AP PHYSICS I <u>**Salmon**</u>

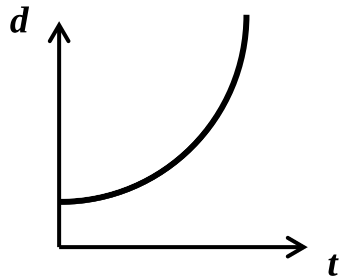
For all students taking AP physics I

JANUARY 14, 2016

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.

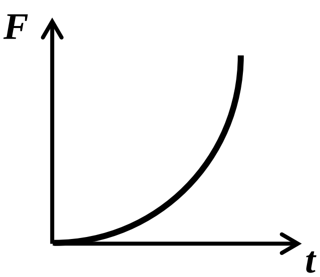
1.

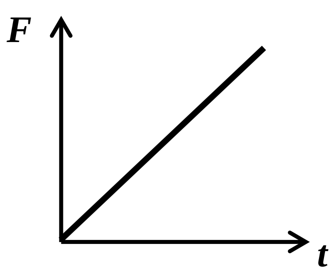


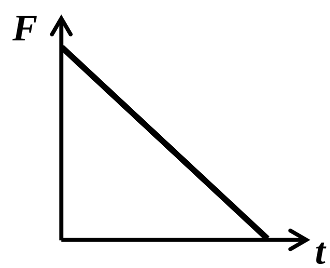
$$d \propto t^2$$

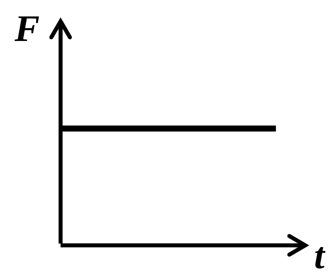
The sketch above represents the *displacement* versus *time* graph of an object constrained to move in one direction. The relationship is $d \propto t^2$. Which of the following graphs would represent the magnitude of the net force acting on the object for the same time period?

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









Use the following information for Questions #2 & #3 : A 5-kg bowling ball is rolled with constant speed ***V*** on the smooth horizontal roof of a tall science building of height ***H***. It rolls off the building.

2. Which of the following expressions correctly represents the horizontal displacement of the ball upon hitting the ground?

(A) $\sqrt{2gH}$ (B) $V\sqrt{2gH}$ (C) $V\sqrt{\frac{2H}{g}}$ (D) $\sqrt{\frac{2H}{g}}$

3. Which of the following expressions correctly represents the magnitude of the final velocity of the ball upon hitting the ground?

(A) $\sqrt{V^2 + 2gH}$ (B) $\sqrt{V^2 + (2gH)^2}$ (C) $V + \sqrt{2gH}$ (D) $V + 2gH$

Use the following information for Questions #4 & #5 : A projectile, capable of being fired at any angle, is launched on level ground at an initial speed of 100 m/s. Ignore air resistance.

4. Which of the following angles measured from the horizontal would produce a horizontal range of 640-m for this projectile?

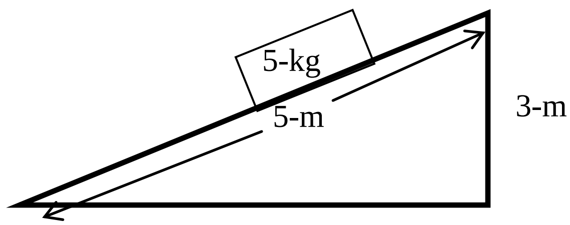
(A) 20° (B) 30° (C) 40° (D) 60°

5. After several data sets are complete, it is noticed that some angles produced the same horizontal range. Which one of the following angles would result in the same horizontal range of a projectile fired at an angle of 15°?

(A) 30° (B) 45° (C) 75° (D) 85°

6. What happens to the horizontal displacement, if you double the initial velocity of a projectile while keeping all other parameters constant? *Assume non-zero parameters*.
(A) It remains the same (B) It also doubles (C) It quadruples
(D) Cannot be determined without more information.

Use the following information for Questions #7 - #9 : The sketch below represents a 5-kg mass on a rough incline of length 5-m, height 3-m, and coefficient of kinetic friction of 0.2.



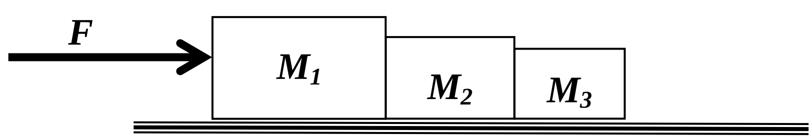
7. With what acceleration will this mass slide down the ramp when released?
(A) $1.6\,{}^{m}\!/\!_{s^2}$ (B) $4.4\,{}^{m}\!/\!_{s^2}$ (C) $6\,{}^{m}\!/\!_{s^2}$ (D) $10\,{}^{m}\!/\!_{s^2}$

8. Once the mass reaches the bottom of the ramp and is stationary, what force would have to be applied parallel to the ramp in order for the mass to move up the ramp at a constant velocity?
(A) 8 N (B) 30 N (C) 38 N (D) 46 N

9. What is the minimum coefficient of *static* friction that would cause this mass to remain stationary when placed on the ramp?
(A) 0.6 (B) 0.75 (C) 0.8 (D) 0.85

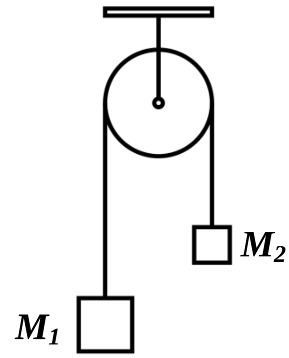
10. During the recent California wildfires, the US Air Force dropped emergency supply packages to stranded farmers who wouldn't leave their livestock. From an altitude of 400-m, packages were dropped at 4 second intervals from a plane flying at a level and constant 80 m/s. Neglecting air resistance, how far apart from each other did these packages land?
(A) 80-m (B) 320-m (C) 400-m (D) 1600-m

11. As shown below, three boxes of unused physics textbooks are sliding to the right across a rough floor at constant speed by a horizontal force of magnitude $\boldsymbol{F}$. The coefficient of sliding friction between the floor and each box is $\boldsymbol{\mu}$. What is the force of $\boldsymbol{M_1}$ on $\boldsymbol{M_2}$?



(A) $\mu(M_2 + M_3)g$ (B) $F - \mu(M_2 + M_3)g$ (C) $\mu M_1 g$ (D) F

Use the following information for Questions #12 & #13 : Below is pictured a basic *Atwood* machine. Two masses, M_1 and M_2, hang from either side of a frictionless massless pulley by a massless string. M_1 = 5-kg and M_2 = 3-kg.



12. Which of the following is the magnitude of the acceleration of M_1?

(A) $2.5\,{}^{m}\!/_{s^2}$ (B) $4\,{}^{m}\!/_{s^2}$ (C) $6.7\,{}^{m}\!/_{s^2}$ (D) $10\,{}^{m}\!/_{s^2}$

13. While the system is in motion, what is the tension in the string holding M_2?

(A) $10N$ (B) $22.5N$ (C) $30N$ (D) $37.5N$

Use the following information for Questions #14 - #17 : A football coach is twirling his large assortment of keys around in a vertical circle at a constant speed at the end of his lanyard (long heavy string). The mass of the keys is 0.5-kg and the length of the lanyard is 50-cm. The keys complete two full revolutions every second.

14. What is the linear speed of the keys at any point?

(A) 1.5 m/s (B) 3.1 m/s (C) 6.3 m/s (D) 12.6 m/s

15. What is the tension in the lanyard at the top of the swing?

(A) 34.5 N (B) 39.5 N (C) 44.5 N (D) 50 N

16. What is the tension in the lanyard at the bottom of the swing?

(A) 34.5 N (B) 39.5 N (C) 44.5 N (D) 50 N

17. If the lanyard slips out of the couch's hand at the instant the keys are at the top of the swing and the coach's hand is one meter above the ground, what horizontal distance do the keys travel before hitting the ground?

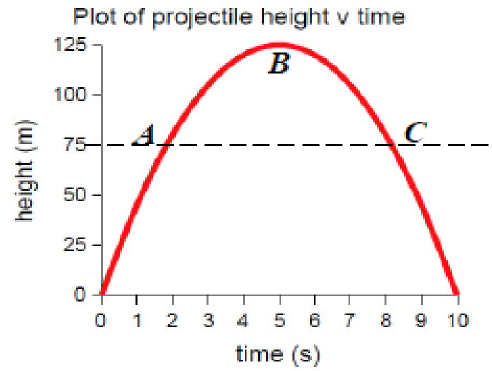
(A) 1.4 m (B) 2.8 m (C) 3.4 m (D) 4.4 m

18. Captain Scott Kelly, pictured below, is an astronaut on board the International Space Station currently undergoing a year-long test to determine the effects of micro-gravity on the human body. His twin brother, Captain Mark Kelly, also an astronaut, is on Earth as a test control.

During one of his many science demonstrations for school kids back on Earth, Kelly twirled a massive bolt of mass $\boldsymbol{M}$ around his head at the end of a string of length $\boldsymbol{L}$. He measured the tension in the string as $\boldsymbol{T}$. He then doubled the mass, the length, and the speed. What was his new measured tension compared to the original $\boldsymbol{T}$?

(A) $\boldsymbol{T}$ (B) $2\boldsymbol{T}$ (C) $4\boldsymbol{T}$ (D) $8\boldsymbol{T}$

Use the following information for Questions #19 - #22 : During a physics experiment, you collected data and constructed a *height* (H) versus *time* (t) graph for a projectile fired from a catapult at an initial angle of 30° above the horizontal. The plot is shown below. Points ***A*** & ***C*** are both at a height of 75m and point ***B*** is the maximum height.



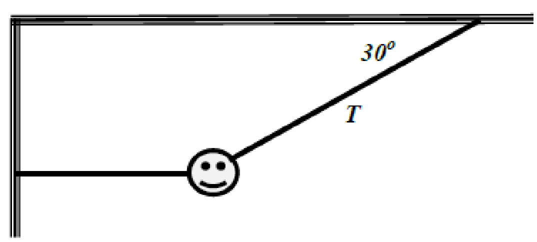
19. At what point(s) is the speed of the projectile the same?
(A) A & C (B) B & C (C) A & B
(D) All points; A, B, & C

20. At which point is the magnitude of the velocity a minimum?
(A) A (B) B (C) C
(D) None; all points are the same.

21. What is the initial speed of this projectile?
(A) 50 m/s (B) 100 m/s (C) 125 m/s (D) 150 m/s

22. What is the horizontal range of this projectile?
(A) 300 m (B) 870 m (C) 1000 m (D) 1250 m

23. A 5-kg ball is suspended as shown below by a horizontally positioned cable and another cable that is attached up and to the right. Find the tension in the cable labeled ***T***.

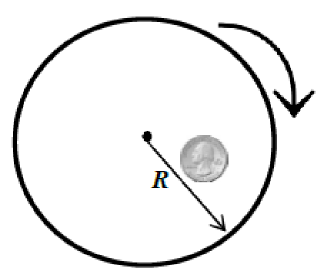


(A) 25 N (B) 50 N (C) 87 N (D) 100 N

24. For yet another physics experiment, your class travels to a newly discovered exoplanet orbiting a nearby star. On the surface, you drop a 2-kg mass from rest and note that it falls 4 meters in the first second. What is the acceleration of gravity on this exoplanet?
(A) $2\,{}^{m}\!/_{s^2}$ (B) $4\,{}^{m}\!/_{s^2}$ (C) $6\,{}^{m}\!/_{s^2}$ (D) $8\,{}^{m}\!/_{s^2}$

25. Below is a sketch of a turntable from a view above. The turntable is rotating at a constant rate. Note a US quarter is located at ${}^{R}\!/_{2}$. Compared to the magnitude of the linear velocity and the angular velocity at ${}^{R}\!/_{2}$, what is the relationship between these if you move the quarter out to the edge at R. Assume the mass of the coin is negligible compared to the mass of the turntable.

	Linear Velocity, V	***Angular Velocity, ω***
(A)	Remains constant	Remains constant
(B)	Remains constant	Doubles
(C)	Doubles	Remains constant
(D)	Doubles	Doubles



AP I and AP 2 PHYSICS FORMULAE Updated 12-23-2015

Constants & Conversion Factors

Proton and Neutron Mass	$m_p = 1.67x10^{-27}\,kg$	Fundamental charge	$e = 1.6x10^{-19}\,C$
Electron Mass	$m_e = 9.11x10^{-31}\,kg$	Electron Volt	$1eV = 1.6x10^{-19}\,J$
Avogadro's #	$6.02x10^{23}\,mol^{-1}$	Universal Gravitational constant	$G = 6.67x10^{-11}\,Nm^2/kg^2$
Universal gas constant	$R = 8.31\,J/mol \cdot K$	Speed of Light	$c = 3.00x10^8\,m/s$
Boltzmann's constant	$k_B = 1.38x10^{-23}\,J/K$	Magnetic constant	$k' = 1x10^{-7}\,T \cdot m/A$
1 unified atomic mass unit		$1u = 1.66x10^{-27}\,kg = 931\,MeV/c^2$	
Planck's Constant		$h = 6.63x10^{-34}\,J \cdot s = 4.14x10^{-15}\,eV \cdot s$ $hc = 1.99x10^{-25}\,J \cdot m = 1240\,eV \cdot nm$	
Coulomb's Law constant		$k = \frac{1}{4\pi\varepsilon_o} = 9.0x10^9\,N \cdot m^2/kg^2$ $\varepsilon_o = 8.85x10^{-12}\,C^2/N \cdot m^2$	

MECHANICS

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

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

$v_f = v_i + at$

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

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

$\Sigma F = ma$

$W = mg$

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

$U_g = G\frac{m_1 m_2}{r}$

$\rho = mv$

$F\Delta t = m\Delta v$

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

- Δx = displacement (change of position)
- $\bar{v}$ = average velocity
- $\bar{a}$ = average acceleration
- v_i = initial velocity
- v_f = final velocity
- F = force
- F_f = force of friction
- F_N = normal force
- F_g = gravitational force
- G = Universal Gravitational Constant
- ρ = momentum
- μ = coefficient of friction
- r = distance between center of masses
- W = weight
- m = mass
- U_g = gravitational PE

ELECTRICITY

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

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

$\Delta U_E = q\Delta V$

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

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

$V = IR$

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

SERIES CIRCUIT

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

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

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

PARALLEL CIRCUITS

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

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

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

- C = Capacitance
- E = electric field intensity
- I = electric current
- k = electrostatic constant
- P = Power
- q = charge
- R = resistance
- U_E = electric potential Energy
- U_C = energy stored in capacitor
- V = electric potential difference
- W = Work

$C = Q/\Delta V$

$U_C = \frac{1}{2}Q\Delta V = \frac{1}{2}C\Delta V^2$

$C_{parallel} = \Sigma C_i$

$C_{series} = \frac{1}{\Sigma\left(\frac{1}{C_i}\right)}$

ENERGY AND WORK

$W = F\Delta x\cos\theta$

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

$PE_g = mgh$

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

$F = -kx$

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

- h = height
- k = spring constant
- KE = kinetic energy
- PE_g = gravitational potential energy
- PE_s = potential energy stored in a spring
- P = power
- W = work
- x = change in spring length from the equilibrium position

CIRCULAR MOTION & ROTATION

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

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

$1rev = 2\pi rad = 360°$

$\tau = Fxr = I\alpha$

$I = \Sigma mr^2$

$L = I\omega$

$K_{rot} = \frac{1}{2}I\omega^2$

$x = A\cos(\omega t)$

$x = A\cos(2\pi ft)$

- a_c = centripetal acceleration
- F_c = centripetal force
- τ = Torque
- I = Rotational Inertia
- α = Angular acceleration
- ω = Angular velocity
- K_{rot} = Rotational KE
- x = position

HEAT AND THERMODYNAMICS

$Q = mc\Delta T$

$Q = mL_f$

$Q = mL_V$

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

$\frac{Q}{\Delta t} = \frac{kA\Delta T}{L}$

$PV = nRT = NkT$

$K = \frac{3}{2}k_B T$

$\Delta U = \frac{3}{2}nR\Delta T$

$W = -P\Delta V$

$\Delta U = Q + W$

c = specific heat

L_f = latent heat of fusion

L_V = latent heat of vaporization

Q = amount of heat

ΔT = change in temperature

α = coefficient of linear expansion

L_o = original length

$c_{water} = 4186 \frac{J}{kg°K}$

K = kinetic energy

L = thickness

U = internal energy

W = work done on a system

WAVE PHENOMENA & SHM

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

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

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

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

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

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

$T_S = 2\pi\sqrt{\frac{m}{k}}$

$T_P = 2\pi\sqrt{\frac{L}{g}}$

c = speed of light in a vacuum

d = distance between slits

$f = \nu$ = frequency

L = distance from slit to screen

n = index of absolute refraction

T = period

v = speed

x = distance from central maximum to first-order maximum

λ = wavelength

θ = angle

θ_c = critical angle relative to air

GEOMETRIC OPTICS & SOUND

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

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

$\beta = 10\log\frac{I}{I_o}$

f = focal length

d_i = image distance

d_o = object distance

h_o = object size

h_i = image size

β = Sound level

I = Sound Intensity

I_o = Threshold Intensity

ELECTROMAGNETIC APPLICATIONS

$F_M = Bqv$

$F_M = BIL$

$\varepsilon = BLv$

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

$V_P I_P = V_S I_S$ (ideal)

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

$\phi_B = B \cdot A$

$\Delta\phi_B = \varepsilon t$

B = magnetic field strength

I_P = current in primary

I_S = current in secondary

N_P = number of turns in primary coil

N_S = number of turns in secondary coil

V_P = voltage of primary

V_S = voltage of secondary

L = length of conductor

V = electric potential difference

v = speed of particle

FLUID MECHANICS

$\rho = \frac{m}{V}$

$P = \frac{F}{A}$

$P = P_o + mgh$

$F_b = \rho V g$

$A_1 v_1 = A_2 v_2$

$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 =$

$= P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$

A = Area

F = force

h = depth

P = pressure

V = volume

v = speed

y = height

ρ = density

MODERN PHYSICS

$E = hf$

$K_{max} = hf - \phi$

$\lambda = \frac{h}{p}$

$E = mc^2$

E = energy

f = frequency

K = kinetic energy

m = mass

p = momentum

λ = wavelength

ϕ = work function

AP PHYSICS I **Salmon**

JANUARY 14, 2016

SOLUTIONS (Corrections None)

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

PHYSICS I for all students currently enrolled in AP physics I. 25 multiple choice questions per exam.

JANUARY: Kinematic, Dynamics, Circular motion.

FEBRUARY: Simple harmonic motion, Pendulae and spring-mass systems, impulse and linear momentum, work and energy, plus January topics.

MARCH: Rotational dynamics: torque, rotational kinematics and energy, rotational dynamics and conservation of angular momentum, electrostatics: electric charge and force, plus January and Feb topics.

APRIL: circuits (resistors only) and mechanical waves and sound, plus January, Feb, and March topics.

Dates for 2016 Season

Thursday January 14, 2016 Thursday February 11, 2016

Thursday March 10, 2016 Thursday April 14, 2016

New Jersey Science League

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www:entnet.com/~personal/njscil/html

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

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

Dates for 2017 Season

Thursday January 12, 2017 Thursday February 9, 2017

Thursday March 9, 2017 Thursday April 13, 2017

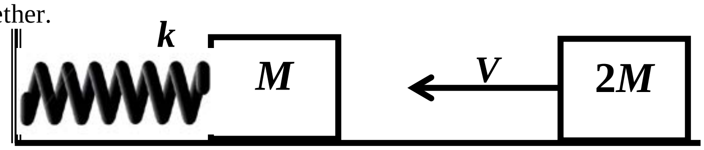
AP PHYSICS I __Salmon__

For all students taking AP physics I

FEBRUARY 11, 2016

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***.

Use the following information for Questions #1 - 3: The diagram below represents an ideal spring with spring constant ***k*** attached at the left end to a rigid wall and attached on the right to a mass ***M***. Initially, the mass and spring system is at rest with the spring at its unstretched and uncompressed equilibrium length. Another mass 2***M*** is sliding on the frictionless horizontal surface with speed ***V***. The masses collide and stick together.



1. Which expression below correctly represents the speed of the masses immediately after the collision?

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

2. Which expression below correctly represents the distance the spring compresses when the masses come to rest?

(A) $\frac{2MV^2}{3k}$ (B) $\sqrt{\frac{3MV^2}{2k}}$ (C) $V\sqrt{\frac{3M}{2k}}$ (D) $2V\sqrt{\frac{M}{3k}}$

3. Which expression below correctly represents the resulting frequency of oscillation of the mass-spring system?

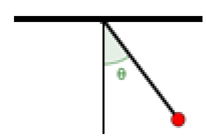
(A) $\frac{1}{2\pi}\sqrt{\frac{3M}{k}}$ (B) $2\pi\sqrt{\frac{3M}{k}}$ (C) $2\pi\sqrt{\frac{k}{3M}}$ (D) $\frac{1}{2\pi}\sqrt{\frac{k}{3M}}$

4. A 1500-kg vehicle is traveling at the local speed limit of 20 m/s when a deer jumps from the roadside into the vehicle path. If the driver applies the brakes when the front of the car is 60-m from the deer and the deer doesn't move, what average force is applied in order to stop the car just in the proverbial nick-of-time?

(A) 250 *N* (B) 2500 *N* (C) 5,000 *N* (D) 10,000 *N*

5. The sketch below represents a simple pendulum that you built during a physics activity. The length of the pendulum is 2-m and the mass of the "bob" (the steel ball at the end of the string) is 500 grams. To what angle as measured from the vertical must the string make when you raise the bob in order for the bob to have a speed of 4 m/s as it swings through the bottom of the path?

(A) 30° (B) 37° (C) 53° (D) 60°



6. Linear momentum is conserved immediately before and immediately after a collision if and only if:

(A) the collision is "head-on"
(B) there are no external forces involved
(C) the masses are either identical or multiples of each other
(D) momentum is conserved in all collisions regardless of the conditions and parameters.

Use the following information for Questions #7 & 8: The image below depicts a child pushing a lawn mower on level ground. The child is pushing straight down the handles with a force of 200 Newtons, the handles make an angle of 60° to the horizontal, and the mass of the lawn mower is 25-kg.

7.How much work is the child doing on the lawn mower in moving it 12-m along the horizontal ground?

(A) 600 *J* (B) 1200 *J* (C) 2076 *J* (D) 2400 *J*

8. If there is a force of friction of magnitude 50 Newtons opposing the lawn mower motion, what is the *net* work done on the lawn mower for the 12-m moved?
(A) 600 *J* (B) 1200 *J* (C) 2076 *J* (D) 2400 *J*

9. An object is undergoing SHM, ***S***imple ***H***armonic ***M***otion. This means the object is being acted upon by a force that is:
(A) directly proportional to the displacement from equilibrium
(B) constant
(C) inversely proportional to the displacement from equilibrium
(D) proportional to the square of the displacement

Use the following information for Questions* #10, 11, and 12**: You construct a pendulum for yet another physics class activity. The length of the pendulum (including to center of mass of the bob) is ***L and the mass of the bob is ***M***.

10. After raising the bob so that the string makes an angle of θ with the vertical, the bob reaches a maximum speed of ***V*** at the lowest point of the swing. Which expression below correctly states the length ***L*** in terms of the given quantities ***M***, θ, ***V***, and fundamental constants here on the surface of the earth?

(A) $\frac{MV^2}{2g(1-\cos\theta)}$ (B) $\frac{2g(1-\cos\theta)}{MV^2}$ (C) $\frac{2g(1-\cos\theta)}{V^2}$ (D) $\frac{V^2}{2g(1-\cos\theta)}$

11. What is the tension in the string when the bob reaches the pendulum equilibrium point?

(A) $Mg+\frac{V^2}{L}$ (B) MgL (C) $M\left(g+\frac{V^2}{L}\right)$ (D) $M\left(g-\frac{V^2}{L}\right)$

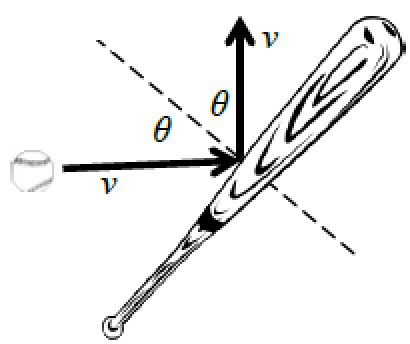
12. At the exact moment the pendulum bob reaches the equilibrium point, the tension in the string just barely exceeds the tension limit of the string and it snaps. If the bottom-most point of the mass is ***H*** meters above the floor when the string snaps, how far horizontally will the bob move before hitting the floor?

(A) $V\sqrt{\frac{2H}{g}}$ (B) $\sqrt{2}V\sqrt{\frac{2H}{g}}$ (C) $V\sqrt{MgH}$ (D) $V\sqrt{\frac{2g}{H}}$

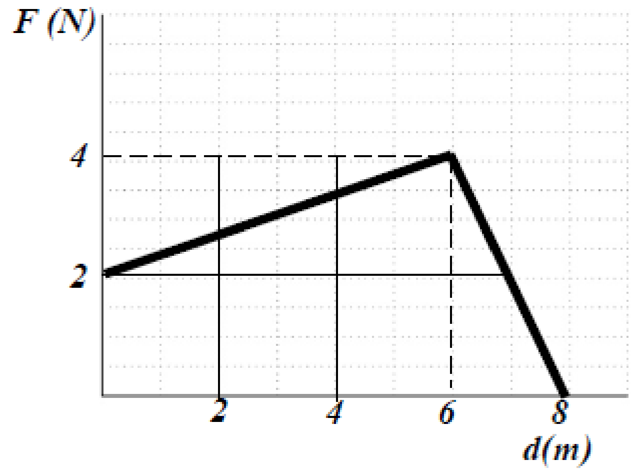
13. For an extremely expensive field trip, your physics teacher takes your class to the newly discovered exo-planet, *KeplerFizz42*. While on the surface of this planet, you measure the period of a pendulum and call it T. When you return to Earth, the period of the same pendulum is decreased by a factor of four, $T/4$. What is the gravitational acceleration on the surface of *KeplerFizz42*compared to that on the surface of Earth in New Jersey, $\boldsymbol{g}$?

(A) $16g$ (B) $4g$ (C) $\frac{g}{4}$ (D) $\frac{g}{16}$

14. During a baseball game, the batter bunts a ball of mass ***M*** such that the ball leaves the bat at the exact same speed ***v*** and angle θ with the normal as it hit the bat, as shown below. The impulse delivered to the ball is
(A) *zero* (B) $Mv\sin\theta$
(C) $2Mv\cos\theta$ (D) $2Mv\sin\theta$



Use the following information for Questions #15 - #17: Below is a graph of force ***F*** applied versus displacement ***d*** for an object of mass 4-kg constrained to move in a straight line

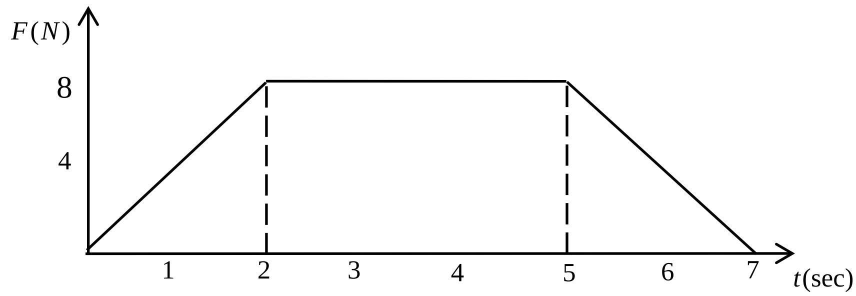


15. What is the change in kinetic energy of this mass for the first 6-m displacement shown?
(A) 6 *J* (B) 12 *J* (C) 18 *J* (D) 24 *J*

16. What is the additional change in kinetic energy for the last 2-m interval?
(A) 2 *J* (B) 4 *J* (C) 6 *J* (D) 8 *J*

17. If this 4-kg mass started at rest, what is its final speed at 8-m?
(A) 3.3 m/s (B) 6.6 m/s (C) 9.9 m/s (D) 11.1 m/s

18. A 2-kg mass experiences a force as represented in the accompanying graph of force ***F*** as a function of time ***t***. If the mass had an initial speed of 10 m/s at ***t*** = 0, what is its speed at ***t*** = 7 seconds?



(A) 10 m/s (B) 20 m/s (C) 30 m/s (D) 40 m/s

19. A large asteroid of mass M is entering the upper atmosphere with velocity V directed vertically downward. As it begins the inevitable burning due to atmospheric compressions, it explodes into two unequal parts. One part of mass $\frac{M}{5}$ is propelled vertically upward with a speed of $\frac{V}{2}$. What is the speed of the remaining piece that continues moving vertically downward?

(A) V (B) $\frac{V}{2}$ (C) $\frac{8V}{11}$ (D) $\frac{11V}{8}$

20. A mass ***M*** oscillates with a frequency ***f*** at the end of a vertically hung spring of spring constant ***k***. What would be the length of a simple pendulum that has the same frequency?

(A) $\frac{mg}{k}$ (B) $\frac{k}{mg}$ (C) $\frac{g}{mk}$ (D) $\sqrt{2\pi\frac{m}{k}}$

21. A cart of mass 4-kg is moving to the right on a frictionless horizontal surface at a speed of 4 m/s. How much work must be performed to increase the speed of the cart to 10 m/s?
(A) 32 *J* (B) 64 *J* (C) 168 *J* (D) 200 *J*

22. Mars has an acceleration due to gravity at the surface of about 4 m/s^2. The radius of Mars is 3400 km. What is the period of a satellite placed in low circular orbit around Mars?

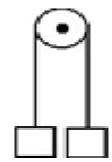
(A) 2300 sec (B) 5800 sec (C) $5.3x10^6$ sec (D) $1x10^7$ sec

23. The ISS, International Space Station, has mass ***m*** and is in a nearly circular orbit of radius ***R*** about Earth. Earth's mass is ***M***. Which of the following expressions correctly states the speed of the ISS?

(A) $\sqrt{\frac{GM}{R}}$ (B) $\sqrt{\frac{GMm}{R}}$ (C) $\sqrt{\frac{GM}{R^2}}$ (D) $\sqrt{\frac{GMm}{R^2}}$

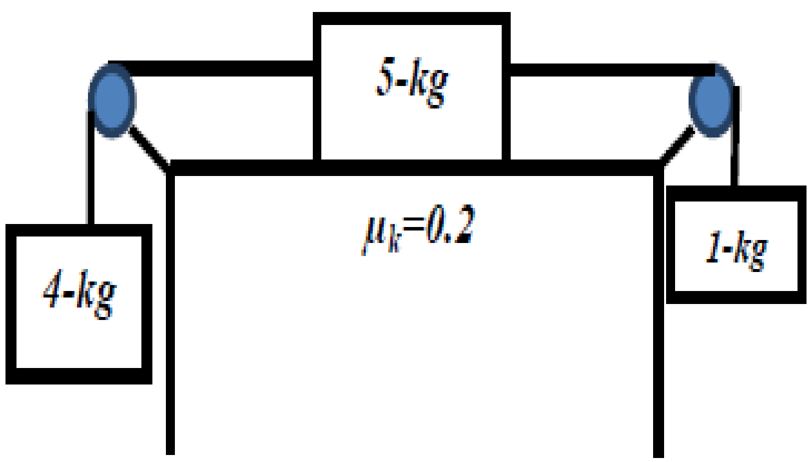
24. A simple Atwood machine, shown below, is motionless with two identical masses, each of mass ***M***. When a small mass ***m*** is placed on the mass ***M*** on the right side, the system attains an acceleration of ***a***. Which of the following expressions represents the mass ***M***? Ignore air resistance and any friction or other effects from the pulley.

(A) $\frac{mg-ma}{2a}$ (B) $\frac{2mg-2ma}{a}$ (C) $\frac{mg+ma}{2a}$ (D) $\frac{2mg+2ma}{a}$



25. Below is a sketch of a three-mass system connected by massless cords over massless/frictionless pulleys. The coefficient of kinetic friction between the 5-kg mass and the table is 0.2. What is the acceleration of the system?

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



AP I and AP 2 PHYSICS FORMULAE Updated 12-23-2015

Constants & Conversion Factors

Proton and Neutron Mass	$m_p = 1.67x10^{-27} kg$	Fundamental charge	$e = 1.6x10^{-19} C$
Electron Mass	$m_e = 9.11x10^{-31} kg$	Electron Volt	$1eV = 1.6x10^{-19} J$
Avogadro's #	$6.02x10^{23} mol^{-1}$	Universal Gravitational constant	$G = 6.67x10^{-11} Nm^2/kg^2$
Universal gas constant	$R = 8.31 J/mol \cdot K$	Speed of Light	$c = 3.00x10^8 m/s$
Boltzmann's constant	$k_B = 1.38x10^{-23} J/K$	Magnetic constant	$k' = 1x10^{-7} T \cdot m/A$
1 unified atomic mass unit		$1u = 1.66x10^{-27} kg = 931 MeV/c^2$	
Planck's Constant		$h = 6.63x10^{-34} J \cdot s = 4.14x10^{-15} eV \cdot s$ $hc = 1.99x10^{-25} J \cdot m = 1240 eV \cdot nm$	
Coulomb's Law constant		$k = \frac{1}{4\pi\varepsilon_o} = 9.0x10^9 N \cdot m^2/kg^2$ $\varepsilon_o = 8.85x10^{-12} C^2/N \cdot m^2$	

MECHANICS

$\bar{v} = \frac{\Delta x}{\Delta t}$	Δx = displacement (change of position)
$\bar{a} = \frac{\Delta v}{\Delta t}$	$\bar{v}$ = average velocity
$v_f = v_i + at$	$\bar{a}$ = average acceleration
$\Delta x = v_i t + \frac{1}{2}at^2$	v_i = initial velocity
$2a\Delta x = v_f^2 - v_i^2$	v_f = final velocity
$\Sigma F = ma$	F = force
$W = mg$	F_f = force of friction
$F_g = G\frac{m_1 m_2}{r^2}$	F_N = normal force
$U_g = G\frac{m_1 m_2}{r}$	F_g = gravitational force
$\rho = mv$	G = Universal Gravitational Constant
$F\Delta t = m\Delta v$	ρ = momentum
$\mu = \frac{F_f}{F_N}$	μ = coefficient of friction
	r = distance between center of masses
	W = weight
	m = mass
	U_g = gravitational PE

ELECTRICITY

$F_e = k\frac{q_1 q_2}{r^2}$	C = Capacitance
$E = \frac{F}{q}$	E = electric field intensity
$\Delta U_E = q\Delta V$	I = electric current
$V = \frac{W}{q} = Ed$	k = electrostatic constant
$I = \frac{\Delta q}{\Delta t}$	P = Power
$V = IR$	q = charge
$P = VI = I^2R = \frac{V^2}{R}$	R = resistance
	U_E = electric potential Energy
	U_C = energy stored in capacitor
	V = electric potential difference
	W = Work

SERIES CIRCUIT

$I_T = I_1 = I_2 = I_3 = ...$

$V_T = V_1 + V_2 + V_3 + ...$

$R_T = R_1 + R_2 + R_3 + ...$

PARALLEL CIRCUITS

$I_T = I_1 + I_2 + I_3 + ...$

$V_T = V_1 = V_2 = V_3 = ...$

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

$C = Q/\Delta V$

$U_C = \frac{1}{2}Q\Delta V = \frac{1}{2}C\Delta V^2$

$C_{parallel} = \Sigma C_i$

$C_{series} = \frac{1}{\Sigma\left(\frac{1}{C_i}\right)}$

ENERGY AND WORK

$W = F\Delta x\cos\theta$	h = height
$P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t} = Fv$	k = spring constant
$PE_g = mgh$	KE = kinetic energy
$KE = \frac{1}{2}mv^2$	PE_g = gravitational potential energy
$F = -kx$	PE_s = potential energy stored in a spring
$PE_s = \frac{1}{2}kx^2$	P = power
	W = work
	x = change in spring length from the equilibrium position

CIRCULAR MOTION & ROTATION

$a_c = \frac{v^2}{r}$	a_c = centripetal acceleration
$F_c = m\frac{v^2}{r}$	F_c = centripetal force
$1rev = 2\pi rad = 360^\circ$	τ = Torque
$\tau = Fxr = I\alpha$	I = Rotational Inertia
$I = \Sigma mr^2$	α = Angular acceleration
$L = I\omega$	ω = Angular velocity
$K_{rot} = \frac{1}{2}I\omega^2$	K_{rot} = Rotational KE
$x = A\cos(\omega t)$	x = position
$x = A\cos(2\pi ft)$	

HEAT AND THERMODYNAMICS

$Q = mc\Delta T$

$Q = mL_f$

$Q = mL_V$

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

$\frac{Q}{\Delta t} = \frac{kA\Delta T}{L}$

$PV = nRT = NkT$

$K = \frac{3}{2}k_B T$

$\Delta U = \frac{3}{2}nR\Delta T$

$W = -P\Delta V$

$\Delta U = Q + W$

c = specific heat
L_f = latent heat of fusion
L_V = latent heat of vaporization
Q = amount of heat
ΔT = change in temperature
α = coefficient of linear expansion
L_o = original length
$c_{water} = 4186 \frac{J}{kg°K}$
K = kinetic energy
L = thickness
U = internal energy
W = work done on a system

WAVE PHENOMENA & SHM

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

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

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

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

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

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

$T_S = 2\pi\sqrt{\frac{m}{k}}$

$T_P = 2\pi\sqrt{\frac{L}{g}}$

c = speed of light in a vacuum
d = distance between slits
$f = \nu$ = frequency
L = distance from slit to screen
n = index of absolute refraction
T = period
v = speed
x = distance from central maximum to first-order maximum
λ = wavelength
θ = angle
θ_c = critical angle relative to air

GEOMETRIC OPTICS & SOUND

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

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

$\beta = 10\log\frac{I}{I_o}$

f = focal length
d_i = image distance
d_o = object distance
h_o = object size
h_i = image size
β = Sound level
I = Sound Intensity
I_o = Threshold Intensity

ELECTROMAGNETIC APPLICATIONS

$F_M = Bqv$

$F_M = BIL$

$\varepsilon = BLv$

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

$V_P I_P = V_S I_S$ (ideal)

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

$\phi_B = B \cdot A$

$\Delta\phi_B = \varepsilon t$

B = magnetic field strength
I_P = current in primary
I_S = current in secondary
N_P = number of turns in primary coil
N_S = number of turns in secondary coil
V_P = voltage of primary
V_S = voltage of secondary
L = length of conductor
V = electric potential difference
v = speed of particle

FLUID MECHANICS

$\rho = \frac{m}{V}$

$P = \frac{F}{A}$

$P = P_o + mgh$

$F_b = \rho V g$

$A_1 v_1 = A_2 v_2$

$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 =$

$= P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$

A = Area
F = force
h = depth
P = pressure
V = volume
v = speed
y = height
ρ = density

MODERN PHYSICS

$E = hf$

$K_{max} = hf - \phi$

$\lambda = \frac{h}{p}$

$E = mc^2$

E = energy
f = frequency
K = kinetic energy
m = mass
p = momentum
λ = wavelength
ϕ = work function

AP PHYSICS I **Salmon**

FEBRUARY 11, 2016

SOLUTIONS (No Corrections Feb Key)

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

PHYSICS I for all students currently enrolled in AP physics I. 25 multiple choice questions per exam.
JANUARY: Kinematic, Dynamics, Circular motion.
FEBRUARY: Simple harmonic motion, Pendulae and spring-mass systems, impulse and linear momentum, work and energy, plus January topics.
MARCH: Rotational dynamics: torque, rotational kinematics and energy, rotational dynamics and conservation of angular momentum, electrostatics: electric charge and force, plus January and Feb topics.
APRIL: circuits (resistors only) and mechanical waves and sound, plus January, Feb, and March topics.

Dates for 2016 Season
Thursday February 11, 2016
Thursday March 10, 2016 Thursday April 14, 2016

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

PLEASE RETURN THE AREA RECORD AND ALL TEAM MEMBER SCANTRONS(ALL STUDENTS PLACING 1ST, 2ND, 3RD, AND 4TH).
If you return scantrons of alternates, then label them as ALTERNATES.

Dates for 2017 Season
Thursday January 12, 2017 Thursday February 9, 2017
Thursday March 9, 2017 Thursday April 13, 2017

AP PHYSICS 1 **Salmon Exam**

MARCH 10, 2016

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*.**

ADDITIONAL INFORMATION: *All axes of rotation are taken to be at the center of mass unless specifically stated otherwise.*

Rotational Inertia of a *solid disc*: $\frac{1}{2}MR^2$

Rotational Inertia of a *hollow disc* (hoop or ring): MR^2

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

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

Fundamental charge: $e = 1.6x10^{-19}C$

1. The Hubble Space Telescope of mass ***M*** moves in a stable circular orbit of radius ***R*** at a constant speed ***v***. Which of the following must be true?

I. The net force on the Hubble is equal to MV^2/R and is directed toward the center of the orbit.
II. The net work done on the Hubble by gravity in one revolution is zero.
III. The angular momentum of the Hubble is a constant.

(A) I only (B) III only (C) II and III only (D) I, II, and III

2. 10 years behind schedule due to budget cuts, the *James Webb Space Telescope*, *JWSP*, is the successor of the *incomparable Hubble Space Telescope*, *HST*. The *JWSP* has a mass that is only about $1/2$ that of the *HST; HST* mass is 12,500-kg whereas *JWST* is 6500-kg. *HST* is, as Question #1 states, in a stable circular orbit of orbital radius ***R*** about the Earth. What must be the orbital radius of the *JWST* in order to maintain a stable circular orbit?

(A) $R/\sqrt{2}$ (B) $R/2$ (C) R (D) Anywhere NASA decides; they have that capability.

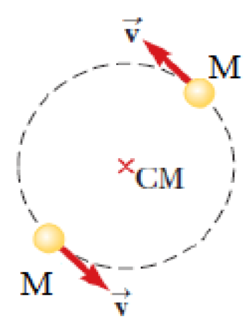
3. At this time of year, Winter, most folks are surprised to find out that the Earth is at closest approach to the Sun during the one year orbit. So, as the Earth leaves the current orbital position where the Northern Hemisphere experiences Winter and approaches Summer, which of the following pairs of choices is accurate for a description of the orbital speed and angular momentum of the Earth?

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

4. A Hollywood-produced planet in the movie *Interstellar*, starring Matthew McConaughey, has seven times the mass of Earth, but only twice the radius of Earth. What would be the gravitational acceleration at the surface of this fake Hollywood planet?

(A) $2.9\,m/s^2$ (B) $5.7\,m/s^2$ (C) $17.5\,m/s^2$ (D) $35\,m/s^2$

5. As you probably know, most stars in the Milky Way galaxy are paired with another star in what is called a *binary star* system. Our Sun is the local "odd-ball" as a single star with no partner; poor us. There's a true binary star system called Plaskett's System officially catalogued as HR-2422, named after Canadian astronomer John Plaskett, who found several such systems. This system, previously thought to have been a single extremely bright star only 6600 light years from us, consists of two identical giant stars orbiting every 14 earth days around a common center of mass located half-way between them, as shown in the simplified diagram below. The orbital velocity of each star is 300 km/s (Yep, that's fast…). Find the mass of each star.



(A) $1x10^{27}\,kg$ (B) $3.2x10^{32}\,kg$ (C) $7.8x10^{31}\,kg$ (D) $2x10^{30}\,kg$

6. An unknown toxic object in your physics lab is placed on an equal arm balance and needs 10- kg to balance it and when hung from a spring scale it reads 100-N. You then take everything from your physics lab and take a field trip to the planet Mars (balance, a spring scale, set of masses, your teacher, and the unknown toxic object). The gravitational force on Mars is roughly 40% that on Earth. What are the new readings of the balance and the spring scale reading (respectively)?
(A) 10- kg, 100-N (B) 4-kg, 100-N (C) 10- kg, 40-N (D) 4-kg, 40-N

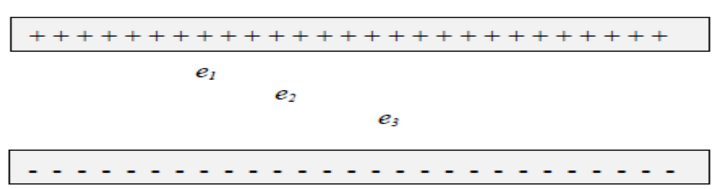
7. As a figure skater can spin unbelievably fast during a performance, a star can "outshine" (pun intended) any athlete. Our own Sun has a rotational period of 24 days, mass $M_{Sun} = 2x10^{30}\,kg$ & radius $R_{Sun} = 7x10^{8}\,m$. The Sun will eventually collapse after a series of events that will result in a white dwarf that has a radius of only 1% the original, about the size of the Earth at $R_{Dwarf} = 7x10^{6}\,m$. Assuming the resulting white dwarf contains the original Sun mass (a poor assumption, but it allows for easier math), what is the new rotational period of the resulting white dwarf formed?
(A) 200 seconds (B) 2,000 seconds (C) 0.24 days (D) 24 days

8. A positive point charge of $40\mu C$ is located on the *x*-axis at $x = -20cm$ and a negative point charge of $-50\mu C$ is located at $x = +30cm$. What is the magnitude of the total electrostatic force on a negative point charge of $-4\mu C$ that is placed at the origin?
(A) 1 N (B) 13 N (C) 16 N (D) 56 N

9. An electron is injected with an initial velocity of $4x10^{4}\,{}^{m}\!/_{s}$ to the right into a uniform electric field of magnitude $E = 50\,{}^{N}\!/_{C}$ also directed to the right. What is the velocity of the electron $1.5x10^{-9}$ sec after entering the electric field?
(A) $4x10^{4}\,{}^{m}\!/_{s}$ to the right (B) $4x10^{4}\,{}^{m}\!/_{s}$ to the left
(C) $2.7x10^{4}\,{}^{m}\!/_{s}$ to the left (D) $2.7x10^{4}\,{}^{m}\!/_{s}$ to the right

10. Two isolated point charges, q_1 and q_2, are stationary and a distance ***d*** apart. $q_2 = 5q_1$, F_1 is the force exerted on q_1 and F_2 is the force exerted on q_2. Which one of the following represents the relationship between the magnitudes of the forces?
(A) $F_2 = 5F_1$ (B) $F_1 = 5F_2$ (C) $F_2 = F_1$ (D) $F_2 = 25F_1$

11. The image below shows two charged plates with three electrons located between them. What is the relationship between the forces exerted on the electrons due to their respective positions between the plates? F_1 Is the force acting on e_1, F_2 Is the force acting on e_2, and F_3 is the force acting on e_3.



(A) $F_1 > F_2 > F_3$
(B) $F_3 > F_2 > F_1$
(C) $F_3 = F_2 = F_1$
(D) $F_1 = F_3 > F_2$

12. How much work is done in moving a point charge of $8\mu C$ through a potential difference of 4-V?
(A) $2\mu J$ (B) $32\mu J$ (C) $2J$ (D) $32J$

Use the following information or Questions #13 & 14: Two identical negative charges, $-Q$, are located at equal distances from the origin on an x-axis. One charge to the left of the origin a distance ***D*** with coordinates (***-D***,0) and the other to the right of the origin a distance ***D***. Assume this system is isolated with no external forces other than those caused by the two charges.

13. What is the magnitude of the net electric force on a test charge placed at the origin?

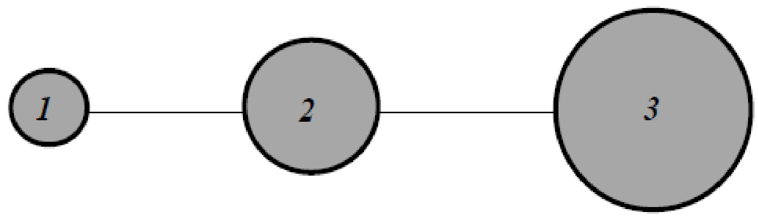
(A) Zero (B) $\frac{Q^2}{4\pi\varepsilon_o D^2}$ (C) $\frac{2Q^2}{4\pi\varepsilon_o D^2}$ (D) $\frac{kQ^2}{D^2}$

14. What is the magnitude of the net electric potential at the origin?

(A) Zero (B) $\frac{2Q}{4\pi\varepsilon_o D}$ (C) $\frac{Q^2}{4\pi\varepsilon_o D}$ (D) $\frac{2kQ^2}{D}$

15. The diagram below shows three charged conducting solid spheres (***1***, ***2***, & ***3***) each connected by a conducting wire. Each sphere is constructed of the same material. Which of the choices provided correctly ranks the potential ***V*** and the electric field strength ***E*** at the surface of each sphere?

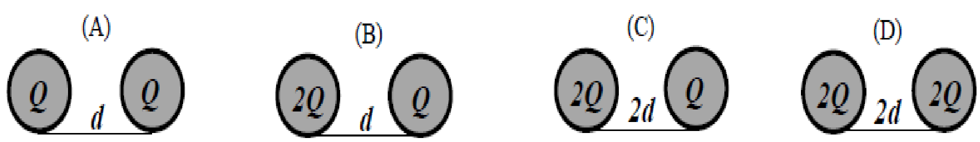
	Potential	***Electric Field***
(A)	$V_1 = V_2 = V_3$	$E_1 = E_2 = E_3$
(B)	$V_1 = V_2 = V_3$	$E_1 > E_2 > E_3$
(C)	$V_1 > V_2 > V_3$	$E_1 = E_2 = E_3$
(D)	$V_1 > V_2 > V_3$	$E_1 > E_2 > E_3$



16. An electric field is
(A) always tangent to an equipotential surface.
(B) always perpendicular to an equipotential surface.
(C) always strongest at the center of a conductor
(D) dependent on the speed of the particle moving through it.

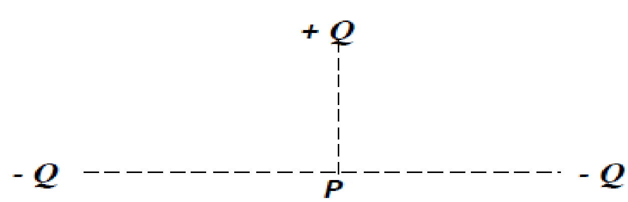
17. The diagram depicts four pairs of isolated charges in terms of ***Q*** each separated by a distance between the respective centers given in terms of ***d***. Which choice correctly provides the order of magnitude of the electric potential energy, ***U***, between the charges? NOTE: Diagrams are NOT drawn to scale.

(A) $U_A = U_B > U_C = U_D$
(B) $U_A = U_C > U_B = U_D$
(C) $U_B = U_D > U_A = U_C$
(D) $U_A < U_B < U_C < U_D$



18. The following diagram depicts three isolated point charges; two negatives and one positive, each of the same magnitude. In what direction is the electric field at point ***P***, midway between the two negative charges?

(A) Toward the top of the page.
(B) Toward the bottom of the page.
(C) To the left.
(D) To the right.



19. Two identical point charges are separated by a distance of 50-cm. There is an electrostatic force of magnitude 2-N between them. What is the magnitude of the charges?

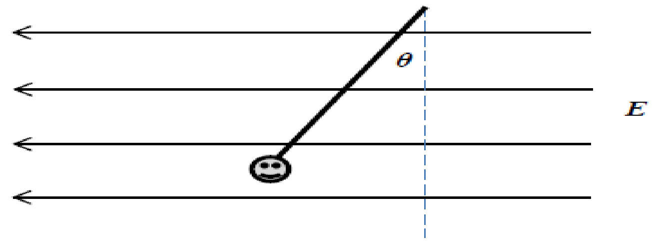
(A) $5.5x10^{-11}C$ (B) $7.5x10^{-11}C$ (C) $5.5x10^{-6}C$ (D) $7.5x10^{-6}C$

Use the following information for Questions #20 - 22: The following depicts a charged pith ball suspended from an insulated thread in a region where an electric field is present. The ball hangs in equilibrium. The charge on the pith ball is $8x10^{-3}C$, the electric field strength is $3\,{}^{N}\!/_{C}$, and the mass of the pith ball is 5 grams.

20. What is the deflection angle labeled as θ?

(A) 12° (B) 18°

(C) 26° (D) 32°



21. Based on the information given, what is the number of electrons either deficient or in excess on/in the pith ball to cause the charge stated?

(A) A deficiency of $5x10^{16}e$

(B) An excess of $5x10^{16}e$

(C) An excess of $1.3x10^{21}e$

(D) A deficiency of $1.3x10^{21}e$

22. If the thread snaps at the instant the image shows while the pith ball is stationary, which description below correctly describes the path the pith ball follows while still in the electric field? Ignore air resistance.

(A) A straight line path in the direction the thread was pointing, θ; down and to the left.

(B) A parabolic path downward starting in the direction the thread was pointing, θ.

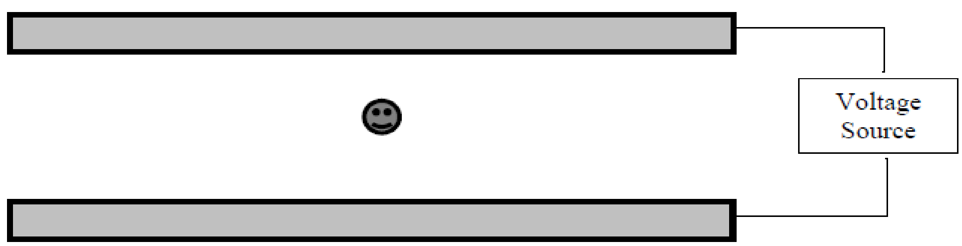
(C) A straight line downward.

(D) A straight line to the left.

23. In 1909, Robert Millikan and Harvey Fletcher performed one of the most respected experiments in all of modern physics; they calculated experimentally the fundamental charge on an electron. This was performed by simply placing small charged oil droplets between two charged plates adjusting the potential between the plates till the drops remained suspended; sketched below. Which of the choices can be used to correctly find the distance between the plates so that the droplet shown is suspended? The mass of the droplet is ***M***, it has a charge of ***q***, and the potential difference between the plates is ***V***.

(A) $\frac{Vg}{Mq}$ (B) $\frac{Vq}{Mg}$

(C) $\frac{Mg}{Vq}$ (D) $\frac{VM}{qg}$



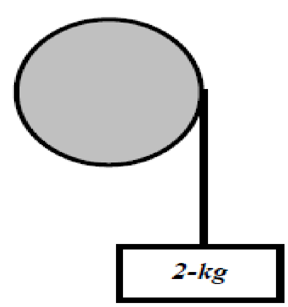
24. A wheel in the shape of a solid disc starting at rest rolls without slipping down a ramp. The ramp is inclined at 30° to the horizontal. When the wheel reaches the bottom of the ramp the center of the wheel (the axis of rotation) has a speed of 6 m/s. The wheel has a mass of 3-kg and a radius of 20-cm. What is the length of the ramp?

(A) 1.8 m (B) 2.7 m (C) 3.6 m (D) 5.4 m

25. Below, a frictionless solid disc pulley of mass 3-kg and radius 20-cm has a mass of 2-kg hanging from a massless cord wrapped around the pulley. What is the acceleration of the 2-kg mass?

(A) $1.4\,{}^{m}\!/_{s^2}$ (B) $2.8\,{}^{m}\!/_{s^2}$

(C) $5.7\,{}^{m}\!/_{s^2}$ (D) $10\,{}^{m}\!/_{s^2}$



AP I and AP 2 PHYSICS FORMULAE Updated 12-23-2015

Constants & Conversion Factors

Proton and Neutron Mass	$m_p = 1.67x10^{-27}\,kg$	Fundamental charge	$e = 1.6x10^{-19}\,C$
Electron Mass	$m_e = 9.11x10^{-31}\,kg$	Electron Volt	$1eV = 1.6x10^{-19}\,J$
Avogadro's #	$6.02x10^{23}\,mol^{-1}$	Universal Gravitational constant	$G = 6.67x10^{-11}\,Nm^2/kg^2$
Universal gas constant	$R = 8.31\,J/mol \cdot K$	Speed of Light	$c = 3.00x10^8\,m/s$
Boltzmann's constant	$k_B = 1.38x10^{-23}\,J/K$	Magnetic constant	$k' = 1x10^{-7}\,T \cdot m/A$
1 unified atomic mass unit		$1u = 1.66x10^{-27}\,kg = 931\,MeV/c^2$	
Planck's Constant		$h = 6.63x10^{-34}\,J \cdot s = 4.14x10^{-15}\,eV \cdot s$ $hc = 1.99x10^{-25}\,J \cdot m = 1240\,eV \cdot nm$	
Coulomb's Law constant		$k = \frac{1}{4\pi\varepsilon_o} = 9.0x10^9\,N \cdot m^2/kg^2$ $\varepsilon_o = 8.85x10^{-12}\,C^2/N \cdot m^2$	

MECHANICS

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

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

$v_f = v_i + at$

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

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

$\Sigma F = ma$

$W = mg$

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

$U_g = G\frac{m_1 m_2}{r}$

$\rho = mv$

$F\Delta t = m\Delta v$

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

Δx = displacement (change of position)

$\bar{v}$ = average velocity

$\bar{a}$ = average acceleration

v_i = initial velocity

v_f = final velocity

F = force

F_f = force of friction

F_N = normal force

F_g = gravitational force

G = Universal Gravitational Constant

ρ = momentum

μ = coefficient of friction

r = distance between center of masses

W = weight

m = mass

U_g = gravitational PE

ELECTRICITY

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

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

$\Delta U_E = q\Delta V$

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

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

$V = IR$

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

SERIES CIRCUIT

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

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

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

PARALLEL CIRCUITS

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

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

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

C = Capacitance

E = electric field intensity

I = electric current

k = electrostatic constant

P = Power

q = charge

R = resistance

U_E = electric potential Energy

U_C = energy stored in capacitor

V = electric potential difference

W = Work

$C = Q/\Delta V$

$U_C = \frac{1}{2}Q\Delta V = \frac{1}{2}C\Delta V$

$C_{parallel} = \Sigma C_i$

$C_{series} = \frac{1}{\Sigma\left(\frac{1}{C_i}\right)}$

ENERGY AND WORK

$W = F\Delta x \cos\theta$

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

$PE_g = mgh$

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

$F = -kx$

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

h = height

k = spring constant

KE = kinetic energy

PE_g = gravitational potential energy

PE_s = potential energy stored in a spring

P = power

W = work

x = change in spring length from the equilibrium position

CIRCULAR MOTION & ROTATION

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

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

$1rev = 2\pi rad = 360°$

$\tau = Fxr = I\alpha$

$I = \Sigma mr^2$

$L = I\omega$

$K_{rot} = \frac{1}{2}I\omega^2$

$x = A\cos(\omega t)$

$x = A\cos(2\pi ft)$

a_c = centripetal acceleration

F_c = centripetal force

τ = Torque

I = Rotational Inertia

α = Angular acceleration

ω = Angular velocity

K_{rot} = Rotational KE

x = position

HEAT AND THERMODYNAMICS

$Q = mc\Delta T$

$Q = mL_f$

$Q = mL_V$

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

$\frac{Q}{\Delta t} = \frac{kA\Delta T}{L}$

$PV = nRT = NkT$

$K = \frac{3}{2}k_B T$

$\Delta U = \frac{3}{2}nR\Delta T$

$W = -P\Delta V$

$\Delta U = Q + W$

c = specific heat
L_f = latent heat of fusion
L_V = latent heat of vaporization
Q = amount of heat
ΔT = change in temperature
α = coefficient of linear expansion
L_o = original length

$c_{water} = 4186 \frac{J}{kg°K}$

K = kinetic energy
L = thickness
U = internal energy
W = work done on a system

WAVE PHENOMENA & SHM

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

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

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

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

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

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

$T_S = 2\pi\sqrt{\frac{m}{k}}$

$T_P = 2\pi\sqrt{\frac{L}{g}}$

c = speed of light in a vacuum
d = distance between slits
$f = \nu$ = frequency
L = distance from slit to screen
n = index of absolute refraction
T = period
v = speed
x = distance from central maximum to first-order maximum
λ = wavelength
θ = angle
θ_c = critical angle relative to air

GEOMETRIC OPTICS & SOUND

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

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

$\beta = 10\log\frac{I}{I_o}$

f = focal length
d_i = image distance
d_o = object distance
h_o = object size
h_i = image size
β = Sound level
I = Sound Intensity
I_o = Threshold Intensity

ELECTROMAGNETIC APPLICATIONS

$F_M = Bqv$

$F_M = BIL$

$\varepsilon = BLv$

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

$V_P I_P = V_S I_s$ (ideal)

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

$\phi_B = B \cdot A$

$\Delta\phi_B = \varepsilon t$

B = magnetic field strength
I_P = current in primary
I_S = current in secondary
N_P = number of turns in primary coil
N_S = number of turns in secondary coil
V_P = voltage of primary
V_S = voltage of secondary
L = length of conductor
V = electric potential difference
v = speed of particle

FLUID MECHANICS

$\rho = \frac{m}{V}$

$P = \frac{F}{A}$

$P = P_o + mgh$

$F_b = \rho V g$

$A_1 v_1 = A_2 v_2$

$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 =$

$= P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$

A = Area
F = force
h = depth
P = pressure
V = volume
v = speed
y = height
ρ = density

MODERN PHYSICS

$E = hf$

$K_{max} = hf - \phi$

$\lambda = \frac{h}{p}$

$E = mc^2$

E = energy
f = frequency
K = kinetic energy
m = mass
p = momentum
λ = wavelength
ϕ = work function

AP PHYSICS I Salmon

For all students taking AP physics I

MARCH 10,2016

Record on the area record the % correct (Corrections)

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

PHYSICS I for all students currently enrolled in AP physics I. 25 multiple choice questions per exam.
JANUARY: Kinematic, Dynamics, Circular motion.
FEBRUARY: Simple harmonic motion, Pendulae and spring-mass systems, impulse and linear momentum, work and energy, plus January topics.
MARCH: Rotational dynamics: torque, rotational kinematics and energy, rotational dynamics and conservation of angular momentum, electrostatics: electric charge and force, plus January and Feb topics.
APRIL: circuits (resistors only) and mechanical waves and sound, plus January, Feb, and March topics.

Dates for 2016 Season

Thursday March 10, 2016 Thursday April 14, 2016

New Jersey Science League

*All areas and schools must complete the April exam and mail in the results by April 28th, 2016.

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**

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

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

Dates for 2017 Season

Thursday January 12, 2017 Thursday February 9, 2017

Thursday March 9, 2017 Thursday April 13, 2017

AP PHYSICS I <u>**Salmon**</u>

For all students taking AP physics I

APRIL 14, 2016

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 and speed of sound in air is 340 m/s.***

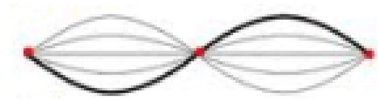
ADDITIONAL INFORMATION: Fundamental charge: $e = 1.6x10^{-19}C$

1. WCMC is a radio station in Wildwood, NJ, which plays "Oldies" and broadcasts at 102.5 *MHz*. Meanwhile, WNSH in Newark, NJ, blasts out Country songs at 94.7 *MHz*. What is the ratio of the wavelengths of WCMC to WNSH, $\frac{\lambda_{WCMC}}{\lambda_{WNSH}}$?

(A) 0.86 (B) 0.92 (C) 1.00 (D) 1.08

2. A guitar string is firmly attached at both ends and vibrates, as shown below, at 60 Hz. Assuming the length density and tension of the string remain unchanged, which of the following frequencies could *not* be produced on this same string?

(A) 15 Hz (B) 30 Hz (C) 90 Hz (D) 120 Hz



3. Two toy ducks, like the one imaged below, are bobbing up and down in the ocean. As a wave goes by them, one duck is at a maximum height while the second duck is at a minimum height with no crests between them. They are separated by a horizontal distance of 6-m and it takes 2 seconds for a duck to move from a position of maximum height to a position of minimum height. What is the speed of the ocean wave?

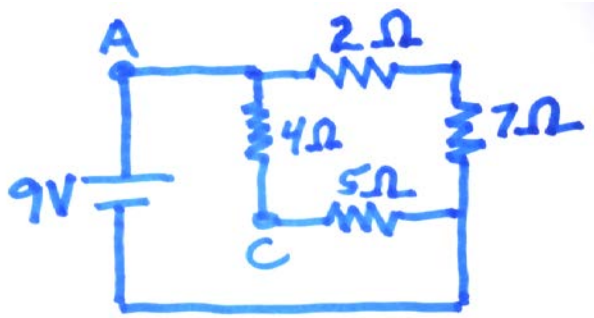
(A) 3 m/s (B) 4 m/s (C) 6 m/s (D) 12 m/s

4. What is the primary differentiation between transverse waves and longitudinal (compressional) waves?
(A) Transverse waves do not need a medium to travel through whereas longitudinal waves do.
(B) Transverse waves occur in all physical wave types like springs and ropes whereas longitudinal waves only occur in springs.
(C) Longitudinal waves travel perpendicularly to the vibrations of the medium whereas transverse waves travel parallel to the vibrations of the medium.
(D) Transverse waves travel perpendicularly to the vibrations of the medium whereas longitudinal waves travel parallel to the vibrations of the medium.

5. A pipe resonates at odd integral multiples of 100 Hz; 100 Hz, 300 Hz, 500 Hz, … The pipe is
(A) Open at both ends and has length of 0.85 m
(B) Closed at one end and has a length of 0.85 m
(C) Open at both ends and has length of 1.7 m
(D) Closed at one end and has a length of 1.7 m

6. Which of the following situations would result in the observer, you, hearing an increase in the frequency of a constant sound source?
(A) You move at a constant speed away from the sound source which remains stationary.
(B) The sound source moves away from you while you remain stationary.
(C) Both you and the sound source move in the same direction at the same constant speed.
(D) The sound source is accelerating at a constant rate toward you.

Use the following circuit sketch for Questions #7 – 10: Assume the battery has negligible internal resistance.



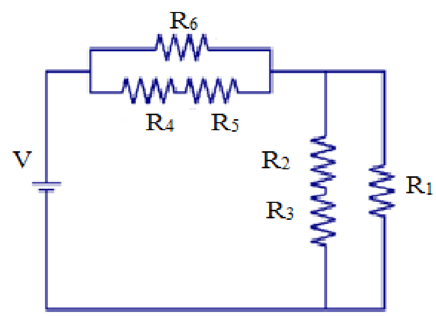
7. What is magnitude and direction of the conventional current through point ***A***?
(A) 2-A to the right (B) 2-A to the left (C) 1-A to the right (D) 1-A to the left

8. What is the current through point C?
(A) 2-A (B) 1-A (C) $\frac{1}{2}$-A (D) Zero

9. What is the potential difference across the 2-Ω resistor?
(A) 1-V (B) 2-V (C) 4.5-V (D) 9-V

10. What is the power dissipated by this circuit?
(A) 2-W (B) 4.5-W (C) 9-W (D) 18-W

Use the following circuit sketch for Questions #11 & 12: You are provided the following sketch of a DC circuit.



You are told that $R_1 = R_2 = R_3 = 6\Omega$ and $R_4 = R_5 = R_6 = 12\Omega$.

11. What is the terminal voltage of the battery that would supply a current of 2A through R_4?
(A) 8-V (B) 16-V
(C) 32-V (D) 72-V

12. How does the total current and effective resistance of the circuit change, it at all, if the battery used in #11 remains the same, but you insert one more resistor of unknown non-zero magnitude in parallel with R_1?

	Total Current	***Effective Resistance***
(A)	Remains the same	Decreases
(B)	Decreases	Remains the same
(C)	Increases	Decreases
(D)	Decreases	Increases

13. A large oil ship sounds its horn while approaching Barnegat Light House at a low speed on a cold foggy night. The speed of sound is 340 m/s and the Captain of the ship hears the echo of the horn six seconds after pushing the horn button. How far from the light house is the ship?
(A) 57 m (B) 113 m (C) 1020 m (D) 2040 m

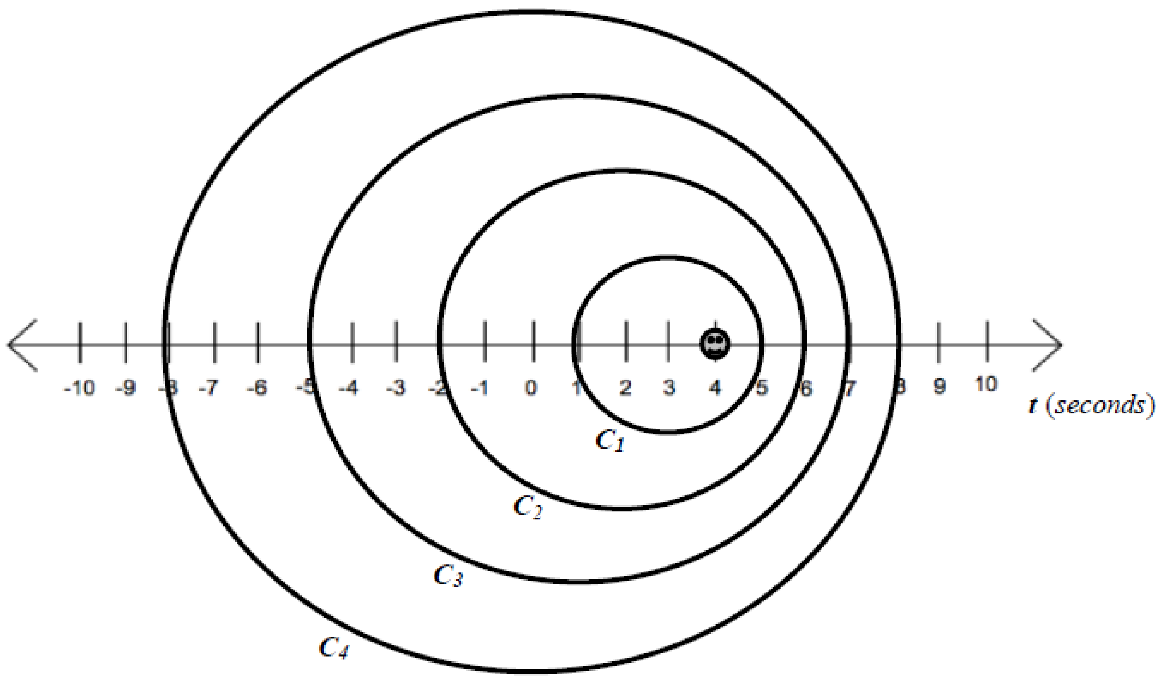
14. A guitarist creates a standing wave on one of the six strings and then increases the tension in that string while it vibrates. Of the following three wave properties, which one(s) change(s) while the guitarist increases the tension?

I. Speed of the wave on the string that causes the standing wave pattern
II. The frequency of the standing wave
III. The wavelength of the standing wave

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

15. When three resistors of unequal size are connected in parallel across a constant voltage source, the effective resistance of the parallel branch is
(A) always larger than the smallest value of the resistors
(B) always equal to the average of the values of the resistors
(C) always equal to the sum of the values of the resistors
(D) always smaller than the smallest resistor

Use the following circuit sketch for Questions #16 – 18: The sketch below represents the sound wave fronts produced by a jet plane moving in a straight line at a constant speed. The current position of the plane is shown on the number line at the position '***4***'. The diagram information began when the plane was at the origin, labeled '0', representing $t = 0$. The circles labeled C_1, C_2, C_3, & C_4 represent the positions of the wave fronts of sound produced by the plane 1 second, 2 seconds, 3 seconds, and 4 seconds ago, respectively. The speed of sound in air is 340 m/s.



16. In what direction and with what speed is the plane traveling?

	Direction	***Speed***
(A)	To the right	85 m/s
(B)	To the right	170 m/s
(C)	To the left	85 m/s
(D)	To the left	170 m/s

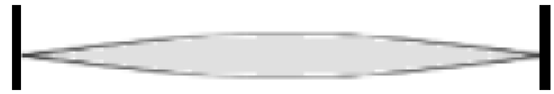
17. The ratio of the wavelength of the sound directly to the right of the plane to that of the stationary plane is

(A) $3/2$ (B) 1 (C) $1/2$ (D) $1/4$

18. At the current positions shown in the diagram, what is the ratio of the frequencies of the sound at -8 seconds to the frequency at +8 seconds?

(A) $3/2$ (B) $3/1$ (C) $1/3$ (D) $2/3$

19. The image below represents a vibrating guitar string of length 1.2-m anchored at both ends. What are the next three higher frequencies above this one that this string could produce if tension, length density, and the speed of sound in air all remain unchanged? Use 340 m/s for the speed of sound in air.



(A) 142, 283, & 425 Hz (B) 283, 425, & 567 Hz
(C) 283, 567, &1133 Hz (D) 142, 283, & 567 Hz

20. You are given a constant voltage source, some wire of negligible resistance, and several unequal waterproof resistors where all you know is $R_1 > R_2 > R_3$. You are tasked with designing an electrical circuit with just these items so that, when the resistors are immersed in water, they will heat it to a given temperature increase in the shortest amount of time. Which of the following would achieve this task?
(A) Connect all three resistors in series, then place them under water.
(B) Connect all three resistors in parallel, then place them under water.
(C) Connect R_1 & R_2 in parallel and then R_3 in series with them, then place them under water.
(D) Connect R_2 & R_3 in parallel and then R_1 in series with them, then place them under water.

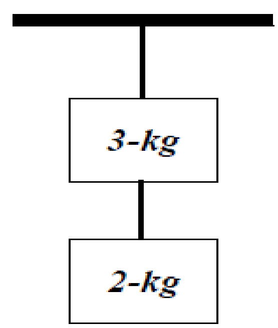
21. Three resistors of values 3Ω, 6Ω, and 9Ω are connected in parallel with a constant 10-V battery. Consider the following three statements about this set-up.

I. The current in the 3Ω resistor is three times the current in the 9Ω resistor.
II. The potential drop across each of the three resistors is the same.
III. The power dissipated in the 9Ω resistor is greater than the power dissipated in either of the other two resistors.

Which statement(s) is/are correct?
(A) I & II only (B) II & III only (C) II only (D) III only

22. When two identical resistors are connected in parallel to a battery they dissipate power ***P***. When the same two resistors are connected in series to the same battery, the power dissipated is
(A) $P/4$ (B) $P/2$ (C) $2P$ (D) $4P$

Use the following sketch for Questions #23 & 24: Two metal blocks are hanging vertically from a ceiling using massless strings, as shown to the right.



23. What is the tension in the upper string?
(A) Zero (B) 20-N (C) 30-N (D) 50-N

24. If the upper string is now replaced by a spring that has the length as the string when relaxed and a spring constant of 200 N/m. The blocks are held in place then released from rest. What is the frequency of oscillation of the resulting SHM?
(A) $\frac{\sqrt{40}}{2\pi}$ (B) $\frac{2\pi}{\sqrt{40}}$ (C) $\frac{\sqrt{67}}{2\pi}$ (D) $\frac{2\pi}{\sqrt{67}}$

25. Two charged particles, ***A*** & ***B***, repel each other and are isolated from all other influences where the electrostatic force between them is the only force involved. The masses are such that $M_A = 2M_B$. If particle ***B*** accelerates away at $6.6\,m/s^2$, what is the magnitude of the acceleration of particle ***A***?
(A) $1.6\,m/s^2$ (B) $3.3\,m/s^2$ (C) $6.6\,m/s^2$ (D) $13.2\,m/s^2$

AP I and AP 2 PHYSICS FORMULAE Updated 12-23-2015

Constants & Conversion Factors

Proton and Neutron Mass	$m_p = 1.67x10^{-27} kg$	Fundamental charge	$e = 1.6x10^{-19} C$
Electron Mass	$m_e = 9.11x10^{-31} kg$	Electron Volt	$1eV = 1.6x10^{-19} J$
Avogadro's #	$6.02x10^{23} mol^{-1}$	Universal Gravitational constant	$G = 6.67x10^{-11} Nm^2/kg^2$
Universal gas constant	$R = 8.31 J/mol \cdot K$	Speed of Light	$c = 3.00x10^8 m/s$
Boltzmann's constant	$k_B = 1.38x10^{-23} J/K$	Magnetic constant	$k' = 1x10^{-7} T \cdot m/A$
1 unified atomic mass unit		$1u = 1.66x10^{-27} kg = 931 MeV/c^2$	
Planck's Constant		$h = 6.63x10^{-34} J \cdot s = 4.14x10^{-15} eV \cdot s$ $hc = 1.99x10^{-25} J \cdot m = 1240 eV \cdot nm$	
Coulomb's Law constant		$k = \frac{1}{4\pi\varepsilon_o} = 9.0x10^9 N \cdot m^2/kg^2$ $\varepsilon_o = 8.85x10^{-12} C^2/N \cdot m^2$	

MECHANICS

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

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

$v_f = v_i + at$

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

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

$\Sigma F = ma$

$W = mg$

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

$U_g = G\frac{m_1 m_2}{r}$

$\rho = mv$

$F\Delta t = m\Delta v$

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

Δx = displacement (change of position)

$\bar{v}$ = average velocity

$\bar{a}$ = average acceleration

v_i = initial velocity

v_f = final velocity

F = force

F_f = force of friction

F_N = normal force

F_g = gravitational force

G = Universal Gravitational Constant

ρ = momentum

μ = coefficient of friction

r = distance between center of masses

W = weight

m = mass

U_g = gravitational PE

ELECTRICITY

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

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

$\Delta U_E = q\Delta V$

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

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

$V = IR$

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

SERIES CIRCUIT

$I_T = I_1 = I_2 = I_3 = ...$

$V_T = V_1 + V_2 + V_3 + ...$

$R_T = R_1 + R_2 + R_3 + ...$

PARALLEL CIRCUITS

$I_T = I_1 + I_2 + I_3 + ...$

$V_T = V_1 = V_2 = V_3 = ...$

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

C = Capacitance

E = electric field intensity

I = electric current

k = electrostatic constant

P = Power

q = charge

R = resistance

U_E = electric potential Energy

U_C = energy stored in capacitor

V = electric potential difference

W = Work

$C = Q/\Delta V$

$U_C = \frac{1}{2}Q\Delta V = \frac{1}{2}C\Delta V^2$

$C_{parallel} = \Sigma C_i$

$C_{series} = \frac{1}{\Sigma\left(\frac{1}{C_i}\right)}$

ENERGY AND WORK

$W = F\Delta x\cos\theta$

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

$PE_g = mgh$

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

$F = -kx$

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

h = height

k = spring constant

KE = kinetic energy

PE_g = gravitational potential energy

PE_s = potential energy stored in a spring

P = power

W = work

x = change in spring length from the equilibrium position

CIRCULAR MOTION & ROTATION

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

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

$1rev = 2\pi rad = 360°$

$\tau = Fxr = I\alpha$

$I = \Sigma mr^2$

$L = I\omega$

$K_{rot} = \frac{1}{2}I\omega^2$

$x = A\cos(\omega t)$

$x = A\cos(2\pi ft)$

a_c = centripetal acceleration

F_c = centripetal force

τ = Torque

I = Rotational Inertia

α = Angular acceleration

ω = Angular velocity

K_{rot} = Rotational KE

x = position

HEAT AND THERMODYNAMICS

$Q = mc\Delta T$

$Q = mL_f$

$Q = mL_V$

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

$\frac{Q}{\Delta t} = \frac{kA\Delta T}{L}$

$PV = nRT = NkT$

$K = \frac{3}{2}k_B T$

$\Delta U = \frac{3}{2}nR\Delta T$

$W = -P\Delta V$

$\Delta U = Q + W$

c = specific heat
L_f = latent heat of fusion
L_V = latent heat of vaporization
Q = amount of heat
ΔT = change in temperature
α = coefficient of linear expansion
L_o = original length
$c_{water} = 4186 \frac{J}{kg°K}$
K = kinetic energy
L = thickness
U = internal energy
W = work done on a system

WAVE PHENOMENA & SHM

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

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

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

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

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

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

$T_S = 2\pi\sqrt{\frac{m}{k}}$

$T_P = 2\pi\sqrt{\frac{L}{g}}$

c = speed of light in a vacuum
d = distance between slits
$f = \nu$ = frequency
L = distance from slit to screen
n = index of absolute refraction
T = period
v = speed
x = distance from central maximum to first-order maximum
λ = wavelength
θ = angle
θ_c = critical angle relative to air

GEOMETRIC OPTICS & SOUND

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

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

$\beta = 10\log\frac{I}{I_o}$

f = focal length
d_i = image distance
d_o = object distance
h_o = object size
h_i = image size
β = Sound level
I = Sound Intensity
I_o = Threshold Intensity

ELECTROMAGNETIC APPLICATIONS

$F_M = Bqv$

$F_M = BIL$

$\varepsilon = BLv$

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

$V_P I_P = V_S I_S$ (ideal)

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

$\phi_B = B \cdot A$

$\Delta\phi_B = \varepsilon t$

B = magnetic field strength
I_P = current in primary
I_S = current in secondary
N_P = number of turns in primary coil
N_S = number of turns in secondary coil
V_P = voltage of primary
V_S = voltage of secondary
L = length of conductor
V = electric potential difference
v = speed of particle

FLUID MECHANICS

$\rho = \frac{m}{V}$

$P = \frac{F}{A}$

$P = P_o + mgh$

$F_b = \rho V g$

$A_1 v_1 = A_2 v_2$

$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 =$

$= P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$

A = Area
F = force
h = depth
P = pressure
V = volume
v = speed
y = height
ρ = density

MODERN PHYSICS

$E = hf$

$K_{max} = hf - \phi$

$\lambda = \frac{h}{p}$

$E = mc^2$

E = energy
f = frequency
K = kinetic energy
m = mass
p = momentum
λ = wavelength
ϕ = work function

AP PHYSICS I **Salmon No Corrections**

APRIL 14, 2016

SOLUTIONS

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

PHYSICS I for all students currently enrolled in AP physics I. 25 multiple choice questions per exam.
JANUARY: Kinematic, Dynamics, Circular motion.
FEBRUARY: Simple harmonic motion, Pendulae and spring-mass systems, impulse and linear momentum, work and energy, plus January topics.
MARCH: Rotational dynamics: torque, rotational kinematics and energy, rotational dynamics and conservation of angular momentum, electrostatics: electric charge and force, plus January and Feb topics.
APRIL: circuits (resistors only) and mechanical waves and sound, plus January, Feb, and March topics.

Dates for 2016 Season
Thursday April 14, 2016

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

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

Dates for 2017 Season

Thursday January 12, 2017 Thursday February 9, 2017

Thursday March 9, 2017 Thursday April 13, 2017