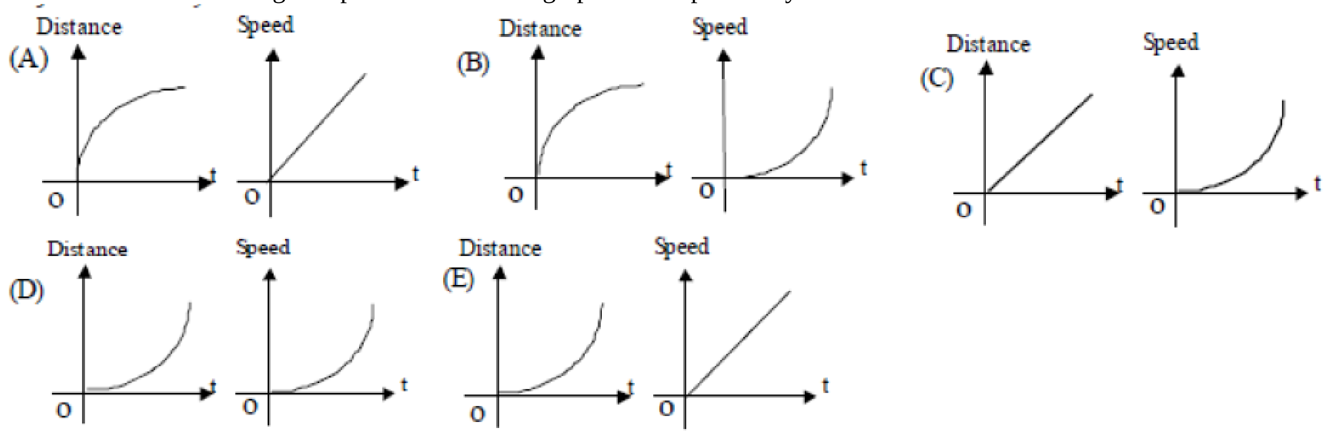
Directions: For each question or statement fill in the appropriate space on the answer sheet. Use the letter preceding the word, phrase, or quantity which best completes or answers the question. Each of the 25 questions is worth 4 points. *Use: g =10 m/s^2*

1. You are sitting patiently at a red light in your souped up Turbo-charged 17-hp 1974 Ford Pinto. The light eventually turns green and you accelerate uniformly at a neck-snapping 0.1 m/s^2; even the little old granny behind you in her 1967 Dodge Dart is getting ticked off at you. Which of the following five pairs of d/t and v/t graphs best represents your uniform acceleration from rest?



2. A projectile is fired from a local high school for a physics demonstration. It has a muzzle velocity of 200 m/s and is fired at an angle of 30^o above horizontal. Assuming the high school parking lot is level and long enough, what is the maximum height reached by this projectile? Ignore air resistance and monsters.

(A) 5 m (B) 10 m (C) 500 m (D) 1 000 m (E) 2 000 m

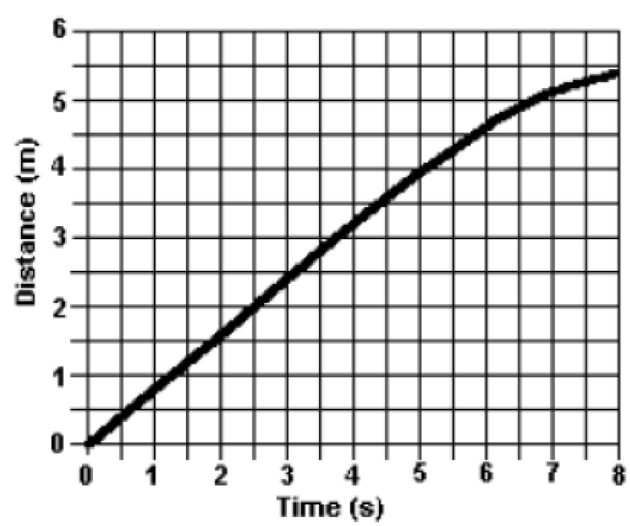
3. On Monday, 12/09/2013, it was announced by the CDC that a new cockroach has been found in New York City that had never before been seen in North America. The new cockroach, named *Periplaneta japonica*, seems to have hitched a ride from China on green plants used to finish some rich guy's rooftop forest. The scary thing about these bugs is they love the cold, will survive outside during our cold snowy winters and they fly over long distances. YIKES! Anyway, one of these bugs is seen crawling along the walls inside a typical cubical NYC room of edges 3 m. The icky bug starts from the back lower right corner and finishes up staring right at you at the upper left hand corner. What is the magnitude of the displacement of this icky monster in bug's clothing?

(A) $3\sqrt{3}m$ (B) $3\sqrt[3]{2}m$ (C) $\sqrt{3}m$ (D) $3m$ (E) $9m$

4. A freely falling object near the surface of the Earth is measured to be moving at 18 m/s. After it has fallen another two seconds, it is moving at

(A) 9.8 m/s (B) 18 m/s (C) 28 m/s (D) 38 m/s (E) 48 m/s

Use the following information for Questions #5 & #6: The graph shown below represents a distance/time relationship for an object that is moving along a straight line.



5. What is the instantaneous speed of this object at ***t*** = 3 sec?

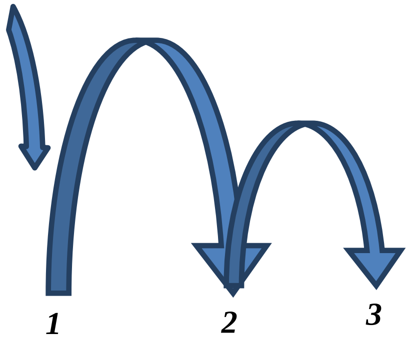
(A) Zero (B) 0.8 m/s (C) 1.2 m/s
(D) 2.5 m/s (E) 7.5 m/s

6. During which of the following time intervals does the object have only a non-zero acceleration?

(A) At 0.0 sec only (B) 0 – 5 sec (C) 0 – 8 sec (D) 5 – 8 sec

(E) The object is not accelerating at any time.

7. During another fabulous physics class demonstration, a super-bouncy ball is dropped from some unknown original height onto the hard physics room floor. It is noticed that, after each bounce, the ball reaches ½ the height of the bounce before it, as shown. The time of the 1st bounce flight, measured from point ***1*** to point ***2*** on the diagram below (the time between the ball first hitting the floor and the 2nd time it hits the floor), is measured at one second.
What is the time between the ***2nd*** and ***3rd*** bounce (measured between points ***2*** and ***3***)?

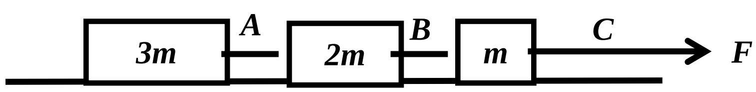


(A) 0.5 sec (B) 0.71 sec (C) 1 sec (D) 1.4 sec (E) 2 sec

8. The ultimate fate of our Sun is well understood. It will eventually blow off its own atmosphere and outer layers into what we call a planetary nebula (has nothing to do with "planets"). The burned out core left behind will essentially have the mass of the original Sun, about 2 x 10^{30} kg, but will have compacted down to the size of the Earth with a radius of only 6000 km! This is indeed dense! Calculate the density of such a burned out Sun core called a "white dwarf."

(A) $3x10^{26}\ kg/m^3$ (B) $2.2x10^{18}\ kg/m^3$ (C) $2.2x10^{9}\ kg/m^3$ (D) $1.1x10^{50}\ kg/m^3$ (E) $1.1x10^{18}\ kg/m^3$

Use the following information for Questions #9 & #10: Three blocks of masses 3***m***, 2***m***, and ***m*** are connected to strings ***A***, ***B***, and ***C*** , respectively, as shown below. The blocks are pulled along a smooth frictionless surface by a force of magnitude ***F*** exerted by string ***C,*** giving the system an acceleration of '***a***'.



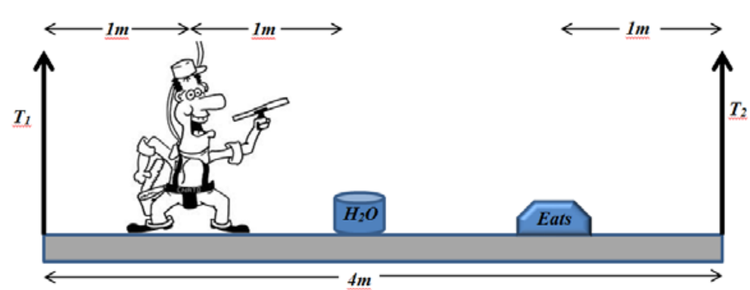
9. What is the tension in string B?
(A) $F/3$ (B) $F/2$ (C) F (D) $2F/3$ (E) $5F/6$

10. What is the tension in string A?
(A) $F/3$ (B) $F/2$ (C) F (D) $2F/3$ (E) $5F/6$

11. The following diagram represents a window washer, Bob, standing on a stationary uniform wooden plank suspended by two vertical cables, one at each end of the plank, a few hundred feet above unforgiving concrete sidewalks. Here is what we know:

Mass of plank = 50 kg
Mass of Bob = 70 kg
Mass of bucket of water = 10 kg
Mass of Bob's lunch bucket = 10 kg (He's a big eater…)
T_2 *= 550 N*

The relative positions of each object are given in the diagram. Find T_1.



(A) 550 N (B) 650 N (C) 750 N (D) 850 N (E) 950 N

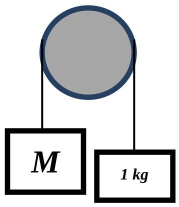
12. The following image is a famous bronze art piece by artist *W. Stanley Proctor* at the Kent Place School (Private girl's school) in Summit, NJ.

Image source: http://www.proctorbronzes.com/public_installations.php

If each team is pulling on the ends of the rope with a force of 300 N, the tension in the rope is:

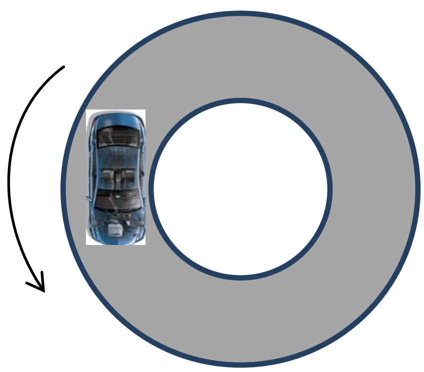
(A) 0 N (B) 150 N (C) 300 N (D) 450 N (E) 600 N

13. One end of a massless rope is attached to a mass ***M*** while the other end is looped over a massless frictionless pulley and then attached to a mass of 1-kg. When released from rest, the 1-kg mass accelerates upward at 5 m/s^2. What is the value of ***M***?



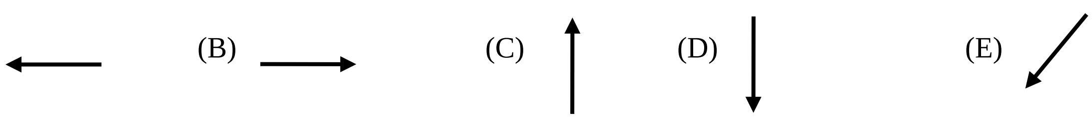
(A) 3.0 kg (B) 2.0 kg (C) 1.5 kg (D) 1.0 kg (E) 0.5 kg

Use the following info for Questions #14 & #15: The figure below shows the top view of a car going around a horizontal circular track at a constant speed in the counterclockwise direction. Assume the frictional force between the tires and the road is at its maximum value.



14. Which of the following vectors represents the frictional force acting on the tires of the car?

(A) (B) (C) (D) (E)



15. The car has a mass m and a speed v as it moves around the track of radius R. Which of the following expressions can be used to find the value of the coefficient of friction between the tires and the road?

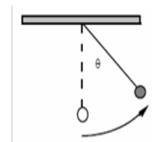
(A) $\mu = \frac{gR}{v}$ (B) $\mu = \frac{gv}{R}$ (C) $\mu = vgR$ (D) $\mu = \frac{v^2}{gR}$ (E) $\mu = \frac{mv^2}{R}$

16. In Newton's 3rd Law of Motion, the "reaction" force does not cancel the "action" force because:
(A) The action force is greater than the reaction force.
(B) The action force is less than the reaction force.
(C) The reaction exists only after the action force is removed.
(D) They are in the same direction.
(E) They act on different bodies.

17. The acceleration due to gravity ***g*** at a distance ***r*** from the center of a planet of mass ***M*** is 9 m/s^2. In terms of the orbital distance ***r***, what would the speed of a satellite have to be to remain in a circular orbit around this planet at this distance?

(A) $v = 3\sqrt{r}$ (B) $v = 3r$ (C) $v = 9\sqrt{r}$ (D) $v = 9r$ (E) $v = 3\sqrt[3]{r}$

18. In general,
(A) the smaller the orbital radius of a satellite, the longer its orbital period.
(B) the larger the orbital radius of a satellite, the shorter its orbital period.
(C) the larger the orbital radius of a satellite, the longer its orbital period.
(D) the smaller the orbital radius of a satellite, the smaller its acceleration.
(E) the larger the orbital radius of a satellite, the greater the gravitational force acting on it.



19. A pendulum bob of mass ***m*** on a cord of length ***L*** is pulled sideways until the cord makes an angle ***θ*** with the vertical as shown in the figure to the right. The change in potential energy of the bob during the displacement is:

(A) $mgL(1-\cos\theta)$ (B) $mgL(1-\sin\theta)$ (C) $mgL\sin\theta$ (D) $mgL\cos\theta$ E) $mgL\tan\theta$

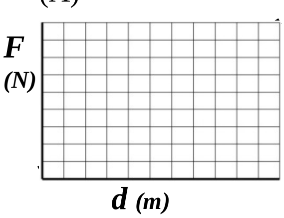
20. An automobile engine delivers 24,000 W to the wheels. If the car maintains a constant speed of 30 m/s, what is the magnitude of the retarding force acting on the car?
(A) 800 N (B) 960 N (C) 1950 N (D) 720,000 N (E) 1,560,000 N

21. The mass of a planet can be calculated if it is orbited by a small satellite by setting the gravitational force on the satellite equal to the centripetal force on the satellite. Which of the following would NOT be required in this calculation?
(A) Newton's universal gravitational constant
(B) The radius of the satellite orbit
(C) The period of the satellite orbit
(D) The mass of the satellite
(E) All of the above quantities are required for this calculation.

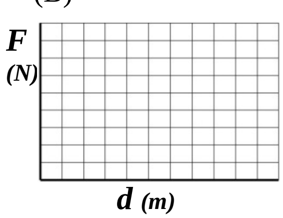
22. Goliath lifts a 200-kg crate onto a chariot 1 m high in 2 seconds. Meek mild-mannered David lifts 200 1-kg boxes onto the same chariot in a time of 2 minutes. Which of the following statements is true?
(A) Goliath does more work than David does.
(B) David does more work than Goliath does.
(C) They do the same amount of work, but Goliath operates at a higher power level.
(D) They do the same amount of work, but David operates at a higher power level.
(E) Goliath and David do the same amount of work and operate at the same power level.

23. Which of the following five graphs would produce the largest change in kinetic energy on a 3-kg mass. Each graph represents a force vs. displacement relationship using the same units and are all to the same scale.

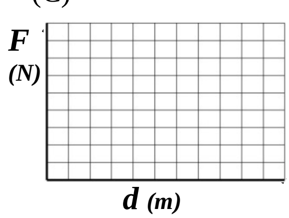
(A)



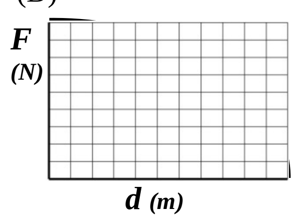
(B)



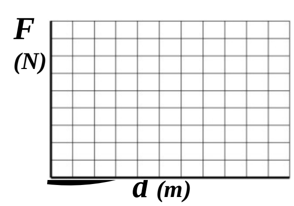
(C)



(D)



(E)



24. Which of the following represents the SI unit for power reduced to the *fundamental* units of the MKS system?

(A) $kg \cdot m/s$ (B) $kg \cdot m^2/s^2$ (C) $kg^2 \cdot m^2/s^2$ (D) $kg \cdot m^2/s^3$ (E) $kg \cdot m^3/s^3$

25. An unused Physics textbook slides down a long ramp set up in your physics lab room. It reaches the bottom of the ramp considerably slower than originally calculated by a group of eager physics students. Why?
(A) Mechanical energy is not really conserved in the "real" world outside physics classrooms.
(B) Mechanical energy is "lost" due to a gravitational gradient from the top of the ramp to the bottom.
(C) Mechanical energy is "lost" due to friction doing work.
(D) Mechanical energy is "gained" due to friction doing work.
(E) Velocity is not a conserved quantity, so the book can end up with whatever speed it needs to.

FIRST YEAR PHYSICS **Salmon test**

JANUARY, 2014

SOLUTIONS

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

PHYSICS 1 for All First year Students in physics. If you are taking physics for the first time, then sign up for physics I. 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, equilibrium of forces and torques, simple machines, plus previous topics
MARCH: temperature, thermal equilibrium, linear expansion and contraction, specific heat, calorimetry, modes of energy transfer, thermodynamic laws, simple harmonic motion, wave propagation, standing waves, sound, plus previous topics
APRIL: electrical charges 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 previous topics.

Dates for 2014 Season

Thursday January 9, 2014 Thursday February 13, 2014

Thursday March 13, 2014 Thursday April 10, 2014

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 www://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.

FIRST YEAR PHYSICS

FEBRUARY, 2014

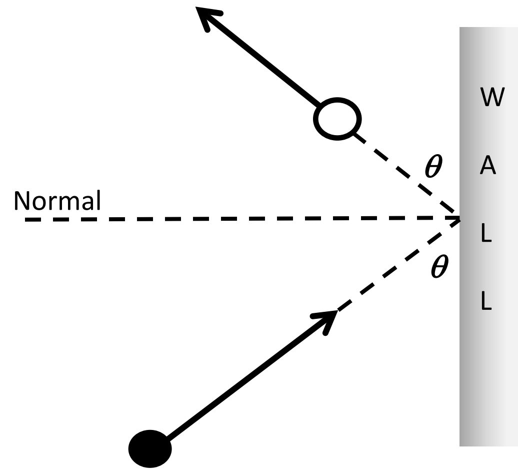
Directions: For each question or statement fill in the appropriate space on the answer sheet. Use the letter preceding the word, phrase, or quantity which best completes or answers the question. Each of the 25 questions is worth 4 points. ***Use: g = 10 m/s²***

1. When the velocity of a moving object of mass ***M*** is doubled, which of the following quantities must also double?

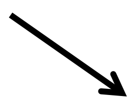
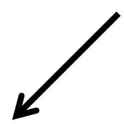
(A) Acceleration (B) Kinetic Energy (C) Potential Energy (D) Mass (E) Momentum

Use the following information for Questions #2 & #3.

The diagram at right represents an aerial view of a squash ball of mass ***M*** moving with speed ***v*** toward a rigid front wall. After rebounding, the squash ball moves at the same angle with the wall and speed as the original.



2. Which of the following vectors indicates the direction of the impulse exerted on the ball by the wall?

(A)  (B)  (C)  (D)  (E) 

3. The impulse delivered by the wall to the squash ball is

(A) zero (B) $mv\sin\theta$ (C) $mv\cos\theta$ (D) $2mv\sin\theta$ (E) $2mv\cos\theta$

4. A girl of mass ***m*** and her big brother of mass 2***m*** are initially at rest on a perfectly smooth frozen lake. He pushes his little sister so that she slides to the left with a speed ***v*** and he slides to the right. With what speed does the brother move after separation?

(A) Zero (B) $v/4$ (C) $v/2$ (D) v (E) $2v$

5. An out-of-control ice skater at Rockefeller Center has mass ***m*** and is traveling with speed ***v*** when he collides perfectly elastically (Yes, impossible in the real world, but it is Rockefeller Center after all…) with a skater of the same mass who was just standing motionless minding her own business. Which of the following statements *must* be true for these two folks after the collision?

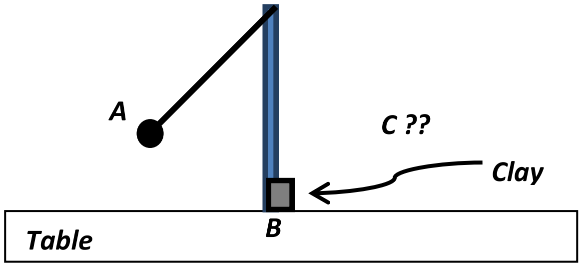
(A) The total momentum is mv and the total kinetic energy is $\frac{1}{2}mv^2$.

(B) The total momentum is mv and the total kinetic energy is less than $\frac{1}{2}mv^2$.

(C) The total momentum is less than mv and the total kinetic energy is $\frac{1}{2}mv^2$.

(D) The momentum of each person is $\frac{1}{2}mv$. (E) The kinetic energy of each person is $\frac{1}{4}mv^2$.

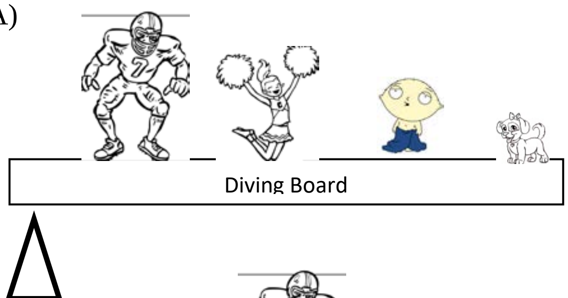
6. A typical pendulum begins at position ***A*** at rest, as shown below. It is released and collides with a clump of wet clay at point ***B***, the lowest point of the swing. The clay sticks to the pendulum bob. It then rises to point ***C*** somewhere on the right side of the diagram. Which description is the best explanation for a description of the respective heights above the table the bob attains at points ***A*** and ***C***?



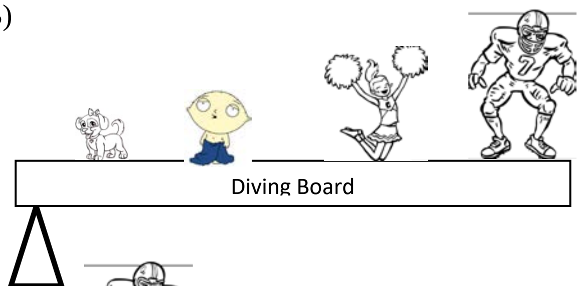
(A) There is no accurate way to determine how the heights at points ***A*** and ***C*** are related.
(B) According to the Conservation of Energy principles, the increased mass implies increased energy, so the height at ***C*** is larger than the height at ***A.***
(C) Since energy must be conserved, mass is not important so the height at ***C*** is the same as the height at ***A***.
(D) Momentum must be conserved when the pendulum bob hits the clay, yielding a smaller velocity, so the height at ***C*** is smaller than the height at ***A***.
(E) Momentum and kinetic energy must be conserved when the pendulum bob hits the clay, so the height at ***C*** is smaller than the height at ***A***.

7. Four living creatures are on a diving board: a 100 kg linebacker for the Rutgers Scarlet Knights, a 50 kg Rutgers cheerleader, a small child and a tiny (smaller than "small") puppy. The torque caused by each of the four living creatures is equal. Which diagram below correctly matches this description?

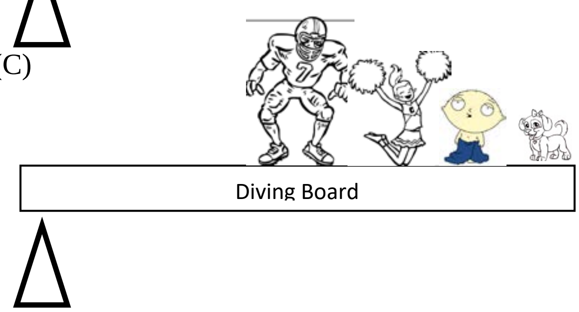
(A)



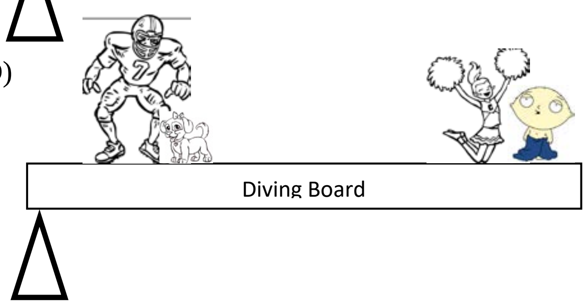
(B)



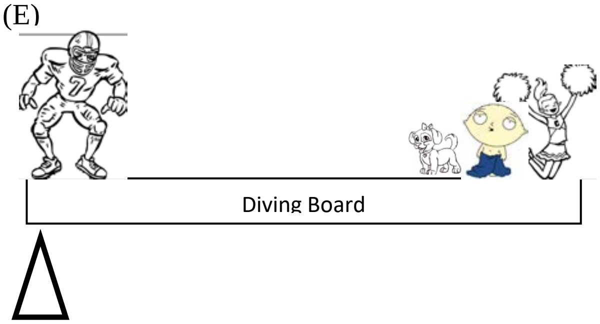
(C)



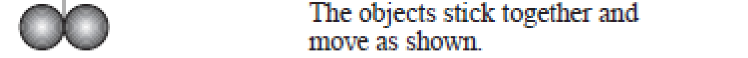
(D)

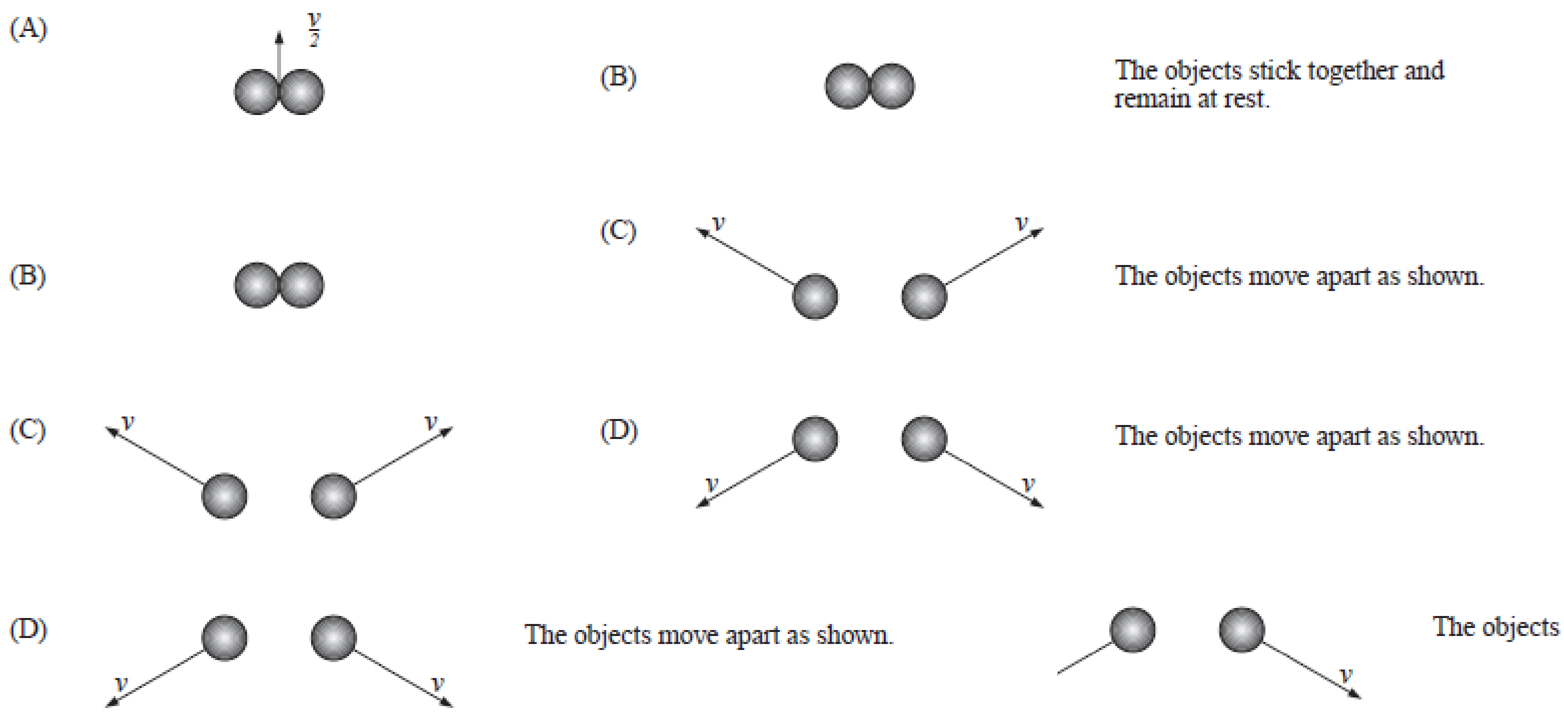


(E)

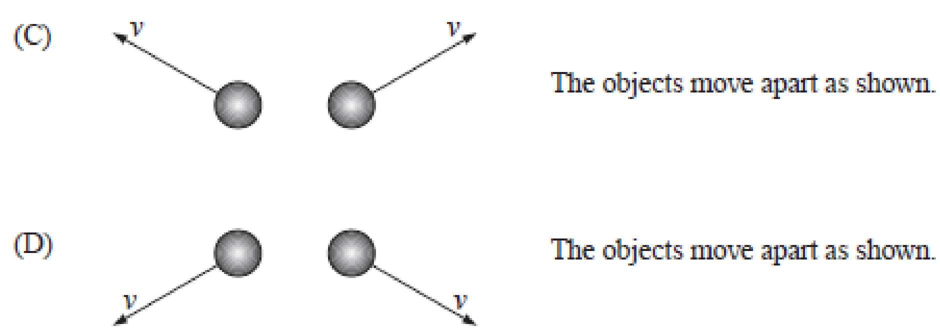


Which one of the following diagrams repre
momentum is conserved but kinetic energy



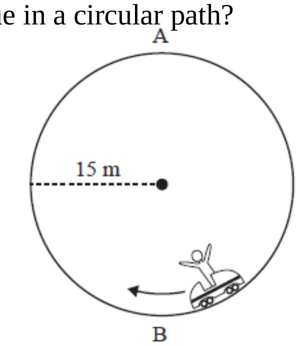


10. Usi ... ters, ***m***,
what is
(A) The
(B) The
(C) *F* ·
(D) *Fx*
(E) *F* ·



11. A n ... hown
below. ... st have at
point A, the top of the circle, if it is not to lose contact with the rails and will continue in a circular path?

(A) 10 m/s (B) 12 m/s (C) 15 m/s
(D) 100 m/s (E) 150 m/s



12. On another Great Adventure rollercoaster type ride, your car travels on the *outside* of a vertical circle of radius 20 m. When you are traveling at the top of the circular track, your apparent weight is measured as one-third your normal weight. What is the speed of the rollercoaster?
(A) 1.5 m/s (B) 5.1 m/s (C) 11 m/s (D) 14 m/s (E) 130 m/s

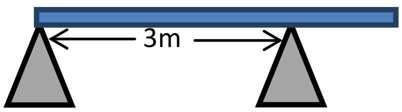
13. You were given an old-fashioned record player for your birthday. It's the kind that magically generates music by rubbing a needle across a rotating disc of plastic. Ask your Grandparents. If the record spins at 33 RPM, what is the period of rotation?

(A) 0.03 seconds (B) 0.29 seconds (C) 0.35 seconds (D) 1.8 seconds (E) 33 seconds

14. Your CD player spins the CD disc at a playing speed of 15 $^{rad}/_{s}$. If it starts from rest and the motor generates an angular acceleration of 4.3 $^{rad}/_{s^2}$, how long does it take to get up to operating speed?

(A) 0.057 seconds (B) 0.23 seconds (C) 0.29 seconds (D) 3.5 seconds (E) 7 seconds

15. A uniform plank of wood 4 meters long and of mass 50 kg rests on two supports as shown below. What is the magnitude of the force exerted on the plank by the right support?



(A) 120 N (B) 250 N (C) 330 N (D) 370 N (E) 500 N

16. The Earth has a radius of 6.4×10^6 m, a mass of 5.98×10^{24} kg, and completes one full revolution about its axis in 24 hours. What is the linear speed of a point on the equator?

(A) 75 m/s (B) 280 m/s (C) 470 m/s (D) 570 m/s (E) 1.7×10^6 m/s

17. The momentum of an object far out in deep space is

(A) dependent on its mass. (B) independent of its inertia. (C) independent of its velocity.
(D) dependent on its potential energy. (E) dependent on the largest mass close to it to provide gravity.

18. Two 1-kg blocks are sliding on a frictionless surface toward each other. The first block has a speed of 2 m/s to the right. After they collide, they stick together and move to the left at a speed of 3 m/s. What is the initial speed of the second block?

(A) 2 m/s (B) 3 m/s (C) 6 m/s (D) 8 m/s (E) 12 m/s

19. You have two air track carts, one of mass ***m*** and the other of mass 2***m***. If you push the cart of mass ***m*** for 3 seconds and then the other cart for the same length of time, exerting equal force on each, the momentum gained by the cart of mass ***m*** compared to the momentum gained by the more massive cart is

(A) quadrupled (B) doubled (C) equal (D) $1/2$ (E) $1/4$

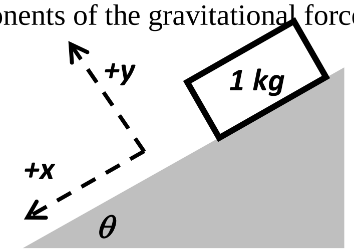
20. The acceleration due to gravity ***g*** at a distance ***r*** from the center of a planet of mass ***M*** is 9 m/s^2. In terms of the orbital distance ***r***, what would the speed of a satellite have to be to remain in a circular orbit around this planet at this distance?

(A) $v = 3\sqrt{r}$ (B) $v = 3r$ (C) $v = 9\sqrt{r}$ (D) $v = 9r$ (E) $v = 3\sqrt[3]{r}$

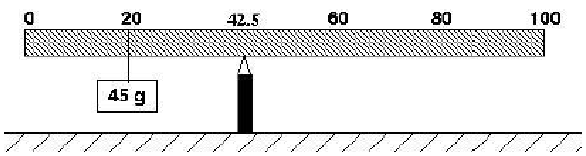
21. In general,
(A) the smaller the orbital radius of a satellite, the longer its orbital period.
(B) the larger the orbital radius of a satellite, the shorter its orbital period.
(C) the larger the orbital radius of a satellite, the longer its orbital period.
(D) the smaller the orbital radius of a satellite, the smaller its acceleration.
(E) the larger the orbital radius of a satellite, the greater the gravitational force acting on it.

22. An object of mass 1 kg rests on an inclined plane elevated at 37^o above the horizontal as shown below. Which of the following pairs of values correctly identifies the x- and the y-components of the gravitational force?

	x-component	*y-component*
(A)	+6 ***N***	-8 ***N***
(B)	+8 ***N***	-6 ***N***
(C)	-6 ***N***	+8 ***N***
(D)	-8 ***N***	+6 ***N***
(E)	0 N	+10 N



23. A meter stick of uniform density is balanced at the 42.5 cm mark when a 45 gram mass if placed at the 20 cm mark, as shown below. What is the mass of the meter stick?



(A) 18 g (B) 45 g (C) 72 g (D) 120 g (E) 135 g

24. A 1200 kg satellite is placed in circular orbit with a constant speed of 5,000 m/s around Planet Fitness, a newly discovered planet orbiting a dumb-bell shaped red supergiant star. The satellite has an orbital radius of 7.5×10^7 m. What is the magnitude of the gravitational attraction on the satellite caused by Planet Fitness?
(A) 12,000 N (B) 800 N (C) 400 N (D) 200 N (E) More information is needed to find the solution.

25. A block of mass M is connected to the end of a massless ideal spring of spring constant k. The other end of the spring is attached to a wall and the mass is placed on a rough horizontal surface. The mass is then pulled back a distance x from equilibrium. What minimum coefficient of static friction between the surface and the block would prevent the mass from moving from this point back toward equilibrium?

(A) $\frac{kx^2}{2Mg}$ (B) $\frac{kx}{2Mg}$ (C) $\frac{kx}{Mg}$ (D) $\frac{Mg}{2kx}$ (E) $\frac{k}{4Mgx}$

FIRST YEAR PHYSICS **Salmon test**

FEBRUARY, 2014

SOLUTIONS

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

PHYSICS 1 for All First year Students in physics. If you are taking physics for the first time, then sign up for physics I. 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, equilibrium of forces and torques, simple machines, plus previous topics

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

APRIL: electrical charges 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 previous topics.

Dates for 2014 Season

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Thursday March 13, 2014 Thursday April 10, 2014

New Jersey Science League

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FIRST YEAR PHYSICS
MARCH, 2014

***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

Work done *on a system* is expressed as +*W*, *by a system* as -*W*.

Latent Heat of Fusion of water, $L_F = 80\,{cal}/{g} = 335\,{J}/{g}$

Latent Heat of Vaporization of water, $L_v = 540\,{cal}/{g} = 2260\,{J}/{g}$

Specific Heat Capacity of water, $c = 1\,{cal}/{g \cdot C^o} = 4.186\,{J}/{g \cdot C^o}$

$PV = nRT = NkT$ **, where Universal Gas Constant,** $R = 8.31\,{J}/{mol^\circ K}$ **, Boltzmann's Constant,** $k = 1.38x10^{-23}\,{J}/{K}$ **, *n* is number of moles, and *N* is number of molecules.**

1. What temperature change on the Kelvin scale is equivalent to a 100 degree change on the Celsius scale?
(A) 373 K (B) 273 K (C) 173 K (D) 100 K (E) 0 K

2. A heat engine operates under the following conditions: It absorbs 2000 J of heat from a heat source, does 500 J or useful work, and releases 1500 J of heat to the environment. What is the efficiency, in percentage, of this heat engine?
(A) 25 % (B) 33 % (C) 67 % (D) 75 % (E) 300 %

3. You perform an experiment in class to determine the specific heat of a sample of copper. You heat a hunk of copper in an oven then immediately drop it into a beaker of water. To calculate the specific heat of this copper sample, you must know or be able to measure the value of all the quantities listed below *except* the
(A) mass of the water. (B) original temperatures of the copper and the water. (C) specific heat of the water
(D) final temperatures of the copper and water after reaching equilibrium.
(E) time taken to achieve thermal equilibrium after the copper is dropped into the water.

4. 12 Joules of heat is added to an ideal gas then the gas performs 8 Joules of useful work. Which of the following is true of the internal energy of the gas during this process?
(A) It increases by 20 Joules. (B) It increases by 4 Joules (C) It remains the same.
(D) It decreases by 4 Joules. (E) It decreases by 20 Joules.

5. An ideal gas is heated and expands. In so doing, the gas raises a piston. Which of the following describes the energy exchanges during this process?
(A) Energy is transferred to the gas by the piston and to the piston from the heat source.
(B) Energy is transferred to the gas from the heat source and to the piston from the gas.
(C) Energy is transferred to the gas in the form of heat and work done by the piston.
(D) Energy is transferred directly to the piston from the heat source.
(E) There is no transfer of energy since this must be a closed system.

Use the following information for Questions #6 - #8. The diagram below represents a Carnot heat-engine cycle, 1→2→3→4→1.

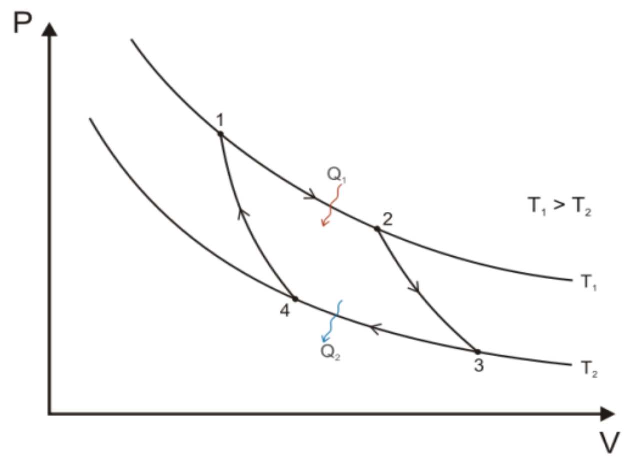


Image credit: Wiki Commons http://en.wikipedia.org/wiki/File:Carnot_cycle_p-V_diagram.svg

6. Which process, if any, indicates an adiabatic expansion?
(A) 1→2 (B) 2→3 (C) 3→4 (D) 4→1 (E) There are none.

7. During which processes, if any, is work done on the gas by the environment?

(A) 1→2 & 2→3 (B) 3→4 & 4→1 (C) 1→2 & 3→4 (D) 2→3 & 4→1 (E) There are none.

8. Entropy is unchanged in which processes, if any?

(A) 1→2 & 2→3 (B) 3→4 & 4→1 (C) 1→2 & 3→4 (D) 2→3 & 4→1 (E) There are none.

9. An ideal gas is initially held at 1.5 x 10^5 Pa. The gas is compressed isothermally till the volume reaches $1/4$ the original volume. What is the new pressure of the ideal gas?

(A) 1.5 x 10^5 Pa (B) 2 x 10^5 Pa (C) 3 x 10^5 Pa (D) 4 x 10^5 Pa (E) 6 x 10^5 Pa

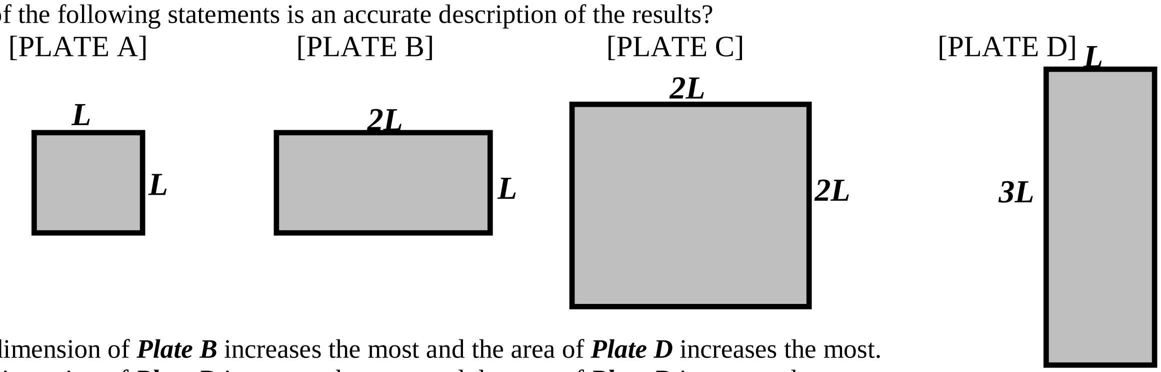
10. The temperature of an ideal gas increases from 30^o C to 60^o C while the pressure is held constant. What is the volume of the gas after the temperature increase in terms of the original volume, $\boldsymbol{V_o}$?

(A) $2V_o$ (B) $4V_o$ (C) $V_o/2$ (D) $V_o/4$ (E) it increases only slightly

11. Which of the following is a characteristic of an adiabatic process?

(A) $\Delta U = 0$ (B) $W = 0$ (C) $Q = 0$ (D) $\Delta V = 0$ (E) $\Delta P = 0$

12. The sketch below depicts four rectangular metal plates, all made from the same material to the same thickness. The temperature of each is identical. Then, the temperature is raised under the same conditions for each sample till the same final temperature is reached for each. Which of the following statements is an accurate description of the results?

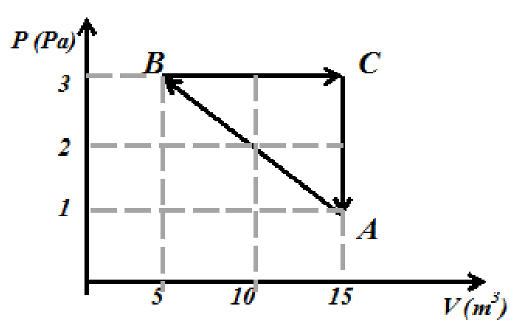


(A) The vertical dimension of ***Plate B*** increases the most and the area of ***Plate D*** increases the most.
(B) The vertical dimension of ***Plate D*** increases the most and the area of ***Plate D*** increases the most.
(C) The vertical dimension of ***Plate D*** increases the most and the area of ***Plate C*** increases the most.
(D) The vertical dimension of ***Plate C*** increases the most and the area of ***Plate A*** increases the most.
(E) The vertical dimension of ***Plate A*** increases the most and the area of ***Plate A*** increases the most.

13. An ideal gas of pressure 2 x 10^5 Pa and volume 6 m^3 is taken through an isothermal process. Which of the following pairs could be the final pressure and volume of the gas?

(A) 4 x 10^5 Pa and 4 m^3
(B) 8 x 10^5 Pa and 2 m^3
(C) 6 x 10^5 Pa and 2 m^3
(D) 1 x 10^5 Pa and 10 m^3
(E) 3 x 10^5 Pa and 6 m^3

Use the following information for Questions #14 & 15. The following graph represents a ***P-V*** diagram of a cyclic process ***A→B→C→A***.



14. The net change in internal energy of the system in one complete cycle is

(A) +10 J (B) -10 J (C) +20 J
(D) -20 J (E) Zero

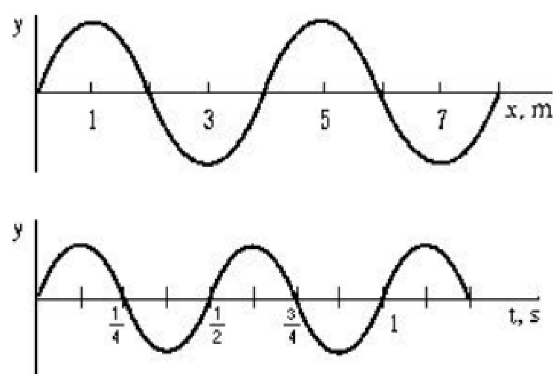
15. As shown on the ***P-V*** diagram, this system is performing like
(A) a refrigerator (B) an engine (C) both a heat engine and a refrigerator
(D) neither a heat engine or a refrigerator
(E) It's impossible to tell without further information.

16. For an object to undergo simple harmonic motion, which of the following must be true?
(A) The amplitudes are usually regarded as being large
(B) The acceleration is greatest when the displacement is greatest.
(C) The maximum potential energy is larger than the maximum kinetic energy.
(D) The acceleration is greatest when the speed is greatest.
(E) The displacement is greatest when the speed is greatest.

17. What happens to the period of a simple pendulum if ***both*** the mass of the bob and the length of the string are doubled?
(A) It will increase by a factor of $\sqrt{2}$
(B) It will increase by a factor of 2.
(C) It will increase by a factor of $\sqrt{2}/2$
(D) It will be unchanged.
(E) It will increase by a factor of 4.

18. On a certain summer day, sound travels in air at 340 m/s and at 1500 m/s in water. You make a sound of 256 Hz *under water*. When the sound leaves the water and travels through the air,
(A) the frequency remains the same, but the wavelength is shorter.
(B) the frequency is higher but the wavelength stays the same.
(C) the frequency is lower but the wavelength is longer.
(D) the frequency is lower and the wavelength is shorter.
(E) both the frequency and the wavelength remain the same.

19. The following image shows a wave traveling with speed ***v*** along the ***x***-axis in the positive direction. Each of the two graphs shows a different relationship between two of the wave properties. However, the two ***x***-axes are not directly related in scaling. From the information provided, what is the speed of the wave?



(A) 2 m/s (B) 4 m/s (C) 6 m/s (D) 8 m/s (E) Not enough information to tell.

20. An organ pipe used at the Sochi Olympics opening ceremony that is open at both ends is found to have two successive harmonics at frequencies of 210 Hz and 240 Hz. If the speed of sound that day is 345 m/s, the length of the organ pipe is approximately
(A) 2.76 m (B) 3.62 m (C) 4.90 m (D) 5.25 m (E) 5.75 m

21. Another organ used will resonate at frequencies of 50 Hz, 150 Hz, 250 Hz, 350 Hz, … etc. The pipe is
(A) open at both ends and has length 1.7 m.
(B) open at both ends and has length 3.4 m
(C) open at both ends and has length 6.8 m
(D) closed at one end, open at the other end & has length 1.7 m
(E) closed at one end, open at the other end & has length 3.4 m

22. You are provided a task in physics class to design a pendulum clock similar to an old-fashioned "Grandfather" clock. The pendulum swing must take 3 seconds to complete an entire round trip; from one side where maximum displacement from equilibrium occurs, to the other side, then back to the original position. What length should this pendulum be?

(A) 1 m (B) 1.6 m (C) 2.3 m (D) π m (E) 4.8 m

23. A 5-g lead bullet moving at 400 m/s penetrates a wood block and comes to rest inside the block. If half of the kinetic energy of the bullet goes into heating the bullet and the rest into the environment, what is the change in temperature of the bullet?

The specific heat of lead is $128 \, {}^{J}\!/_{kg \cdot K}$.

(A) 94 K (B) 106 K (C) 278 K (D) 313 K (E) 625 K

24. A guitarist sets up a standing wave on a string fixed at both ends. It is noted that adjacent antinodes are separated by a distance of 20 cm. The speed of the waves traveling on this guitar string is measured at 12 m/s. What is the frequency of the vibration of the string to produce this standing wave?

(A) 120 *Hz* (B) 60 *Hz* (C) 40 *Hz* (D) 30 *Hz* (E) 20 *Hz*

25. A car starts from rest and accelerates at a constant rate in a straight line. In the ***first*** second the car covers a distance of 2 meters. What is the acceleration of the car?

(A) 1 m/s^2 (B) 2 m/s^2 (C) 3 m/s^2 (D) 4 m/s^2 (E) 8 m/s^2

FIRST YEAR PHYSICS **Salmon test**

MARCH, 2014

SOLUTIONS

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

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FIRST YEAR PHYSICS
APRIL, 2014

***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. **Unless specifically stated, use *conventional current direction*.**

1. A positively charged object is observed to attract a second object. Which of the following statements *could* be true?

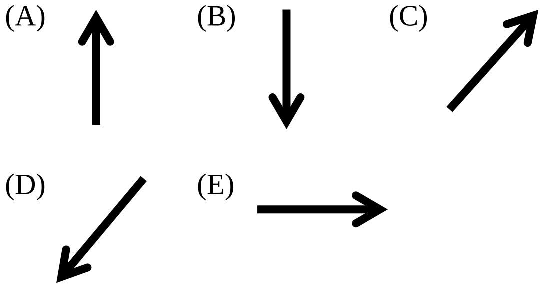
I. The second object is a conductor with negative net charge.
II. The second object is a conductor with zero net charge.
III. The second object is an insulator with zero net charge..

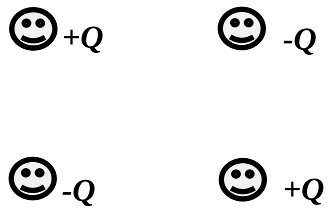
(A) I only (B) II only (C) III only (D) I & II only (E) I, II & III

2. A point charge of +4.0 μC is placed on the negative x-axis 0.20 m to the left of the origin. A second point charge ***q*** is placed on the positive x-axis 0.30 m to the right of the origin. The net electric field at the origin is zero. What is the magnitude and sign of ***q***?

(A) +9.0 μC (B) +6.0 μC (C) 0 (D) –6.0 μC (E) –9.0 μC

3. Assuming the four electrically charged particles at the corners of a square are isolated from any other influence and all have the same charge magnitude, in what direction is the net force on the lower left charged particle?



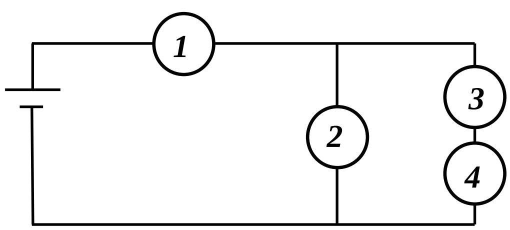


4. Which of the following statements about a solid conductor is true?

I. The electric field inside the conductor is always zero.
II. The electric potential inside the conductor is always zero.
III. Any net charge is on the surface.

(A) I only (B) II only (C) III only (D) I & III only (E) II & III only

5. In a physics lab, you connect four identical 40-W light bulbs to a constant voltage source. As shown below, the bulbs are cleverly labeled ***1***, ***2***, ***3***, & ***4***. Which choice provided indicates the brightness of each bulb in decreasing order; brightest first – dullest last.

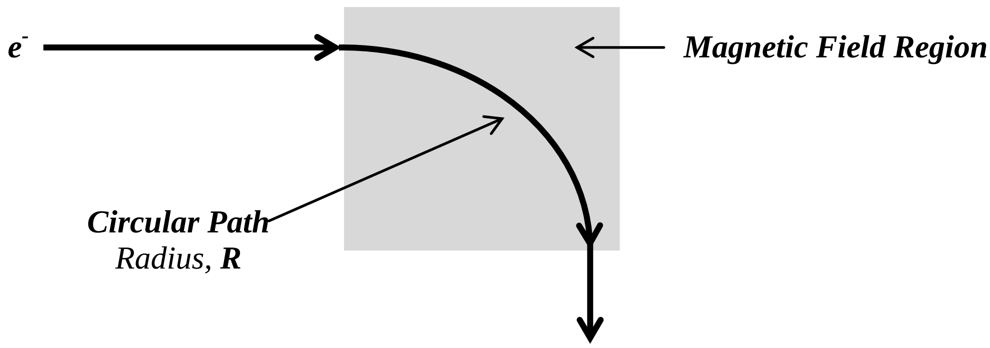


(A) ***1 > 2 > 3 = 4*** (B) ***1 > 2 = 3 = 4*** (C) ***2 = 3 > 4 > 1*** (D) ***2 = 3 = 4 > 1*** (E) ***2 > 3 = 4 > 1***

6. The image produced by a plane mirror is best described as

(A) real, inverted, and larger than the object. (B) real, upright, and the same size as the object.
(C) virtual, upright, and the smaller than the object. (D) virtual, inverted, and smaller than the object.
(E) virtual, upright, and the same size as the object.

Use the following information for Questions #7 & #8: During yet another exciting physics lab activity, you are provided a cathode ray tube which you use to shoot a stream of electrons at a speed of ***v*** into a region that contains a uniform magnetic field, as shown below. Upon entering the magnetic field, the electrons move in a circular path of radius ***R***.



7. Which of the following described the direction of the magnetic field lines?
(A) Toward the bottom of the page (B) Toward the top of the page (C) Out of the page
(D) Into the page. (E) Toward the left of the page.

8. The accelerating voltage of the cathode ray tube that gave these electrons such a high speed acts through a short distance of ***d***. If this accelerating voltage is doubled and ***d*** remains the same, what is the resulting velocity of the electrons compared to the original velocity?

(A) v (B) $\sqrt{2}v$ (C) $2v$ (D) $\frac{v}{\sqrt{2}}$ (E) $\frac{v}{2}$

9. Two large parallel plates separated by a distance ***d*** are charged by connection to an external battery of potential difference ***V***. Once maximum charge is reached, the battery is disconnected and the plates are slowly moved apart. As the distance between the plates increases, what happens to the charge on the plates and the potential difference between them?

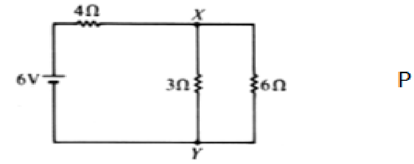
	Charge (Q)	***Potential Difference (V)***
(A)	Increases	Increases
(B)	Decreases	Increases
(C)	Decreases	Decreases
(D)	Unchanged	Increases
(E)	Unchanged	Decreases

10. A proton of mass, ***m***, and kinetic energy, ***K***, passes un-deflected through a region with both an electric field, ***E***, and a magnetic field, ***B***. The magnitude of the magnetic field is

(A) $\sqrt{\frac{mE^2}{K}}$ (B) $\sqrt{\frac{mE}{2K}}$ (C) $\sqrt{\frac{2mE^2}{K}}$ (D) $\sqrt{\frac{mE^2}{2K}}$ (E) $\sqrt{\frac{mE^2}{K^2}}$

11. How much work is required to move a negative charge of magnitude 24 μC a distance of 4 meters parallel to a 6 *N/C* electric field?
(A) 1 μJ (B) 16 μJ (C) 363 μJ (D) 62 μJ (E) 576 μJ

Use the following information for Questions #12 - #14: Below, find a circuit and a point ***P*** outside the circuit.



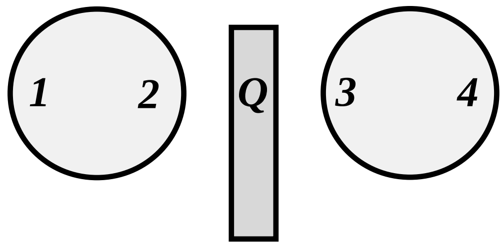
12. What is the potential difference across the 6Ω resistor?
(A) 1 V (B) 2 V (C) 3 V
(D) 4 V (E) 6 V

13. What is the current passing through the 3Ω resistor?
(A) $\frac{1}{3}A$ (B) $\frac{2}{3}A$ (C) $1A$ (D) $\frac{3}{2}A$
(E) $2A$

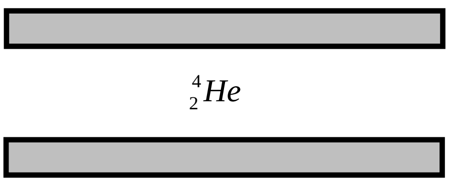
14. In what direction is the net magnetic field caused by the electrical current pointing at point P?
(A) Into the page (B) Out of the page (C) Toward the top of the page
(D) Toward the bottom of the page (E) To the right of the page

15. As shown below, a charged rod of unknown polarity is placed directly between two isolated conducting neutral spheres. Regions of each sphere are labeled. Which region will have the same polarity as Region ***3***?
(A) ***1*** only (B) ***2*** only (C) ***4*** only

(D) Both ***2*** & ***4*** (E) Both ***1*** & ***4***



Use the following information for Questions #16 & #17: In an experiment similar to Millikan's oil drop experiment, a single alpha particle (helium nucleus) is located between the plates of a parallel-plate capacitor, as shown below. The alpha particle has a mass of 6.6×10^{-27} kg. The charge of an electron is -1.60×10^{-19} C



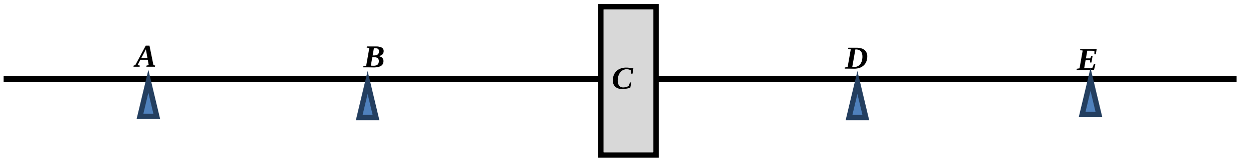
16. If the alpha particle is to remain stationary (suspended midway between the plates), what must be the charges of the top and bottom plates?

	Top Plate	***Bottom Plate***
(A)	Positive	Negative
(B)	Positive	Positive
(C)	Negative	Negative
(D)	Negative	Positive
(E)	Neutral	Neutral

17. What is the magnitude of the electric field such that the electric force exactly balances the gravitational force acting on the alpha particle so that it remains stationary?
(A) $1.4x10^{8}\ {}^{N}\!/_{C}$ (B) $5x10^{-3}\ {}^{N}\!/_{C}$ (C) $2x10^{-7}\ {}^{N}\!/_{C}$ (D) $4x10^{-7}\ {}^{N}\!/_{C}$ (E) $6.6x10^{-26}\ {}^{N}\!/_{C}$

18. You need to create a beam of light that consists of parallel rays in order to pass another devious physics lab. Which one of the following arrangements would allow you to accomplish this?
(A) A light bulb is placed at the focal point of a convex mirror.
(B) A light bulb is placed at the focal point of a diverging lens.
(C) A light bulb is placed at the focal point of a converging lens.
(D) A light bulb is located at twice the focal length from a concave mirror.
(E) A light bulb is located at twice the focal length from a converging lens.

Use the following information for Questions #19 - #21: The following diagram represents the principal axis of an optical device that is represented by a box. The device could be a mirror or a lens.

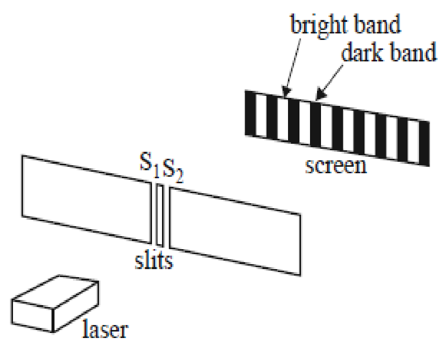


19. If the device is a plane mirror that forms an image at point ***E***, where must the object be?
(A) Point ***A*** only (B) Point ***B*** only (C) Anywhere to the left of the device.
(D) Point ***D*** only (E) Anywhere to the right of the device

20. If the device is a converging lens with focal point located at ***D***, where must the object be placed to the left of the mirror in order to form a large, upright, virtual image?
(A) To the left of ***A*** only (B) At ***A*** only (C) Between ***A*** and ***B***
(D) At ***B*** only (E) Between ***B*** and ***C***

21. If the device is a spherical concave mirror with center of curvature at point ***A***, where must an object be placed to the left of the mirror in order to form no image at all?
(A) To the left of ***A*** only (B) At ***A*** only (C) Between ***A*** and ***B***
(D) At ***B*** only (E) Between ***B*** and ***C***

Use the following information for Questions #22 - #23: The image below shows a green laser of wavelength 550 nm incident upon two narrow slits. This results in a series of bright and dark regions on a distant screen.

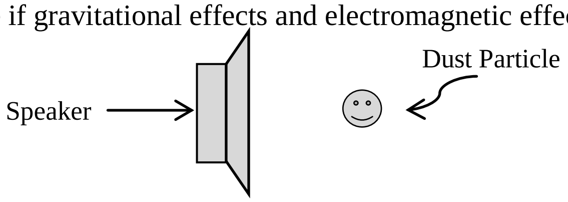


22. This apparatus demonstrates the concept of
(A) Refraction (B) Diffraction (C) Dispersion
(D) Chromatic Aberration (E) Particle nature of light

23. The green laser is now replaced with one of lower frequency, but the slits and screen remain the same. What happens to the bright and dark patterns on the screen?
(A) The bands remain in the same positions, but become narrower.
(B) The bands remain in the same positions, but become broader.
(C) The bands move closer to the central band, becoming closer together.
(D) The bands move further from the central band, increasing the distance between them.
(E) There is no change in the location or size of the bands.

24. The straight line path difference from each slit to the first bright band to the left of the central bright band is
(A) $\frac{\lambda}{2}$ (B) λ (C) 2λ (D) $\sqrt{2}\lambda$ (E) $\frac{\lambda}{\sqrt{2}}$

25. As shown below, a small dust particle is suspended motionless in air directly in front of a powerful audio speaker. When the speaker is switched on, it emits a loud obnoxious sound that some teenagers call "music." What happens to the dust particle if gravitational effects and electromagnetic effects from the magnet of the speaker are ignored?



(A) It will not interact with the sound and remain stationary.
(B) It will move steadily with uniform motion to the right away from the speaker.
(C) It will move with non-uniform motion to the right away from the speaker.
(D) It will oscillate vertically to the beat of the music.
(E) It will oscillate horizontally to the beat of the music.

FIRST YEAR PHYSICS **Salmon test**

APRIL, 2014

SOLUTIONS

Record the % correct onto the area record

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

PHYSICS 1 for All First year Students in physics. If you are taking physics for the first time, then sign up for physics I. 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, equilibrium of forces and torques, simple machines, plus previous topics

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

APRIL: electrical charges 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 previous topics.

Dates for 2014 Season

Thursday April 10, 2014

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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 2015 Season

Thursday January 8, 2015 Thursday February 12, 2015

Thursday March 12, 2015 Thursday April 9, 2015