Test #2 Equations Sheet Fall 2021 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, $W = (F \times Cos\,\theta)\times S.$ Power = Work/Time.

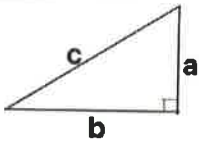
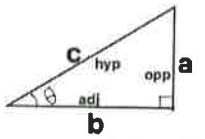
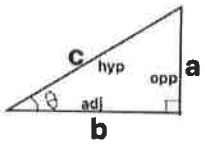
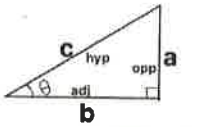
Work-Energy Theorem: $Work = \frac{1}{2}mv_f^{\,2} - \frac{1}{2}mv_i^{\,2}$

Linear momentum of an object of mass, *m* and velocity, ***v*** is given by: ***p*** = *m* x ***v***.

Impulse is defined as the product of the force and time, ***J*** = ***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 ϑ*	*cos ϑ*	*tan ϑ*	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 Name: KEY

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A. For the MC questions write your answers in the line next to the question number.

3pt/Q.

d 1. Which one of the following statements correctly states Newton's third law motion?
a. Every particle in the universe exerts an attractive force on every other particle.
b. 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.
c. The net force acting on an object is equals to the product of the mass of the object and the acceleration of the object.
d. 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.
e. Frictional forces are in the opposite direction of motion.
f. Every particle in the universe exerts a repulsive force on every other particle.

e 2. Which one of the following objects has the greatest inertia?
a. Penny b. book c. bicycle d. car e. Supertanker

a 3. Which one of the following is also the unit joule, J? watt
d 4. Which one of the following is also the unit ~~joule~~, W?
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

d 5. A stack of books whose true weight is 165 N is placed on a scale in an elevator. The scale reads 175 N. What can be said about the motion of the elevator?
a. It is at rest
b. It is moving with a constant velocity upward
c. It is moving with a constant velocity downward
d. It is accelerating upward
e. It is accelerating downward

f 6. Which one of the following is a non-contact force?
a. Drag force b. static frictional force
c. kinetic frictional force d. normal force
e. tension f. gravitational force

f 7. Which one of the following is an example for a conservative force?
a. pushing b. static frictional force c. Tension
d. kinetic frictional force e. normal force f. gravitational force

c 8. Which one of the following is a fundamental force?
a. tension b. normal force c. strong nuclear force
d. frictional force e. elastic spring force

B 9. Estimate the cost of electricity for operating ten 60-W incandescent light bulb for 4 hours a day for 20 days a month for one year. Assume a cost of 9 cents per kWh.
A. \$ 57.6 B. \$ 51.8 C. \$ 1.29 D. 52 cents E. \$ 5.18 $\frac{10\times 60}{1000}\times 4\times 20\times 12\times 0.09$

d 10. What is the angle between the acceleration and velocity of an object in uniform circular motion?
a. 0 b. 30^0 c. 45^0 d. 90^0 e. 180^0

d 11. 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

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. What is the centripetal force for a real plane when it turns in the air?
a. Tension b. Weight c. Component of the lift force
d. Frictional force e. Gravity

a 14. Which one of the following is a definition for conservative force?
a. A force is conservative when the work it does on a moving object is independent of the path between the object's initial and final positions.
b. A force is conservative when it does a net work on an object moving around a closed path, starting and finishing at the same point.
c. A force is conservative when the work it does on a moving object is dependent of the path between the object's initial and final positions.

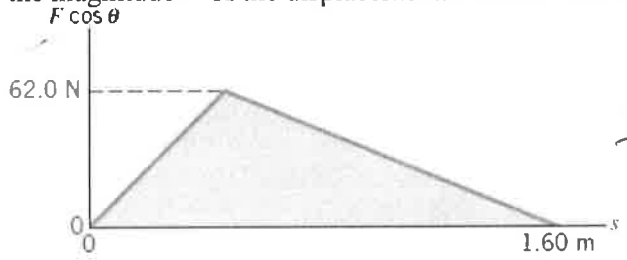
c 15. A volleyball of mass 0.35 kg is spiked so that its incoming velocity of -15 m/s is changed to an outgoing velocity of +12 m/s. What impulse does the player apply to the ball?
a. 4.2 kg.m/s b. -5.3 kg.m/s c. 9.5 kg.m/s d. -9.5 kg.m/s e. 1.1 kg.m/s f. -1.1 kg.m/s

-15 ← → +12
$0.35(12-(-15))$
$0.35\times(27)$

a 16. An engineer is asked to design a playground slide such that the speed a child reaches at the bottom does not exceed 6.0 m/s. Determine the maximum height that the slide can be.
a. 1.8 m b. 2.9 m c. 3.2 m d. 4.5 m e. 7.4 m

$mgh = \frac{1}{2}mv^2$
$h = \frac{v^2}{2g} = \frac{6}{2\times 9.8}$

b 17. The graph shows how the force component $F\cos\theta$ along the displacement varies with the magnitude s of the displacement. Find the work done by the force.



$\frac{1}{2}bh = \frac{1}{2}\times 1.6\times 62$
$=$

a. 24.8 J b. 49.6 J c. 62 J d. 99.2 J

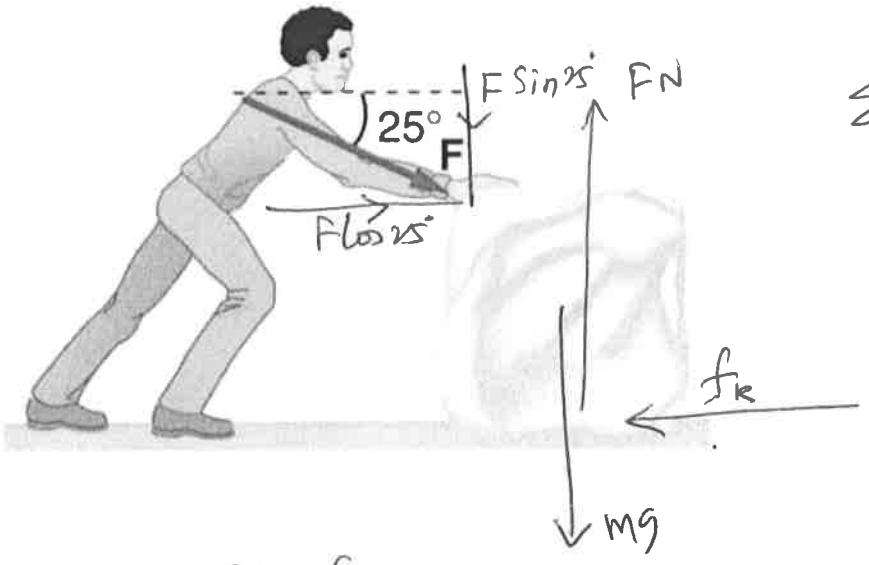
13 B. A warehouse worker exerts a force of **F** = 75 N, at an angle of 25^0 below horizontal, on a package of mass 30 kg as shown below, to make the package move slowly at constant velocity. There is friction on the floor.

a. Draw a free-body diagram for the package.

b. Determine the normal force.

c. Determine the frictional force.

d. Determine the coefficient of kinetic friction between the package and floor.



$\Sigma f_y = 0$

$F_N = mg + F\sin 25^\circ$

$= 30 \times 9.8 + 75 \sin 25^\circ$

$= 294 + 31.7$

$f_N = 326\ N$

$\Sigma f_x = 0,\ a = 0$

$F\cos 25^\circ = f_k$

$f_k = F\cos 25^\circ$

$= 75 \cos 25^\circ$

$f_k = 68\ N$

$f_k = \mu_k \cdot f_N$

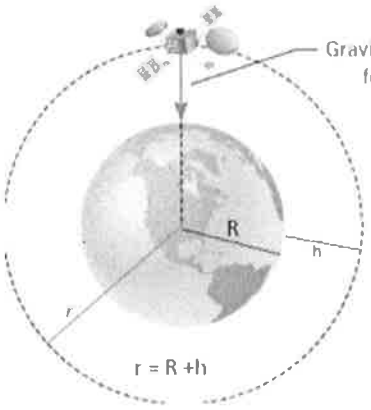
$68 = \mu_k \cdot 326$

$\mu_k = \frac{68}{326} = 0.21$

$\mu_k = 0.21$

12 C. A satellite circles the Earth in an orbit whose altitude, h is equal to the radius of the Earth. 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)



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

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

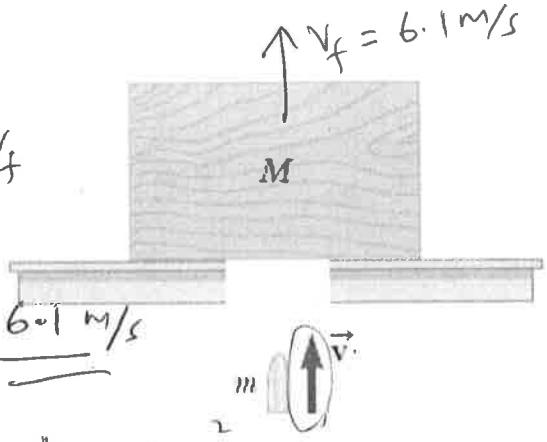
$V = \sqrt{\frac{GM}{r}} = \sqrt{\frac{6.673 \times 10^{-11} \times 5.98 \times 10^{24}}{(6380 + 6380) \times 10^3}}$

$V = 5592\ m/s$

12 D. A bullet of mass, $m = 25$ g is fired vertically with a velocity, $\vec{V} = 250$ m/s into a (M =1.0 kg) block of wood at rest directly above it, as shown below. The bullet becomes embedded in the block and both travel vertically up afterwards.

a. Using the conservation of momentum, find the velocity of the block-bullet system just after the bullet is embedded.

b. How high will the block-bullet system will rise into the air after the bullet becomes embedded in it?



a. $\Sigma m v_i = \Sigma m v_f$

$m V = (m+M) V_f$

$0.025 \times 250 = (0.025 + 1) V_f$

$0.025 \times 250 = 1.025\, V_f$

$V_f = \frac{0.025 \times 250}{1.025} = 6.1$ m/s

b. Conservation of ME

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

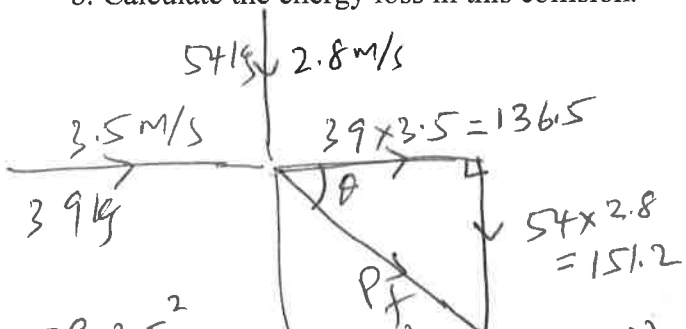
$v^2 = 2gh \rightarrow h = \frac{v^2}{2g} = \frac{6.1^2}{2 \times 9.8} = 1.9$ m

$h = 1.9$ m

12 E. A 39-kg skater is moving due east at a speed of 3.5 m/s. A 54-kg skater is moving due south at a speed of 2.8 m/s. They collide and hold on to each other after the collision.

a. Find the velocity (speed and direction) of the skaters after the collision, assuming that friction can be ignored.

b. Calculate the energy loss in this collision.



$\tan\theta = \frac{151.2}{136.5} = 1.108$

$\theta = \tan^{-1}(1.108) = 47.9$

$\theta \simeq 48°$

$P_f = \sqrt{151.2^2 + 136.5^2}$

$P_f = \sqrt{41\,493.69}$

$P_f = 203.7$ kg.m/s

$V_f = \frac{P_f}{m_f} = \frac{203.7}{(39+54)} = \frac{203.7}{93} = 2.2$ m/s $= 2.19$

$V_f = 2.2$ m/s

b. $\frac{1}{2} \times 39 \times 3.5^2 + \frac{1}{2} \times 54 \times 2.8^2 - \frac{1}{2}(93)(2.2^2)$

$238.9 + 211.7 - 225$

Energy loss $= 225.65$