

1.	2.	3.	4.	5.	Newton's 2 nd 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 = $g = 9.8 \text{ m/s}^2$, down.

Newton's law of gravitation is given by: $F = G \frac{m_1 m_2}{r^2}$; $G = 6.673 \times 10^{-11} (SI)$.

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

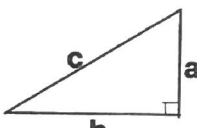
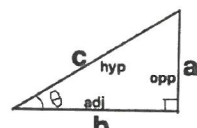
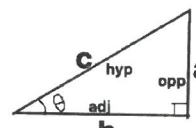
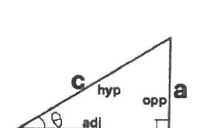
Linear momentum of an object of mass, m and velocity, v is given by: $p = m \times v$.

Impulse is defined as the product of the force and time, $J = F \times t$.

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

Area of a triangle = $\frac{1}{2} \times \text{base} \times \text{height}$.

Area of a rectangle = length x width

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

3 pts each

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

- b 1. Which one of the following is Newton's law of universal gravitation?
- 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.

- f 2. Which one of the following is the unit for impulse?

- a 3. Which one of the following is also the unit joule, J?
- a. $\text{kg}\cdot\text{m}^2/\text{s}^2$
 - b. $\text{kg}/(\text{m}\cdot\text{s}^2)$
 - c. $\text{kg}\cdot\text{m}/\text{s}^2$
 - d. $\text{kg}\cdot\text{m}^2/\text{s}^3$
 - e. $\text{kg}\cdot\text{m}/\text{s}^3$
 - f. $\text{kg}\cdot\text{m}/\text{s}$

- f 4. 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 5. Which one of the following is a vector?

- a. Impulse
- b. Work
- c. Energy
- d. Density
- e. Power

- d 6. 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 7. 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 8. What is represented by the slope of the Work VS. Time, graph?

- a. Impulse
- b. Work
- c. Energy
- d. Density
- e. Power

- d 9. What is represented by the area under a Force VS. Time, graph?

- a. Velocity
- b. Acceleration
- c. Work
- d. Impulse
- e. Displacement

- a 10. Two identical cars have the same speed and both traveling in the same direction. 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.

d 11. What is the angle between the acceleration and velocity of an object in uniform circular motion?

- a. 0 b. 30° c. 45° d. 90° e. 180°



b 12. In another solar system a planet has ^{2M}twice the earth's mass and ^Rearth'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.

- a. 1 b. 2 c. 3 d. 4 e. 8

b 13. Which one of the following energy transformations takes place when you charge your cell phone?

- a. Chemical is converted into electrical energy
b. Electrical energy is converted into chemical 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

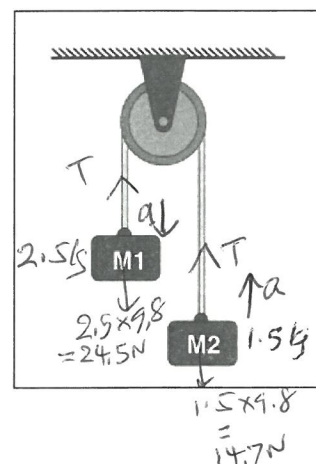
end of MC questions

B. Two masses ($M_1 = 2.5\text{-kg}$ and $M_2 = 1.5\text{-kg}$) are attached by a massless cord passing over a massless, frictionless pulley of an Atwood's machine and released.

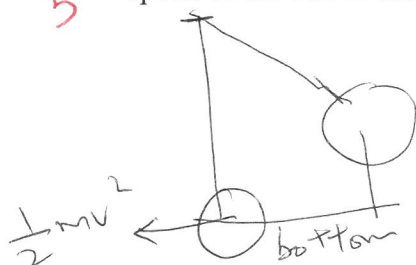
- a. Draw free-body diagrams for each mass and show the acceleration in the diagram.
b. Calculate the magnitude of the acceleration of the masses.

$$a = \frac{\sum F}{m} = \frac{(2.5 - 1.5) \times 9.8}{2.5 + 1.5}$$

$$a = \frac{9.8}{4} = 2.45 \text{ m/s}^2$$



C. A wrecking ball is raised to a height 1.8 m and released from rest. What will be the speed of the ball at the bottom of its swing? (Neglect air drag)



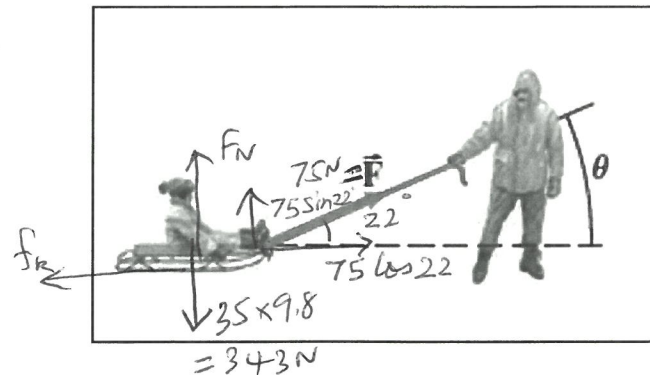
$$\begin{aligned} mgh &= \frac{1}{2}mv^2 \\ v^2 &= 2gh \\ v &= \sqrt{2gh} = \sqrt{2 \times 9.8 \times 1.8} = 5.94 \text{ m/s} \end{aligned}$$

D. A large household air conditioner may consume 18kW of power. What is the cost (in \$) of operating this air conditioner 7 hours per day for 3 months, if the cost of electricity is \$0.10 per kW · h?

$$18 \text{ kW} \times 7 \text{ H} \times 90 \times \$0.10 = \$1134$$

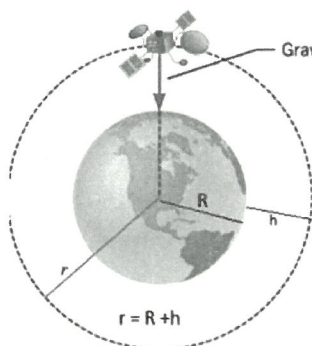
E. A child in a sled (total mass = 35-kg) is pulled along a horizontal surface at a constant velocity. The pulling force has a magnitude, $F = 75 \text{ N}$, which is applied at a 22° angle as shown below. Frictional force is also present.

3. 1. Draw a free-body diagram for the child-sled system.
2. 2. Resolve the 75-N force into horizontal and vertical components, in the diagram.
3. 3. Determine the normal force.
4. 4. Determine the frictional force.
5. 5. Determine the coefficient of kinetic friction between the box and surface.
6. 6. Determine the work done for moving it by 4.5 m.
7. 7. Determine the power if it takes 3.5 s for 6.



$$\begin{aligned}
 3. \quad & F_N + 75 \sin 22 = 343 \\
 & F_N = 343 - 75 \sin 22 = 343 - 28 \\
 & F_N = 315 \text{ N} \\
 4. \quad & f_k = 75 \cos 22 = 69.5 \text{ N} \\
 5. \quad & f_k = \mu_k F_N \rightarrow 69.5 = \mu_k \cdot 315 \\
 & \mu_k = \frac{69.5}{315} = 0.22 \\
 6. \quad & W = F \cdot d = (75 \cos 22) \times 4.5 = 69.5 \times 4.5 = 313 \text{ J} \\
 7. \quad & W = 313 \text{ J}, t = 3.5 \text{ s} \\
 & P = \frac{W}{t} = \frac{313}{3.5} = 89 \text{ W}
 \end{aligned}$$

8. F. A satellite circles the Earth in an orbit whose altitude is 620 km. Calculate the speed of the satellite. ($G = 6.673 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{Kg}^2$, Mass of Earth = $M = 5.98 \times 10^{24} \text{ Kg}$, Radius of Earth = $R = 6380 \text{ km}$)



$$\text{Gravitational force} = \frac{GMm}{r^2} = m \frac{v^2}{r} \rightarrow v^2 = \frac{GM}{r}$$

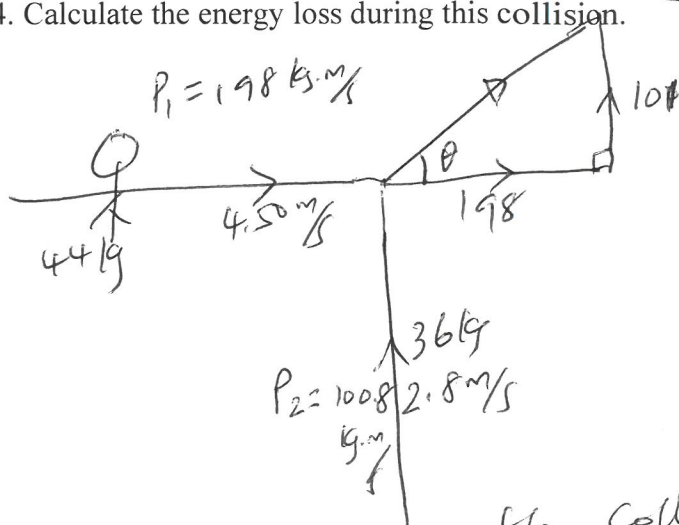
$$v = \sqrt{\frac{GM}{r}}$$

$$v = \sqrt{\frac{6.673 \times 10^{-11} \times 5.98 \times 10^{24}}{(6380 + 620) \times 10^3}}$$

$$v = 7550 \text{ m/s}$$

20. G. A 44.0-kg skater is moving due east at a speed of 4.50 m/s. A 36.0-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.



$$P_f = \text{Total momentum after collision} = \sqrt{198^2 + 101^2} = 222 \text{ kg}\cdot\text{m/s}$$

$$V_f = \frac{P_f}{(m_1 + m_2)} = \frac{222}{44 + 36} = 2.78 \text{ m/s}$$

$$\tan \theta = \frac{101}{198} = 0.510$$

$$\theta = \tan^{-1}(0.510) = 27^\circ$$

$$4. \quad \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 - \frac{1}{2} (m_1 + m_2) v_f^2$$

$$\text{Loss} = \frac{1}{2} \times 44 \times 4.5^2 + \frac{1}{2} \times 36 \times 2.80^2 - \frac{1}{2} \times 80 \times 2.78^2$$

$$\text{Loss} = 445.5 + 141.1 - 309.1$$

$$\text{Loss} = 586.6 - 309.1 = 277.5 \text{ J}$$

$$\text{Loss} \approx 278 \text{ J}$$