

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

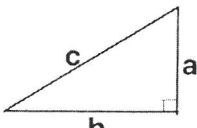
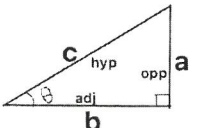
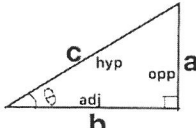
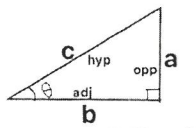
Linear momentum of an object of mass, m and velocity, v is given by: $p = m \times v$.

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:
 $c^2 = b^2 + a^2$	 $\sin \theta = \frac{\text{opp}}{\text{hyp}} = \frac{a}{c}$	 $\cos \theta = \frac{\text{adj}}{\text{hyp}} = \frac{b}{c}$	 $\tan \theta = \frac{\text{opp}}{\text{adj}} = \frac{a}{b}$	Adjacent component = Cos Opposite component = Sin

2.5 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. For 9&14 show your answer in diagrams.

e 1. The amount of matter in an object can be described by what scientific term?
a. Friction b. motion c. gravity d. force e. mass

d 2. Which one of the following objects has the largest inertia?
a. paper clip b. book c. bicycle d. car e. chair

c 3. Newton's first law of motion states that a body in motion does what if it is not acted on by a net force?
a. Comes to rest b. Changes direction
c. Maintains a constant velocity d. Increases inertia

4-5) Newton's law of gravitation is given: $F = G \frac{m_1 m_2}{r^2}$; $G = 6.673 \times 10^{-11} (SI)$.

b 4. What is the SI unit for G, gravitational constant?
a. $\frac{m^3}{kg \cdot s}$ b. $\frac{m^3}{kg \cdot s^2}$ c. $kg \cdot m/s^2$ d. $kg \cdot m^2/s^3$ e. $\frac{m^4}{kg \cdot s^2}$ f. $\frac{m^2}{kg \cdot s^2}$

a 5. In another solar system a planet has twice the earth's mass and twice the earth's radius. Your weight on this planet is _____ times your earth-weight.
a. 0.5 b. 1 c. 2 d. 4 e. 8 f. 10

c 6. Which one of the following is a scalar?
a. Impulse b. Momentum c. Work d. Acceleration e. Weight

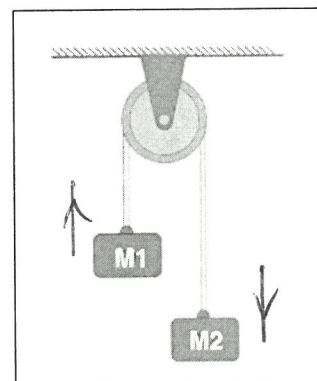
d 7. What is the centripetal force for the ISS orbiting the Earth?
a. Normal force b. Kinetic frictional force
c. Static frictional force d. Gravitational force

d 8. What is represented by the area under a Force VS. Time, graph?
a. Velocity b. Acceleration c. Work d. Impulse e. Power

9-10) Two masses ($M_1 = 1.5\text{-kg}$ and $M_2 = 3.5\text{-kg}$) are attached by a massless cord passing over a massless, frictionless pulley of an Atwood's machine and released.

9. Show the motion of each of the masses in the diagram.

b 10. Calculate the magnitude of the acceleration of the masses?
a. 0.40 m/s^2 b. 3.9 m/s^2 c. 5.6 m/s^2
d. 13 m/s^2 e. 9.8 m/s^2 f. 3.3 m/s^2



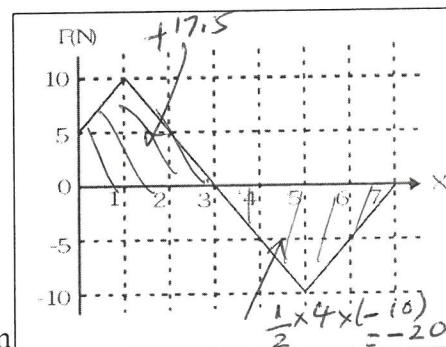
11. What is the angle between the frictional force and displacement for a moving object? a. 0° b. 30° c. 45° d. 90° e. 180°

12. Which one of the following energy transformations takes place in an electric motor?

- Electrical energy is converted into mechanical energy
- Solar energy is converted into electrical energy
- Mechanical energy is converted into electrical energy
- Solar energy is converted into thermal energy
- Chemical energy is converted into electrical energy
- Electrical energy is converted into thermal energy

13. The figure shows the force (F) versus displacement (x) graph for a particle. Determine the net work done by the force?

- 37.5 N.m
- 20 N.m
- 17.5 N.m
- 2.5 N.m
- 2.5 N.m

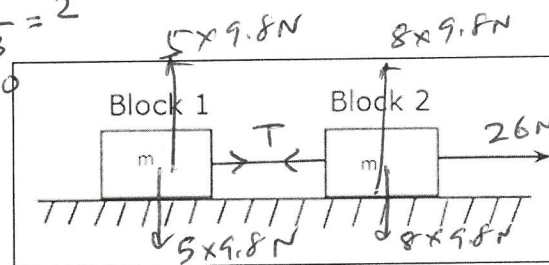


14-15) Two blocks of masses (Block 1 = 5 kg and Block 2 = 8 kg) are pulled by a force of 26 N applied to Block 2. Ignore friction.

14. Draw a free-body diagram for each of the masses in the diagram.

15. What is the tension (in SI unit) in the cable connecting the two blocks?

- 2
- 10
- 16
- 26 N



end of MC questions

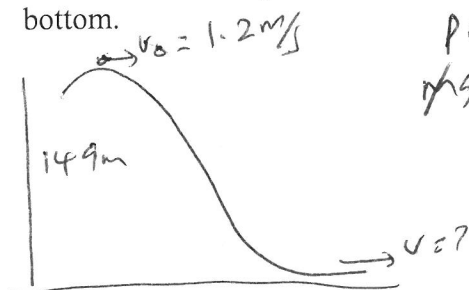
B. When starting a foot race, a 75.0-kg sprinter exerts an average force of 550 N backward on the ground for 0.350 s. (a) What is his initial acceleration? (b) What is his final speed? (b) How far does he travel during the time interval 0.350 s?

(a) $a = \frac{F}{m} = \frac{550}{75} = 7.33 \text{ m/s}^2$

(b) $v = v_0 + at = 0 + 7.33 \times 0.35 = 2.57 \text{ m/s}$

(c) $x = v_0 t + \frac{1}{2} at^2 = \frac{1}{2} \times 7.33 \times 0.35^2 = 0.45 \text{ m}$

C. For a roller coaster, the ride includes a vertical drop of 149 m. The coaster has a speed of 1.2 m/s at the top of the drop. Neglect friction and find the speed of the riders at the bottom.



$PE + KE = KE$
 $mgh + \frac{1}{2}mv_0^2 = \frac{1}{2}mv^2$

$gh + \frac{1}{2}v_0^2 = \frac{1}{2}v^2$

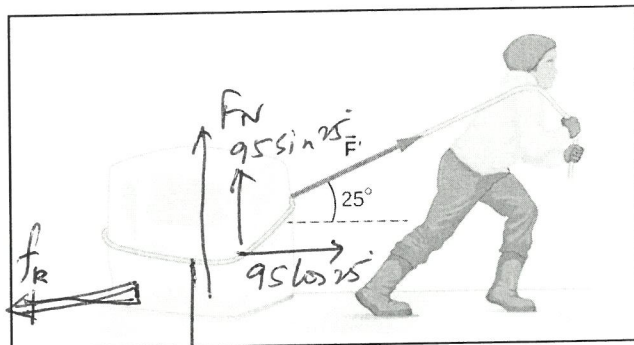
$2.5h + v_0^2 = v^2$

$v^2 = 1.2^2 + 2 \times 9.8 \times 149 = 2921.84 = 2921$

$v = \sqrt{2921.84} = 54 \text{ m/s}$

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D. A 45-kg ice block is pulled along a horizontal surface at a constant velocity. The pulling force has a magnitude, $F = 95 \text{ N}$, which is applied at 25° above the horizontal as shown. Frictional force is also present.



1. Draw a free-body diagram for the ice block.
2. Resolve the 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. How much work is done in pulling the ice block 5.5 m.
7. If the above work is done in 5 seconds, what is the power output of the person?

$$\begin{aligned} \underline{3.} \quad \sum F_y = 0 &\rightarrow F_N + 95 \sin 25^\circ = 45 \times 9.8 \\ &F_N + 40.15 = 441 \\ &F_N = 441 - 40.15 \\ &F_N = 401 \text{ N} \end{aligned}$$

$$\begin{aligned} \underline{4.} \quad \sum F_x = 0 & \text{ (constant vel. } \rightarrow a=0) \\ 95 \cos 25^\circ &= f_k \\ f_k = 95 \cos 25^\circ &= 86.1 \text{ N} \end{aligned}$$

$$\underline{5.} \quad \mu = \frac{f_k}{F_N} = \frac{86.1}{401} = 0.215$$

$$\begin{aligned} \underline{6.} \quad W = F \times d &= (F \cos 25^\circ) \times 5.5 = (95 \cos 25^\circ) \times 5.5 \\ W &= 86.1 \times 5.5 = \underline{473.6 \text{ W}} \end{aligned}$$

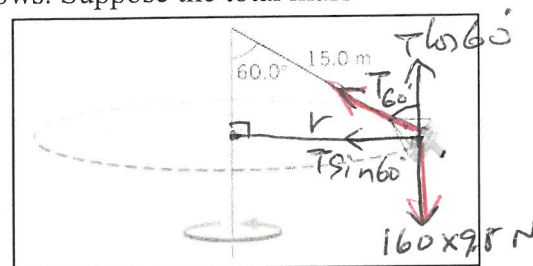
$$\underline{7.} \quad P = \frac{W}{t} = \frac{473.6}{5} = \underline{94.7 \text{ W}}$$

E. A "swing" ride at a carnival consists of chairs that are swung in a circle by 15.0-m cables attached to a vertical rotating pole, as the drawing shows. Suppose the total mass of a chair and its occupant is m ($= 160$ kg).

a. Find the radius for the circular motion.

$$\sin 60^\circ = \frac{r}{15} \rightarrow r = 15 \sin 60^\circ$$

$$r = 13 \text{ m}$$



b. Considering the chair and its occupant as the object of interest, show all the forces acting on it, in the diagram, a free-body diagram.

c. Resolve the tension into horizontal and vertical components, in the diagram.

d. Determine the tension in the main cable attached to the chair.

$$T \cos 60^\circ = 160 \times 9.8$$

$$T = \frac{160 \times 9.8}{\cos 60^\circ} = 3136 \text{ N}$$

e. Find the speed of the chair.

$$T \sin 60^\circ = \frac{mv^2}{r}$$

$$3136 \times \sin 60^\circ = \frac{160 \times v^2}{13}$$

$$v^2 = \frac{13 \times 3136 \times \sin 60^\circ}{160} = 220.6$$

$$v = 14.9 \text{ m/s}$$

F. A bullet of mass 25-gram (moving at $u = 130$ m/s) is fired into a hanging wood block of mass 2500-gram as shown.

a. Find the velocity v of the block & bullet just after the bullet is completely impeded in the block.

$$mu + 0 = (m+M)V$$

$$25u = 2525V \rightarrow V = \frac{25 \times 130}{2525}$$

$$V = 1.29 \text{ m/s}$$

b. How high, h will the block & bullet be raised?

$$\frac{1}{2}(m+M)V^2 = (m+M)gh$$

$$V^2 = 2gh \rightarrow h = \frac{V^2}{2g} = \frac{1.29^2}{2 \times 9.8} = 0.085 \text{ m} = \underline{\underline{8.5 \text{ cm}}}$$

c. Calculate the loss of energy during the collision, impeding of the bullet in the block.

$$KE_i = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.025 \times 130^2 = 211.25 \text{ J}$$

$$KE_f = \frac{1}{2}(m+M)V^2 = \frac{1}{2} \times 2.525 \times 1.29^2 = 2.1 \text{ J}$$

$$\text{Loss} = 211.25 - 2.1 = \underline{\underline{209 \text{ J}}}$$

