NJSL Physics I **Salmon test**

JANUARY 15, 2015

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.

This exam is not for any ap level students.

1. A Fizzix textbook salesman travels 40-km due north and then 30-km due south on the daunting Garden State Parkway. What is the ratio of the distance the salesman traveled to the displacement of the salesman?

(A) 1/7 (B) 1/1 (C) 7/1 (D) 1/35 (E) 35/1

2. Two dragsters at Englishtown Raceway, NJ, both start from rest and accelerate at the same constant rate in straight paths. Dragster 1 accelerates for 2 seconds when the engine fails. Dragster 2 accelerates for 8 total seconds and wins the race. If the distance moved by Dragster 1 *while accelerating* is called $\boldsymbol{d_1}$, how far does Dragster 2 move *while accelerating*?

(A) 2$\boldsymbol{d_1}$ (B) 4 $\boldsymbol{d_1}$ (C) 8 $\boldsymbol{d_1}$ (D) 16 $\boldsymbol{d_1}$ (E) 32 $\boldsymbol{d_1}$

3. The time rate of change of velocity is

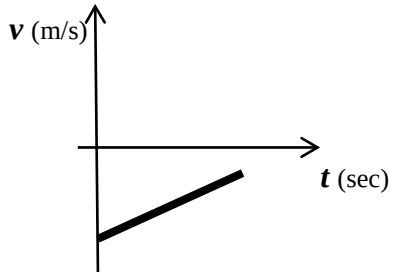
(A) displacement (B) distance (C) average velocity (D) instantaneous velocity (E) acceleration

4. You are driving on an incredibly straight flat section of *I-95* heading due north at a constant speed of 40 km/hr. Well ahead of you is another car traveling due south at 60 km/hr. If the initial distance between you and the other car is 100 km (yes, an *incredibly* straight flat section of *I-95*…), how much time goes by till you are both at the same mile marker ("side-by-side" even though you are each heading in opposite directions)?

(A) 30 minutes (B) 1 hour (C) 1.5 hours (D) 2.5 hours (E) 5 hours

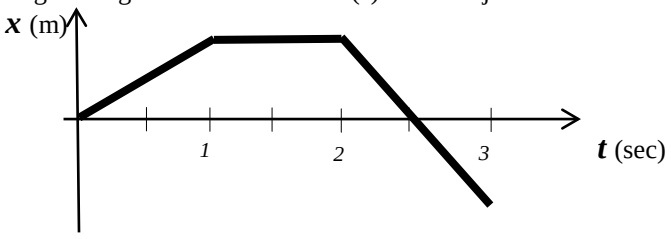
5. The graph shown below represents an object confined to moving along an x-axis. Which one of the descriptions provided best represents just what this object is doing?

(A) It is moving to the right while speeding up.
(B) It is moving to the right while slowing down.
(C) It is stationary.
(D) It is moving to the left while speeding up.
(E) It is moving to the left while slowing down.



6. The graph shown below represents an object moving along a straight line. At what time(s) is this object at rest?

(A) t = 0 (B) between t = 1 and t = 2 sec
(C) t = 2.5 sec (D) from t = 2 to t = 3 sec
(E) There is not enough information to answer.



7. A soccer ball is kicked vertically straight upward with an initial speed of 30 m/s. How long is the soccer ball in the air?

(A) 3 sec (B) 6 sec (C) 10 sec (D) 30 sec (E) There is not enough information to answer.

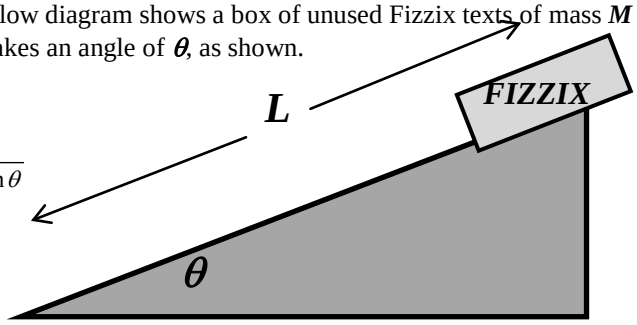
8. Three identical tennis balls are taken to the top of a tall building. Ball ***A*** is fired from a tennis ball machine horizontally with an initial speed of v_i , Ball ***B*** is shot at an angle of 45^o above the horizontal at the same initial speed v_i , and Ball ***C*** is dropped from rest. Which of the following descriptions is true?
(A) ***A*** & ***B*** hit the ground at the same time and ***C*** hits later.
(B) ***A*** & ***B*** hit the ground at the same time and ***C*** hits earlier.
(C) ***A*** & ***C*** hit the ground at the same time and ***B*** hits later.
(D) ***A*** & ***C*** hit the ground at the same time and ***B*** hits earlier.
(E) All three balls hit at the same time.

9. Which expression below would determine the horizontal displacement from the base of the building of Ball ***A*** in #8 above given the height of the building is ***h***?
(A) $v_i\sqrt{\frac{2h}{g}}$ (B) $v_i\sqrt{\frac{h}{2g}}$ (C) $v_i\sqrt{\frac{h}{g}}$ (D) $\sqrt{2gh}$ (E) $2\sqrt{2gh}$

10. You are using an "old-fashioned" well to raise a 30-N bucket of water. The massless rope has a breaking "strength" of 90-N. What is the largest acceleration you can provide to the bucket via the rope without breaking the rope?
(A) 3 m/s^2 (B) 6 m/s^2 (C) 10 m/s^2 (D) 15 m/s^2 (E) 20 m/s^2

11. Two identical masses are isolated away from any influence other than their mutual gravitational attraction, ***F***. If you double each mass and cut the distance between them in half, what is the new gravitational attraction between these masses compared to ***F***?
(A) $\frac{F}{16}$ (B) $\frac{F}{4}$ (C) F (D) $4F$ (E) $16F$

Use the following information for Questions #12, 13, 14. The below diagram shows a box of unused Fizzix texts of mass ***M*** released from rest at the top of an incline plane of length ***L*** that makes an angle of θ, as shown.



12. Assuming a frictionless surface, what is the speed of the box when it reaches the bottom of the incline?
(A) $\sqrt{2Lg\sin\theta}$ (B) $\sqrt{2Lg\cos\theta}$ (C) $\sqrt{2Lg\tan\theta}$
(D) $2Lg\sin\theta$ (E) $2Lg\cos\theta$

13. Now, assuming a coefficient of kinetic friction of μ_k, What speed does the box have when reaching the bottom of the incline?
(A) $\sqrt{2Lg(\sin\theta-\mu_k\cos\theta)}$ (B) $\sqrt{2Lg(\sin\theta+\mu_k\cos\theta)}$ (C) $\sqrt{2Lg(\mu_k\cos\theta-\sin\theta)}$
(D) $\sqrt{2Lg(\mu_k\cos\theta+\sin\theta)}$ (E) $\sqrt{2Lg(\tan\theta-\mu_k)}$

14. Given the coefficient of static friction is μ_s, which expression below would represent the maximum angle of the incline and still have the box remain stationary at the top of the incline?
(A) $\sin^{-1}\mu_s$ (B) $\cos^{-1}\mu_s$ (C) $\tan^{-1}\mu_s$ (D) $\cot^{-1}\mu_s$ (E) $\csc^{-1}\mu_s$

15. According to the work-energy theorem, if the *net* work done on an object is zero for some time interval, the object *must*
(A) be at rest (B) be accelerating (C) be decelerating (D) have a change in potential energy
(E) have no change in kinetic energy

16. For a Physics class field trip, you have traveled to a newly discovered trans-Neptunian planet named *Joizzee*. This planet has **½** the mass of Earth and **½** the radius of Earth. What is the acceleration of gravity on the surface of *Joizzee*?
(A) 2.5 m/s^2 (B) 5 m/s^2 (C) 10 m/s^2 (D) 20 m/s^2 (E) 80 m/s^2

17. Your favorite 75-kg physics teacher is ice-skating and decides to perform an experiment. She picks up and holds a 25-kg metal mass she just happens to have with her and begins coasting at a speed of 5 m/s in a straight line. At some point while coasting, she throws the mass at a speed of 5 m/s forward in the direction of her motion relative to her. How fast is your favorite physics teacher moving after throwing the mass?
(A) 1 m/s (B) 2.3 m/s (C) 2.7 m/s (D) 3.3 m/s (E) 3.7 m/s

18. The diagram below represents a semi-circular loop as part of an amusement park ride at Great Adventure™. If you and a few friends are in a cart, of total mass ***M***, that starts at rest at the position shown, at height equal to the radius of the semi-circle ***R***, what is the normal force experienced at the bottom of the semi-circle? Ignore friction.
(A) $2gR$ (B) $\sqrt{2gR}$ (C) Mg (D) $2Mg$ (E) $3Mg$

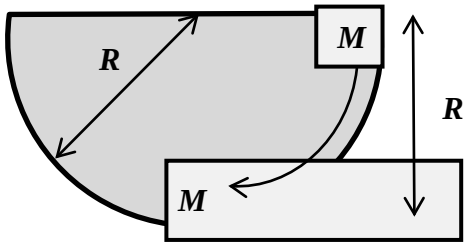
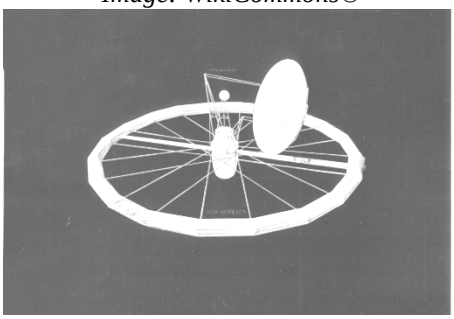


Image: WikiCommons©



19. The classic movie, *2001: A Space Odyssey*, was a 1968 Stanley Kubrick depiction of a future proposed in an Arthur C. Clark novel. In the movie, there are spinning wheel-shaped space stations depicted where the human occupants inside the "wheel" experience simulated gravity due to this spinning. One such station actually designed by 1964 scientists is depicted below.

If the radius of this rotating space wheel is 100-m, find the approximate speed of an occupant on the outside rim that would experience a simulated acceleration of gravity equal to that on the surface of Earth.
(A) 10 m/s (B) 21 m/s (C) 32 m/s
(D) 43 m/s (E) 54 m/s

20. Which of the following expressions could be used to calculate the mass of a star that has a planet in stable circular orbit around it with period ***T*** and orbital radius ***R***?

(A) $\frac{2\pi R}{GT}$ (B) $\frac{4\pi^2 R^2}{G^2 T^2}$ (C) $\frac{4\pi^2 R^3}{G^2 T^2}$ (D) $\frac{4\pi^2 R^2}{GT^3}$ (E) $\frac{4\pi^2 R^3}{GT^2}$

Use the following information for Questions #21, 22, 23. According to the US Army, in 1955, a paratrooper fell 370-m during a training mission and his parachute never opened! Luckily, he landed in a deep snow drift and created a hole 2-m deep and walked away with only a few bruises. Assume his terminal velocity was 50 m/s and his mass was 80-kg.

21. Calculate the work done by the snow drift in bringing him to rest.

(A) 1×10^5 J (B) 2×10^5 J (C) 1×10^3 J (D) 2×10^3 J (E) 5×10^3 J

22. Calculate the average force exerted on him by the snow drift.

(A) 1×10^4 N (B) 2×10^4 N (C) 4×10^4 N (D) 5×10^4 N (E) 5×10^5 N

23. Calculate the power expended during his deceleration.

(A) 1.25 MW (B) 2 MW (C) 2.5 MW (D) 3 MW (E) 3.5 MW

24. It is firmly believed that a supermassive black hole resides at the center of our own Milky Way galaxy as well as every other large galaxy. Data shows many stars orbiting an invisible extremely massive object at the center of our galaxy. One such star is *SO2*, for *Sagittarius Object 2* with an orbital period of 15.2 earth years and an average orbital radius of 17 light-hours (1.5×10^{14} m). Calculate the mass of this invisible supermassive black hole that *SO2* is orbiting.

(A) 2×10^{30} kg (B) 9×10^{30} kg (C) 2×10^{36} kg (D) 9×10^{36} kg (E) 2×10^{40} kg

25. What is the highest speed a 1000-kg car can negotiate a non-banked circular interstate ramp of radius 100-m, if the coefficient of static friction between the tires and road surface is 0.4?

(A) 5 m/s (B) 11 m/s (C) 16 m/s (D) 20 m/s (E) 24 m/s

NJSL Physics I **Salmon test**

JANUARY 15, 2015

SOLUTIONS

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

FIRST YEAR PHYSICS **Salmon test**

FEBRUARY 12, 2015

This exam is not for any ap level students.

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.

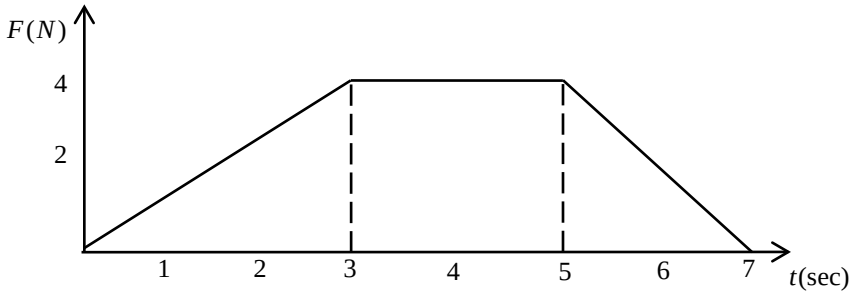
Use: g =10 m/s^2.

ADDITIONAL INFORMATION: All axes of rotation are taken to be at the center of mass.

Moment of Inertia of a *solid disc*: $\frac{1}{2}MR^2$ Moment of Inertia of a *hollow disc* (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. An object experiences a force as represented in the accompanying graph of force as a function of time. What is the change in the momentum of the object from ***t*** = 0 to ***t*** = 7 seconds?



(A) 4 $kg \cdot m/s$ (B) 14 $kg \cdot m/s$ (C) 18 $kg \cdot m/s$ (D) 28 $kg \cdot m/s$

Use the following information for Questions #2 & 3: During an action movie scene, our hero of mass ***M*** is gliding on ice (no friction) at a constant speed of v_o sitting on a sled of mass ***M***. Just as our hero glides under a bridge, our villain, coincidentally of mass ***M***, drops onto the back of our hero's sled from a height of ***h***.

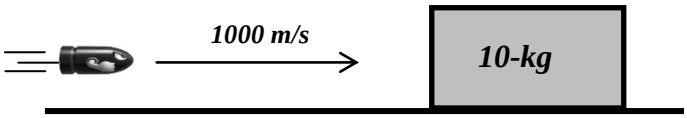
2. What is the resulting speed of the sled-hero-villain system in terms of v_o?

(A) $\frac{v_o}{2}$ (B) $\frac{2v_o}{3}$ (C) $\frac{3v_o}{2}$ (D) $\frac{5v_o}{2}$

3. What is the ratio of the initial ***KE*** to the final ***KE*** of the sled-hero-villain system?

(A) $\frac{3}{2}$ (B) $\frac{2}{3}$ (C) 1 (D) $\frac{1}{2}$

Use the following information for Questions #4 & 5: A 2-kg pistol fires a 1-g bullet with a muzzle speed (speed leaving the end of the barrel) of 1000 m/s. The bullet then strikes and embeds into a 10-kg wooden block resting on a horizontal frictionless surface.



4. The gunpowder explosive acts for a mere $\frac{1}{1000}$ sec. What is the average force exerted on the bullet by the explosion while in the barrel?

(A) 0.001 N (B) 1 N (C) 100 N (D) 1000 N

5. What is the speed of the bullet-block system immediately after the bullet embeds in the block?

(A) 0.1 m/s (B) 10 m/s (C) 100 m/s (D) 1000 m/s

6. Imagine the alien mother-ship is in orbit about Earth in a stable circular orbit of radius $\boldsymbol{R}$ and constant speed $\boldsymbol{v}$. It must quickly maneuver to a circular orbit of radius $2\boldsymbol{R}$ in order to escape the last-ditch attack effort from a high-paid Hollywood action hero. In terms of $\boldsymbol{v}$, what must be the new speed at the larger radius in order to hold a stable circular orbit?

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

7. A bicyclist is pedaling at a constant speed along a horizontal road. The bicycle wheels are 1-m in diameter and are rotating at a rate of 120 RPM (Revolutions/Minute). What is the linear speed of the bicycle?

(A) π m/s (B) 2π m/s (C) 4π m/s (D) 8π m/s

8. A nearby star has a mass of 5 times our Sun, $\boldsymbol{M_{Sun}}$. One of the planets orbiting this nearby star has a mass of 5 times the Earth, $\boldsymbol{M_E}$, and an average orbital radius of 5 times the orbital radius of Earth, $\boldsymbol{R_E}$. What is the orbital period of this planet in terms of Earth years?

(A) $\sqrt{5}$ (B) 5 (C) 25 (D) 125

9. The world's largest Ferris wheel is the High Roller Ferris Wheel in Las Vegas, NV. It has a diameter of a whopping 158m (more than 1 ½ soccer field lengths!) and a total of 30 minutes per non-stop revolution. In an emergency, it can be stopped from this operating speed in 20 seconds. What tangential acceleration do the passengers feel during this stopping timeframe?

(A) $1.7x10^{-4}\ m/s^2$ (B) $3.5x10^{-3}\ m/s^2$ (C) $1.4x10^{-2}\ m/s^2$ (D) $2.8x10^{-2}\ m/s^2$

10. A DVD is spinning in a DVD player in a clockwise direction as seen from the accompanying overhead view. In what direction, relative to the plane of the disc, is the angular momentum vector?

(A) To the left.
(B) To the right.
(C) Out of the plane of the page.
(D) Into the plane of the page.

Use the following information for Questions #11 & 12: A solid ball of uniform density, radius $\boldsymbol{r}$, and mass $\boldsymbol{m}$ is released from rest at the top of an inclined ramp and rolls without slipping. The ramp is inclined at an angle $\boldsymbol{\theta}$ above the horizontal and has a length of $\boldsymbol{L}$.

11. Which of the following expressions correctly identifies the speed of the ball when reaching the bottom of the ramp? Express your answer in terms of only the variables given and universal constants.

(A) $\sqrt{\frac{10gL\sin\theta}{7}}$ (B) $\sqrt{\frac{7gL\sin\theta}{10}}$ (C) $\sqrt{2gh}$ (D) $\sqrt{2gL\sin\theta}$

12. If this solid ball is replaced by a hollow ball of the same mass and radius, will the speed at the bottom of the same ramp be the same, less, or more than the solid ball speed?

(A) The same (B) More because the hollow ball has more rotational inertia.
(C) Less because the solid ball has more rotational inertia. (D) Less because the solid ball has less rotational inertia.

13. After a supernova explosion, the remaining collapsed core of the now dead star, normally a neutron star, has a rotational frequency drastically larger than the original star. In a typical collapsed core, the mass is twice that of our own Sun and only about the size of Manhattan, roughly 10-km in diameter with a rotation of more than 500 revolutions per second! What is the reason for such a large rotational velocity?

(A) The angular momentum of the system must increase. (B) The kinetic energy of the system must remain the same.
(C) The angular momentum of the system must remain the same. (D) The system must obey Newton's First Law of Motion.

Use the following information for Questions #14 & 15:

14. A solid disc, of NHL regulation diameter ***D*** and mass ***M***, is moving on a frictionless ice surface under the influence of only the three forces shown, each of the same magnitude, ***F***. What is the net torque acting on the disc?

(A) Zero

(B) $\frac{FD}{2}$

(C) FD

(D) $\frac{3FD}{2}$

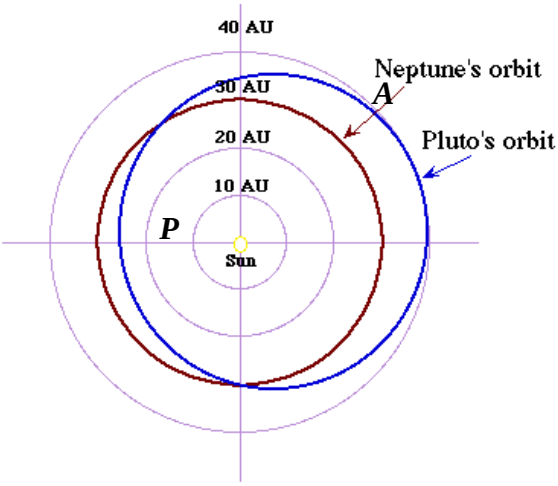
15. What is the acceleration of this puck across the ice?

(A) Zero (B) $\frac{F}{M}$ (C) $\frac{2F}{M}$ (D) $\frac{F}{2M}$

16. A 100-kg man and his 20-kg child are contemplating getting on a 6-m long see-saw made from a very light plastic at the local park. Each wants to sit at the very end of the see-saw. Where should the fulcrum be placed under the see-saw plank so this can be accomplished and the system remain in equilibrium?

(A) In the middle (B) 1-m from the man (C) 1-m from the child (D) 5-m from the man

17. One of the many reasons Pluto had its Planetary Society Membership Card revoked is due to the extreme eccentricity of its orbit about the sun. The image below shows a comparison of the orbits of Pluto and Neptune.

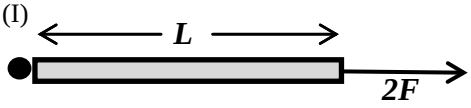


As Pluto moves in the orbit from ***Point P*** (perihelion) to ***Point A*** (aphelion), which of the following pairs correctly describes the orbital speed and the angular momentum of Pluto?

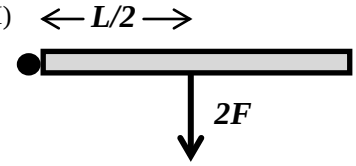
	Speed	***Angular Momentum***
(A)	Remains Constant	Remains Constant
(B)	Decreases	Increases
(C)	Increases	Decreases
(D)	Decreases	Remains Constant

18. A diagrams below show different forces acting on a door of length ***L*** that hinges on the left. Each is an overhead view. Which pair of diagrams would produce equal torques about the hinge to the left?

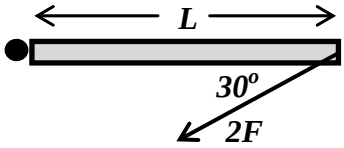
(I)



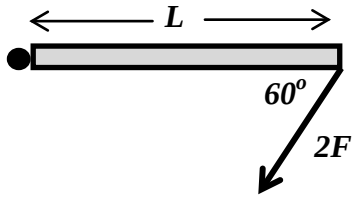
(II)



(III)



(IV)



(A) I & III only (B) II & III only (C) III & IV only (D) No two produce the same torque

19. A merry-go-round initially at rest is pushed by an energetic child that provides a constant angular acceleration ***α***. After one complete revolution, the merry-go-round will have an angular velocity that can be expressed by which of the following?

(A) $2\pi\alpha$ (B) $4\pi\alpha$ (C) $\sqrt{4\pi\alpha}$ (D) $\sqrt{2\pi\alpha}$

20. A car is moving on a level horizontal road at a constant speed. Each wheel of this car has mass ***M***, radius ***R***, and rolls without slipping with angular velocity of ***ω***. Which of the following expressions correctly represents the linear momentum of each wheel?

(A) $M\omega R$ (B) $M\omega^2 R$ (C) $M\omega R^2$ (D) $M\omega^2 R^2$

21. 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 v_{max}. The force constant of the spring is:

(A) $\frac{Mgv_{\max}}{A}$ (B) $\frac{Mv_{\max}}{A^2}$ (C) $\frac{Mv_{\max}^2}{A}$ (D) $\frac{Mv_{\max}^2}{A^2}$

22. An object is projected vertically upward from ground level. It rises to a maximum height ***H***. If air resistance is negligible, which of the following must be true for the object when it is at a height ***H***/2 ?

(A) Its speed is half of its initial speed.
(B) Its kinetic energy is half of its initial kinetic energy.
(C) Its potential energy is half of its initial potential energy.
(D) Its total mechanical energy is half of its initial value.

23. A block of mass ***M*** on a horizontal surface is connected to the end of a massless spring of spring constant ***k*** . The block is pulled a distance ***x*** from equilibrium and when released from rest, the block moves toward equilibrium. What coefficient of kinetic friction between the surface and the block would allow the block to return to equilibrium and stop?

(A) $\frac{kx^2}{2Mg}$ (B) $\frac{kx}{Mg}$ (C) $\frac{kx}{2Mg}$ (D) $\frac{Mg}{2kx}$

24. A boy of mass ***m*** and a girl of mass 2***m*** are initially at rest at the center of a frozen pond. They push each other so that she slides to the left at speed ***v*** across the frictionless ice surface and he slides to the right. What is the total work done by the children?

(A) mv^2 (B) $2mv^2$ (C) $3mv^2$ (D) Zero

25. Two iron spheres separated by some distance have a minute gravitational attraction, ***F***. If the spheres are moved to one half their original separation and allowed to rust so that the mass of each sphere increases 41%, what would be the resulting gravitational force?

(A) $2F$ (B) $4F$ (C) $6F$ (D) $8F$

NJSL Physics I **Salmon test**

FEBRUARY 12, 2015
SOLUTIONS

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

NJSL Physics I **Salmon test**

This exam is not for any ap level students.

MARCH 12, 2015

***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, $L_F = 80\,{}^{cal}/_{g} = 3.35x10^5\,{}^{J}/_{kg}$

Latent Heat of Vaporization of water, $L_v = 540\,{}^{cal}/_{g} = 2.26x10^6\,{}^{J}/_{kg}$

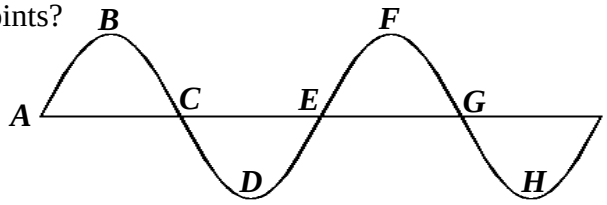
Specific Heat Capacity of liquid water, $c = 1\,{}^{cal}/_{g\cdot C^o} = 4186\,{}^{J}/_{kg\cdot C^o}$

Specific Heat Capacity of water ice, $c = 0.5\,{}^{cal}/_{g\cdot C^o} = 2100\,{}^{J}/_{kg\cdot C^o}$

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

1 atm = 1x10^5 Pa

1. The sketch below represents a simple transverse physical wave. The wavelength of this wave is equal to the distance between which two points?



(A) *A* to *G* (B) *B* to *D* (C) *C* to *E* (D) *C* to *G* (E) *A* to *C*

2. A certain vibration on a string clamped at both ends has an overtone of 1980 *Hz*. Which of the following could be the fundamental frequency of the string?

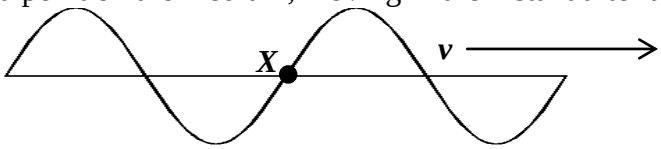
(A) 660 Hz (B) 1320 Hz (C) 2970 Hz (D) 3960 Hz (E) 5940 Hz

3. A system comprised of an ideal spring and a mass undergo simple harmonic motion. While oscillating, the mass reaches a maximum speed of 9 m/s. What is the amplitude of oscillation?

(A) 0.17 m (B) 0.3 m (C) 1.7 m (D) 3 m

(E) Can't determine without more information.

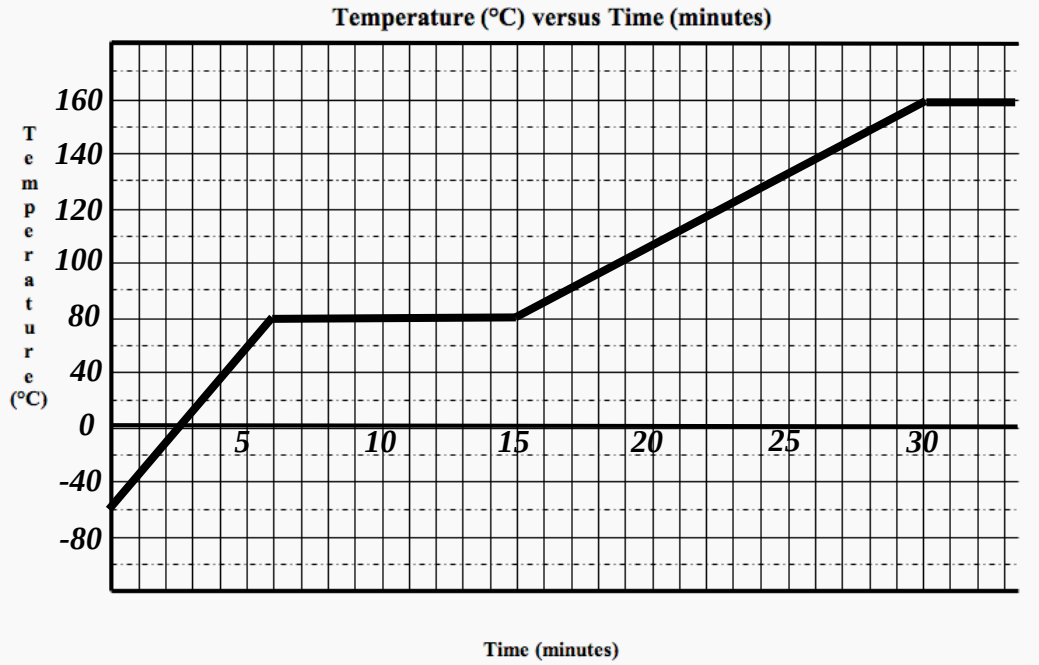
4. The sketch below represents a simple transverse physical wave traveling to the right as noted. In what direction is ***Point X***, representing a point on the medium, moving in the instant after this sketch shows?



(A) Up (B) Down (C) Right (D) Left

(E) Can't determine without more information.

Use the following info for Questions #5 - #7: During a physics Lab activity, you are provided a 2-kg sample of an unknown solid which your teacher found in a glowing green meteorite that has been kept in deep freeze. You are to determine what the material is made from. You set up a lab experiment so that you can supply a constant 100 J/s of heat energy to the sample and are reasonably confident no energy escapes into the environment. After taking data for a long period of time, you construct the following temperature as a function of time graph.



Background graph: Wiki Commons

5. Which of the following statements is correct about this strange substance?
(A) It melts at 160°C (B) It melts at - 60°C (C) It is only a liquid at 80°C
(D) It is a solid, a liquid, and a gas at 80°C (E) It is a liquid and a gas at 160°C

6. What is the latent heat of fusion of this glowing green toxic thing your teacher gave you?
(A) 80 J/kg (B) 5,400 J/kg (C) 8,000 J/kg (D) 27,000 J/kg (E) 54,000 J/kg

7. What is the specific heat of this solid glowing green toxic thing your teacher gave you?
(A) 13 J/Kg^oC (B) 130 J/Kg^oC (C) 1300 J/Kg^oC (D) 56 J/Kg^oC (E) 560 J/Kg^oC

8. Which statement is true regarding the internal energy of an ideal monatomic gas?
(A) proportional to the pressure and inversely proportional to the volume of the gas.
(B) independent of the number of moles of the gas.
(C) proportional to the absolute temperature of the gas.
(D) dependent on both the pressure and the absolute temperature of the gas.
(E) a constant that is independent of pressure, volume or absolute temperature.

9. A large ice-cube container that holds 1000 ml of pure water at 20 °C is placed in a freezer which has an internal constant temperature of -20°C. After a short time period, the water freezes and everything within the freezer is once again in thermal equilibrium. How much heat is extracted from the water in this freezing water process?

(A) 48 KJ (B) 100 KJ (C) 335 KJ (D) 460 KJ (E) 550 KJ

10. Radon gas is found in your basement. For a class show-and-tell, you collect it in a sturdy non-expandable non-collapsible vessel. It is initially at 32°C and kept at constant volume at a pressure $\boldsymbol{P_i}$. The radon is then cooled down to −78°C where it has a new pressure $\boldsymbol{P_f}$. What is the ratio of P_i / P_f ?

(A) 0.41 (B) 0.64 (C) 0.717 (D) 1.28 (E) 1.56

Use the following info for Questions #11 & #12: A heat engine operates between a hot reservoir at 1200 *K* and a cold reservoir at 300 *K*. During each full cycle 100,000 J of heat is removed from the hot reservoir and 50,000 J of work is performed.

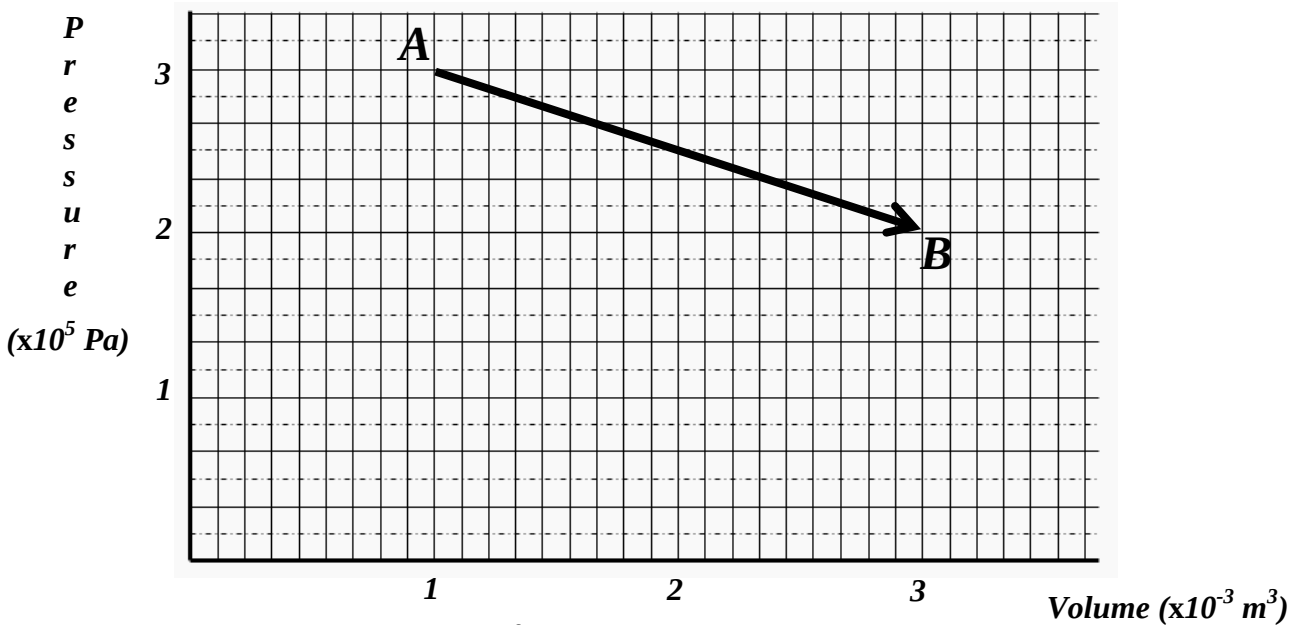
11. What is the actual efficiency of this engine?

(A) 0.10 (B) 0.20 (C) 0.33 (D) 0.50 (E) 0.75

12. Determine the Carnot (ideal) efficiency of this engine.

(A) 0.10 (B) 0.20 (C) 0.33 (D) 0.50 (E) 0.75

Use the following info for Questions #13 & #14: Two moles of an ideal monatomic gas originally in state ***A*** is taken reversibly to state ***B*** along the straight line path shown in the ***PV*** diagram below.



13. How much work is done on or by the gas for process $\boldsymbol{A \rightarrow B}$?

(A) 100 J *by* the gas (B) 500 J *by* the gas (C) 500 J *on* the gas (D) 1000 J *by* the gas (E) 1000 J *on* the gas

14. What is the magnitude of the change in temperature of the gas from ***A*** to ***B***?

(A) 18 K (B) 36 K (C) 54 K (D) 72 K (E) 108 K

15. Shortly after the "Great Blizzard of 2015" that dumped all of 3" of snow on NJ, the entire area was plunged into a long-lasting deep freeze. One of the consequences of such extreme cold is the minor damage it can cause to real aluminum siding of houses. The typical aluminum siding strips, before cutting to fit, used today is 20.00-m long on a typical 33°C NJ summer day. If the coefficient of linear expansion of aluminum is $22.20x10^{-6}\,K^{-1}$, what is the length of this 20-m strip on a "Polar Express" –20°C day?

(A) 19.00-m (B) 19.98-m (C) 20.00-m (D) 20.02-m (E) 20.98-m

16. A mass ***M*** is dropped from rest from a height h above a floor. It bounces from the floor back up to a maximum height of $\frac{3}{4}h$. If we assume all of the "lost" mechanical energy is transformed to heat energy, which of the following expressions can be used to find the specific heat of the material given the temperature of the mass increases by ΔT?

(A) $\frac{3gh}{4\Delta T}$ (B) $\frac{4gh}{\Delta T}$ (C) $\frac{gh}{4\Delta T}$ (D) $\frac{Mgh}{4\Delta T}$ (E) $\frac{3Mgh}{4\Delta T}$

17. What is the change in internal energy on a system if the following four processes are performed in order:

1. 500 J of heat is added
2. 200 J of work is done by the system
3. 200 J of heat is exhausted from the system
4. 750 J of work are done on the system

(A) +250 J (B) –250 J (C) +850 J (D) –850 J (E) +1650 J

18. A mass ***M*** is attached to a vertical spring and allowed to oscillate in simple harmonic motion at a frequency ***f***. The spring has a spring constant of ***k***. Which of the following actions would result in a frequency of 2***f*** while using the same spring?

(A) Double the amplitude of oscillation.
(B) Quadruple the amplitude of oscillation.
(C) Decrease the amplitude by a factor of two.
(D) Replace the mass with one of 4***M***.
(E) Replace the mass with one of ¼ ***M***.

19. Similar to Question #18 above, but for a pendulum. A mass ***M*** oscillates with frequency ***f*** in simple harmonic motion as a simple pendulum while attached to the end of a string of length ***L***. Which of the following actions would result in a frequency of 2***f*** ?

(A) Double the amplitude of oscillation.
(B) Replace the mass with one of 4***M***.
(C) Replace the mass with one of ¼ ***M***.
(D) Replace the string with one of length 4***L***.
(E) Replace the string with one of length ¼ ***L***.

20. What type of physical wave is described by the particles of the medium vibrating only perpendicularly to the wave direction?

(A) Longitudinal
(B) Transverse
(C) Compressional
(D) Surface Waves
(E) Electromagnetic waves

21. Compared to the wavelength λ of an incident sound wave, what is the shortest length of tube closed at one end and open at the other that will resonate under that sound wave?

(A) λ (B) $\lambda/2$ (C) $\lambda/4$ (D) 2λ (E) 4λ

22. On a certain musical string instrument, a fundamental frequency of 440 Hz occurs when the wave speed on the string is 220 m/s. Assuming the strings are clamped in place at both ends, what is the length of this string?

(A) 0.25-m (B) 0.5-m (C) 1-m (D) 1.5-m (E) 2-m

Use the following information for Questions #23 – 25: Five pendula are set up for a class demonstration. Each consists of a string and an attached mass. Lengths of the string and the mass attached are provided as factors of a base length ***L*** and mass ***M***.

	Length	***Mass***
A	$L/2$	M
B	$L/2$	$2M$
C	L	M
D	L	$2M$
E	$2L$	$2M$

23. Which pendulum or pendula would experience the largest period of oscillation, if each is raised to the same initial vertical height?
(A) A (B) B (C) C (D) D (E) E

24. Which pendulum or pendula would experience the largest frequency of oscillation, if each is raised to the same initial vertical height?
(A) A & B (B) C & D (C) A & C (D) B, D, & E (E) E only

25. Which pendulum or pendula would experience the largest maximum velocity when released from rest, if each is raised to the same initial vertical height?
(A) A & B (B) C & D (C) A & C (D) B, D, & E (E) All are equal

FIRST YEAR PHYSICS **Salmon test**

MARCH 12, 2015

SOLUTIONS

Record onto the area record the # correct (Corrections None)

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

NJSL Physics I **Salmon test**

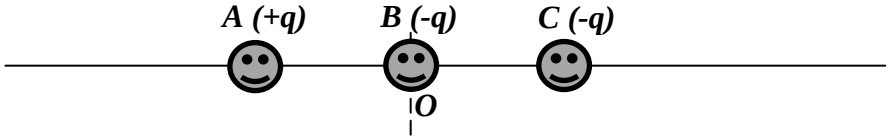
APRIL 9, 2015

This exam is not for any ap level students.

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.

ADDITIONAL INFORMATION: Use: g =10 m/s^2**.** Fundamental charge: $e = 1.6x10^{-19}C$

1. The three point charges of equal magnitude ***q*** and indicated polarity, shown below lie on the x-axis and the origin, ***O***, as indicated. Which charge has the largest net electric force acting on it? Assume the only forces on each charge are caused by the other charges.



(A) A (B) B (C) C (D) Both B & C

2. After combing her hair on a particularly dry day, Mary's comb has a net charge of -6.4 μC. How many electrons have to be taken away from the comb to make it neutral once again?
(A) 3 x 10^6 (B) 4 x 10^{13} (C) 4 x 10^{16} (D) 6.25 x 10^{18} (E) 1.6 x 10^{19}

3. Four positive charges of equal magnitude ***+q*** are arranged at the corners of a square. At the center of the square, the potential due to *one charge alone* is $\boldsymbol{V_o}$ and the electric field due to *one charge alone* has magnitude $\boldsymbol{E_o}$. Which of the following correctly gives the net electric potential and the magnitude of the net electric field at the center of the square due to all four charges?

	Net Electric Potential	***Net Electric Field***
A	Zero	Zero
B	Zero	2 $\boldsymbol{E_o}$
C	2 $\boldsymbol{V_o}$	4 $\boldsymbol{E_o}$
D	4 $\boldsymbol{V_o}$	Zero
E	4 $\boldsymbol{V_o}$	2 $\boldsymbol{E_o}$

4. Two positive point charges are located on an *x-y* axis calibrated in meters. Both have a charge of +3 μC. Charge ***A*** is located at (0,3) and charge ***B*** is at (3,0). What is the magnitude of the electric field at the origin?
(A) 3 x 10^3 V/m (B) 4.2 x 10^3 V/m (C) 3 x 10^9 V/m (D) 4.2 x 10^9 V/m (E) 9 x 10^3 V/m

5. A light is attached to a 4.5 *V* battery and a current of 0.12 *A* passes through it. What is the resistance of the light?
(A) 0.54 Ω (B) 1.4 Ω (C) 9.3 Ω (D) 28 Ω (E) 38 Ω

6. What is the length of a copper wire that has a resistance of 0.2 Ω, cross section area of 7.85 x 10^{-5} m^2? The resistivity of copper is 1.72 x 10^{-8} Ωm.
(A) 78.5 m (B) 91.3 m (C) 785 m (D) 913 m (E) 91,300 m

7. Which statement below *must* be true for any two or more resistors connected in series?
(A) The current through each resistor is the same.
(B) The power used by each resistor is the same.
(C) The voltage across each resistor is the same.
(D) The total current leaving the battery is the sum of the currents of each resistor.

Use the following for Questions #8 & 9: You are provided a battery that has a constant *emf* and three resistors; a 3Ω, a 6Ω, and an 18Ω.

8. What is the effective resistance of these three resistors when connected in series?

(A) 1.8 Ω (B) 3 Ω (C) 10 Ω (D) 18 Ω (E) 27 Ω

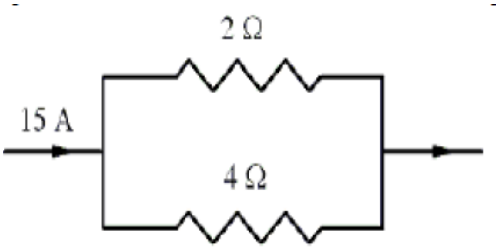
9. What is the effective resistance of these three resistors when connected in parallel?

(A) 1.8 Ω (B) 3 Ω (C) 10 Ω (D) 18 Ω (E) 27 Ω

10. A circuit is set up so it has a battery of 10 V and two lamps rated at 50 Ω each connected in series. What is the total power dissipated by the circuit?

(A) 0.2 W (B) 1 W (C) 5 W (D) 10 W (E) 500 W

11. Part of a circuit is shown below. Which table entry has the correct values?

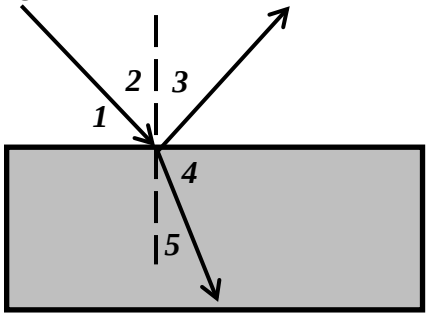


	Current through 2 Ω Resistor	***Voltage Drop across the 4 Ω Resistor***
A	15 A	15 V
B	10 A	10 V
C	5 A	10 V
D	5 A	20 V
E	10 A	20 V

12. A candle is placed on the principal axis in front of a thin converging lens of focal length f. The object is placed at a distance of f/2 from the center of the lens. The image produced is

(A) virtual, upright and larger (B) virtual, upright and smaller
(C) real, inverted and larger (D) real, inverted and smaller
(E) virtual, inverted and larger

13. A monochromatic laser beam of light passes from the air into and through a large pool of water as shown below. Which of the following angles is the angle of refraction? The dotted vertical line represents the normal at the surface.



(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

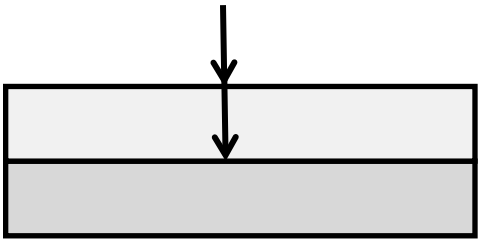
14. The speed of light in a specific material is measured to be 1.5×10^8 m/s. What is the index of refraction for this material?

(A) 2/3 (B) 1 (C) 1.5 (D) 2 (E) 2.5

15. Which of the following colors, when passed through a double-slit opening, will produce the largest separation of bright bands??

(A) red (B) yellow (C) green (D) blue (E) violet

Use the following information for Questions #16 & 17: As imaged below, sunlight on a clear day is perpendicularly incident upon an oil/water slick. The pertinent information is labeled.



16. At which interface does a wave phase shift of 180° occur?
(A) Air – Oil (B) Oil – Water (C) Both Air-Oil and Oil-Water (D) Neither interface
(E) Can't tell without knowing the wavelength of the incoming light.

17. If only green light of wavelength λ is seen coming off the top of the oil surface as viewed from above, what is the minimum thickness of the oil layer?
(A) $\lambda/4$ (B) $\lambda/2$ (C) λ (D) $\sqrt{2}\ \lambda$ (E) 2λ

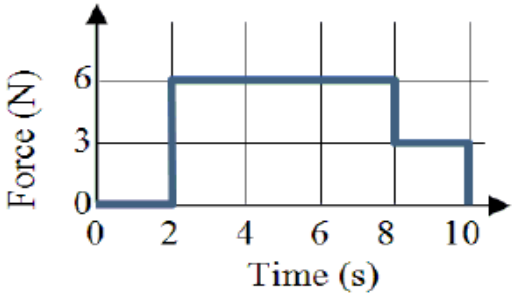
18. When calculating the size of an image, h_i, of an upright object formed by a single optical instrument, what is the meaning of obtaining a value for $h_i < 0$?
(A) The image is to the left of the object. (B) The image is to the right of the object.
(C) The image is upright. (D) The image is inverted.
(E) The image does not exist.

19. You are performing Young's Double Slit Experiment for your class. You provide that the distance between the diffraction slits is 2×10^{-3} *cm* and the screen is located six meters away from the slits. What is the distance on the screen between the central bright spot and the 2nd maximum spot when you shine green laser light of wavelength 532 *nm* through the slits?
(A) 0.027 m (B) 0.08 m (C) 0.16 m (D) 0.24 m (E) 0.32 m

20. When light passes from air (***n*** = 1.00) into oil (***n*** = 1.4), what happens to the speed, wavelength, and frequency of light respectively as it crosses the boundary?

	Speed	***Wavelength***	***Frequency***
A	Remains the same	Decreases	Remains the same
B	Remains the same	Remains the same	Increases
C	Increases	Remains the same	Decreases
D	Decreases	Increases	Remains the same
E	Decreases	Decreases	Remains the same

21. A mass of 4-kg has a variable force applied for a specific time as indicated in the graph below. Assuming the mass started at rest, what is the change in kinetic energy of the mass over the 10 second time interval?
(A) 10.5 J (B) 42 J (C) 110.25 J
(D) 220.5 J (E) 441 J



22. A small bullet of mass ***m*** is fired with initial speed v_o into a large wooden block of mass ***M***. The bullet embeds into the block and the pair (block & bullet) slides along a horizontal surface that has a coefficient of kinetic friction of μ_k. Which of the choices provided would correctly calculate the distance ***d*** the pair slides before coming to rest?

(A) $d = \frac{m}{M+m}\frac{v_o^2}{\mu g}$ (B) $d = \left(\frac{m}{M+m}\right)^2 \frac{v_o^2}{2\mu g}$ (C) $d = \left(\frac{m}{M+m}\right)^2 \sqrt{\frac{v_o^2}{2\mu g}}$ (D) $d = \frac{v_o^2}{\mu g}$ (E) $d = \frac{mv_o^2}{M\mu g}$

23. An artificial satellite in a circular orbit around the Sun has a period of 8 years. Determine the ratio of the orbital radius of the satellite to that of the orbital radius of Earth. Assume that the orbit of Earth around the Sun is circular.
(A) 1 (B) 2 (C) 4 (D) 8 (E) 16

24. A 1500-kg DirecTV *geosynchronous* (remains above the same spot directly over the equator at all times) satellite orbits Earth in a circular orbit of radius 4.2×10^7 m. What is the angular momentum of this satellite in its orbit around Earth? Use $I = MR^2$ for an object in circular orbit.

(A) $1.9x10^{14}\ kg \cdot m^2/s$ (B) $1.1x10^{17}\ kg \cdot m^2/s$ (C) $2.6x10^{18}\ kg \cdot m^2/s$ (D) $3x10^{13}\ kg \cdot m^2/s$
(E) Insufficient information provided to answer.

25. During an exciting and seemingly magical physics class demonstration, your teacher places a test tube inside a beaker half-filled with vegetable oil. Then, by slowly pouring this same vegetable oil into the empty test tube, the teacher apparently makes the test tube disappear!

Image BEFORE inner test tube is filled with oil. You can even notice typical bending of the test tube.
Original photo: D Taylor 2013.

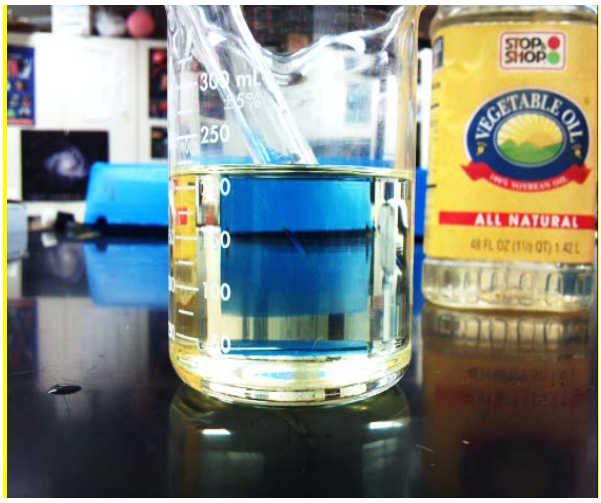


Image AFTER oil is placed inside test tube.
Original photo: D Taylor 2013.

Which of the following is the best explanation for this?
(A) Pyrex has a higher optical index of refraction then does vegetable oil.
(B) Both Pyrex and vegetable oil have the same optical index of refraction.
(C) Pyrex has a lower optical index of refraction then does vegetable oil.
(D) This is a trick best performed by skilled "magicians".
(E) Refraction cannot occur through both Pyrex and an oily liquid.

NJSL PHYSICS 1 **Salmon test**

APRIL 9, 2015

SOLUTIONS

Record onto the area record the % correct (Corrections) none

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