HIGH SCHOOL PHYSICS **IVORY**

JANUARY 14, 2016

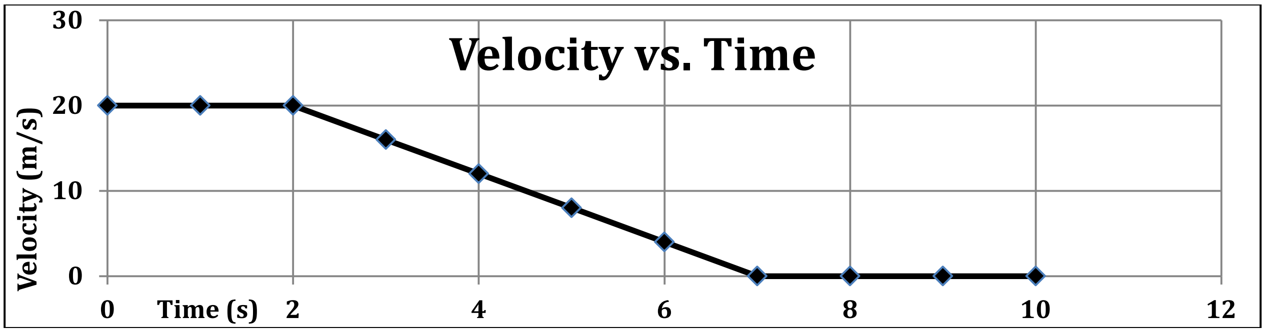
THIS TEST IS NOT FOR ANY AP PHYSICS STUDENTS (No Corrections)

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. Each of the 25 questions is worth 4 points.

Use: g =10. m/s^2 on Earth

Use the following to answer questions 1-4:

The driver of a 2000 kg car sees a barricade on the road ahead and comes to a stop. The velocity vs. time graph of the car is shown below.



1. The acceleration of the car is _______ during the first two seconds and is ____ during the interval 2-7 seconds.
A) 0 m/s^2, 4 m/s^2 B) 0 m/s^2, 5 m/s^2 C) 0 m/s^2 , -4 m/s^2 D) 0 m/s^2 , -5 m/s^2
E) 20 m/s^2, 10 m/s^2

2. The average velocity of the car during the interval 0 -7 seconds is
A) 10.0 m/s B) 7.10 m/s C) 12.9 m/s D) 14.3 m/s E) 20.0 m/s

3. The distance traveled by the car during the deceleration period is
A) 40 m B) 50 m C) 90 m D) 100 m E) 140 m

4. The net work done on the car during the deceleration period is
A) 4.0×10^4 J B) 4.0×10^5 J C) -4.0×10^4 J D) -4.0×10^5 J
E) Not enough information is provided

5. A series of experiments are performed on a manned trip to the asteroid, SCIL0116. An astronaut kicks a soccer ball at an angle of 30.0 degrees and it lands 1.25 seconds later a horizontal distance of 25 meters away. The acceleration due to gravity on the asteroid is. ____.
A) 11.5 m/s^2 B) 15.0 m/s^2 C) 18.5 m/s^2 D) 20.0 m/s^2 E) 25.0 m/s^2

6. A bird flies 2.0 m North, 4.0 m West and 5.0 m South in 2.5 seconds. Its average velocity is _______.
A) 4.4 m/s Southwest B) 4.4 m/s 37° S of W C) 4.4 m/s 53° S of W
D) 2.0 m/s 53° S of W E) 2.0 m/s 37° S of W

7. An arrow is projected vertically upward at 35.0 m/s. How much later is the arrow moving at half its initial velocity?
A) 1.75 s B) 3.50 s C) 1.75 s and 5.25 s D) 5.25 s E) 3.50 s and 7.00 s

8. The density of a particular cylindrical piece of wood is 1.15 g/cm^3 . Its dimensions are given as: diameter = 0.100 m, height = 0.200 m. The mass of the cylinder is _______.
A) 6.28 kg B) 7.22 kg C) 1.81 kg D) 1.57 kg E) 1.37 kg

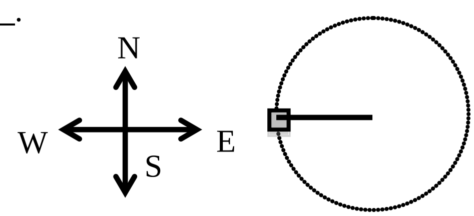
9. A 2.00 kg box on a horizontal frictionless surface is accelerated by the following constant forces: 10.0 N straight down, 10.0 N at an angle of 60.0 degrees above the horizontal. The magnitude of the net force acting on the block is
A) 5.00 N B) 10.0 N C) 14.1 N D) 20.0 N E) 21.9 N

10. A constant force of 10.0 N at an angle of 60.0 degrees above the horizontal is applied to a 2.00 kg box, initially at rest on a horizontal surface. The coefficient of static friction between the surfaces is 0.600 and the coefficient of kinetic friction is 0.200 . The horizontal acceleration of the block is _________.
A) 5.00 m/s^2 B) 2.50 m/s^2 C) 2.00 m/s^2 D) 1.37 m/s^2 E) 0 m/s^2

Use the following to answer questions 11-13:
A constant magnitude centripetal force of 5.40 Newtons is applied to a 20.0 gram rubber stopper. The stopper moves in a horizontal circle of radius 30.0 cm.
11. The speed of the stopper is __________.
A) 0.600 m/s B) 2.85 m/s C) 8.10 m/s D) 9.00 m/s E) 81.0 m/s

12. If the radius of the circle were to be halved without changing the centripetal force, what would happen to the speed of the stopper?
A) speed quadruples B) speed doubles C) speed is halved
D) speed is one-fourth original speed E) speed is 0.707 times original speed

13. If the centripetal force was removed at the instant the stopper is in the position shown, as it is moving counterclockwise, the stopper will fly off to the ___________.



A) north B) south C) east D) west

E) none of the above

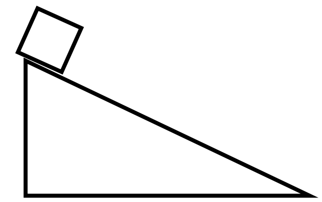
Use the following to answer questions 14-16:
A clumsy juggler throws a ball straight up at a velocity of 10.0 m/s from a height of 1.10 meters above the ground.
14. What is the ball's maximum height above the ground?
A) 1.10 m B) 1.60 m C) 5.00 m D) 6.10 m E) 6.60 m

15. How long is the ball in the air?
A) 0.117 s B) 1.00 s C) 1.88 s D) 2.10 s E) 2.22 s

16. At the top of the ball's trajectory, the magnitude of the velocity of the ball is ______ and the magnitude of its acceleration is ______.
A) 0 m/s, 0 m/s^2 B) 10.0 m/s, 0 m/s^2 C) 0 m/s, 10.0 m/s^2
D) 10.0 m/s, 10.0 m/s^2 E) none of these choices

17. A golf ball is struck at an angle of 35 degrees above the horizontal and strikes the ground 45 meters away horizontally. If the ball were to be struck at the same angle with twice the initial speed, it would strike the ground ______ away.
A) 45 m B) 90. m C) 130 m D) 180 m E) not enough information

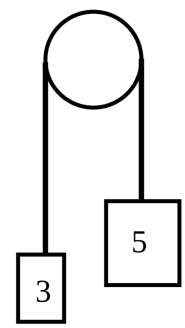
Use the following to answer questions 18-19:
A 2.00 kg block is observed to slide from rest down a rough plane with an acceleration of 3.40 m/s^2. The incline has a length of 2.00 meters and the plane is inclined at 25.0 degrees.



18. The coefficient of kinetic friction between the block and the plane is _____.
A) 0.0825 B) 0.0912 C) 0.279 D) 0.624 E) 0.729

19. The kinetic energy of the block at the bottom of the plane is ______.
A) 8.45 J B) 13.6 J C) 15.1 J D) 16.9 J E) 21.9 G

20. An Atwood's machine is shown with m_1=3.00 kg and m_2 = 5.00 kg.



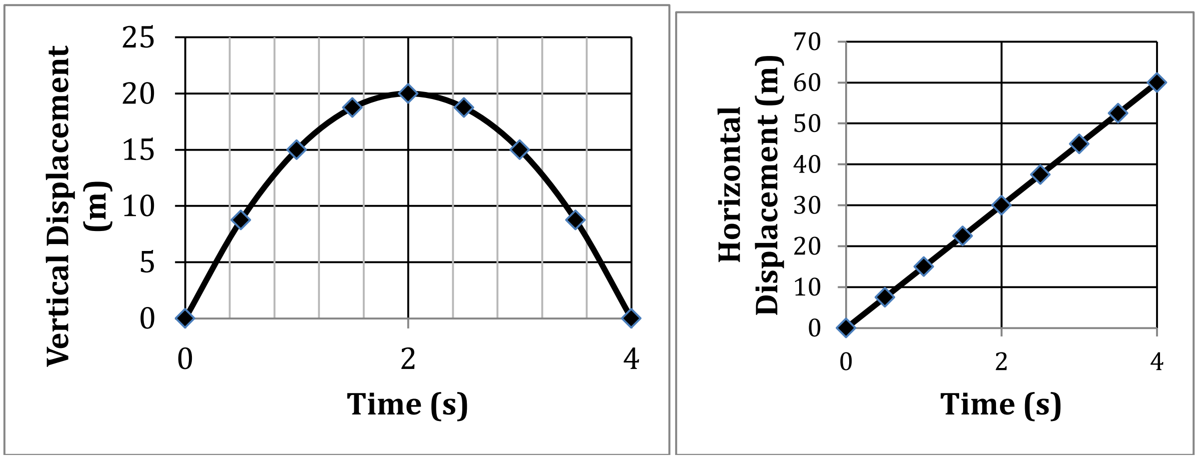
If the masses are released from rest when the 5.00 kg block is 1.20 meters above the ground, with what speed does the 5.00 kg mass strike the ground?

A) 2.45 m/s B) 4.00 m/s C) 5.00 m/s
D) 5.47 m/s E) 6.00 m/s

21. The distance between two traffic lights is 185 meters. A 2000 kg car is waiting at the first red light when the light turns green. The car undergoes uniform acceleration of 3.00 m/s^2 for 4.00 seconds and travels at constant velocity for 9.00 seconds. The driver now observes that the next light turns red. Assuming a reaction time of 0.750 seconds and a maximum deceleration of -2.00 m/s^2. Which of these statements is false?
A) The total time the car is in motion is 19.75 seconds
B) The total distance traveled by the car is 168 meters
C) The car travels 36.0 meters while decelerating
D) The maximum speed of the car is 12.0 m/s
E) The car is able to stop in time

22. Joe (70 kg) and Jane (60 kg) are racing up the 3.75 m high staircase at their high school. Jane runs up in 2.50 seconds. Joe runs up in 3.00 seconds. Which statement is true?
A) Joe and Jane do the same amount of work and Joe generates more power than Jane
B) Joe and Jane do the same amount of work and Jane generates more power than Joe
C) Joe does more work than Jane and Joe generates more power than Jane
D) Joe does more work than Jane and Jane generates more power than Joe
E) Joe does more work than Jane and Joe and Jane generate the same power

23. A golf ball is hit. These graphs show the motion of the ball.



The magnitude of the initial velocity of the ball is _______.

A) 15 m/s B) 20. m/s C) 25 m/s D) 35 m/s E) cannot be determined

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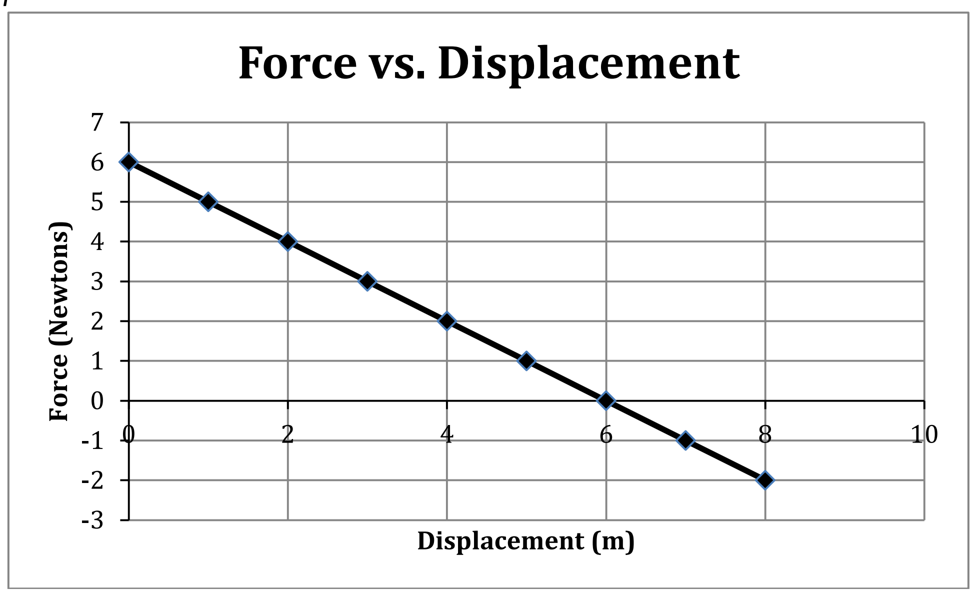
Use the following to answer questions 24-25:

A 40.0 kg shopping cart, initially rolling at 4.00 m/s horizontally encounters the net horizontal force shown below.



24. The work done on the cart by the force is _______.

A) -20.0 J B) -16.0 J C) 16.0 J D) 20.0 J E) 32.0 J

25. Which of the following is a **true** statement for the 8.0 m displacement?

A) The cart keeps moving faster and faster

B) The cart speeds up and then slows down, stops and reverses direction

C) The cart speeds up and then slows down and final velocity is less than 4.00 m/s

D) The cart speeds up and then slows down and final velocity is more than 4.00 m/s

E) None of these statements are true

HS PHYSICS Answer Key IVORY EXAM
Date: Thursday Jan 14, 2016 (No Corrections)

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

High School PHYSICS For all Honors and college prep student. (No AP level students). 25 multiple choice questions per exam.

JANUARY: scalars, vectors, kinematics, projectiles, mass, density, Newton's laws, forces (mechanical, gravitational, frictional, centripetal), work, energy (potential, kinetic), and its conservation, power.

FEBRUARY: impulse, linear momentum and its conservation, elastic and inelastic collisions, angular measure and motion, the concept of angular momentum and its conservation, torques, simple machines, plus all previous topics

MARCH: temperature and heat, thermal equilibrium, linear expansion and contraction, specific heat, calorimetry, modes of energy transfer, thermodynamic and ideal gas laws, simple harmonic motion, wave propagation, standing waves, sound, plus all previous topics

APRIL: electrical charges, fields and force, coulombs law, voltage sources and resistances, series/parallel networks, electricity and magnetism, light, index of refraction, color, optics, lenses, mirrors, interference phenomena, plus all previous topics

Dates for 2016 Season

Thursday January 14, 2016 Thursday February 11, 2016
Thursday March 10, 2016 Thursday April 14, 2016
***The April 2016 exam can be changed based upon the Schools spring break.**
The April exam must be completed by April 29th. No area may take the April exam during the first week of April or the first week of May

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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 2017 Season

Thursday January 12, 2017 Thursday February 9, 2017
Thursday March 9, 2017 Thursday April 13, 2017

High School PHYSICS <u>**Color is Ivory**</u>

FEBRUARY 11, 2016

<u>**This exam is not for any AP level students**</u>. (No Corrections)

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. Each of the 25 questions is worth 4 points. ***Use: g =10. m/s²***

Note: All axes of rotation are taken to be at the center of mass (and perpendicular to the plane of the disks)

Moment of Inertia of a *solid disk*: $\frac{1}{2}MR^2$ Moment of Inertia of a *hollow disk* (hoop or ring): MR^2

Moment of Inertia of a *solid sphere*: $\frac{2}{5}MR^2$ Moment of Inertia of a *hollow sphere*: $\frac{2}{3}MR^2$

1. A 2.00 gram bullet leaves an initially stationary 1.00 kg pistol at 800. m/s. Which of the following statements is correct immediately after the bullet leaves the pistol? The pistol is free to move.

(A) The kinetic energy of the system is 0, but the momentum of the bullet/pistol system is non-zero
(B) The kinetic energy of the system is non-zero, but the momentum of the bullet/pistol system is 0
(C) The kinetic energy of the system is 0, and the momentum of the bullet/pistol system is 0
(D) The kinetic energy of the system is non-zero, and the momentum of the bullet/pistol system is non-zero

2. Superman experiences a spray of 0.10 kg bullets striking his body at 1000 bullets per minute at an initial velocity of 500 m/s. Calculate the force on Superman if the bullets ricochet off at 300 m/s.

(A) 333 N (B) 1333 N (C) 19,980 N (D) 80,000 N

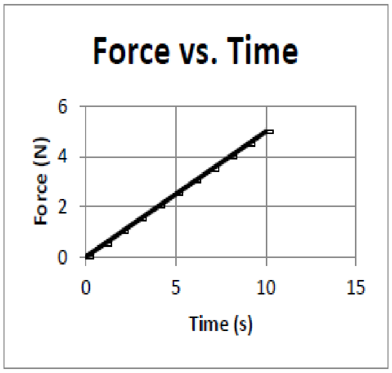
3. An object experiences a force as represented in the accompanying graphs of force vs. time and force vs. displacement. Which of the following statements is correct?

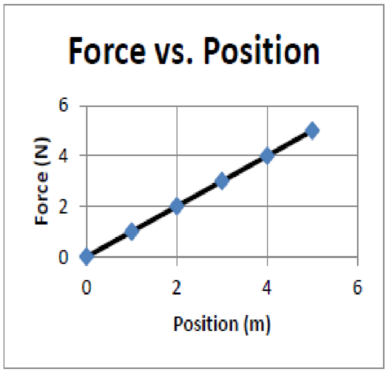
(A) Net work on object = 25.0 J and Impulse on object = 12.5 Ns

(B) Net work on object = 12.5 J and Impulse on object = 25.0 Ns

(C) Net work on object = 50.0 J and Impulse on object = 25.0 Ns

(D) Net work on object = 25.0 J and Impulse on object = 50.0 Ns





4. After a completely inelastic collision between two identical spheres, each having an initial speed v, the two spheres move off with a final speed of v/5. What is the angle between their initial directions?

(A) 23.1 degrees (B) 78.5 degrees (C) 84.3 degrees (D) 157 degrees

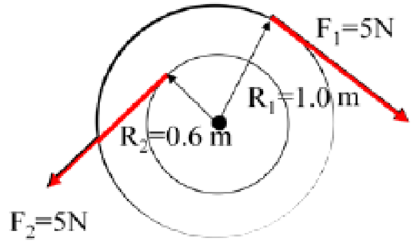
5. A spaceship of mass m orbits a planet of mass M at speed v and an orbital distance of R (as measured from the center of the planet). If the captain of the spaceship wants to orbit at an orbital distance of 1.5 R, the new orbital speed would be:
(A) 1.5 v (B) 0.667 v (C) 1.22 v (D) 0.816 v

6. A child has one-fourth the mass of her dad. However, the dad has twice the momentum of the child. What is the ratio of their Kinetic Energies (KE_{dad}/KE_{child})

(A) 1:4 (B) 4:1 (C) 2:1 (D) 1:1

7. Calculate the net torque on the compound cylindrical object due to the forces caused by strings wrapped around the circumference of the disks.

(A) 2.0 Nm clockwise
(B) 8.0 Nm clockwise
(C) 2.0 Nm counterclockwise
(D) 8.0 Nm counterclockwise



8. A merry-go-round of mass M, radius R and rotational inertia I, is initially rotating counterclockwise at angular speed ω as seen from above. What force must be provided at the circumference of the ride in order to stop the merry-go-round in 5 complete rotations?

(A) $\dfrac{I\omega}{20\pi R}$ (B) $\dfrac{I\omega}{20\pi}$

(C) $\dfrac{I\omega^2}{20\pi R}$ (D) $\dfrac{I\omega^2}{20\pi}$

9. A disk, a ring and a solid sphere, each with mass M and radius R, are rolling at the same speed v along the horizontal ground until they reach an incline. They roll up the incline without slipping and come momentarily to a stop. Which statement is correct?

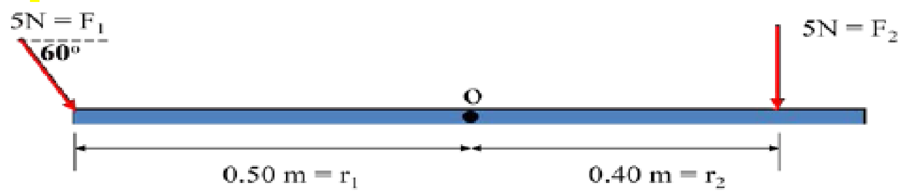
(A) The initial kinetic energy of each is the same, therefore, $h_{disk} = h_{ring} = h_{sphere}$
(B) The maximum heights are ranked as follows: $h_{disk} > h_{ring} > h_{sphere}$
(C) The maximum heights are ranked as follows: $h_{ring} > h_{disk} > h_{sphere}$
(D) The maximum heights are ranked as follows: $h_{sphere} > h_{disk} > h_{ring}$

10. An ideal spring is attached at one end to a wall and the other end to a mass ***M***. The mass is set into oscillation along the frictionless floor by pulling it to the right a distance ***A***. As the mass passes through the equilibrium position, the mass attains maximum velocity $\boldsymbol{v_{max}}$. At any time, the displacement of the mass from equilibrium is x. At what location(s) does the oscillator have equal kinetic and potential energies?

(A) x = 0 (B) x = ± A (C) x = ± 0.5 A (D) x = ± 0.707 A

11. Calculate the magnitude of the net torque on the uniform rod about point O, located at the center of mass of the rod.

(A) 0.165 Nm
(B) 0.75 Nm
(C) 4.165 Nm
(D) 4.75 Nm

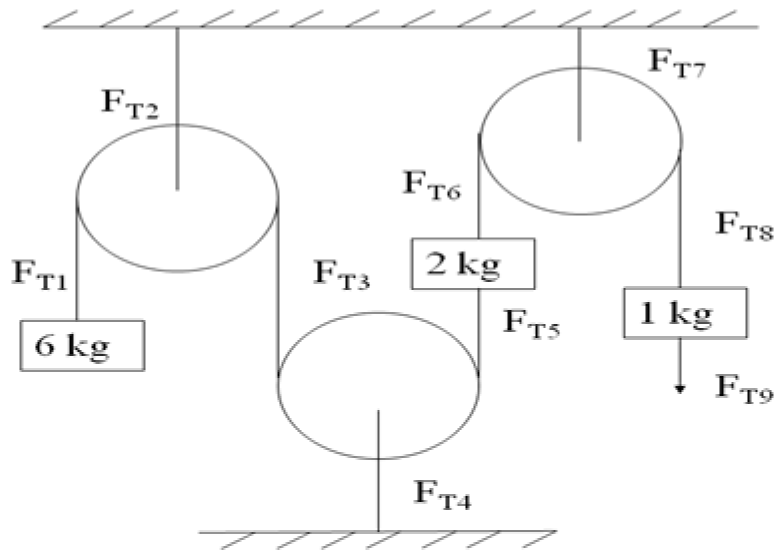


12. A new planet, with a mass that is twice the Earth's mass, is discovered orbiting the Sun at an average orbital distance that is 64 times the Earth's orbital radius. What is the orbital period of the new planet in Earth years?

(A) 512 years (B) 724 years (C) 1024 years (D) 4096 years

13. What force must be provided at F_{T9} if the pulley system is in equilibrium? Note: All pulleys are "massless" and frictionless.

(A) 60 N
(B) 70 N
(C) 80 N
(D) 90 N



14. When the Egyptians were building the pyramids, they used an elaborate series of ramps to lift the large blocks of stone up to where they were needed. If a 1500 kg block was needed at a height of 100 m above the ground and the workers could only exert a force of 200 N on the block, how long of an inclined plane would the Egyptians need to lift the block into place? Assume all ramps are frictionless.

(A) 750 m (B) 1500 m (C) 7500 m (D) 15000 m

15. An ice skater performs a spin with her arms extended. She then pulls her arms in. Which of the following statements regarding her kinetic energy and angular momentum are true?

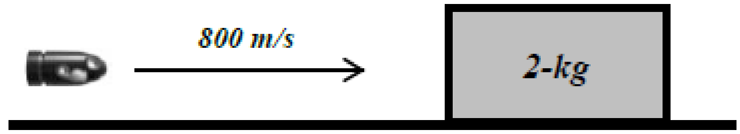
	Kinetic Energy	***Angular Momentum***
(A)	Remains Constant	Remains Constant
(B)	Increases	Increases
(C)	Increases	Remains Constant
(D)	Decreases	Remains Constant

16. Our sun makes one revolution every 27 days. If the sun were to collapse into a neutron star of radius 20 km (about the length of Manhattan Island), what would be its new angular speed? (M_{sun}= 1.99 x 10^{30} kg, R_{sun}= 6.98 x10^{8} meters, however effectively 98% of the sun's mass is confined to only 20% of its radius. Therefore, use effective R_{sun} = 0.20(6.98 x10^{8} m))

(A) 4.87x10^{7} rad/s (B) 1.72x10^{4} rad/s (C) 6.98x10^{3} rad/s (D) 1.31x10^{2} rad/s

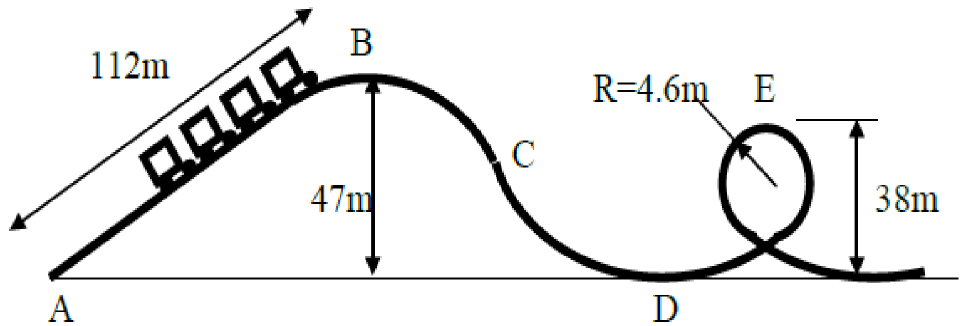
17. A 2.00 gram bullet initially moving at 800 m/s strikes and penetrates a 2.00 kg wooden block initially at rest on a rough surface. Immediately after the bullet exits the block, the bullet travels at 200.0 m/s and the block travels at 0.50 m/s. How much work is done by friction?

(A) – 40.25 J
(B) 680 J
(C) 600 J
(D) – 600 J



18. Take a ride on a roller coaster with a 60.0 kg physics student. The coaster starts from rest at location B. Calculate the magnitude force of the coaster seat on the student when the student is upside down and located at E. The distance AB is the length of 112 meters.

(A) 2340 N
(B) 2160 N
(C) 1740 N
(D) 13.4 N



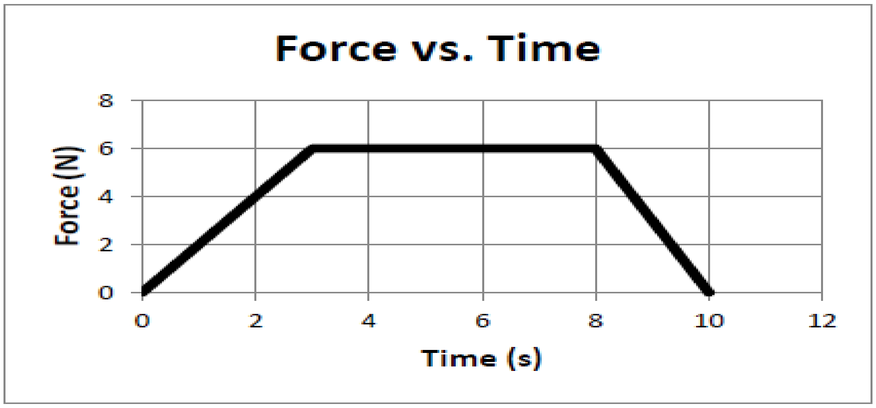
19. Imagine a ballistic pendulum system containing a bullet of mass m_1 with an initial velocity v. The mass of the pendulum bob is m_2. The bullet becomes imbedded in the bob, and the bullet and bob rise to height h (where h < length of pendulum's string). What is the expression for the initial velocity of the bullet in terms of m_1, m_2, h and any constants that are necessary (like g)?

(A) $\frac{m_1 + m_2}{m_1}\sqrt{2gh}$ (B) $\left(\frac{m_1 + m_2}{m_1}\right)2gh$ (C) $\frac{m_1 + m_2}{m_2}\sqrt{2gh}$ (D) $\left(\frac{m_1 + m_2}{m_2}\right)2gh$

20. An asteroid is discovered with a mass that is one-tenth the mass of Earth and a radius that is one-hundredth the radius of Earth. What is the acceleration due to gravity on the surface of the asteroid as a function of **g** at Earth's surface?

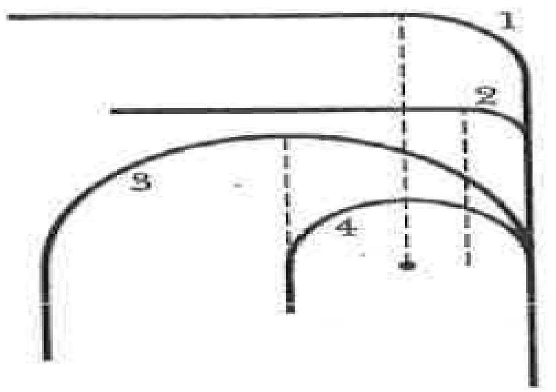
(A) 1 **g** (B) 10 **g** (C) 100 **g** (D) 1000 **g**

21. A 10.0 kg shopping cart, initially moving at 2.0 m/s, experiences the force described in the graph below. What is the final velocity of the cart?



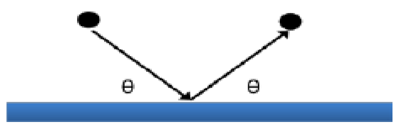
(A) 2.5 m/s
(B) 4.5 m/s
(C) 6.5 m/s
(D) 25 m/s

22. The figure below shows four tracks (either half-circles or quarter-circles) that can be taken by a train moving at constant speed. Rank the tracks according to the magnitude of the acceleration of the train on the curved portion, greatest first.



(A) $a_2 > a_1 > a_4 > a_3$
(B) $a_3 > a_4 > a_1 > a_2$
(C) $a_3 > a_4 = a_1 > a_2$
(D) $a_2 > a_1 = a_4 > a_3$

23. As shown in the overhead view, a 200 gram ball with a speed of 6.0 m/s strikes a wall at θ = 37 degrees and then rebounds with the same speed and angle. It is in contact with the wall for 10.0 ms. Calculate the magnitude of the average force on the ball from the wall.



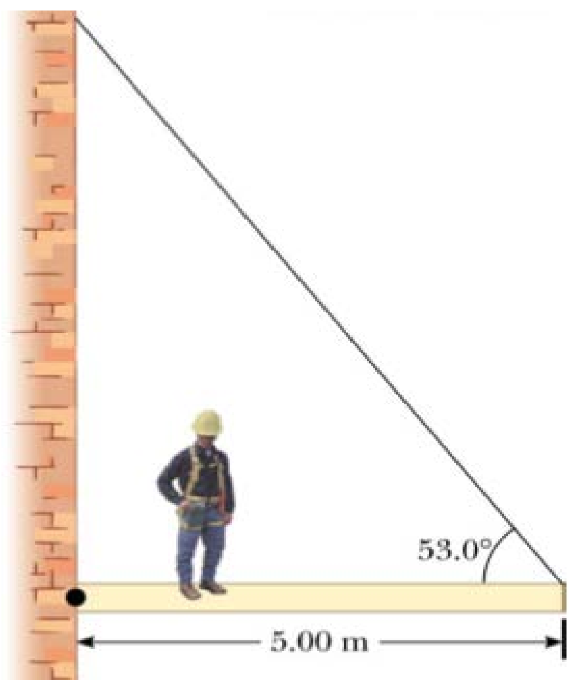
(A) 2.4 N
(B) 4.8 N
(C) 144 N
(D) 191 N

24. Tarzan plans to cross a gorge by swinging from a hanging vine. Tarzan's mass is 85.0 kg and the "massless" vine is 4.80 meters long. If the maximum tension in the rope (and Tarzan's arms) is 1400 N, what is Tarzan's maximum speed?

(A) 5.57 m/s (B) 8.89 m/s
(C) 31 m/s (D) 79 m/s

25. A 600 N man stands 1.50 m from the left end of a 300 N, 5.00 meter long uniform beam, as shown. The supporting cable makes an angle of 53 degrees with the beam. Calculate the magnitude of the tension force.

(A) 900 N
(B) 1050 N
(C) 413 N
(D) 180 N



High School PHYSICS: **Ivory Exam**

FEBRUARY 11, 2016

This exam is not for any AP level students. (NO Corrections)

SOLUTIONS

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

High School PHYSICS For all Honors and college prep student. (No AP level students). 25 multiple choice questions per exam.

JANUARY: scalars, vectors, kinematics, projectiles, mass, density, Newton's laws, forces (mechanical, gravitational, frictional, centripetal), work, energy (potential, kinetic), and its conservation, power.

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MARCH: temperature and heat, thermal equilibrium, linear expansion and contraction, specific heat, calorimetry, modes of energy transfer, thermodynamic and ideal gas laws, simple harmonic motion, wave propagation, standing waves, sound, plus all previous topics

APRIL: electrical charges, fields and force, coulombs law, voltage sources and resistances, series/parallel networks, electricity and magnetism, light, index of refraction, color, optics, lenses, mirrors, interference phenomena, plus all previous topics

Dates for 2016 Season

Thursday February 11, 2016

Thursday March 10, 2016 Thursday April 14, 2016

***The April 2016 exam can be changed based upon the Schools spring break.**

The April exam must be completed by April 29th. No area may take the April exam during the first week of April or the first week of May

New Jersey Science League

PO Box 65 Stewartsville, NJ 08886-0065

phone # 908-213-8923 fax # 908-213-9391 email: **newjsl@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).

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Dates for 2017 Season

Thursday January 12, 2017 Thursday February 9, 2017

Thursday March 9, 2017 Thursday April 13, 2017

HIGH SCHOOL PHYSICS IVORY test

March 10, 2016

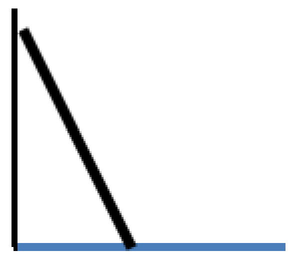
This exam is not for any AP level students. (No Corrections)

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. Each of the 25 questions is worth 4 points.

Use: g =10. m/s^2.

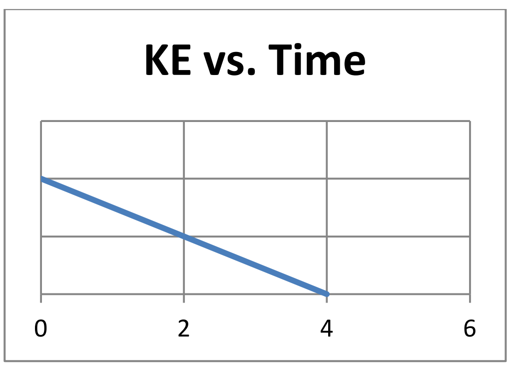
1. A ladder has a mass of 60 kg and is 2.0 m long. As shown in the diagram below, the ladder is stable as it leans against a frictionless wall. The bottom end of the ladder is 1.0 m from the base of the wall. Rank the following Forces from greatest to least:

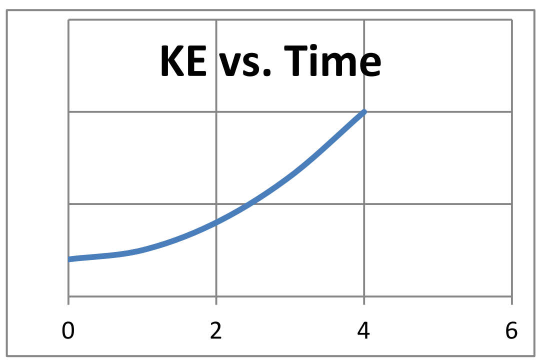
$F_{gravity}$= weight of ladder
F_{wall}=normal force of wall on the ladder
F_{floor}=normal force of floor on the ladder
$F_{friction}$=friction force of floor on ladder

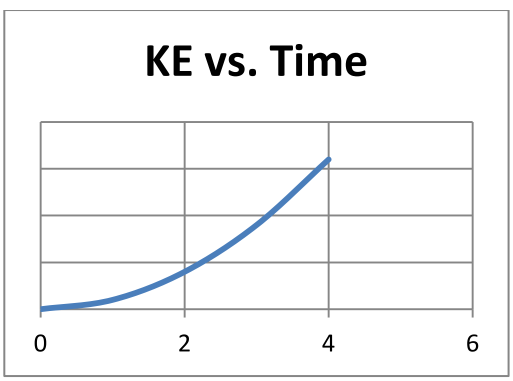


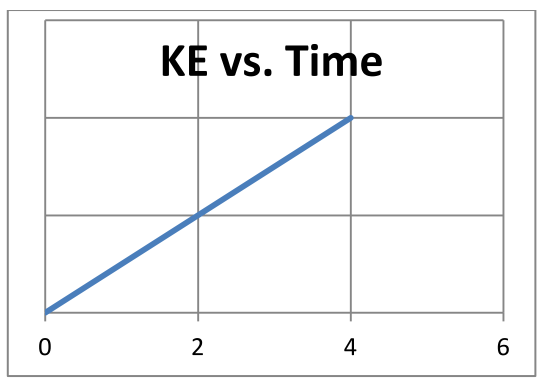
(A) $F_{gravity} > F_{floor} > F_{wall} > F_{friction}$
(B) $(F_{gravity} = F_{floor}) > (F_{wall} = F_{friction})$
(C) $F_{gravity} > (F_{friction} = F_{floor}) > F_{wall}$
(D) $(F_{gravity} = F_{friction}) > (F_{floor} = F_{wall})$

2. Which one of the following graphs represents the Kinetic Energy vs. Time for an object thrown horizontally from the top of a building?

(A) 

(B) 

(C) 

(D) 

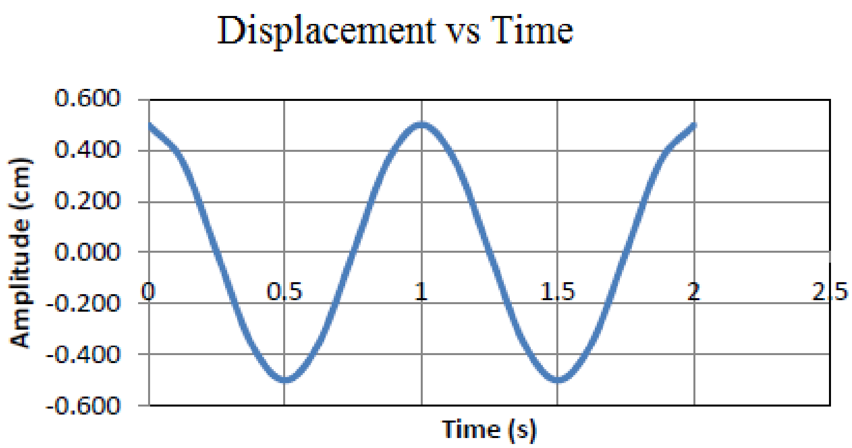
3. As Earth orbits closer to the Sun, the gravitational potential energy of the Earth-Sun system is

(A) greater, because the Earth and Sun are closer together and gravitational forces are greater

(B) greater, because the speed of the Earth is greater and both potential energy and kinetic energy increase
(C) less, because kinetic energy is greater and the sum of potential energy plus kinetic energy is constant
(D) less, because the Earth and Sun are closer together and both potential energy and kinetic energy decrease

Questions # 4 and 5 use the graph of Displacement vs Time for a simple harmonic oscillator.
4. At which of the following times is spring's potential energy **maximum**?

(A) 0.25 s
(B) 0.50 s
(C) 0.75 s
(D) 1.25 s



5. At which of the following times does kinetic energy of the system equal spring potential energy of the system?

(A) 0.125 s (B) 0.25 s (C) 0.500 s (D) none of the given times

6. A small metal cube with a temperature of 300 K is placed in contact with a much larger cube of the same metal with a temperature of 282 K. Assume no loss of energy to the environment around the cubes. Which of the following statements is **true**?

(A) The smaller cube will undergo a greater change in temperature than the larger cube
(B) After a long time, the temperature of both cubes will be 286 K
(C) The smaller cube will contain more internal energy than the larger cube after the cubes reach equilibrium
(D) The smaller cube will transfer more energy to the larger cube than the larger cube transfers to the smaller

7. An engine receives 500 J from a heat reservoir at 400 K and rejects 400 J to a cold reservoir at 200 K. The actual efficiency and the theoretical maximum Carnot efficiency for this engine are:

	Actual Efficiency	Theoretical Maximum Carnot Efficiency
(A)	20%	20%
(B)	50%	50%
(C)	50%	20%
(D)	20%	50%

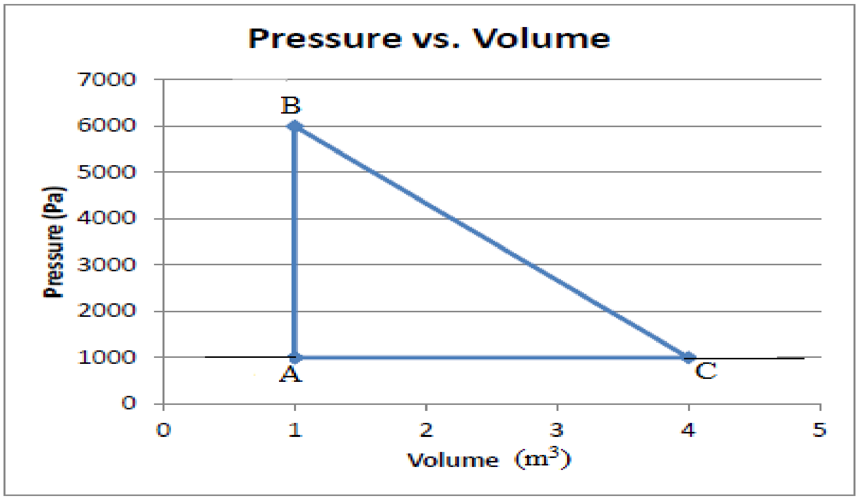
8. A system of ideal gas molecules contains 2.0 moles of gas. Ninety Joules of work is done on the gas compressing it. During this time, the gas gives off 35 J of energy. With no heat entering or leaving the system the gas is allowed to expand, doing 50 J of work on its surroundings. The net change in internal energy of the gas is _____.

(A) 2.5 J (B) 5.0 J (C) 75 J (D) 105 J

9. Assuming that the state of matter does not change, which of these quantities does **not** normally increase with an increase in **temperature**?
(A) Length of a metal bridge
(B) The speed of sound in air
(C) The density of a gas in a steel container
(D) The pressure of a gas at constant volume

10. The thermodynamics cycle for one mole of an ideal gas is described by the graph below. Determine the net heat(J) flowing into the system during one complete cycle, A-B-C.

(A) 1000 J
(B) 4000 J
(C) 6000 J
(D) 7500 J



11. A simple pendulum oscillates with a period of T seconds. The length of the pendulum is doubled and the mass attached to the pendulum string is halved. What is the new period of the pendulum?

(A) 2 T (B) 1.414 T (C) T (D) 0.707 T

12. A simple pendulum oscillates with a period of T seconds. The length of the pendulum is doubled and the pendulum is taken to a planet where the acceleration due to gravity is ½ of what it is on Earth. What is the new period of the pendulum?

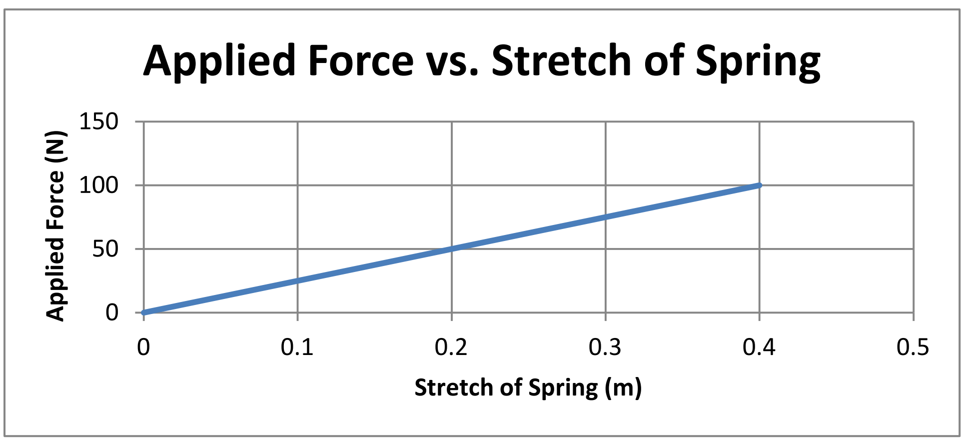
(A) 2 T (B) 1.414 T (C) T (D) 0.707 T

13. A mass hangs from a spring and is set into vertical motion. Which statement is true when the mass is at its lowest position?

(A) The mass's velocity is zero and acceleration is zero
(B) The mass's velocity is zero and distance from equilibrium is zero
(C) The mass's acceleration is zero and distance from equilibrium is maximum
(D) The mass's velocity is zero and distance from equilibrium is maximum

For Questions 14 and 15 use the graph of Applied force (N) vs Stretch of Spring (m)
14. How much work is done on the spring by the applied force in extending the spring from equilibrium
to 0.2 meters?

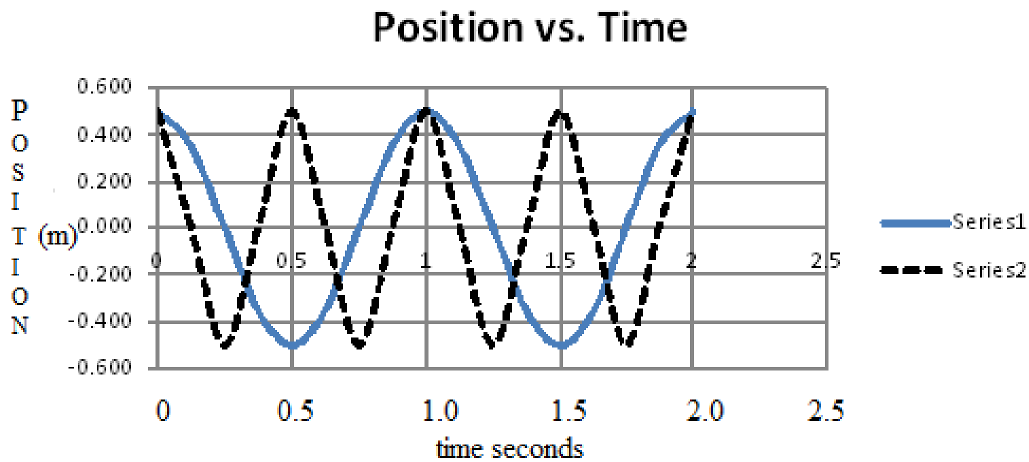
(A) 100 J
(B) 50. J
(C) 10. J
(D) 5.0 J



15. What is the force constant for this spring?
(A) 400 N/m (B) 250 N/m (C) 100 N/m (D) 40 N/m

16. A speaker is emitting a sound and the sound detected by the receiver is I. The speaker is now moved twice as far from the receiver, but the volume is turned up so that the power of the source is doubled. What is the ratio of the new intensity to the original intensity, I?
(A) 4:1 (B) 2:1 (C) 1:1 (D) 1:2

17. The graph illustrates Position vs. Time for two waves. The solid line is wave 1 and the dashed line is wave 2. Which of the following correctly compares the two waves in the graph?



(A) The frequency of wave 1 is greater than that of wave 2
(B) Wave 1 has greater amplitude than wave 2
(C) The two waves undergo constructive interference at about 0.5 seconds
(D) The period of wave 1 is greater than that of wave 2

18. When you blow across one end of a thin tube open at both ends, a musical note is created. If the length of the tube is L and the speed of sound that day is v, what is the fundamental frequency of the note?

(A) v/L (B) v/2L (C) v/4L (D) 4L/v

19. A sound wave travels in air from a region of higher temperature to a region of lower temperature. Which of the following is the best explanation for what happens to the wave?

(A) Sound travels faster in the lower temperature air, causing diffraction of the wave
(B) Sound travels faster in the lower temperature air, causing refraction of the wave
(C) Sound travels faster in the higher temperature air, causing diffraction of the wave
(D) Sound travels faster in the higher temperature air, causing refraction of the wave

20. You are driving northbound on the NJ Turnpike at 30 m/s while an ambulance with a siren emits a constant frequency of 1000 Hz. Under which of the following situations will you hear the highest frequency?

(A) The ambulance is south of you and moving northbound at 40 m/s
(B) The ambulance is north of you and moving northbound at 40 m/s
(C) The ambulance is south of you and moving southbound at 40 m/s
(D) The ambulance is north of you and moving southbound at 40 m/s

21. A ball floats 90% below the surface when placed in water and 75% below the surface when placed in an unknown liquid. If the density of water is 1000 kg/m^3, calculate the density of the unknown liquid.

(A) 675 kg/m^3 (B) 833 kg/m^3 (C) 1200 kg/m^3 (D) 1333 kg/m^3

22. A ping pong ball is dropped from the top of a building. It will reach terminal velocity when

(A) the final velocity of the ball is zero
(B) the net force on the ball is maximum
(C) the net force on the ball is zero
(D) air drag on the ball is greater than the weight of the ball

Some of the physical properties of substance X are below. Use them with question #23.

Melting Point	0 °C	**Heat of Fusion, H_f**	6.30×10^4 J/kg
Boiling Point	100 °C	**Heat of Vaporization, H_v**	8.78×10^5 J/kg

Specific Heats of Substance X

Form	**J/(kgK)**
Solid	2900
Liquid	4500
Gaseous	1500

23. What is the amount of heat necessary to vaporize 100 grams of liquid X at its boiling point?

(A) 8.78×10^4 J
(B) 8.78×10^7 J
(C) 6.30×10^3 J
(D) 6.30×10^6 J

24. The heat necessary to raise 100 grams of gaseous X from its boiling point to 130 degrees C

(A) 4,500 J
(B) 4,500,000 J
(C) 900,000 J
(D) 900 J

25. During a Mythbusters episode, a lead bullet is fired horizontally into an iron plate at initial speed v. The bullet deforms and stops. As a result, its temperature increases by an amount ΔT. If an identical bullet were to strike the iron plate with twice the original initial speed, the increase in temperature would be approximately

(A) 1.0 ΔT (B) 1.414 ΔT (C) 2 ΔT (D) 4 ΔT

HIGH SCHOOL PHYSICS: IVORY test

March 10, 2016

This exam is not for any AP level students.

SOLUTIONS

Record on the area record the % correct (No Corrections)

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

High School PHYSICS For all Honors and college prep student. (No AP level students). 25 multiple choice questions per exam.

JANUARY: scalars, vectors, kinematics, projectiles, mass, density, Newton's laws, forces (mechanical, gravitational, frictional, centripetal), work, energy (potential, kinetic), and its conservation, power.

FEBRUARY: impulse, linear momentum and its conservation, elastic and inelastic collisions, angular measure and motion, the concept of angular momentum and its conservation, torques, simple machines, plus all previous topics

MARCH: temperature and heat, thermal equilibrium, linear expansion and contraction, specific heat, calorimetry, modes of energy transfer, thermodynamic and ideal gas laws, simple harmonic motion, wave propagation, standing waves, sound, plus all previous topics

APRIL: electrical charges, fields and force, coulombs law, voltage sources and resistances, series/parallel networks, electricity and magnetism, light, index of refraction, color, optics, lenses, mirrors, interference phenomena, plus all previous topics

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HIGH SCHOOL PHYSICS IVORY Exam

April 14, 2016

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Use: g = 10. m/s². Unless specifically stated, use conventional current direction.

1. Which of the following correct ranks the frequency of electromagnetic radiation, from lowest to highest?
(A) visible, infrared, radio, gamma
(B) infrared, visible, ultraviolet, X-ray
(C) radio, ultraviolet, infrared, gamma
(D) visible, ultraviolet, gamma, X-ray

2. As monochromatic light passes through a double slit, it produces a pattern of light and dark bands on a screen. Which of the following accurately describes this situation?
(A) Light has a particle nature. The momentum of the photons causes cancellation of the velocities when the photons collide.
(B) Light is absorbed in the region around the double slit, leaving only certain beams of light.
(C) Light has a wave nature, so it cannot pass efficiently through the double slit, allowing only certain rays of light to produce a pattern on a screen.
(D) Light has a wave nature, so that the wave patterns produced by the two slits interfere constructively and destructively when they reach the screen

3. Which of the following cannot be polarized?
(A) radio waves passing through a vacuum
(B) sound waves passing through air
(C) gamma rays passing through a vacuum
(D) visible light passing through a vacuum

4. What is the "red shift" of distant objects in the universe?

(A) Observed increase in frequency of light emitted by objects moving away from Earth
(B) Observed decrease in frequency of light emitted by objects moving away from Earth
(C) Observed increase in frequency of light emitted by objects moving toward Earth
(D) Observed decrease in frequency of light emitted by objects moving toward Earth

5. Which of the following is NOT possible?
(A) A concave mirror produces a real image
(B) A plane mirror produces a virtual image
(C) A convex mirror produces a virtual image
(D) A concave lens produces a real image

6. Light travels from medium #1 with an index of refraction of n_1 toward medium #2 with an index of refraction of n_2, where n_2 is greater than n_1. Which of the following must be true for total internal reflection to occur?
(A) The incident angle must be greater than 45^o
(B) The incident angle must be less than 45^o
(C) The incident angle must be greater than $\sin^{-1}(n_2/n_1)$
(D) Total internal reflection is not possible in this situation

7. Laser light must be both
(A) monochromatic and coherent
(B) polarized and monochromatic
(C) polarized and coherent
(D) monochromatic and diffuse

8. A negatively charged metal rod is brought near a second identical rod that is neutral and suspended by a non-conducting string. The second rod is observed to move toward the first. The first rod is then removed. After the first rod is removed, the second rod ____.

(A) is polarized, with one end positive and one end negative
(B) has no net charge
(C) has a positive net charge
(D) has a negative net charge

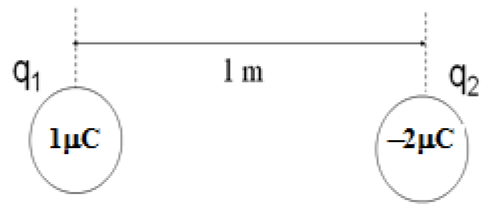
9. An isolated conducting sphere is given a net charge of -10 μC by touching it with a negatively charged rod. After the rod is removed, which of the following best describes the sphere?

(A) The net charge of -10 μC will be distributed throughout the volume of the sphere
(B) The net charge of -10 μC will be distributed uniformly over the surface of the sphere
(C) The net charge of -10 μC will be concentrated on the side of the sphere where the rod touched it
(D) -5 μC will be distributed throughout the volume of the sphere and -5 μC will be distributed uniformly over the surface of the sphere

10. Four equally charged positive particles are held in position at the vertices of a square of side d. If the charge on each particle is q, what is the magnitude of the net force on the particle in the position located at the upper right corner?

(A) $F = \frac{kq^2}{2d^2}$ (B) $F = \frac{1.41\,kq^2}{d^2}$ (C) $F = \frac{3kq^2}{2d^2}$ (D) $F = \frac{1.91\,kq^2}{d^2}$

11. Given the arrangement of charges shown, in which region(s) is there a location where the net electrostatic force on a -3 μC placed in the region(s) equals zero?



(A) To the right of q_2
(B) Between q_1 and q_2
(C) To the left of q_1
(D) Between q_1 and q_2 <u>and</u> to the left of q_1

12. As distance to a positive charge doubles, the magnitudes of the

(A) electric field reduces to one half and the electric potential reduces to one half
(B) electric field reduces to one half and the electric potential reduces to one fourth
(C) electric field reduces to one fourth and the electric potential reduces to one fourth
(D) electric field reduces to one fourth and the electric potential reduces to one half

13. A metal of resistivity ρ is made into a wire of resistance R when its radius is r and length is L. What happens to the resistivity and resistance when the wire is stretched so that its length triples?

	New Resistivity	New Resistance
(A)	3 ρ	R
(B)	1/3 ρ	9 R
(C)	ρ	3 R
(D)	ρ	9 R

14. In which of the following actions is the least average power required?

(A) Lifting a 5 kg block to a height of 2 meters in 2 seconds
(B) Pushing a 5 kg block horizontally across a floor with a net horizontal force of 10 N at a velocity of 3 m/s
(C) Changing the kinetic energy of a 5 kg bowling ball from 10 J to 50 J in 20 seconds
(D) Burning a 10 Ohm light bulb using a current of 2 A

15. Two identical 10 Ω resistors are connected in series to a battery, generating a total power output of 100 W. If the resistors are disconnected and then reconnected in parallel to same battery, the total power output of the new arrangement of resistors is _____.

(A) 25 W (B) 50 W (C) 200 W (D) 400 W

16. A 12 Volt battery is connected to a parallel combination of resistors, which are 1Ω, 3Ω and 4Ω. The battery produces a current of ____ through the 3Ω resistor.

(A) 1.5 A (B) 3 A (C) 4 A (D) 19 A

17. A 12 Volt battery is connected to a series combination of resistors, which are 1Ω, 3Ω and 4Ω. The potential difference across the 3Ω resistor is ____.

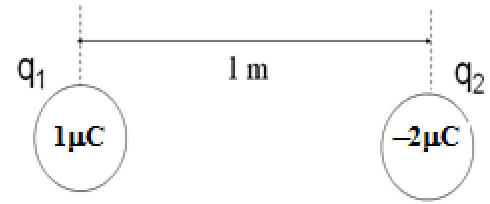
(A) 1.5 V (B) 4.5 V (C) 12 V (D) none of these

18. A 10 Ω and a 15 Ω resistor are placed in parallel in a circuit with a 12 V battery. The power dissipated by the 10 Ω resistor is ____.

(A) 1.44 W (B) 2.30 W (C) 14.4 W (D) 48.0 W

19. Given the arrangement of charges shown, in which region(s) is there a location where the electric potential in the region equals **zero**? Key has D B and C are correct as well

(A) To the right of q_2
(B) Between q_1 and q_2
(C) To the left of q_1
(D) Between q_1 and q_2 and to the left of q_1

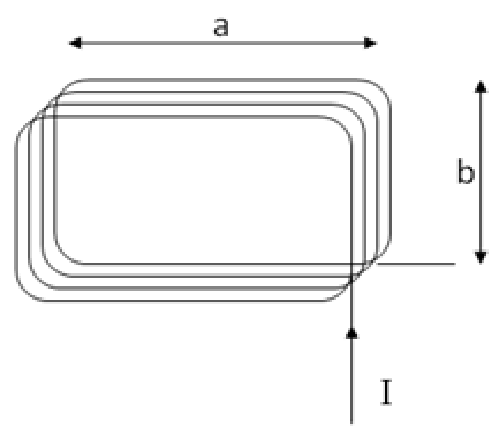


20. A particle travels uniform circular motion in a circular path of radius 0.15 meters. If its kinetic energy is a constant 3.0 J, the net force on the particle

(A) is 40 N
(B) is 20 N
(C) is 0.45 N
(D) cannot be determined

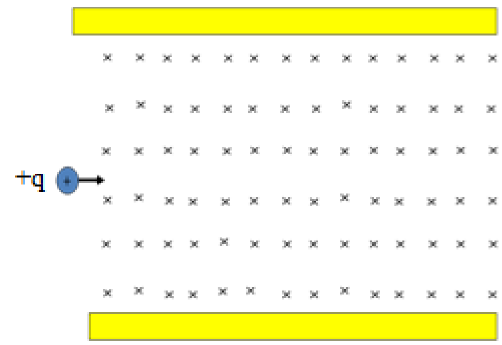
21. A coil of wire is in the plane of the paper. Current flows in the coil of wire in the direction shown. At the center of the coil, the direction of the magnetic field due to the flow of current _______.

(A) is into the page
(B) is out of the page
(C) is upward
(D) cannot be determined from the given information



22. Both magnetic and electric fields can produce forces on charged particles. Under what conditions may this positively charged particle of mass m and charge q go straight through the fields from left to right?

(A) The top plate is + and the bottom plate is -
(B) The top plate is - and the bottom plate is +
(C) The electric field points into page
(D) The electric field points out of page



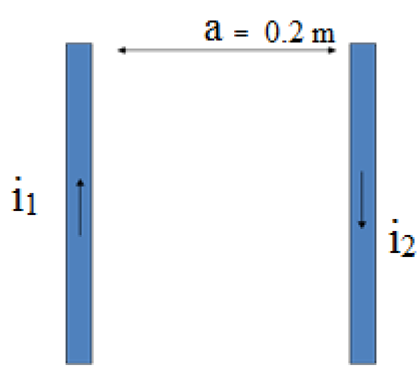
Magnetic Field is into the page

23. A 0.15 kg mass falls from rest from a height of 0.80 meters and reaches the ground with a speed of 3.5 m/s. How much work is done by air resistance?

(A) 0.28 J
(B) 0.92 J
(C) - 0.28 J
(D) - 0.92 J

24. Current i_1, on the left, flows toward the top of the page, and current i_2, on the right, flows toward the bottom of the page. Current $i_1 = 4$ A, current $i_2 = 8$ A, and the distance between the wires is 0.20 m. In which region(s) could the net magnetic field due to long current carrying wires be zero?

(A) To the right of i_2
(B) Between i_1 and i_2
(C) To the left of i_1
(D) Between i_1 and i_2 <u>and</u> to the left of i_1



25. A coil of wire of N turns has a radius R and a current I. Which of the following actions will increase the strength of the magnetic field inside the coil?

(A) Reduce the current in the coil
(B) Insert an iron rod into the middle of the coil
(C) Increase the radius of the coil
(D) Reduce the number of turns of wire in the coil

High School PHYSICS: **<u>Ivory Exam</u>**

April 14, 2016

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SOLUTIONS (corrections)

1. B	6. D	11. C	16. C	21. B
2. D	7. A	12. D	17. B	22. A
3. B	8. B	13. D	18. C	23. C
4. B	9. B	14. C	19. D (B, C)	24. C
5. D	10. D	15. D	20. A	25. B

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<u>MARCH</u>: temperature and heat, thermal equilibrium, linear expansion and contraction, specific heat, calorimetry, modes of energy transfer, thermodynamic and ideal gas laws, simple harmonic motion, wave propagation, standing waves, sound, plus all previous topics

<u>APRIL</u>: electrical charges, fields and force, coulombs law, voltage sources and resistances, series/parallel networks, electricity and magnetism, light, index of refraction, color, optics, lenses, mirrors, interference phenomena, plus all previous topics

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PHYSICS FORMULAE

MECHANICS

$$\bar{v} = \frac{\Delta x}{\Delta t}$$

$$\bar{a} = \frac{\Delta v}{\Delta t}$$

$$v_f = v_i + at$$

$$\Delta x = v_i t + \tfrac{1}{2} at^2$$

$$2a\Delta x = v_f^2 - v_i^2$$

$$\Sigma F = ma$$

$$W = mg$$

$$F_g = G\frac{m_1 m_2}{r^2}$$

$$p = mv$$

$$F\Delta t = m\Delta v$$

$$\mu = \frac{F_f}{F_N}$$

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

ELECTRICITY AND MAGNETISM

$$F_e = k\frac{q_1 q_2}{r^2}$$

$$E = \frac{F}{q}$$

$$V = \frac{W}{q} = Ed$$

$$I = \frac{\Delta q}{\Delta t}$$

$$V = IR$$

$$P = VI = I^2 R = \frac{V^2}{R}$$

SERIES CIRCUIT

$$I_T = I_1 = I_2 = I_3 = \ldots$$

$$V_T = V_1 + V_2 + V_3 + \ldots$$

$$R_T = R_1 + R_2 + R_3 + \ldots$$

PARALLEL CIRCUITS

$$I_T = I_1 + I_2 + I_3 + \ldots$$

$$V_T = V_1 = V_2 = V_3 = \ldots$$

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$$

E = electric field intensity

I = electric current

k = electrostatic constant

$k = \frac{9 \times 10^9 \text{ Nm}^2}{\text{C}^2}$

$G = 6.67 x 10^{-11} \frac{Nm^2}{kg^2}$

P = Power

q = charge

R = resistance

V = electric potential difference

W = Work

Fundamental particle electron

$e^{-1} = -1.60 \times 10^{-19}$ C

e mass 9.11×10^{-31} kg

ENERGY

$$W = F\Delta x$$

$$P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t} = Fv$$

$$PE_g = mgh$$

$$KE = \tfrac{1}{2} mv^2$$

$$F = -kx$$

$$PE_s = \tfrac{1}{2} kx^2$$

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

MOTION IN 2-D

$$a_c = \frac{v^2}{r}$$

$$F_c = m\frac{v^2}{r}$$

1 rev = 2 π rad = 360°

$$\tau = r \times F$$

L = Iω

KE = $\frac{1}{2}$ I ω^2

a_c = centripetal acceleration

F_c = centripetal force

τ = Torque

L = Angular Momentum

I = Moment of Inertia

ω = angular velocity

PHYSICS FORMULAE

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

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

1 cal = 4.184 joules

WAVE PHENOMENA

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

$v = f\lambda$ OR $= \nu\lambda$

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

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

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

$n\ \lambda$ = d sin θ

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

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

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

$\dfrac{h_i}{h_o} = \dfrac{d_i}{d_o}$

f = focal length

d_i = image distance

d_o = object distance

h_o = object size

h_i = image size

ELECTROMAGNETIC APPLICATIONS

F = Bqv

$F = BIL$

$V = BLv$

$\dfrac{N_P}{N_S} = \dfrac{V_P}{V_S}$

$V_P I_P = V_S I_s$ (ideal)

$efficiency = \dfrac{V_S I_S}{V_P I_P}$

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