastic collision in m/s is....

- a. 9.0 m/s b. 10.0 m/s c. 12.0 m/s d. 14.0 m/s

2. A 0.500 kg metal ball falls from rest from 1.00 meter above the ground. The ball bounces back to a height of 0.90 meters. If the positive direction is upward, then the impulse on the floor due to the ball is

- a. 0.0 b. -4.36 Ns c. 4.36 Ns d. 0.11 Ns

3. If the momentum of a vehicle is tripled, then what happens to its kinetic energy? **Need to add at constant mass. Ans is letter D and C**

- a. kinetic energy is tripled
b. kinetic energy is increased by six fold
c. kinetic energy is increased nine fold
d. without the car's mass and velocity it is impossible to determine.

4. A 30 kg boy and his 25 kg sister are in a playground on identical swings. The masses of the swing seats and the 2.00 meter long chains can be neglected. The ratio of the boy's period of oscillation compared to the girl's is

- a. 6/5 b. 5/6 c. $(6/5)^{1/2}$ d. 1/1

5. An empty 200 kg rollercoaster car starts from rest at the top of a 5.00 meter high hill. It travels down a frictionless track to a rough horizontal section of track that is 1.00 meter above the ground. The brakes engage, locking the wheels, and the car slides to a stop. If the coefficients of static and kinetic friction between the coaster wheels and track are 0.90 and 0.75 respectively, then in how many meters will the rollercoaster car come to rest?

- a. 7.50 m b. 6.67 m c. 5.53 m d. 4.44 m

6. A 65 kg high school junior lifts a 500 ml bottle of water from the table to his mouth, a vertical distance of 0.300 meters, in 1.50 seconds. If 1.0 ml of water has a mass of 1.0 gram, then what is the boy's average power output?

- a. 0.225 W b. 1.00 W c. 1.75 W d. 2.25 W

7. During the Pairs Figure Skating competition at the Winter Olympics, a 70.0 kg male skater and his 50.0 kg partner begin at rest at the center of the effectively frictionless ice rink. If he pushes her off, so her speed is 10.0 m/s, how far apart in meters are they after 2.0 seconds?

- a. 48.0 m b. 34.3 m c. 24.0 m d. 20.0 m

8. You construct a force vs. time (force on the y-axis and t is on the x-axis) graph from data obtained during a physics lab. By using only the graph, how could you find the change in momentum of the object tested?

- a. Calculate the slope of the graph
- b. Find the y-intercept
- c. Find the x-intercept
- d. Calculate the area of the shape under the graph

9. A 12.00 kg box of electronics ready for shipment at Amazon is at the top of a frictionless ramp inclined at 30.0 degrees with the horizontal. How much work (J) is done by the normal force as the box slides down the incline, a distance of 2.00 meters?

- a. 0 J
- b. 60 J
- c. 104 J
- d. 240 J

10. In the game of pool, all the colored balls have the same mass. A solid red ball moving at 5.00 m/s strikes a stationary yellow striped ball in a perfectly elastic collision. The striped ball is observed to move off in the same direction as the red ball moved initially. The final speed of the red ball is _____ and the final speed of the striped yellow ball is _____. Order of answers is red ball, striped yellow ball.

- a. 0, 0
- b. 0, 5.00 m/s
- c. 2.50 m/s, 2.50 m/s
- d. 5.00 m/s, 0

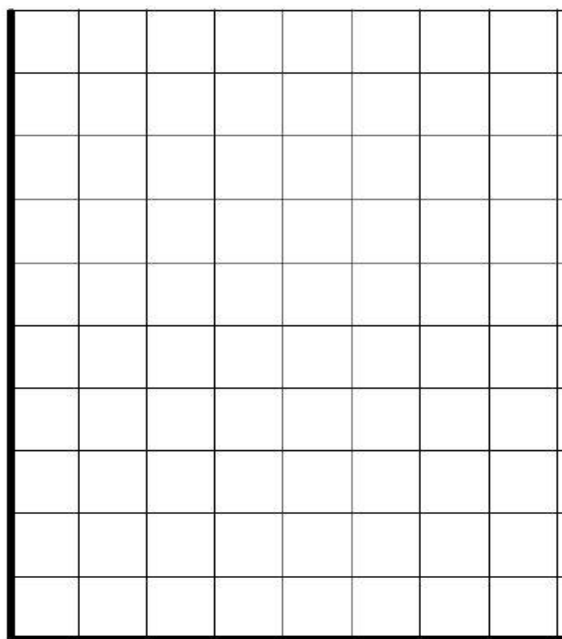
11. A 100 gram “super ball” falls from rest from 1.50 meters above the ground in the absence of air resistance. What is the magnitude of the momentum of the ball as it strikes the ground?

- a. 5.48 kg m/s
- b. 3.00 kg m/s
- c. 1.71 kg m/s
- d. 0.548 kg m/s

12. The data below shows the eastward force on a 0.500 kg ball as a function of time. When the points are graphed, it can be assumed that the points are connected by straight lines. If the initial velocity of the ball is 10.0 m/s west, then what is the velocity of the ball at the end of the time interval shown by these data points?

- a. 23.2 m/s E
- b. 13.2 m/s E
- c. 3.2 m/s E
- d. 3.2 m/s W

| Time (s) | Force (N) to the East |
|----------|-----------------------|
| 0.0 | 0 |
| 0.1 | 0 |
| 0.2 | 6 |
| 0.3 | 12 |
| 0.4 | 12 |
| 0.5 | 12 |
| 0.6 | 12 |
| 0.7 | 8 |
| 0.8 | 4 |
| 0.9 | 0 |
| 1.0 | 0 |
| 1.1 | 0 |
| 1.2 | 0 |
| 1.3 | 0 |
| 1.4 | 0 |



13. The period of a simple pendulum is 2.0 seconds. If the length of the pendulum string is halved and the mass is doubled, the new period would now be _____.

- a. 2.0 s b. 0.71 s c. 1.0 s d. 1.4 s

14. The period of a **simple pendulum** is 2.0 seconds on Earth. If the pendulum is taken to the Moon where the acceleration due to gravity is $1/6$ of "g" on Earth, the new period would now be _____.

- a. 0.33 s b. 0.82 s c. 2.0 s d. 4.9 s

15. A physics book is held from height H and possesses 100 J of total mechanical energy. It is released from rest. At what height does it possess 50 J of total mechanical energy?

- a. $H/4$ b. $H/2$ c. $0.71 H$ d. None of these choices.

THE FOLLOWING INFORMATION APPLIES TO QUESTIONS 16 - 18.

A 4.00 kg box of Holiday gifts is slid 4.00 meters across a floor at constant velocity if pulled by a string held taut at 37 degrees above the horizontal. The tension in the string is 10 N.

16. Calculate the work on the box by the string.

- a. 12 J b. 24 J c. 32 J d. 40 J

17. Calculate the work on the box by the force of gravity.

- a. 0 J b. 109 J c. 136 J d. 160 J

18. Calculate the coefficient of kinetic friction between the box and the floor.

- a. 4.25 b. 0.64 c. 0.24 d. 0.20

19. If you pitch a baseball with twice the kinetic energy you gave it in a previous pitch, the magnitude of its momentum is

- a. the same
b. $1/2$ as much
c. $\sqrt{2}$ times as much
d. twice as much

20. A 25 kg child, sitting in a 5.0 kg wagon, has twelve 1.0 kg bricks in her lap. The child is capable of throwing the bricks at 5.0 m/s relative to her frame of reference. If the wagon is initially moving at 1.0 m/s to the east, what's the minimum number of bricks she should throw all at once, and in which direction should she throw them, in order to stop the wagon? **Letter B is correct**

- a. 5 bricks to the East
b. **7 bricks to the East**
c. 5 bricks to the West
d. 7 bricks to the West

21. The pilot of a plane (cruising speed 150 m/s) is attempting to fly it 200 kilometers directly east. There is a severe wind of 50.0 m/s from the south. The navigator calculates the expected flight time for the pilot. What flight time does the navigator give the pilot?

- a. 66.6 minutes b. 47.2 minutes c. 22.2 minutes d. 23.6 minutes

22. The period of a **simple mass-spring system** is 2.0 seconds on Earth. If the system is taken to the Moon where the acceleration due to gravity is $1/6$ of “g” on Earth, the new period would now be _____.

- a. 0.33 s b. 0.82 s c. 2.0 s d. 4.9 s

23. Which of the following quantities is **NOT** a vector quantity?

- a. momentum b. impulse c. work d. force

THE FOLLOWING STATEMENTS PROVIDE INFORMATION FOR QUESTIONS 24 AND 25.

A simple mass-spring system (mass = 0.50 kg, spring constant = 100 N/m), is placed on a frictionless horizontal surface, attached to a vertical wall and is observed to oscillate with amplitude A when the mass, M, is pulled 2.0 cm from the equilibrium position and released.

24. How much force was applied to the mass in order to stretch the spring 2.0 cm?

- a. 1.0 N b. 2.0 N c. 10.0 N d. 20.0 N

25. What work was done by the force in order to pull the mass 2.0 cm from equilibrium?

- a. 0.02 J b. 0.04 J c. 200 J d. 400 J

PHYSICS FORMULAE High School Physics 2-19-2018

| <u>MECHANICS</u> | <u>ELECTRICITY AND MAGNETISM</u> |
|--|---|
| $\bar{v} = \frac{\Delta x}{\Delta t}$ $\bar{a} = \frac{\Delta v}{\Delta t}$ $v_f = v_i + at$ $\Delta x = v_i t + \frac{1}{2} at^2$ $2a\Delta x = v_f^2 - v_i^2$ $\Sigma F = ma$ $W = mg$ $F_g = G \frac{m_1 m_2}{r^2}$ $p = mv$ $F\Delta t = m\Delta v$ $\mu = \frac{F_f}{F_N}$ | $F_e = k \frac{q_1 q_2}{r^2}$ $E = \frac{F}{q}$ $V = \frac{W}{q} = Ed$ $I = \frac{\Delta q}{\Delta t}$ $V = IR$ $P = VI = I^2 R = \frac{V^2}{R}$ <p style="text-align: center;"><u>SERIES CIRCUIT</u></p> $I_T = I_1 = I_2 = I_3 = \dots$ $V_T = V_1 + V_2 + V_3 + \dots$ $R_T = R_1 + R_2 + R_3 + \dots$ <p style="text-align: center;"><u>PARALLEL CIRCUITS</u></p> $I_T = I_1 + I_2 + I_3 + \dots$ $V_T = V_1 = V_2 = V_3 = \dots$ $R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots}$ |
| Δx = displacement (change of position) \bar{v} = average velocity \bar{a} = average acceleration v_i = initial velocity v_f = final velocity F = force F_f = force of friction F_N = normal force F_g = gravitational force G = Universal Gravitational Constant p = momentum μ = coefficient of friction r = distance between center of masses W = weight | E = electric field intensity I = electric current k = electrostatic constant $k = \frac{9 \times 10^9 \text{ Nm}^2}{\text{C}^2}$ $G = 6.67 \times 10^{-11} \frac{\text{Nm}^2}{\text{kg}^2}$ P = Power q = charge R = resistance V = electric potential difference W = Work Fundamental particle electron $e^{-1} = -1.60 \times 10^{-19} \text{ C}$ e mass $9.11 \times 10^{-31} \text{ kg}$ |

| | | | |
|---|---|---|--|
| <p style="text-align: center;"><u>ENERGY</u></p> $W = F\Delta x$ $P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t} = Fv$ $PE_g = mgh$ $KE = \frac{1}{2} mv^2$ $F = -kx$ $PE_s = \frac{1}{2} kx^2$ | h = height k = spring constant KE = kinetic energy PE_g = gravitational potential energy PE_s = potential energy stored in a spring P = power W = work x = change in spring length from the equilibrium position | <p style="text-align: center;"><u>MOTION IN 2-D</u></p> $a_c = \frac{v^2}{r}$ $F_c = m \frac{v^2}{r}$ $1 \text{ rev} = 2\pi \text{ rad} = 360^\circ$ $\tau = r \times F$ $L = I\omega$ $KE = \frac{1}{2} I\omega^2$ | a_c = centripetal acceleration F_c = centripetal force τ = Torque L = Angular Momentum I = Moment of Inertia ω = angular velocity |
|---|---|---|--|

High School PHYSICS FORMULAE 2-19-2018

HEAT ENERGY

$$Q = mc\Delta T$$

$$Q = mL_f$$

$$Q = mL_v$$

$$\Delta L = \alpha L_o \Delta T$$

c = specific heat

L_f = latent heat of fusion

L_v = latent heat of vaporization

Q = amount of heat

ΔT = change in temperature

α = coefficient of linear expansion

L_o = original length

$$c_{water} = 4186 \frac{J}{kg^\circ K}$$

1 cal = 4.184 joules

WAVE PHENOMENA

$$T = \frac{1}{f}$$

$$v = f\lambda \text{ OR } = v\lambda$$

$$n = \frac{c}{v}$$

$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$\lambda = \frac{xd}{L}$$

$$n \lambda = d \sin \theta$$

$$\sin \theta_c = \frac{1}{n}$$

c = speed of light in a vacuum = 3×10^8 m/s

Speed of sound in air at 0°C = 331 m/s at 20°C 343 m/s

d = distance between slits

$f = \nu$ = frequency

L = distance from slit to screen

n = index of absolute refraction

T = period

v = speed

x = distance from central maximum to first-order maximum

λ = wavelength

θ = angle

θ_c = critical angle

relative to air

GEOMETRIC OPTICS

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

$$\frac{h_i}{h_o} = -\frac{d_i}{d_o} = m$$

f = focal length

d_i = image distance

d_o = object distance

h_o = object size

h_i = image size

m = magnification

ELECTROMAGNETIC

APPLICATIONS

$F = Bqv$

$$F = BIL$$

$$V = BLv$$

$$\frac{N_p}{N_s} = \frac{V_p}{V_s}$$

$$\frac{N_p}{N_s} = \frac{V_p}{V_s}$$

$$V_p I_p = V_s I_s \text{ (ideal)}$$

$$\text{efficiency} = \frac{V_s I_s}{V_p I_p}$$

B = magnetic field strength

I_p = current in primary

I_s = current in secondary

N_p = number of turns in primary coil

N_s = number of turns in secondary coil

V_p = voltage of primary

V_s = voltage of secondary

L = length of conductor

V = electric potential difference

High School PHYSICS: Ivory Exam Corrections:

Date: February 8, 2018

High School PHYSICS -- For all Honors and college prep student.
25 multiple choice questions per exam.

This exam is NOT for any AP level students.

ANSWERS

| | | | | |
|---------|------|------|-------------------|------|
| 1 C | 6 B | 11 D | 16 C | 21 D |
| 2 B | 7 B | 12 C | 17 A | 22 C |
| 3 C & D | 8 D | 13 D | 18 C | 23 C |
| 4 D | 9 A | 14 D | 19 C | 24 B |
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2018 HS Physics Topics of Study

JANUARY: scalars, vectors, kinematics, projectiles, mass, Newton's laws, forces (mechanical, gravitational, frictional, centripetal),

FEBRUARY: impulse, linear momentum and its conservation, elastic and inelastic collisions, work, potential and kinetic energy and conservation of energy, power, simple harmonic motion of the simple pendulum and mass-spring systems, plus January Topics

MARCH: electric charges, fields and force, Coulomb's law, voltage sources and resistances, series/parallel networks, magnetism, plus January and February Topics.

APRIL: wave propagation, standing waves, sound, optics: light, index of refraction, color, lenses, mirrors, interference phenomena, plus January, February, and March Topics.

Dates for 2018 Season

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Thursday March 8, 2018 Thursday April 12, 2018

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New Jersey Science League

PO Box 65 Stewartsville, NJ 08886-0065

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Thursday January 10, 2019 Thursday February 7, 2019

Thursday March 7, 2019 Thursday April 11, 2019

High School PHYSICS **Ivory Exam** **No Corrections**

March 8, 2018

(This exam is **NOT** for any AP level students)

25 multiple choice questions per exam. Each of the 25 questions is worth 4 points.

Directions: For each question or statement fill in the appropriate space on the answer sheet.

Use the letter preceding the word, phrase, or quantity which best completes or answers the question. Fundamental charges and formulae are on the attached formulae sheet.

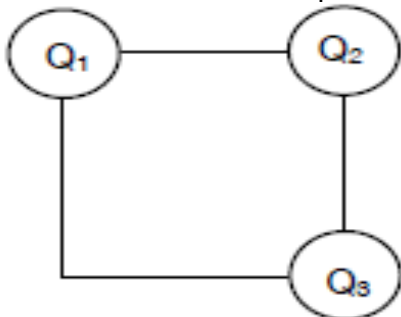
Use: $g = 10. \text{ m/s}^2$ on Earth

Note: Unless told otherwise, all voltage sources are ideal, with no internal resistance.

1. Two charges, Q_1 and Q_2 , located a distance, d , apart repel each other with force F . If, Q_1 is doubled, Q_2 is tripled, and the distance between them is halved, what is the new force of repulsion?

- a. $3F$ b. $6F$ c. $12F$ d. $24F$

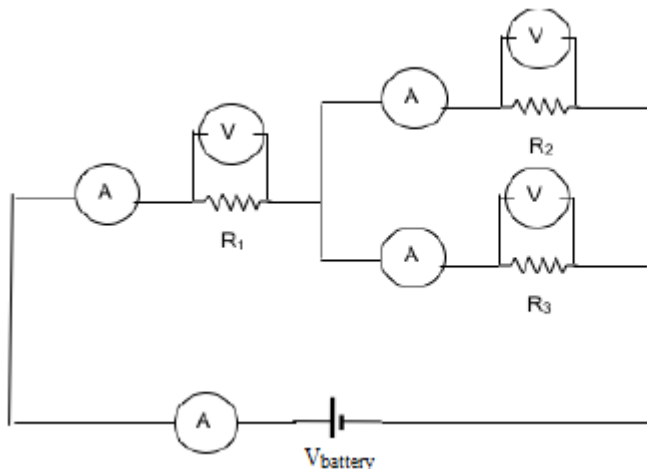
2. Three point charges, Q_1 ($+1.00 \mu\text{C}$), Q_2 ($+2.00 \mu\text{C}$), and Q_3 ($-3.00 \mu\text{C}$) are placed at three of the four vertices of a square with 1.00 meter sides, as shown below. (Not drawn to scale)



What is the magnitude of the net force on Q_2 ?

- a. 0.018 N b. 0.036 N c. 0.057 N d. 0.072N

3. The following circuit has the resistances and battery voltage as shown below. The circled A's and V's represent ammeters and voltmeters.



Given:

$$R_1 = 8 \Omega$$

$$R_2 = 20 \Omega$$

$$R_3 = 30 \Omega$$

$$V_{\text{battery}} = 10 \text{ V}$$

The potential difference across the 30Ω resistor is

- a. 2.0 V b. 4.0 V c. 6.0 V d. 10 V

4. A battery, when not in a circuit, is measured to have a potential difference of 12.0 V. However, when a $3.0\ \Omega$ resistor is placed in series with it, the potential difference across the battery is now read as 9.0 V. What is the internal resistance of the battery?
- a. $1.0\ \Omega$ b. $1.5\ \Omega$ c. $2.0\ \Omega$ d. $2.5\ \Omega$

5. Two identical insulated metal spheres, A and B, have charges of $-1.00\ \mu\text{C}$ and $+2.00\ \mu\text{C}$, respectively. The magnitude of the electrostatic force on A due to B is 0.015 N. What is the magnitude and direction of the electrostatic force on B due to A?

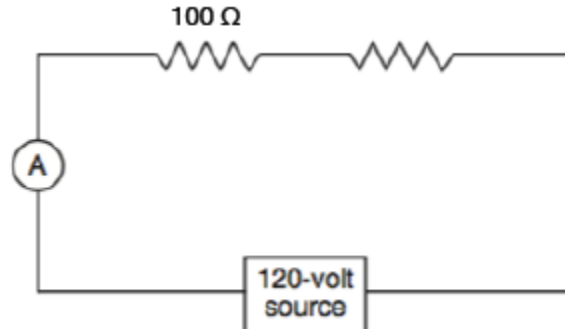


- a. 0.075 N, rightward c. 0.015 N, leftward
b. 0.015 N, rightward d. 0.075 N, leftward

6. A very small $-1.0\ \mu\text{C}$ charge is placed at the origin of a coordinate axis system. What is the magnitude of the electric field, E , at a point located at a point whose coordinates are $(0.5,0)$ m?
- a. 18 N/C b. 36 N/C c. 18,000 N/C d. 36,000 N/C

7. A $100\ \Omega$ resistor and an unknown resistor are placed in series with an ammeter and a 120 V direct current source as shown below. If the current through the ammeter is 0.500 A, what is the resistance of the unknown resistor?

- a. $40\ \Omega$
b. $60\ \Omega$
c. $140\ \Omega$
d. $340\ \Omega$

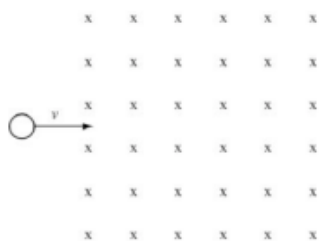


8. Three $100\ \Omega$ lamps are placed in series with a 12 V battery. What power is dissipated in one of the $100\ \Omega$ lamps?
- a. 0.08 W b. 0.12 W c. 0.16 W d. 0.48 W

9. If 9.6×10^{-3} C of charge pass a point in a wire in 10.0 seconds, how much current is flowing through the wire?
- a. 9.6×10^{-1} A b. 9.6×10^{-2} A c. 9.6×10^{-3} A d. 9.6×10^{-4} A

10. What is the net electrical charge on a metal sphere that has 3000 excess electrons on it?
- a. -1.6×10^{-19} C b. -4.8×10^{-16} C c. -2.7×10^{13} C d. -1.9×10^{22} C

11. A particle with a net charge of $+1.0 \times 10^{-3} \text{ C}$ enters a uniform magnetic field directed into the page, as shown.



Immediately after entering the magnetic field, the particle will experience a force that is

- a. into the page
- b. out of the page
- c. toward the top of the page
- d. toward the bottom of the page

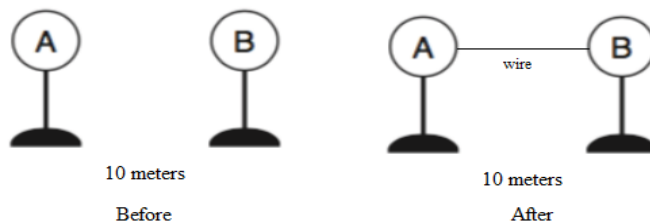
12. A very long current carrying wire sits along the x-axis of a coordinate system. The current in the wire is toward the left. What is the direction of the magnetic field at a point located at coordinates (0, 0.500) meters?

- a. into the page
- b. out of the page
- c. toward the left
- d. toward the right

13. Two identical insulated metal spheres, A and B, have charges of $-1.00 \mu\text{C}$ and $+2.00 \mu\text{C}$, respectively and are located 10.0 meters apart.

The spheres are now connected by a thin wire (after). What is the charge on sphere A after the wire has been placed on the spheres?

- a. $+0.50 \mu\text{C}$
- b. $-0.50 \mu\text{C}$
- c. $+1.50 \mu\text{C}$
- d. $-1.50 \mu\text{C}$



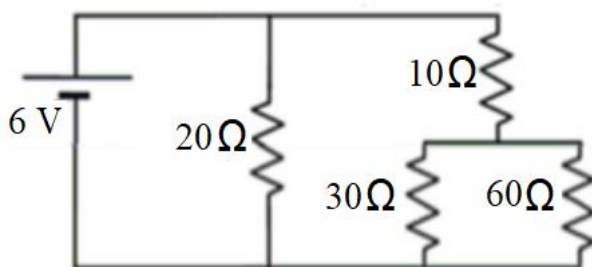
14. A 100 Watt light-bulb is installed in a front porch lamp. The lamp is turned on every evening during the month of January from 4:30 PM to 11:00 PM. If the cost of electricity is 12 cents per kilowatt hour, how much does it cost to keep the light on during the month of January?

- a. \$ 0.24
- b. \$ 0.86
- c. \$ 2.42
- d. \$ 8.60

Use the circuit diagram below of a 6.0 V battery and four resistors for questions 15 and 16

15. What is the potential difference across the 20Ω resistor?

- a. 1.5 V
- b. 3.0 V
- c. 4.0 V
- d. 6.0 V



16. Which resistor has the smallest current passing through it?

- a. 20Ω
- b. 10Ω
- c. 30Ω
- d. 60Ω

17. The unit for magnetic field is

- a. Tesla b. Musk c. Watt d. Weber

18. Outside a bar magnet, magnetic field points

- a. from South to North b. from North to South c. Neither (a) nor (b)

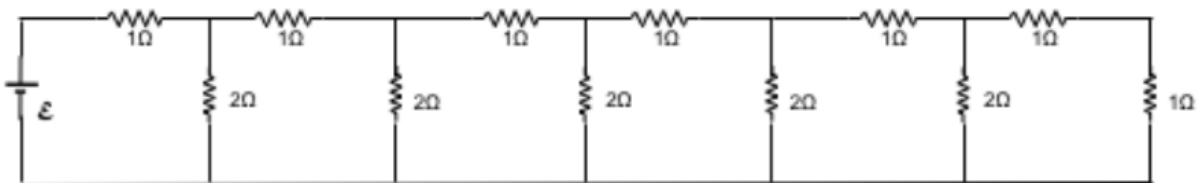
19. Four identical resistors are placed in series with a 6 V battery in a circuit and the equivalent resistance is 16Ω . If the same resistors were instead placed in **parallel** with the same battery in a circuit, the equivalent resistance would now be

- a. 1Ω b. 2Ω c. 4Ω d. 64Ω

20. A 60 Watt light bulb and a 100 Watt light bulb are arranged so that each is in parallel with a 20 Volt direct current source. What is the resistance of the 60 Watt bulb?

- a. $15/16 \Omega$ b. 3.0Ω c. 5.0Ω d. $20/3 \Omega$

21. Refer to the following containing a 6.4 V battery and a combination of 1Ω and 2Ω resistors. Find the current through the resistor closest to the battery.



- a. 0.1 A b. 0.4 A c. 1.6 A d. 3.2 A

22. Two point charges are placed along the x axis. The $+10.0 \mu\text{C}$ charge is located at the origin. The $-3.0 \mu\text{C}$ charge is located at $(2.0, 0)$ m. In which region along the x-axis would the net force on a $+1.0 \text{ nC}$ charge point left in the entire region?

- a. $x < 0$ b. $0 < x < 2.0 \text{ m}$ c. $x > 2.0 \text{ m}$

23. A projectile is fired at speed V at 60 degrees above the horizontal. It travels a horizontal range of R meters in T seconds. If instead the same projectile were to be shot with the same initial speed, but now at an angle of 30 degrees, its new range is _____ and new time is _____.

- a. $R, 0.50 T$ b. $0.50 R, T$ c. $R, 0.577 T$ d. $0.50 R, 0.577 T$

24. In 1974, Nolan Ryan threw the fastest recorded pitch to date. This pitch was thrown horizontally, and fell 0.809 meters by the time it reached home plate, 18.3 meters away. How fast was the ball thrown?

- a. 18.3 m/s b. 22.6 m/s c. 45.5 m/s d. 113 m/s

25. A 100 kg boat requires a horizontal force of 300 N to move it across still water at 10 m/s. The boat's engine must provide energy at a rate of

- a. 100 W b. 300 W c. 1000 W d. 3000 W

PHYSICS FORMULAE High School Physics 2-19-2018

| <u>MECHANICS</u> | <u>ELECTRICITY AND MAGNETISM</u> |
|--|---|
| $\bar{v} = \frac{\Delta x}{\Delta t}$ $\bar{a} = \frac{\Delta v}{\Delta t}$ $v_f = v_i + at$ $\Delta x = v_i t + \frac{1}{2} at^2$ $2a\Delta x = v_f^2 - v_i^2$ $\Sigma F = ma$ $W = mg$ $F_g = G \frac{m_1 m_2}{r^2}$ $p = mv$ $F\Delta t = m\Delta v$ $\mu = \frac{F_f}{F_N}$ | $F_e = k \frac{q_1 q_2}{r^2}$ $E = \frac{F}{q}$ $V = \frac{W}{q} = Ed$ $I = \frac{\Delta q}{\Delta t}$ $V = IR$ $P = VI = I^2 R = \frac{V^2}{R}$ <p style="text-align: center;"><u>SERIES CIRCUIT</u></p> $I_T = I_1 = I_2 = I_3 = \dots$ $V_T = V_1 + V_2 + V_3 + \dots$ $R_T = R_1 + R_2 + R_3 + \dots$ <p style="text-align: center;"><u>PARALLEL CIRCUITS</u></p> $I_T = I_1 + I_2 + I_3 + \dots$ $V_T = V_1 = V_2 = V_3 = \dots$ $R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots}$ |
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High School PHYSICS: Ivory Exam **No Corrections**

Date: March 8, 2018

High School PHYSICS SOLUTIONS For all Honors and college prep student.
25 multiple choice questions per exam.

This exam is NOT for any AP level students.

Deadline: All March exam results must be post marked by March 16th or scan the record sheet and email to newjsl@ptd.net or the scores will not count.

| | | | | |
|-----|------|------|------|------|
| 1 D | 6 D | 11 C | 16 D | 21 D |
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Corrections

April 12, 2018

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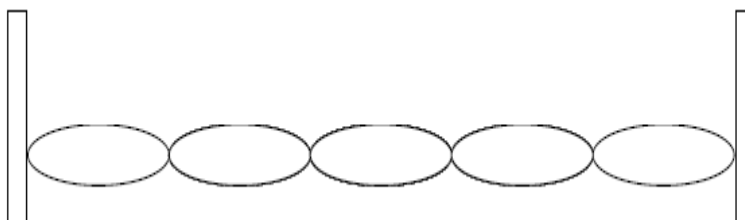
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| Indices of Refraction for Monochromatic Light | | | | |
|---|---------------|--|-------------|------|
| Medium | n | | Medium | n |
| Vacuum | 1.00 | | Quartz | 1.46 |
| Air | 1.0003 ~ 1.00 | | Glycerin | 1.47 |
| Ice | 1.31 | | Crown glass | 1.52 |
| Water | 1.33 | | Flint glass | 1.61 |
| Salt | 1.54 | | Acrylic | 1.70 |
| Ethanol | 1.36 | | Diamond | 2.42 |

Note: Unless told otherwise, all voltage sources are ideal, with no internal resistance.

1. A stretched string, fixed at both ends as shown below, vibrates at a frequency of 12 Hz as a standing wave. The distance between the ends of the string is 5.0 meters. The speed of the wave in m/s is....

- a. 12 m/s
- b. 24 m/s
- c. 30 m/s
- d. 60 m/s



2. How are electromagnetic waves received by your cell phone and sound waves received by your ear similar? All receive full credit since the cell phone and a person can be moving.

- a. Both have the same frequency as their respective sources
- b. Both require a medium for propagation
- c. Both are longitudinal waves
- d. Both are transverse waves

3. It's a cool July 4th evening with a temperature of 20°C . While at the community fireworks display, you observe that the time between seeing the explosion of the fireworks and hearing the sound of the explosion is 2.25 seconds. The distance from the explosion to you is

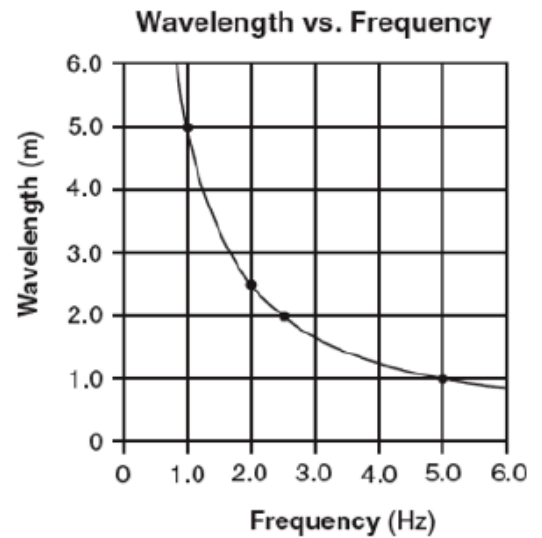
- a. 386 m
- b. 772 m
- c. 797 m
- d. $6.75 \times 10^8 \text{ m}$

4. Which characteristic of a wave is changed whenever a wave is refracted, diffracted or reflected?

- a. wavelength
- b. speed
- c. frequency
- d. none of these

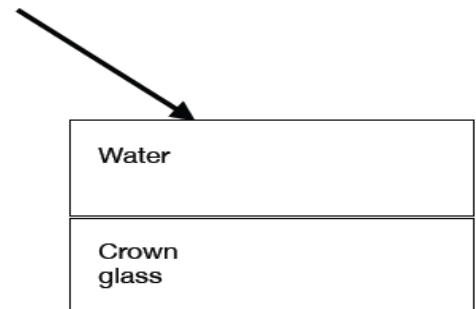
5. The graph below represents the relationship between the wavelength and frequency of waves created by students shaking the ends of a loose string. Calculate the speed of the waves generated in the string.

- a. 2.0 m/s
- b. 2.5 m/s
- c. 5.0 m/s
- d. wave speed cannot be determined from the graph



6. 100 grams of water are placed in a container made of crown glass. A ray of monochromatic light in air enters the water from the top at an angle of 30 degrees with the surface of the water. At what angle, measured from the normal, does the ray of light go through the glass before it exits the bottom surface.

- a. 6°
- b. 30°
- c. 35°
- d. 60°



7. A ray of monochromatic light originates in a swimming pool water. It is projected up toward the surface so that the angle between the surface of the water and the ray is 30° . The light ray will be

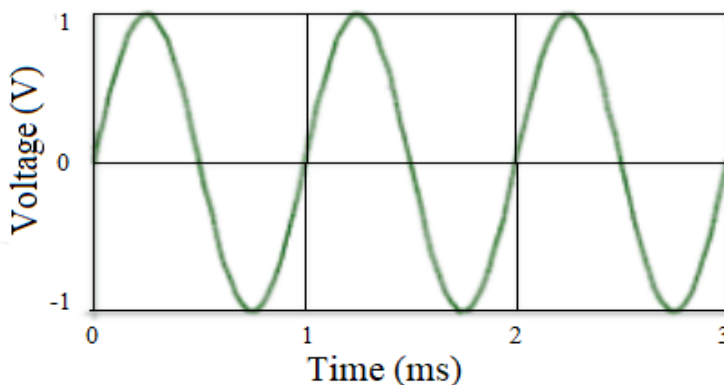
- a. refracted
- b. dispersed
- c. diffracted
- d. reflected

8. You are driving northbound on the NJ Turnpike at 20 m/s with your windows open on a 20°C day. A NJ State trooper car, traveling northbound at 35 m/s, is behind you. The trooper sees an inattentive driver ahead of you, initiates his 1000 Hz siren and lights, and passes you at 35 m/s. The frequency of the siren you observed before the trooper passes you is _____.

- a. 854 Hz b. 960 Hz c. 1179 Hz d. 1049 Hz

9. During an experiment in the physics lab, the following graph is produced when a tone is sounded near the microphone attached to the computer. Calculate the frequency of the sound produced.

- a. 100 Hz
b. 333 Hz
c. 1000 Hz
d. Cannot be calculated without knowing the wavelength of the sound



10. A stretched string of length L produces a fundamental frequency of 1000 vibrations per second when the tension is T Newtons. If the same string is to produce a fundamental frequency of 2000 vibrations per second without changing the length, the tension in the string should be _____ Newtons

- a. $1/4 T$ b. $1/2 T$ c. $1.414 T$ d. $4 T$

11. What happens to the speed and frequency of the sound wave created by a boat propeller as the sound wave passes from the water into the air?

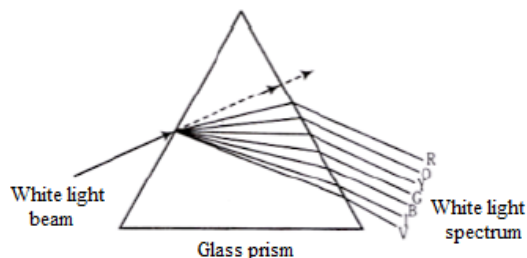
- a. The speed increases and the frequency increases
b. The speed increases and the frequency remains the same
c. The speed decreases and the frequency increases
d. The speed decreases and the frequency remains the same.

12. The image of a 5.0 cm pencil that is placed 3.0 cm in front of a convex spherical mirror with radius of curvature of 15 cm is

- a. real, inverted and smaller c. virtual, upright and smaller
b. real, inverted and larger d. virtual, upright and larger

13. A candle is placed between the center of curvature, C, of a spherical concave mirror and the focal point, F, of the mirror. The candle's image will lie
- a. beyond C
 - b. between C and F
 - c. between F and the mirror
 - d. behind the mirror

14. Which terms best describe the phenomenon illustrated by the white light beam passing through the prism? Choices out of order. No change in answer. Still letter C. It is the responsibility of the tester to select the correct answer. Even though out of sequence the correct answer is still letter C.



- a. scattering and diffraction
- c. refraction and dispersion
- b. reflection and interference
- d. transmission and reflection

15. In an experiment, blue light of wavelength 4.7×10^{-7} m is passed through a double slit. What is produced?

- a. a continuous spectrum
- b. two narrow bands of blue light
- c. alternate blue and black bands
- d. bands of blue light fringed with green

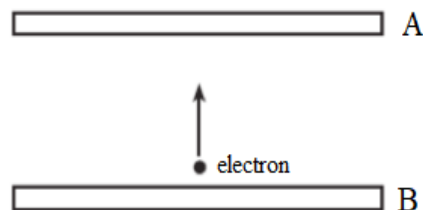
16. A converging lens with a focal length of 20 cm cannot be used to form an image of an object that is

- a. real and larger than the object
- b. real and smaller than the object
- c. virtual and larger than the object
- d. virtual and smaller than the object

17. An electron is placed at rest between two oppositely charged parallel plates and is observed to move toward plate A as shown in the diagram below.

The direction of the electric field between the plates is

- a. toward plate B
- b. toward plate A
- c. into the page
- d. out of the page



18. Which quantity and unit are correctly paired?

- a. resistivity and Ω
- b. potential difference and eV
- c. current and C•s
- d. electric field strength and N/C

19. Satellites A and B orbit the Earth. The masses and orbital radii are related as follows:

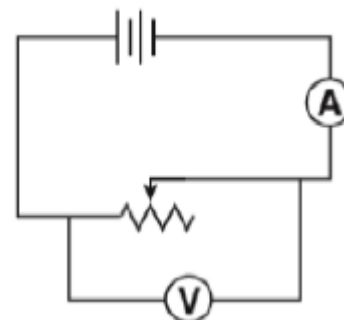
$$m_B = 4 m_A \text{ and } r_B = 4 r_A$$

The ratio of their orbital speeds, v_B/v_A is

- a. 1/4 b. 1/2 c. 1 d. 4

20. The circuit diagram below represents a battery, an ideal ammeter and an ideal voltmeter, and a variable resistor. What is the effect of moving the indicator to the right, thereby increasing the resistance?

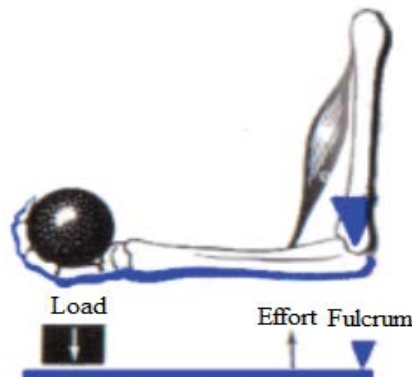
- a. voltmeter reading increases
 b. ammeter reading increases
 c. voltmeter reading decreases
 d. ammeter reading decreases



21. When holding a 0.16 kg billiard ball, your bicep muscle provides the effort and your elbow is the fulcrum of a third class lever, as shown. The horizontal distance from the center of the ball to your bicep is 27.0 cm and the horizontal distance from your elbow to your bicep is 3.00 cm.

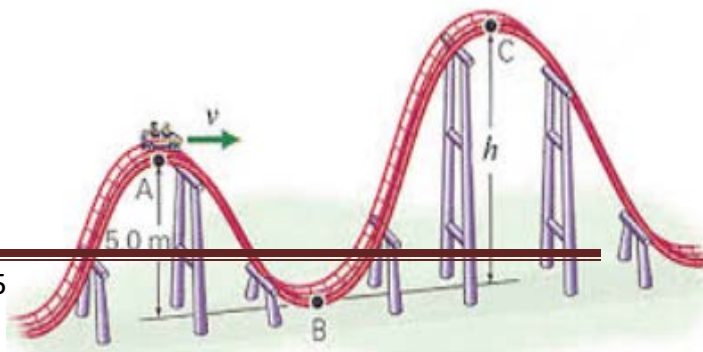
What vertical component of force must the bicep provide in order to hold your forearm parallel to the ground? (The forearm is considered to have zero mass.)

- a. 16.0 N
 b. 14.4 N
 c. 1.60 N
 d. 1.44 N



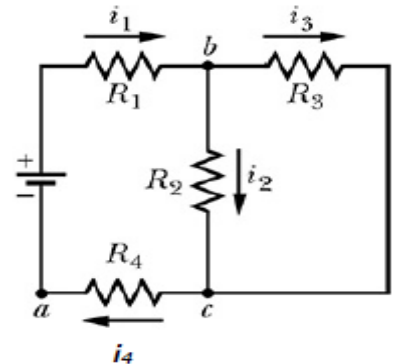
22. During a trip to Six Flags for Physics Day, a roller coaster just makes it over the hill at point C which is located 9.0 meters above the ground. Calculate the minimum speed at point A, which is at a height of 5.0 meters, in order to just make it over the hill at point C.

- a. 9.0 m/s
 b. 9.5 m/s
 c. 13.4 m/s
 d. 14.2 m/s



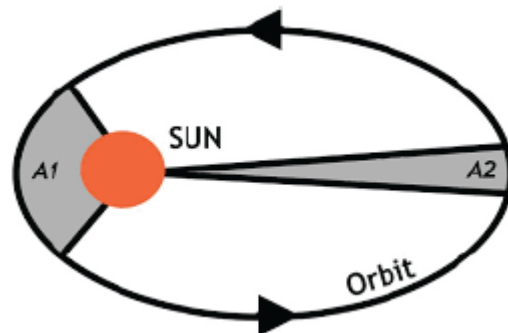
23. The circuit diagram to the right shows an ideal 10 V battery and four identical 20 Ohm resistors, establishing currents i_1 , i_2 , i_3 and i_4 . Resistor, R_3 , is now replaced by an ideal voltmeter. Identify from the table below the correct changes to the currents i_1 , i_2 , and i_4 .

| | i_1 | i_2 | i_4 |
|----|-----------|-----------|-----------|
| a. | decreases | increases | decreases |
| b. | increases | decreases | increases |
| c. | decreases | decreases | increases |
| d. | increases | increases | increases |



24. The diagram below represents the movement of a planet around the Sun. The area of A_1 is equal to the area of A_2 . Compared to the time required to sweep through A_1 , the time required to sweep through A_2 is _____ that of A_1 .

- a. less than
- b. greater than
- c. equal to
- d. Comparison cannot be determined without knowing distances to the Sun



25. A 50.0 kg swimmer, who is capable of swimming at 3.00 m/s in still water, attempts to cross a 60.0 meter wide river which is flowing at 2.00 m/s to the east. If the swimmer aims her body directly north, how far downstream will she land on the north shore of the river and how long will it take her?

- a. 30.0 m, 12.0 s
- b. 40.0 m, 12.0 s
- c. 50.0 m, 20.0 s
- d. 40.0 m, 20.0 s

PHYSICS FORMULAE High School Physics 2-19-2018

| <u>MECHANICS</u> | <u>ELECTRICITY AND MAGNETISM</u> |
|--|---|
| $\bar{v} = \frac{\Delta x}{\Delta t}$ $\bar{a} = \frac{\Delta v}{\Delta t}$ $v_f = v_i + at$ $\Delta x = v_i t + \frac{1}{2} at^2$ $2a\Delta x = v_f^2 - v_i^2$ $\Sigma F = ma$ $W = mg$ $F_g = G \frac{m_1 m_2}{r^2}$ $p = mv$ $F\Delta t = m\Delta v$ $\mu = \frac{F_f}{F_N}$ | $F_e = k \frac{q_1 q_2}{r^2}$ $E = \frac{F}{q}$ $V = \frac{W}{q} = Ed$ $I = \frac{\Delta q}{\Delta t}$ $V = IR$ $P = VI = I^2 R = \frac{V^2}{R}$ <p style="text-align: center;"><u>SERIES CIRCUIT</u></p> $I_T = I_1 = I_2 = I_3 = \dots$ $V_T = V_1 + V_2 + V_3 + \dots$ $R_T = R_1 + R_2 + R_3 + \dots$ <p style="text-align: center;"><u>PARALLEL CIRCUITS</u></p> $I_T = I_1 + I_2 + I_3 + \dots$ $V_T = V_1 = V_2 = V_3 = \dots$ $R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots}$ |
| Δx = displacement (change of position) \bar{v} = average velocity \bar{a} = average acceleration v_i = initial velocity v_f = final velocity F = force F_f = force of friction F_N = normal force F_g = gravitational force G = Universal Gravitational Constant p = momentum μ = coefficient of friction r = distance between center of masses W = weight | E = electric field intensity I = electric current k = electrostatic constant $k = \frac{9 \times 10^9 \text{ Nm}^2}{\text{C}^2}$ $G = 6.67 \times 10^{-11} \frac{\text{Nm}^2}{\text{kg}^2}$ P = Power q = charge R = resistance V = electric potential difference W = Work Fundamental particle electron $e^{-1} = -1.60 \times 10^{-19} \text{ C}$ e mass $9.11 \times 10^{-31} \text{ kg}$ |

| | | | |
|---|---|---|--|
| <p style="text-align: center;"><u>ENERGY</u></p> $W = F\Delta x$ $P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t} = Fv$ $PE_g = mgh$ $KE = \frac{1}{2} mv^2$ $F = -kx$ $PE_s = \frac{1}{2} kx^2$ | h = height k = spring constant KE = kinetic energy PE_g = gravitational potential energy PE_s = potential energy stored in a spring P = power W = work x = change in spring length from the equilibrium position | <p style="text-align: center;"><u>MOTION IN 2-D</u></p> $a_c = \frac{v^2}{r}$ $F_c = m \frac{v^2}{r}$ $1 \text{ rev} = 2\pi \text{ rad} = 360^\circ$ $\tau = r \times F$ $L = I\omega$ $KE = \frac{1}{2} I\omega^2$ | a_c = centripetal acceleration F_c = centripetal force τ = Torque L = Angular Momentum I = Moment of Inertia ω = angular velocity |
|---|---|---|--|

High School PHYSICS FORMULAE 2-19-2018

HEAT ENERGY

$$Q = mc\Delta T$$

$$Q = mL_f$$

$$Q = mL_v$$

$$\Delta L = \alpha L_o \Delta T$$

c = specific heat

L_f = latent heat of fusion

L_v = latent heat of vaporization

Q = amount of heat

ΔT = change in temperature

α = coefficient of linear expansion

L_o = original length

$$c_{water} = 4186 \frac{J}{kg^\circ K}$$

1 cal = 4.184 joules

WAVE PHENOMENA

$$T = \frac{1}{f}$$

$$v = f\lambda \text{ OR } = v\lambda$$

$$n = \frac{c}{v}$$

$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$\lambda = \frac{xd}{L}$$

$$n \lambda = d \sin \theta$$

$$\sin \theta_c = \frac{1}{n}$$

c = speed of light
in a vacuum =
 3×10^8 m/s

Speed of sound in air at 0°C =
331 m/s at 20°C 343 m/s

d = distance between slits

$f = \nu$ = frequency

L = distance from slit to screen

n = index of absolute refraction

T = period

v = speed

x = distance from central maximum to first-order maximum

λ = wavelength

θ = angle

θ_c = critical angle

relative to air

GEOMETRIC OPTICS

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

$$\frac{h_i}{h_o} = -\frac{d_i}{d_o} = m$$

f = focal length

d_i = image distance

d_o = object distance

h_o = object size

h_i = image size

m = magnification

ELECTROMAGNETIC

APPLICATIONS

$F = Bqv$

$$F = BIL$$

$$V = BLv$$

$$\frac{N_p}{N_s} = \frac{V_p}{V_s}$$

$$\frac{N_p}{N_s} = \frac{V_p}{V_s}$$

$$V_p I_p = V_s I_s \text{ (ideal)}$$

$$\text{efficiency} = \frac{V_s I_s}{V_p I_p}$$

B = magnetic field strength

I_p = current in primary

I_s = current in secondary

N_p = number of turns in primary coil

N_s = number of turns in secondary coil

V_p = voltage of primary

V_s = voltage of secondary

L = length of conductor

V = electric potential difference

High School PHYSICS: Ivory Exam Corrections

Date: April 12, 2018

High School PHYSICS -- For all Honors and college prep student.
25 multiple choice questions per exam.

This exam is NOT for any AP level students.

All schools and areas must finish the April exam and post mark or scan all results by April 30th.

| | | | | |
|----------------------|-------|-------|-------|-------|
| 1. B | 6. C | 11. D | 16. D | 21. A |
| 2. A All full credit | 7. D | 12. C | 17. A | 22. A |
| 3. B | 8. D | 13. A | 18. D | 23. A |
| 4. D | 9. C | 14. C | 19. B | 24. C |
| 5. C | 10. D | 15. C | 20. D | 25. D |

2018 HS Physics Topics of Study

JANUARY: scalars, vectors, kinematics, projectiles, mass, Newton's laws, forces (mechanical, gravitational, frictional, centripetal),

FEBRUARY: impulse, linear momentum and its conservation, elastic and inelastic collisions, work, potential and kinetic energy and conservation of energy, power, simple harmonic motion of the simple pendulum and mass-spring systems, plus January Topics

MARCH: electric charges, fields and force, Coulomb's law, voltage sources and resistances, series/parallel networks, magnetism, plus January and February Topics.

APRIL: wave propagation, standing waves, sound, optics: light, index of refraction, color, lenses, mirrors, interference phenomena, plus January, February, and March Topics.

Dates for 2018 Season

Thursday April 12, 2018

All schools and areas must finish the April exam and post mark or scan all results by April 30th.

New Jersey Science League

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phone # 908-213-8923 fax # 908-213-9391 email: newjssl@ptd.net

Web address: <http://entnet.com/~personal/njscil/html/>

What is to be mailed back to our office?

PLEASE RETURN THE AREA RECORD AND ALL TEAM MEMBER SCANTRONS
(ALL STUDENTS PLACING 1ST, 2ND, 3RD, AND 4TH).

If you return Scantrons of alternates, then label them as ALTERNATES.

Dates for 2019 Season

Thursday January 10, 2019 Thursday February 14, 2019

Thursday March 14, 2019 Thursday April 11, 2019