FIRST YEAR PHYSICS **Ivory Exam**

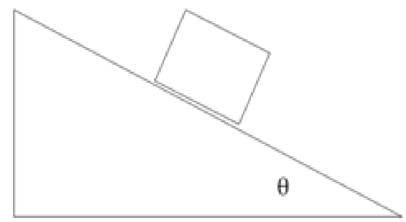
JANUARY 12, 2017

High School PHYSICS for all Honors and College Prep students. (No AP level students).
25 multiple choice questions per exam. Each question is worth 4 points.
Directions: For each question or statement fill in the appropriate space on the answer sheet. Use the letter preceding the word, phrase, or quantity which best completes or answers the question.

Use: g =10 m/s^2 on Earth No Corrections Jan Exam.

1. A car travels northbound at 25.0 kilometers per hour for 30.0 minutes. Then the car turns around, goes in the opposite direction, and travels an additional 1500 meters in 10.0 minutes. What is the magnitude of the average velocity of the car for the entire 40-minute interval?
a. 0.350 km/hr b. 2.90 km/hr c. 16.5 km/hr d. 21.0 km/hr

2. The diagram below shows a rough plane inclined at angle θ with the horizontal.



As the angle, θ, is increased, the coefficient of kinetic friction between the surface of a wooden block and the inclined plane
a. increases because the component of the gravitational force on the block increases
b. decreases because the normal force on the block decreases
c. decreases because the component of the gravitational force on the block decreases
d. remains the same

3. If the sum of all forces acting on an object is zero, then the object
a. will speed up, accelerating uniformly
b. will slow down and stop
c. will move in a circle at constant speed
d. will continue at constant velocity

Base your answers to questions 4 and 5 on the information below:
A 2.0×10^3 kilogram car rounds a flat curve of radius 30.0 meters at a constant speed of 12.0 m/s.

4. What is the magnitude of the acceleration of the car?
a. 0, the car is moving at constant speed c. 2.5 m/s^2
b. 0.4 m/s^2 d. 4.8 m/s^2

5. The net force on the car is
a. directed toward the center of the circle
b. directed away from the center of the circle
c. directed in the direction of motion and tangent to the curve
d. zero because the car is moving at constant speed

6. A 15.0 kg mass is placed on a scale in an elevator. If the initial velocity of the elevator is 3.0 m/s upward and the scale reads 120 N, which of the following is true?
a. The mass will continue upward and speed up with an acceleration of 8.0 m/s^2
b. The mass will continue upward and slow down with an acceleration of –8.0 m/s^2
c. The mass will continue upward and slow down with an acceleration of –2.0 m/s^2
d. The mass will continue upward at a constant velocity of 3.0 m/s

7. A football is kicked with initial speed v at angle θ above the horizontal. The ball reaches a maximum height of 20.0 meters and returns to the ground 50.0 meters from where it was projected. Calculate the speed v and angle θ.

a. v =24 m/s, θ = 32°
b. v =24 m/s, θ = 58°
c. v =32 m/s, θ = 39°
d. v =32 m/s, θ = 51°

Use the following information for questions 8, 9 and 10

A ball is thrown upward into the air with initial velocity v and reaches a maximum height h

8. At maximum height, the

a. velocity of the ball points upward
b. velocity of the ball points downward
c. velocity of the ball is zero
d. acceleration of the ball is zero

9. On the way down, the speed of the ball at half of the maximum height is

a. ($\sqrt{3}/2$) v
b. ($\sqrt{2}/2$) v
c. v/2
d. v/4

10. If the ball had been thrown with velocity 2v, the new maximum height would be

a. ($\sqrt{2}/2$) times the original height
b. $\sqrt{2}$ times the original height
c. 2 times the original height
d. 4 times the original height

11. Three one-meter long vectors are added together: one points north, one points 45 degrees N of E and one points 45 degrees W of S. The magnitude of the resultant is:

a. 0
b. 1 meter
c. 2 meters
d. none of the above

12. A ball is thrown at an angle of 25 degrees above the horizontal from the top of a 20.0-meter high building. The ball hits the ground 15 meters from the bottom of the building. The magnitude of the velocity of the ball is

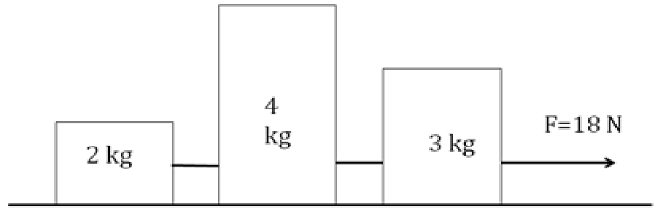
a. greatest just after leaving the hand
b. greatest just before hitting the ground
c. greatest at the top of the trajectory
d. constant during the entire flight of the ball

13. A yoyo is spun around in a horizontal circle of radius, r, with constant speed, v. In order to achieve the same centripetal acceleration when the radius is reduced to r/2, the angular speed, ω, of the yoyo must be

a. half the original angular speed
b. twice the original angular speed
c. four times the original angular speed
d. $\sqrt{2}$ times the original angular speed

14. "Massless" strings connect three boxes as shown. The 2.0 kg, 4.0 kg, and 3.0 kg boxes are pulled along a frictionless horizontal surface by an 18 N force. The tension in the string connecting the 4 kg and 3 kg boxes is

a. 18 N
b. 15 N
c. 12 N
d. 9 N



15. A 4.0 kg piece of electronic equipment is brought to the surface of an asteroid by a space-craft. If the mass of the asteroid is 10% of Earth's mass and the asteroid's radius is 1/5 of Earth's radius, then the **weight of the equipment** on the asteroid is

a. 20 N b. 100 N c. 200 N d. 1000 N

16. The average power generated by an Olympic athlete accelerating a 7.30 kg shot from rest to 14.0 m/s in 2.00 seconds is

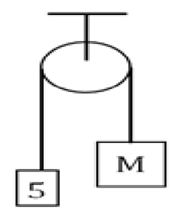
a. 0.051 kWatts b. 0.358 kWatts c. 0.506 kWatts d. 0.715 kWatts

17. Objects made from copper have a density of 8.9×10^3 kg/m^3. A 10.0-m long copper wire with a mass of 2500 grams has a radius of approximately

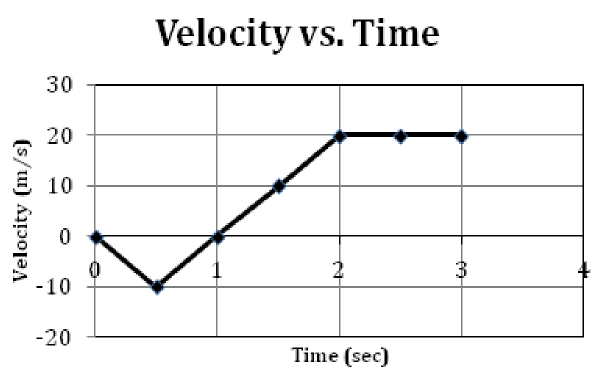
a. 3.0 cm b. 0.30 cm c. 0.30 mm d. 9.0 μm

18. The Atwood's machine shown below has a 5–kg box and an unknown mass, M, suspended from it. If the unknown mass is found to accelerate downward from rest at 2.0 m/s^2, then what is the mass of the unknown mass?

a. 6.0 kg b. 6.5 kg c. 7.0 kg d. 7.5 kg



Use the following graph for number 19, 20, and 21.
The following velocity vs. time graph shows the motion of a particle that starts at the origin at t=0.



19. The **total distance traveled** by the particle in 3.0 seconds is
a. 35 meters
b. 30 meters
c. 25 meters
d. 20 meters

20. The **average velocity** of the particle for the 3-second interval is
a. 5.0 m/s
b. 8.3 m/s
c. 10 m/s
d. 11.7 m/s

21. The particle returns to the origin at approximately
a. t = 1.5 seconds
b. t = 1.7 seconds
c. t = 2.0 seconds
d. never

Use the following information for #22 and #23

A 3.0 kg block starts from rest and slides down from the top of a 2.0-meter long ramp inclined at 30 degrees. The coefficient of kinetic friction between the ramp and the block is 0.25

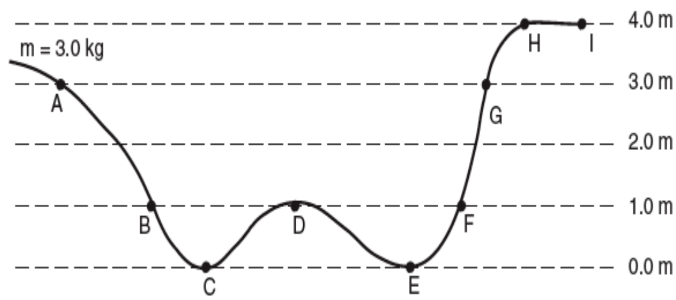
22. The acceleration of the block as it slides down the incline is

a.	2.5 m/s^2	c.	3.1 m/s^2
b.	2.8 m/s^2	d.	3.6 m/s^2

23. The **mechanical energy lost** by the block when it reaches the bottom of the incline is

a.	0 J	c.	13 J
b.	6.5 J	d.	19 J

24. A 60-kg physics student takes a ride on a frictionless 100 kg rollercoaster while holding a 3.0 kg physics textbook (part of the track is shown below). The rollercoaster is observed to travel the horizontal distance of 1.0 meter between points H and I in 0.20 seconds.



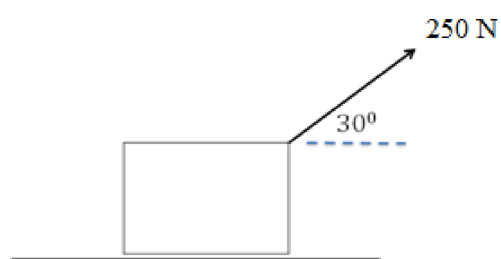
How fast is the textbook moving at point A?

a.	4.5 m/s	c.	6.7 m/s
b.	5.9 m/s	d.	45 m/s

25. A rope held at an angle of 30 degrees is used to pull a 50-kg crate along a rough surface. The coefficient of kinetic friction between the crate and the floor is 0.20

If the crate starts from rest, the velocity of the crate after it is pulled 5.0 meters is

a. 2.8 m/s
b. 3.7 m/s
c. 5.3 m/s
d. 6.0 m/s



High School PHYSICS: Ivory Exam
Date: JANUARY 12, 2017
High School PHYSICS -- For all Honors and college prep student.
25 multiple choice questions per exam.
This exam is NOT for any AP® level students.

ANSWERS No Corrections Jan Exam

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

Topics of Study

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

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

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

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

Dates for 2017 Season
Thursday January 12, 2017 Thursday February 9, 2017
Thursday March 9, 2017 Thursday April 13, 2017
All areas and schools must complete the April exam and mail in the results
by April 28th, 2017

New Jersey Science League
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phone # 908-213-8923 fax # 908-213-9391 email: newjsl@ptd.net
Web address: http://entnet.com/~personal/njscil/html/

What is to be mailed back to our office?
PLEASE RETURN THE AREA RECORD AND ALL TEAM MEMBER SCANTRONS (ALL STUDENTS PLACING 1ST, 2ND, 3RD, AND 4TH).
If you return Scantrons of alternates, then label them as ALTERNATES.

Dates 2018 Season
Thursday January 11, 2018 Thursday February 8, 2018
Thursday March 8, 2018 Thursday April 12, 2018

High School PHYSICS: <u>Ivory Exam</u> No Corrections

February 9, 2017

High School PHYSICS for all Honors and College Prep students. (No AP level students).

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

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

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

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

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

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

1. A disk, a ring and a solid sphere, each with mass M and radius R, are initially held at the top of an incline of height h. They are simultaneously released from rest. Which statement is correct when they reach the bottom of the incline?

(A) The initial potential energy of each is the same, therefore at the bottom, $v_{disk} = v_{ring} = v_{sphere}$

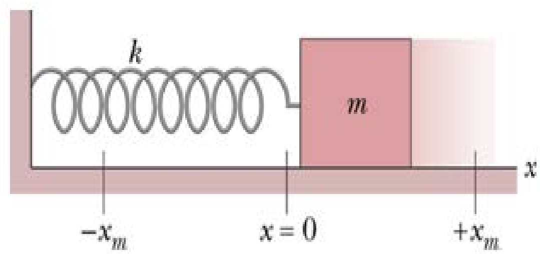
(B) The initial potential energy of each is the same, therefore they take the same time to reach the bottom.

(C) $v_{ring} > v_{disk} > v_{sphere}$

(D) $v_{sphere} > v_{disk} > v_{ring}$

Refer to the following description and figure for questions 2 and 3.

A simple harmonic oscillator has a mass of 200 grams and a spring constant of 100 N/m. The system is compressed so that the amplitude of oscillation is x_m= 4.00 cm.



2. In order to compress the spring the 4.00 cm, the force required was

(A) 1.0 N

(B) 2.0 N

(C) 4.0 N

(D) 8.0 N

3. The maximum kinetic energy stored in the oscillator is

(A) 0.008 J (B) 0.020 J (C) 0.080 J (D) 0.800 J

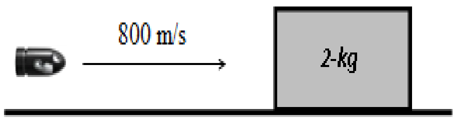
4. A 60 kg physics student rides 2.0 m from the center of a merry-go-round. If the merry-go-round makes 4 rotations every 10 seconds, how fast is the student travelling?

(A) 5.0 m/s (B) 2.5 m/s (C) 1.3 m/s (D) 0.2 m/s

5. A new asteroid, with a mass that is half the Earth's mass, is discovered orbiting the Sun at an average orbital distance that is 400 times the Earth's orbital radius. What is the **<u>orbital period</u>** of the new planet in Earth years?

(A) 54 years (B) 400 years (C) 800 years (D) 8000 years

Refer to the following description and figure for questions 6 and 7.
A 2.00 gram bullet, initially moving at 800 m/s, strikes a 2.00 kg wooden block initially at rest on a rough surface in a totally inelastic collision. The coefficient of kinetic friction between the block and the surface is 0.200.



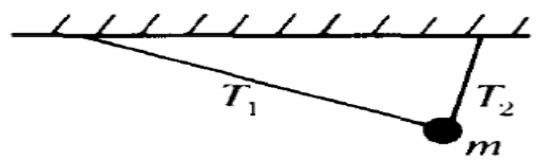
6. Which of the following is true immediately after the collision?
(A) Both kinetic energy and momentum are not conserved
(B) Kinetic energy is conserved and momentum is not conserved
(C) Momentum is conserved and kinetic energy is not conserved
(D) Both kinetic energy and momentum are conserved

7. After the collision, the bullet/block system will travel _____ meters before coming to a stop.
(A) 2.0 cm (B) 4.0 cm (C) 8.0 cm (D) 16 cm

8. A 2.0 kg box of Valentines slides down a rough plank, inclined at 60 degrees. The coefficient of kinetic friction between the box and the incline is 0.200 and the length of the incline is 2.0 meters. The work done by the normal force as the box slides down the incline is
(A) 0 J (B) 8.0 J (C) 17 J (D) 20 J

9. A ball of mass *m* is suspended from two strings of unequal length, as shown below. The magnitudes of the tensions T_1 and T_2 in the strings must satisfy which of the following relations?

(A) $T_1 = T_2$ (B) $T_1 > T_2$
(C) $T_1 < T_2$ (D) $T_1 + T_2 = mg$



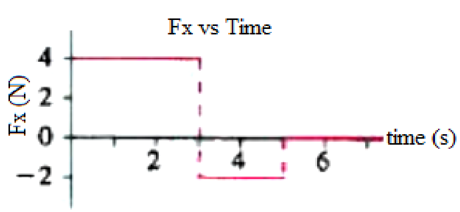
10. The net force on a moving object is suddenly reduced to zero. As a consequence, the object
(A) stops abruptly
(B) stops during a short time interval
(C) changes direction
(D) continues at a constant velocity

11. An astronaut lands on a planet whose mass and radius are each twice that of Earth. If the astronaut weighs 800 Newtons on Earth, how much will he weigh on this planet?

(A) 200 N (B) 400 N (C) 800 N (D) 3200 N

12. On Earth a pendulum of length L and mass M is displaced and shown to have period T. It is taken by astronauts to another planet that has 4 times the mass of Earth and 4 times the radius. Its new period is
(A) T (B) 2T (C) 4T (D) T/4

Refer to the following description and figure for questions 13 and 14.
A 4.0 kg mass has an initial velocity of 1.0 m/s in the positive x direction. At t = 0, a variable net force acts on the mass as shown in the F_x vs. time t graph below.



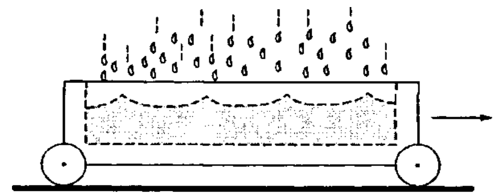
13. What is the mass's speed at $t = 3$ s?
(A) 15 m/s
(B) 12 m/s
(C) 3.0 m/s
(D) 4.0 m/s

14. How does the object move between $t = 3$ s and $t = 5$ s?
(A) It speeds up (B) It slows down (C) It moves with a constant speed

15. A child has a toy tied to the end of a string. He whirls the toy at constant speed in a horizontal circular path of radius *R*. The toy completes each revolution of its motion in a time period *T*. What is the magnitude of the acceleration of the toy?

(A) 0 (B) $\frac{4\pi^2 R}{T^2}$ (C) $\frac{\pi R}{T^2}$ (D) g

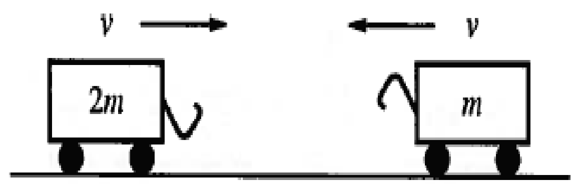
16. An open cart on a level surface is rolling without frictional loss through a vertical downpour of rain, as shown below. As the cart rolls, an appreciable amount of rainwater accumulates in the cart. What will happen to the cart's speed?



(A) The cart will speed up
(B) The cart will slow down
(C) The cart's speed is unchanged

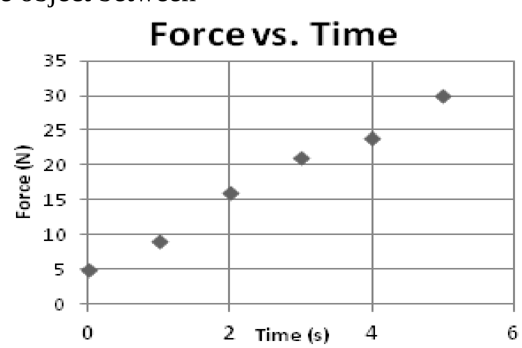
17. The work done in accelerating an object along a frictionless horizontal surface is equal to the change in the object's
(A) momentum (B) velocity (C) potential energy (D) kinetic energy

18. Two carts, having mass 2*m* and *m*, approach each other head-on with the **<u>same speed *v*</u>**, as shown in the figure below. When the carts collide, they hook together. Assuming positive momentum is to the right, which of the following best represents the momentum of the cart of mass *m* after the collision?



(A) mv (B) 2mv
(C) 2mv/3 (D) mv/3

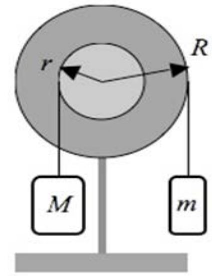
19. A student obtains data on the magnitude of the net force applied to an object as a function of time and displays the data on the graph below. The increase in the momentum of the object between $t = 0$ s and $t = 4$ s is closest to



(A) 40 kg m/s
(B) 50 kg m/s
(C) 60 kg m/s
(D) 80 kg m/s

20. An object of mass *M* travels along a horizontal air track at a constant speed *v* and collides elastically with an object of identical mass that is initially at rest on the track. Which of the following statements is true for the two-object system after the impact?
(A) The total momentum is Mv and the total kinetic energy is $(1/2)Mv^2$.
(B) The total momentum is Mv and the total kinetic energy is less than $(1/2)Mv^2$.
(C) The total momentum is less than Mv and the total kinetic energy is $(1/2)Mv^2$.
(D) The total momentum is less than Mv and the total kinetic energy is less than $(1/2)Mv^2$.

21. The pulley system shown below consists of two "massless and frictionless" disks of different radii fastened together. Two different objects of mass M and m are connected to the pulley system by light strings, as shown. Under what condition will the pulley system be in static equilibrium?

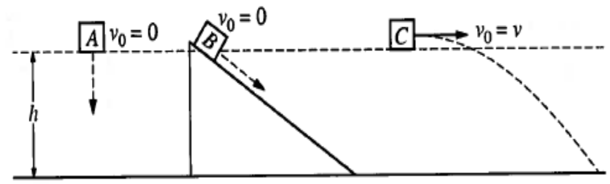


(A) $Rm = rM$ (B) $rm = RM$

(C) $½mr^2 = ½MR^2$ (D) $m = M$

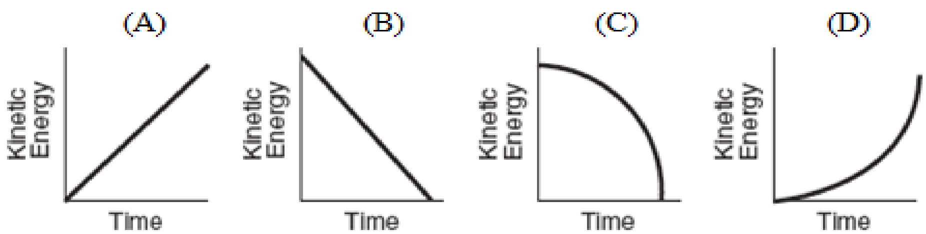
22. Three identical blocks each take a different path from a height h to the ground. Block A is released from rest and falls vertically. Block B is released from rest and slides down a frictionless incline. Block C is projected horizontally with an initial speed v. Which block takes the **longest time** to reach the ground?

(A) A
(B) B
(C) C
(D) The blocks take the same time to reach the ground.



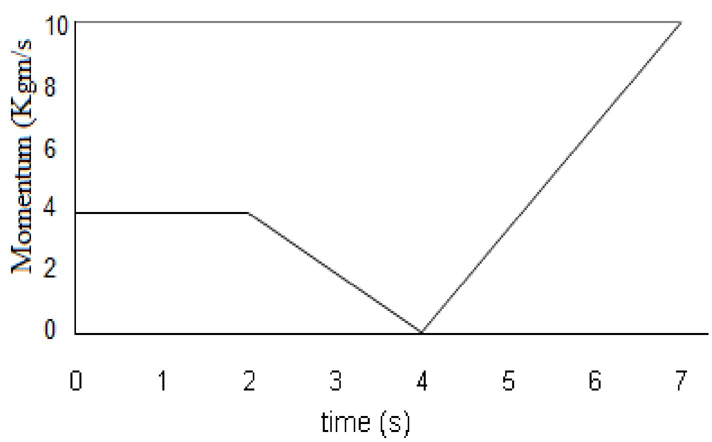
23. A 110-kilogram bodybuilder and his 55-kilogram friend run up identical flights of stairs. The bodybuilder reaches the top in 4.0 seconds while his friend takes 2.0 seconds. Compared to the power developed by the bodybuilder while running up the stairs, the power developed by his friend is
(A) the same (B) twice as much (C) half as much (D) four times as much

24. An object falls freely from rest near Earth's surface. Which graph best represents the relationship between the object's kinetic energy and its time of fall?



25. Based on the graph below, what was the magnitude of a 0.50-kg body's acceleration at 3 seconds?

(A) 0.5 m/s^2
(B) 1 m/s^2
(C) 2 m/s^2
(D) 4 m/s^2



PHYSICS FORMULAE

MECHANICS

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

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

$v_f = v_i + at$

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

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

$\Sigma F = ma$

$W = mg$

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

$p = mv$

$F\Delta t = m\Delta v$

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

Δx = displacement (change of position)

$\bar{v}$ = average velocity

$\bar{a}$ = average acceleration

v_i = initial velocity

v_f = final velocity

F = force

F_f = force of friction

F_N = normal force

F_g = gravitational force

G = Universal Gravitational Constant

p = momentum

μ = coefficient of friction

r = distance between center of masses

W = weight

ELECTRICITY AND MAGNETISM

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

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

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

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

$V = IR$

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

SERIES CIRCUIT

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

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

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

PARALLEL CIRCUITS

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

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

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

E = electric field intensity

I = electric current

k = electrostatic constant

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

$G = 6.67x10^{-11} \frac{Nm^2}{kg^2}$

P = Power

q = charge

R = resistance

V = electric potential difference

W = Work

Fundamental particle electron

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

e mass 9.11×10^{-31} kg

ENERGY

$W = F\Delta x$

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

$PE_g = mgh$

$KE = \frac{1}{2} m v^2$

$F = -kx$

$PE_s = \frac{1}{2} k x^2$

h = height

k = spring constant

KE = kinetic energy

PE_g = gravitational potential energy

PE_s = potential energy stored in a spring

P = power

W = work

x = change in spring length from the equilibrium position

MOTION IN 2-D

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

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

1 rev = 2 π rad = 360°

$\tau = r \times F$

L = Iω

KE = $\frac{1}{2}$ I ω^2

a_c = centripetal acceleration

F_c = centripetal force

τ = Torque

L = Angular Momentum

I = Moment of Inertia

ω = angular velocity

PHYSICS FORMULAE

HEAT ENERGY

$Q = mc\Delta T$

$Q = mL_f$

$Q = mL_V$

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

c = specific heat

L_f = latent heat of fusion

L_V = latent heat of vaporization

Q = amount of heat

ΔT = change in temperature

α = coefficient of linear expansion

L_o = original length

$c_{water} = 4186 \dfrac{J}{kg°K}$

1 cal = 4.184 joules

WAVE PHENOMENA

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

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

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

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

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

$n\ \lambda$ = d sin θ

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

c = speed of light in a vacuum

d = distance between slits

$f = \nu$ = frequency

L = distance from slit to screen

n = index of absolute refraction

T = period

v = speed

x = distance from central maximum to first-order maximum

λ = wavelength

θ = angle

θ_c = critical angle relative to air

GEOMETRIC OPTICS

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

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

f = focal length

d_i = image distance

d_o = object distance

h_o = object size

h_i = image size

ELECTROMAGNETIC APPLICATIONS

F = Bqv

$F = BIL$

$V = BLv$

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

$V_P I_P = V_S I_s$ (ideal)

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

B = magnetic field strength

I_P = current in primary

I_S = current in secondary

N_P = number of turns in primary coil

N_S = number of turns in secondary coil

V_P = voltage of primary

V_S = voltage of secondary

L = length of conductor

V = electric potential difference

High School PHYSICS: Ivory Exam No Corrections
Date February 9, 2017
For all Honors and college prep students.
25 multiple choice questions per exam.
This exam is NOT for any AP® level students.

ANSWERS

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

Topics of Study

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

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

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

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

Dates for 2017 Season
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Thursday March 9, 2017   Thursday April 13, 2017
All areas and schools must complete the April exam and mail in the results
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New Jersey Science League
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High School PHYSICS: Ivory Exam Corrections: None

March 9, 2017

High School PHYSICS for all Honors and College Prep students. (No AP level students).

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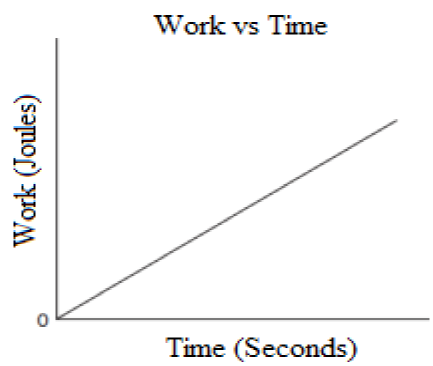
Directions: For each question or statement fill in the appropriate space on the answer sheet. Use the letter preceding the word, phrase, or quantity which best completes or answers the question.

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

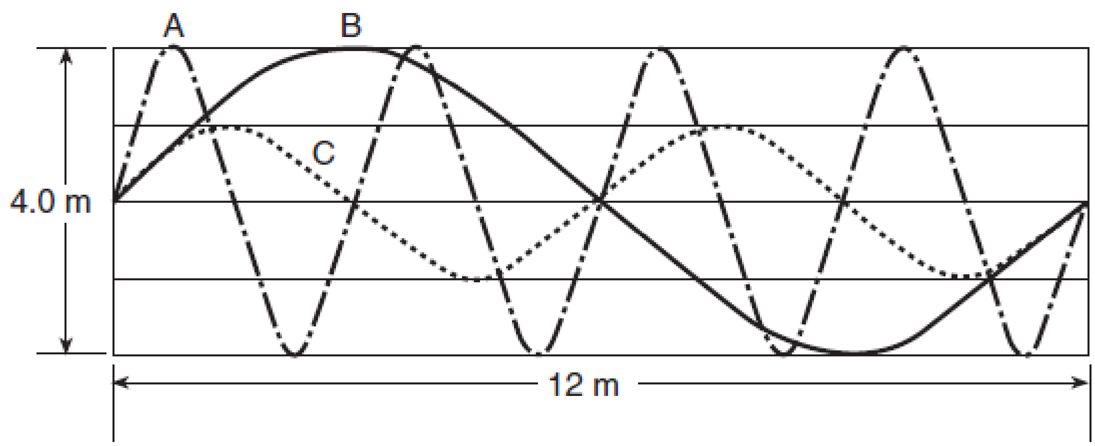
1. The graph below represents the relationship between work done by a student running up a flight of stairs and the time of ascent. What does the slope of this graph represent?

(A) Impulse (B) Momentum

(C) Acceleration (D) Power



Refer to the following description and figure for questions 2, 3, and 4.
Three waves, *A*, *B*, and *C*, travel 12 m in 2.0 s through the same medium, as shown in the diagram below.



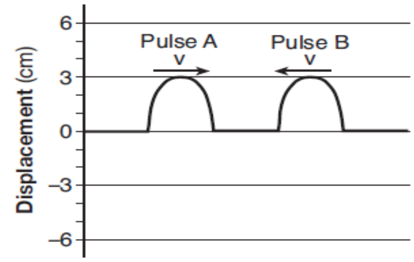
2. What is the amplitude of wave *C*?
(A) 1.0 m (B) 2.0 m (C) 3.0 m (D) 6.0 m

3. What is the period of wave *A*?
(A) 0.25 s (B) 0.50 s (C) 1.0 s (D) 2.0 s

4. What is the speed of wave *B*?
(A) 2.0 m/s (B) 3.0 m/s (C) 6.0 m/s (D) 12 m/s

5. The diagram below represents two identical pulses approaching each other in a uniform medium. As the pulses meet and are superimposed, the maximum displacement of the medium is

(A) -6 cm (B) 0 cm
(C) +3 cm (D) +6 cm

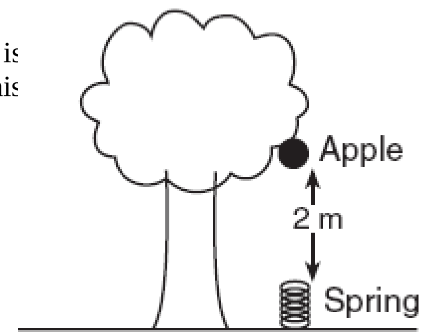


6. The diagram below shows a 0.1 kg apple attached to a branch of a tree 2 m above a spring on the ground below. The apple falls and hits the spring, compressing it 0.1 m from its rest position.

If all of the gravitational potential energy of the apple on the tree is transferred to the spring when it is compressed, the spring constant of this spring is closest to

(A) 10 N/m (B) 40 N/m

(C) 100 N/m (D) 400 N/m



7. A boat weighing 9.0×10^2 N requires a horizontal force of 6.0×10^2 N to move it across the water at 1.5×10^1 m/s. The boat's engine must provide energy at the rate of

(A) 2.5×10^{-2} J (B) 4.0×10^1 W (C) 7.5×10^3 J (D) 9.0×10^3 W

8. Solid X is placed in contact with solid Y. Heat will flow spontaneously from X to Y when
(A) X is 20°C and Y is 20°C
(B) X is 10°C and Y is 5°C
(C) X is -25°C and Y is -10°C
(D) X is 25°C and Y is 30°C

9. At what temperature can no more heat be removed from an object?
(A) -273 °C
(B) absolute zero
(C) 0 K
(D) all of the above

Refer to the following information for question #10.
One hundred grams of a substance, X, are taken from –20 degrees C to 110 degrees C. The following important information is provided:

Melting Point 0 °C **Boiling Point** 100 °C

Specific Heats of Substance

Form	**J/(kg C°) or J/(kg K)**
Solid	2900
Liquid	4500
Gas	1500

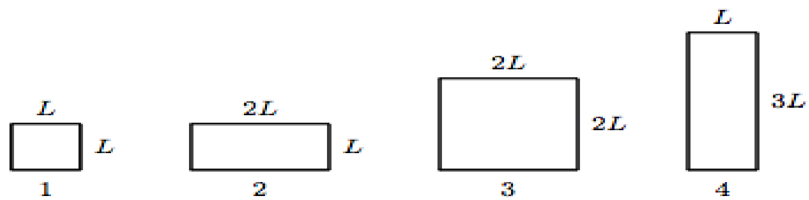
Heat of Fusion, H_f 6.30×10^4 J/kg **Heat of Vaporization, H_v** 8.78×10^5 J/kg

10. The heat necessary to raise 100 grams of X at –20 degrees C to 110 degrees Celsius is
(A) 2.69×10^4 J (B) 1.46×10^5 J (C) 2.69×10^5 J (D) 1.46×10^6 J

11. A 440 Hz tuning fork is placed over a 1.2 meter long adjustable narrow tube of water. When the water level is lowered from 0 cm at the top of the tube, the column first resonates when the air column over the water is measured to be 19 cm. The column resonates again when the water level is at the 57 cm mark. The experimental speed of sound in the lab that day is
(A) 334 m/s (B) 343 m/s (C) 346 m/s (D) 331 m/s

12. A 40.0 W speaker is located 4.00 m from a sound sensor. The decibel level read by the sensor is
(A) 11 dB (B) 113 dB (C) 126 dB (D) 160 dB

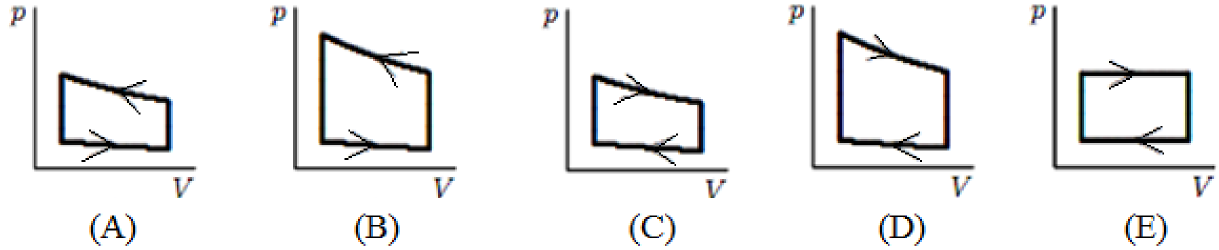
13. The diagram shows four uniform rectangular plates and their dimensions. All are made of the same material and have the same thickness.



The temperature now increases 100 C°. Of these plates:
(A) the vertical dimension of plate 2 increases the most and the area of plate 4 increases the most
(B) the vertical dimension of plate 3 increases the most and the area of plate 1 increases the most
(C) the vertical dimension of plate 4 increases the most and the area of plate 3 increases the most
(D) the vertical dimension of plate 4 increases the most and the area of plate 4 increases the most

14. An isothermal process for an ideal gas is represented on a Pressure vs. Volume graph by
(A) a horizontal line
(B) a vertical line
(C) a portion of a parabola
(D) a portion of a hyperbola

15. Pressure versus volume graphs for a certain gas undergoing five different cyclic processes are shown below. During which cycle does the gas do the greatest positive work?



16. The internal energy of an ideal gas depends on:
(A) the temperature only
(B) the pressure only
(C) the temperature and pressure only
(D) temperature, pressure, and volume

17. According to the second law of thermodynamics:
(A) all heat engines have the same efficiency
(B) all reversible heat engines have the same efficiency
(C) the efficiency of any heat engine is independent of its working substance
(D) the efficiency of a Carnot engine depends only on the temperatures of the two reservoirs

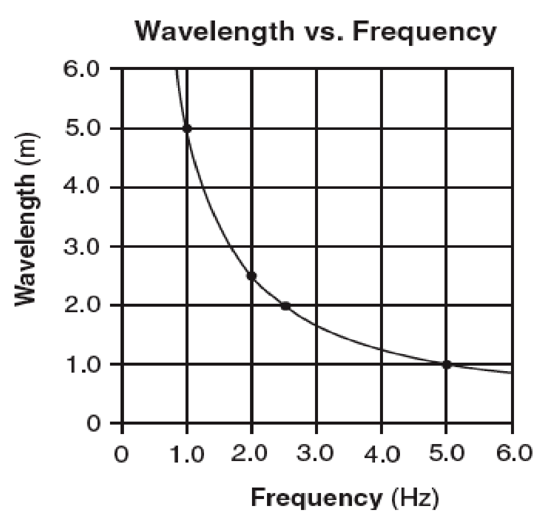
18. A girl on a swing may increase the amplitude of the swing's oscillations if she moves her legs at the natural frequency of the swing. This is an example of
(A) the Doppler effect
(B) destructive interference
(C) wave transmission
(D) resonance

19. A particle oscillating in simple harmonic motion is:
(A) never in equilibrium because it is in motion
(B) in equilibrium at the ends of its path because its velocity is zero there
(C) in equilibrium at the center of its path because the acceleration is zero there
(D) in equilibrium at the ends of its path because the acceleration is zero there

20. Two waves traveling in the same medium and having the same wavelength interfere to create a standing wave. What is the distance between two consecutive nodes on this standing wave?
(A) $\lambda/4$ (B) $\lambda/2$ (C) $3\lambda/4$ (D) λ

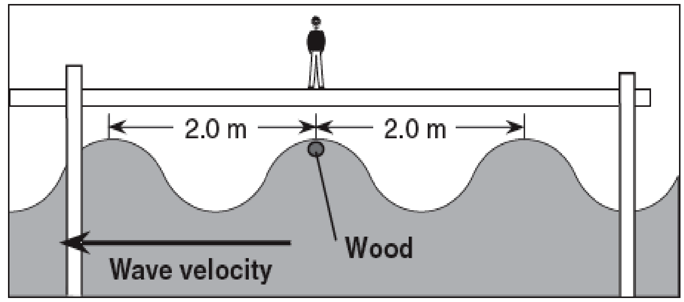
21. The graph below represents the relationship between wavelength and frequency of waves created by two students shaking the ends of a loose spring.

Calculate the speed of the waves generated in the spring.
a. 2.0 m/s
b. 2.5 m/s
c. 5.0 m/s
d. Speed cannot be determined from the graph



Base your answers to questions 22 and 23 on the information and diagram below.
A student standing on a dock observes a piece of wood floating on the water as shown below. As a water wave passes, the wood moves up and down, rising to a wave crest every 5.0 seconds.

22. Calculate the frequency of the passing water waves
(A) 5 Hz (B) 0.2 Hz
(C) 10 Hz (D) 2 Hz



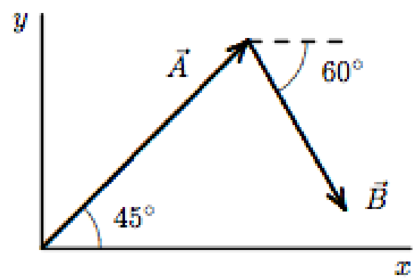
(Not drawn to scale)

23. Calculate the speed of the water waves.
(A) 5 m/s (B) 0.2 m/s (C) 10 m/s (D) 0.4 m/s

24. In the diagram, vector A has magnitude 12 m and vector B has magnitude 8.0 m. The x component of the resultant of vector A + vector B is approximately:

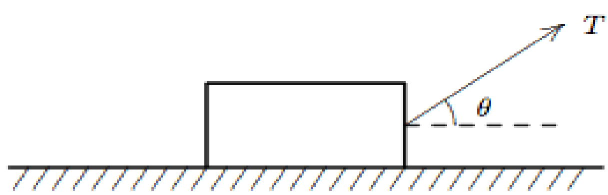
(A) 4 m (B) 8 m

(C) 12 m (D) 15 m



25. A block of mass m is pulled along a rough horizontal floor by an applied force, T, as shown. The vertical component of the force exerted on the block by the floor is:

(A) mg
(B) mg - T cos θ
(C) mg + T sin θ
(D) mg - T sin θ



PHYSICS FORMULAE

MECHANICS

$$\bar{v} = \frac{\Delta x}{\Delta t}$$
$$\bar{a} = \frac{\Delta v}{\Delta t}$$
$$v_f = v_i + at$$
$$\Delta x = v_i t + \tfrac{1}{2}at^2$$
$$2a\Delta x = v_f^2 - v_i^2$$
$$\Sigma F = ma$$
$$W = mg$$
$$F_g = G\frac{m_1 m_2}{r^2}$$
$$p = mv$$
$$F\Delta t = m\Delta v$$
$$\mu = \frac{F_f}{F_N}$$

Δx = displacement (change of position)

$\bar{v}$ = average velocity

$\bar{a}$ = average acceleration

v_i = initial velocity

v_f = final velocity

F = force

F_f = force of friction

F_N = normal force

F_g = gravitational force

G = Universal Gravitational Constant

p = momentum

μ = coefficient of friction

r = distance between center of masses

W = weight

ELECTRICITY AND MAGNETISM

$$F_e = k\frac{q_1 q_2}{r^2}$$
$$E = \frac{F}{q}$$
$$V = \frac{W}{q} = Ed$$
$$I = \frac{\Delta q}{\Delta t}$$
$$V = IR$$
$$P = VI = I^2 R = \frac{V^2}{R}$$

SERIES CIRCUIT

$$I_T = I_1 = I_2 = I_3 = \ldots$$
$$V_T = V_1 + V_2 + V_3 + \ldots$$
$$R_T = R_1 + R_2 + R_3 + \ldots$$

PARALLEL CIRCUITS

$$I_T = I_1 + I_2 + I_3 + \ldots$$
$$V_T = V_1 = V_2 = V_3 = \ldots$$
$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$$

E = electric field intensity

I = electric current

k = electrostatic constant

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

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

P = Power

q = charge

R = resistance

V = electric potential difference

W = Work

Fundamental particle electron

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

e mass 9.11×10^{-31} kg

ENERGY

$$W = F\Delta x$$
$$P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t} = Fv$$
$$PE_g = mgh$$
$$KE = \tfrac{1}{2}mv^2$$
$$F = -kx$$
$$PE_s = \tfrac{1}{2}kx^2$$

h = height

k = spring constant

KE = kinetic energy

PE_g = gravitational potential energy

PE_s = potential energy stored in a spring

P = power

W = work

x = change in spring length from the equilibrium position

MOTION IN 2-D

$$a_c = \frac{v^2}{r}$$
$$F_c = m\frac{v^2}{r}$$
$$1 \text{ rev} = 2\pi \text{ rad} = 360^{\circ}$$
$$\tau = r \times F$$
$$L = I\omega$$
$$KE = \frac{1}{2} I \omega^2$$

a_c = centripetal acceleration

F_c = centripetal force

τ = Torque

L = Angular Momentum

I = Moment of Inertia

ω = angular velocity

PHYSICS FORMULAE

HEAT ENERGY

$Q = mc\Delta T$

$Q = mL_f$

$Q = mL_V$

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

c = specific heat

L_f = latent heat of fusion

L_V = latent heat of vaporization

Q = amount of heat

ΔT = change in temperature

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V_S = voltage of secondary

L = length of conductor

V = electric potential difference

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April, 2017

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

1. When three identical resistors are placed in parallel across a battery, the power generated by the battery is 12 Watts. If the same three resistors are now placed in series with the same battery, the power generated by the battery is now?

(A) 0.50 W
(B) 1.33 W
(C) 4.0 W
(D) 6.0 W

2. Two point charges are placed along the x axis: +4.0 μC at (0,0) and -1.0 μC at (2.0 m, 0). In which location(s) along the x axis is the net Electric field equal to zero.

(A) Only at ± infinity
(B) x = 1.33 m and at ± infinity
(C) x = 4.0 m and at ± infinity
(D) Both answers B and C

3. Fifteen holiday lights are placed in parallel. If one of them burns out, which of the following is true?

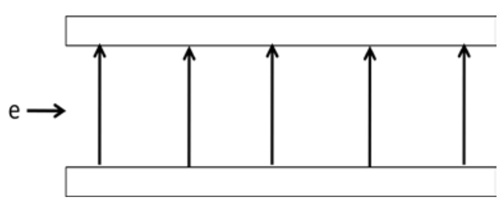
(A) All the bulbs go out
(B) The remaining bulbs get dimmer, but do not go out
(C) The remaining bulbs get brighter
(D) The remaining bulbs' brightness does not change

4. A spherical conductor has a net charge of -3.2 nC. How many excess electrons does it have and where are they located?

(A) 3.5 x10^{17} electrons distributed within the conductor
(B) 3.5 x10^{17} electrons distributed on the surface of the conductor
(C) 2.0 x10^{10} electrons distributed within the conductor
(D) 2.0 x10^{10} electrons distributed on the surface of the conductor

5. A 12 V battery has an internal resistance of 1.0 Ω. It is connected to a 3.0 Ω resistor to create a series circuit. The potential difference across the battery and the current in the circuit are ____and ____, respectively.

(A) 3.0 V, 3.0 A (B) 3.0 V, 4.0 A (C) 9.0 V, 3.0 A (D) 12 V, 3.0 A

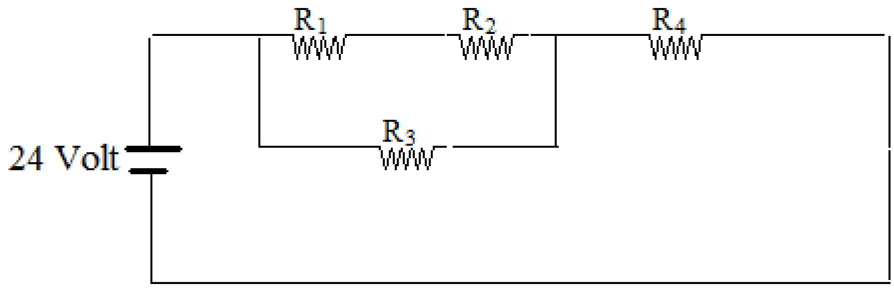


6. An electron enters a uniform electric field, created by two parallel plates. The field is directed upward as shown above. The charge on the top plate is _____ and electrostatic force on the electron is directed_______.

(A) negative, upward
(B) negative, downward
(C) positive, upward
(D) positive, downward

7. What is the potential difference across resistor R_2 in this circuit, given the values in the table to the left below?

R_1 =	15 Ω
R_2 =	45 Ω
R_3 =	30 Ω
R_4 =	4 Ω



(A) 0.53 V (B) 5 V (C) 10 V (D) 15 V

8. Two point charges are placed along the x axis: +4.0 μC at the origin and -1.0 μC at 2.0 meters. At which location(s) on the x axis is the electric potential negative?

(A) x < 0 m
(B) 0 m < x < 1.60 m
(C) 1.60 m < x < 2.67 m
(D) x > 2.67 m

9. Three equally charged positive particles are held in position at the vertices of an equilateral triangle having sides of length, d. If the charge on each particle is q, what is the magnitude of the net force on the particle located at the top?

(A) $F = \frac{2kq^2}{d^2}$ (B) $F = \frac{1.73\,kq^2}{d^2}$ (C) $F = \frac{1.41\,kq^2}{d^2}$ (D) $F = \frac{0.87\,kq^2}{d^2}$

10. A cylindrical copper rod of length 1.0 meters and radius 0.02 m has a resistance R. The rod is stretched in a fixture so that its new length of the now thinner rod is 4.0 meters. What is its new resistance?

(A) 0.25 R
(B) R
(C) 4 R
(D) 16 R

11. Imagine an electron orbiting a proton in a Hydrogen atom. What is the ratio of the electric force on the electron to the gravitational force on the electron due to its orbit, F_E:F_g?

(A) 2.27×10^{39} : 1 (B) 4.76×10^{19} : 1 (C) 6.92×10^{9} : 1 (D) 1.35×10^{6} : 1

12. A physics student holds 2 physics books, one in each arm with her arms extended, while sitting on a lab stool that is spinning at 3 radians per second. She bends her arms and brings the books inward. What happens to the angular speed, angular momentum and kinetic energy of the girl-stool-book system?

	Angular Speed	Angular Momentum	Kinetic Energy
(A)	increases	remains constant	increases
(B)	decreases	remains constant	decreases
(C)	increases	remains constant	remains constant
(D)	increases	increases	increases

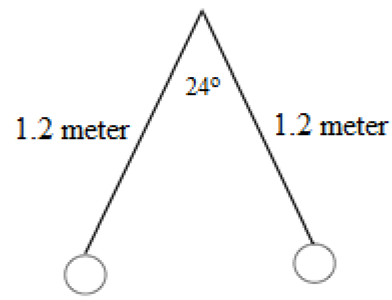
13. What is the approximate linear speed of a point on the Equator?

(A) 463 m/s
(B) 74 m/s
(C) 1.3 m/s
(D) 0.13 m/s

14. A 2000 kg truck is to climb a 12.0 m high hill. How much chemical energy from the fuel must be supplied if the efficiency of the truck engine is 20%?

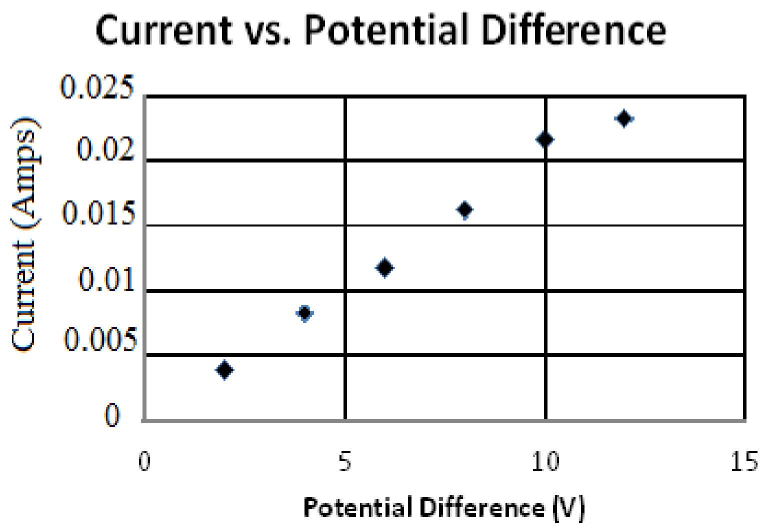
(A) 4.8×10^4 J (B) 2.4×10^5 J (C) 1.2×10^6 J (D) 1.44×10^6 J

15. Two identical positively charged 50.0 gram particles are suspended from an insulating thread as shown. The charge on each particle is_____.



(A) 2.93×10^{-12} C
(B) 1.71×10^{-6} C
(C) 5.88×10^{-12} C
(D) 2.42×10^{-6} C

16. In the lab, a lamp with unknown resistance is connected to a variable voltage source and the current is measured. The data is plotted and the following graph is generated.



What is the approximate resistance of the lamp?

(A) 0.002 Ω
(B) 20 Ω
(C) 50 Ω
(D) 500 Ω

17. A simple pendulum has a 1.0 m long string with a steel sphere of 0.100 kg suspended at the end of the string. Its period on Earth is T. It is taken to an asteroid where the acceleration due to gravity is 1/9 what it is on Earth. The sphere is replaced by another steel sphere of mass 0.900 kg. What is the period of the new pendulum on the asteroid?

(A) $^1/_9$ T
(B) $^1/_3$ T
(C) T
(D) 3 T

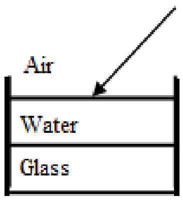
18. The speed of light in a pool of water is 2.25×10^8 m/s. Find the critical angle for light passing from water toward air.

(A) 30.0 degrees
(B) 36.9 degrees
(C) 42.1 degrees
(D) 48.5 degrees

19. In order to use a double convex lens with a focal length of 10 centimeters as a magnifying glass, you can place the object at _____.

(A) 30.0 cm
(B) 20.0 cm
(C) 10.0 cm
(D) 5.0 cm

20. A ray of monochromatic light passes through air, enters water (n=1.33), then glass (n=1.50) as shown. The ray strikes the water at an angle of 50 degrees to the normal. Which of the following is NOT true.



(A) The speed of the light ray in the water is greater than the speed of the ray in the glass
(B) The frequency of the light ray in the water is greater than the frequency of the ray in the glass
(C) The wavelength of the ray in the water is greater than the wavelength of the light in the glass
(D) The ray exits the glass at an angle of 50 degrees to the normal

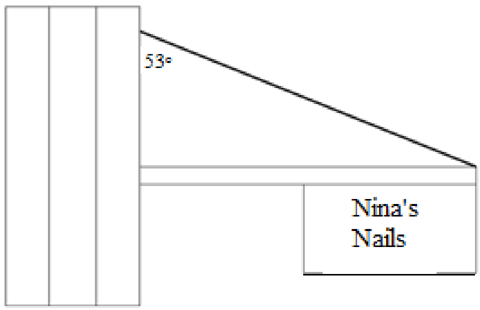
21. Red light + green light combine to make ___ light.

(A) magenta (B) cyan (C) brown (D) yellow

22. What is the focal length of a double convex lens if a 1.0 cm object is placed on the principal axis 30 cm in front of the lens and the resulting image is inverted and 2.0 cm tall?

(A) 12 cm (B) 15 cm (C) 20 cm (D) 30 cm

23. A 1.0 m wide sign is suspended from the right end of a uniform 2.0 m long beam and "massless" cord as shown. The left end of the cord and the beam are attached to a vertical wall. The sign's mass is 10.0 kg and the beam's mass is 5.0 kg. What is the tension in the cord?



(A) 100 N
(B) 133 N
(C) 150 N
(D) 167 N

24. The image from a convex mirror is always

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

25. In your microwave oven, the electromagnetic waves have an average frequency of 2450 MHz. What is the wavelength of these waves?

(A) 12 cm (B) 24 cm (C) 2.4 m (D) 8.2 m

PHYSICS FORMULAE

MECHANICS

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

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

$v_f = v_i + at$

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

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

$\Sigma F = ma$

$W = mg$

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

$p = mv$

$F\Delta t = m\Delta v$

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

Δx = displacement (change of position)

$\bar{v}$ = average velocity

$\bar{a}$ = average acceleration

v_i = initial velocity

v_f = final velocity

F = force

F_f = force of friction

F_N = normal force

F_g = gravitational force

G = Universal Gravitational Constant

p = momentum

μ = coefficient of friction

r = distance between center of masses

W = weight

ELECTRICITY AND MAGNETISM

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

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

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

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

$V = IR$

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

SERIES CIRCUIT

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

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

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

PARALLEL CIRCUITS

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

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

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

E = electric field intensity

I = electric current

k = electrostatic constant

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

$G = 6.67x10^{-11} \frac{Nm^2}{kg^2}$

P = Power

q = charge

R = resistance

V = electric potential difference

W = Work

Fundamental particle electron

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

e mass 9.11×10^{-31} kg

ENERGY

$W = F\Delta x$

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

$PE_g = mgh$

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

$F = -kx$

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

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

MOTION IN 2-D

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

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

1 rev = 2 π rad = 360^o

$\tau = r \times F$

L = Iω

KE = $\frac{1}{2}$ I ω^2

a_c = centripetal acceleration

F_c = centripetal force

τ = Torque

L = Angular Momentum

I = Moment of Inertia

ω = angular velocity

PHYSICS FORMULAE

HEAT ENERGY

$Q = mc\Delta T$

$Q = mL_f$

$Q = mL_V$

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

c = specific heat

L_f = latent heat of fusion

L_V = latent heat of vaporization

Q = amount of heat

ΔT = change in temperature

α = coefficient of linear expansion

L_o = original length

$c_{water} = 4186 \frac{J}{kg°K}$

1 cal = 4.184 joules

WAVE PHENOMENA

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

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

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

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

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

$n\lambda$ = d sin θ

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

c = speed of light in a vacuum

d = distance between slits

$f = \nu$ = frequency

L = distance from slit to screen

n = index of absolute refraction

T = period

v = speed

x = distance from central maximum to first-order maximum

λ = wavelength

θ = angle

θ_c = critical angle relative to air

GEOMETRIC OPTICS

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

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

f = focal length

d_i = image distance

d_o = object distance

h_o = object size

h_i = image size

ELECTROMAGNETIC APPLICATIONS

F = Bqv

$F = BIL$

$V = BLv$

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

$V_P I_P = V_S I_s$ (ideal)

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

B = magnetic field strength

I_P = current in primary

I_S = current in secondary

N_P = number of turns in primary coil

N_S = number of turns in secondary coil

V_P = voltage of primary

V_S = voltage of secondary

L = length of conductor

V = electric potential difference

High School PHYSICS: Ivory Exam No Corrections
Date April 2017
High School PHYSICS -- For all Honors and college prep students.
25 multiple choice questions per exam.
This exam is NOT for any AP® level students.

ANSWERS

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

Topics of Study

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

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

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

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

Dates for 2017 Season
Thursday April 13, 2017

All areas and schools must complete the April exam and mail in the results
by April 28th, 2017

New Jersey Science League
PO Box 65 Stewartsville, NJ 08886-0065
phone # 908-213-8923 fax # 908-213-9391 email: newjsl@ptd.net
Web address: http://entnet.com/~personal/njscil/html/

What is to be mailed back to our office?
PLEASE RETURN THE AREA RECORD AND ALL TEAM MEMBER SCANTRONS
(ALL STUDENTS PLACING 1ST, 2ND, 3RD, AND 4TH).
If you return Scantrons of alternates, then label them as ALTERNATES.

Dates 2018 Season
Thursday January 11, 2018 Thursday February 8, 2018
Thursday March 8, 2018 Thursday April 12, 2018