PHYS 201 Test #2 You may tear this page. Answer Key

1.	2.	3.	4.	5.	Newton's 2nd Law
$x = \bar{v}\,t$	$x = \frac{1}{2}(v_0 + v)t$	$v = v_0 + at$	$x = v_0 t + \frac{1}{2}at^2$	$v^2 = v_0^2 + 2ax$	$\sum \vec{F} = m\vec{a}$

Conversion factors:
1 H = 3600 s, 1 Mile = 1608 m, 1 inch = 2.54 cm, 1 foot = 12 inch, 1 m = 3.281 ft.
1 m = 100 cm, 1 cm = 10 mm, 1 m = 1000 mm, 1 km = 1000 m

Force of friction: $F_{fr} = \mu\, F_N$. Acceleration due to gravity = g = 9.8 m/s^2, down.

Newton's law of gravitation is given by: $F = G\frac{m_1 m_2}{r^2}; G = 6.673\times10^{-11}(SI)$.

Centripetal force is given by, $F_c = m\frac{v^2}{r}$.

Kinetic Energy is given by, $KE = \frac{1}{2}mv^2$. Gravitational Potential Energy = $PE = mgh$.

Work done by a Force, $W = F \times S$ OR $W = (F \times Cos\theta) \times S$. Power = Work/Time.

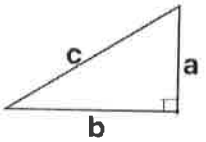
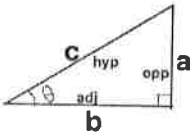
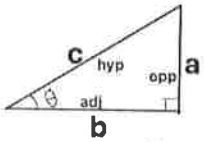
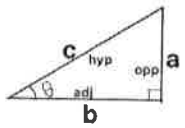
Work-Energy Theorem: $Work = \frac{1}{2}mv_f^{\,2} - \frac{1}{2}mv_i^{\,2}$

Linear momentum of an object of mass, m and velocity, $\boldsymbol{v}$ is given by: $\boldsymbol{p} = m$ x $\boldsymbol{v}$.

Impulse is defined as the product of the force and time, $\boldsymbol{J} = \boldsymbol{F}$ x t.

Impulse-Momentum Theorem: $F \times t = mv_f - mv_i$

Area of a triangle = $\frac{1}{2} \times base \times height$. Area of a rectangle = length x width

Pythagorean Theorem	$\sin\theta$	$\cos\theta$	$\tan\theta$	Components of a vector:
 $c^2 = b^2 + a^2$	 $Sin\,\theta = \frac{opp}{hyp} = \frac{a}{c}$	 $Cos\,\theta = \frac{adj}{hyp} = \frac{b}{c}$	 $Tan\,\theta = \frac{opp}{adj} = \frac{a}{b}$	Adjacent component = Cos Opposite component = Sin

PHYS 201 Test #2 F 2023 Name: Key

A. Select the correct answer for the following multiple choice questions and write your answer in the line next to the question number.

C 1. Which one of the following is Newton's first law motion?
b 2. Which one of the following is Newton's law of universal gravitation?
Answers for 1-2
a. Every particle in the universe exerts a repulsive force on every other particle
b. Every particle in the universe exerts an attractive force on every other particle
c. An object will remain in a state of rest or of uniform motion in a straight line unless acted on by an outside net force.
d. The net force acting on an object is equals to the product of the mass of the object and the acceleration of the object.
e. When one object exerts a force on a second object, the second object exerts a force on the first that has an equal magnitude but opposite direction.
f. Frictional forces are in the opposite direction of motion.

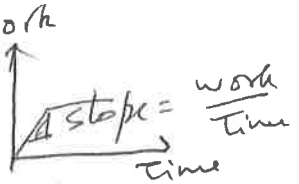
a 3. Which one of the following is a unit for work?
f 4. Which one of the following is a unit for impulse?
Answers for 3-4
a. $kg.m^2/s^2$ b. $kg/(m.s^2)$ c. $kg.m/s^2$ d. $kg.m^2/s^3$ e. $kg.m/s^3$ f. kg.m/s

f 5. Which one of the following is a non-contact force?
a. pushing b. static frictional force c. Tension
d. kinetic frictional force e. normal force f. gravitational force

a 6. Which one of the following is a vector?
a. Impulse b. Work c. Energy d. Density e. Power

d 7. What is the centripetal force for a satellite circling the Earth?
a. Normal force b. Kinetic frictional force
c. Static frictional force d. Gravitational force

C 8. Which one of the following terms is used to indicate the natural tendency of an object to remain at rest or in motion at a constant speed along a straight line?
a. Velocity b. Speed c. Inertia d. Force e. Acceleration



e 9. What is represented by the slope of the Work VS. Time, graph?
a. Impulse b. Work c. Energy d. Density e. Power

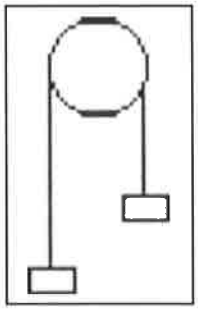
d 10. What is represented by the area under a Force VS. Time, graph?
a. Velocity b. Acceleration c. Work d. Impulse e. Displacement

C 11. Estimate the cost of electricity for operating a 9-W LED light bulb for 4 hours a day for 20 days a month for one year. Assume a cost of 9 cents per kWh.
a. \$ 0.39 b. \$ 0.65 c. \$ 0.78 d. \$ 0.86 e. \$ 1.95 f. \$7.78 g. \$778

d 12. Two identical cars have the same speed, one traveling east and one traveling west. Which one of the following is true?
a. Both have the same momentum and same kinetic energy.
b. Both have the same momentum, but different kinetic energy.
c. Both have different momentum and different kinetic energy.
d. Both have the different momentum, but same kinetic energy.

c 13. If a constant, nonzero force is applied to an object that is at rest, what can you say about the velocity and acceleration of the object after the force is applied?
a. velocity changes, acceleration changes
b. velocity remains constant, acceleration remains constant
c. velocity changes, acceleration remains constant
d. velocity remains constant, acceleration changes

b 14. Two masses (2-kg and 5-kg) are attached by a massless cord passing over a massless, frictionless pulley of an Atwood's machine and released. What will be the acceleration of the masses?



$a = \frac{\Sigma F}{m} = \frac{(5-2)\,9.8}{7}$

a. 0.43 m/s^2 b. 4.2 m/s^2 c. 5.88 m/s^2
d. 1.96 m/s^2 e. 9.8 m/s^2 f. 2.8 m/s^2

d 15. What is the angle between the acceleration and velocity of an object in uniform circular motion?

e 16. What is the angle between the frictional force and displacement for a moving object? Answers for 15 & 16
a. 0 b. 30^0 c. 45^0 d. 90^0 e. 180^0

e 17. In another solar system a planet has twice the earth's mass and half the earth's radius. Your weight on this planet is _____ times your earth-weight. Assume that the masses of the earth and the other planet are uniformly distributed.

$\frac{2}{(\frac{1}{2})^2} = 8$

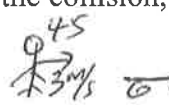
a. 1 b. 2 c. 3 d. 4 e. 8 → 0.71g

c 18. A person with a black belt in karate has a fist that has a mass of 700 g. Starting from rest, this fist attains a velocity of 6.0 m/s by moving 65 cm. What is the magnitude of the net force applied to the fist to achieve this? 0.65m

$V^2 = V_0^2 + 2ax$
$6^2 = 0 + 2 \times a \times 0.65$
$a = 27.69\ m/s^2$

a. 6.5 N b. 6.9 N c. 19 N d. 28 N e. 194 N

c 19. A 45-kg person, running horizontally with a velocity of +3.0 m/s, jumps onto a 12-kg sled that is initially at rest. Ignoring the effects of friction during the collision, find the velocity of the sled and person as they move away.



$45 \times 3 = (45+12)v$

a. 11 m/s b. 3.0 m/s c. 2.4 m/s d. 1.5 m/s e. 0.63 m/s

d 20. Which one of the following energy transformations takes place in a microphone?
a. Radiant energy is converted into electrical energy
b. Electrical energy is converted into mechanical energy
c. Radiant energy is converted into thermal energy
d. Mechanical energy is converted into electrical energy
e. Electrical energy is converted into radiant energy

no acceleration, $\Sigma F = 0$

B. A 45-kg package is pulled along a horizontal surface at a constant velocity. The pulling force has a magnitude, F = 95 N, which is applied at a 25^0 angle as shown below. Frictional force is also present.

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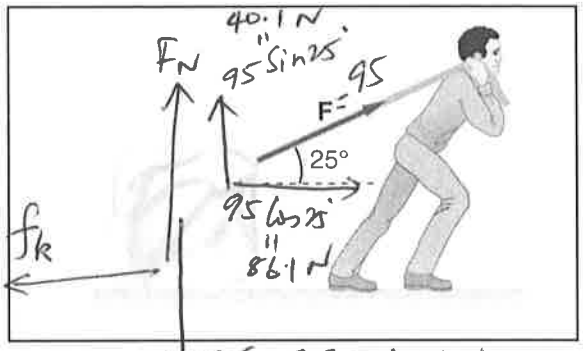
1. Draw a free-body diagram for the package.
2. Resolve the 95-N force into horizontal and vertical components, in the diagram.
3. Determine the normal force.
4. Determine the frictional force.
5. Determine the coefficient of kinetic friction between the box and surface.
6. Determine the work done on the package in moving it by 6.5 m.



2. $95 \cos 25 = 86.1\ N$, $95 \sin 25 = 40.1$

3. Balancing the forces in the vertical direction.

$F_N + 40.1 = 441$

$F_N = 441 - 40.1 = 400\ N$

4. Balancing the forces in the horizontal direction.

$86.1 = f_k \rightarrow f_k = 86.1\ N$

5. $f_k = \mu_k \cdot F_N \rightarrow \mu_k = \frac{f_k}{F_N} = \frac{86.1}{400} = 0.215$

6. $W = (F \cos\theta) \cdot x = (95 \cos 25^\circ) \times 6.5 = 560\ J$

86.1×6.5

C. A satellite circles the Earth in an orbit whose altitude is 545 km. Calculate the speed of the satellite. ($G = 6.673 \times 10^{-11}\ N.m^2/Kg^2$, Mass of Earth = $M = 5.98 \times 10^{24} Kg$, Radius of Earth = R = 6380 km)

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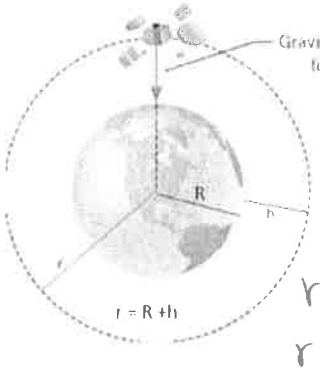


$r = 6380 + 545$

$r = 6925\ km$

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

$v^2 = \frac{GM}{r} = \frac{6.673 \times 10^{-11} \times 5.98 \times 10^{24}}{6925 \times 10^3}$

$v^2 = 5.762 \times 10^7$

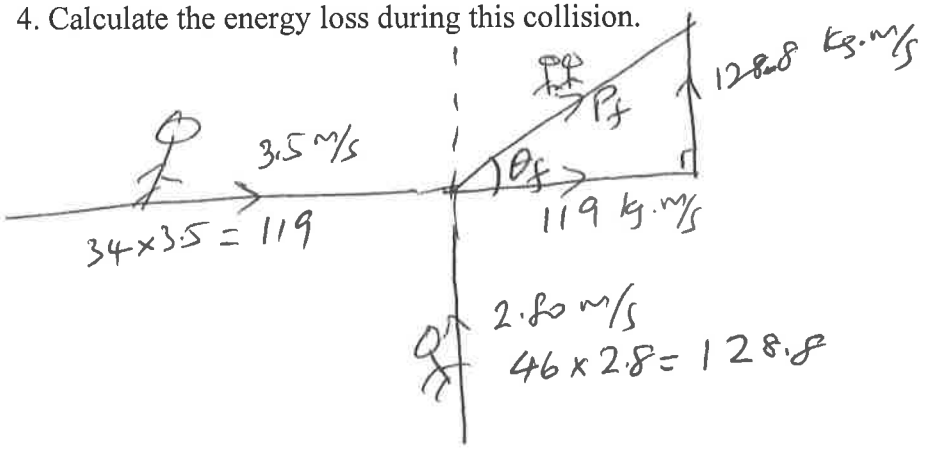
$v = 7.59 \times 10^3\ m/s$

$v = 7591\ m/s$

D. A 34.0-kg skater is moving due east at a speed of 3.50 m/s. A 46.0-kg skater is moving due north at a speed of 2.80 m/s. They collide and hold on to each other after the collision.

1. Sketch a diagram of the above situation, showing the skaters before and after the collision.
2. Find the velocity (speed and direction) of the skaters after the collision, assuming that friction can be ignored.
3. Identify the collision type: Elastic or Inelastic or Completely Inelastic.
4. Calculate the energy loss during this collision.

1.



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2. $P_f^2 = 119^2 + 128.8^2 = 14,161 + 16,589.44$

$P_f^2 = 30,750.44$

$P_f = 175.35 = (34+46)v_f$

$v_f = \frac{175.35}{(34+46)} = 2.19$ m/s

5

2. $\tan\theta_f = \frac{128.8}{119} = 1.082$

$\theta_f = \tan^{-1}(1.082) = 47.3°$

5

3. Completely Inelastic.

5

4. $KE_i = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2}\times 34\times 3.5^2 + \frac{1}{2}\times 46\times 2.8^2 = 388.6$ J (208.25 + 180.32)

$KE_f = \frac{1}{2}(m_1+m_2)v_f^2 = \frac{1}{2}\times 80\times 2.19^2 = 191.8$ J

Loss = $KE_i - KE_f = 196.8$ J

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