Closed book. No work needs to be shown for multiple-choice questions.

1. Patrick pitches a baseball of mass 0.20 kg. The ball arrives at home plate with a speed of 40 m/s and is batted straight back to Patrick with a return speed of 60 m/s. If the bat is in contact with the ball for 0.10 s, what is the magnitude of the impulse experienced by the ball?

a. 4.0 kg(m/s).
b. 12 kg(m/s).
c. 40 kg(m/s).
d. 20 kg(m/s).
e. 200 kg(m/s).

2. During a snowball fight two balls with masses of 0.4 and 0.6 kg, respectively, are thrown in such a manner that they meet head-on and combine to form a single mass. The magnitude of initial velocity for each is 15 m/s. What is the speed of the 1.0-kg mass immediately after collision?

a. zero
b. 3 m/s
c. 6 m/s
d. 9 m/s
e. 12 m/s

3. A 20-kg object sitting at rest is struck elastically in a head-on collision with a 10-kg object initially moving at +3.0 m/s. Find the final velocity of the 20-kg object after the collision.

a. –1.0 m/s
b. –2.0 m/s
c. +1.5 m/s
d. +2.0 m/s
e. –1.5 m/s

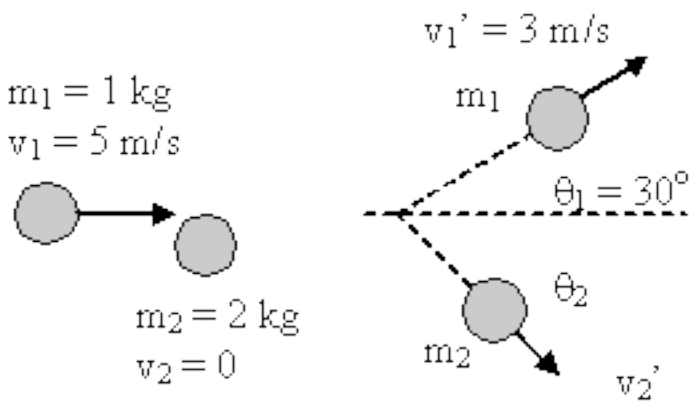
4. Riley the Astronaut weighs 60 kg. She is space walking outside the space shuttle and pushes a 350 kg satellite away from the shuttle at 0.90 m/s. What speed does this give Riley as she moves toward the shuttle?

a. 4.0 m/s.
b. 5.3 m/s.
c. 8.5 m/s.
d. 9.0 m/s.
e. 1.5 m/s.

5. A spring-loaded gun shoots a plastic ball with a speed of 4.0 m/s. If the spring is compressed twice as far, the ball's speed will be:

a. 8.0 m/s.
b. 2.0 m/s.
c. 5.7 m/s.
d. 4.0 m/s.
e. 16 m/s.

6. A mass m_1 traveling to the right with a speed v_1 makes a glancing collision with a mass m_2 initially at rest. After the collision the masses have speeds v_1' and v_2' and move in directions q_1 and q_2, as shown below. What is the value of v_2'?



a. 0.75 m/s.
b. 1.20 m/s.
c. 1.42 m/s.
d. 2.83m/s.
e. 5 m/s.

7. How much energy is required to move a 500 kg object from the Earth surface to an altitude three times the Earth radius?

a. 2.48×10^{8} J.
b. 1.12×10^{7} J.
c. 1.12×10^{10} J.
d. 2.34×10^{10} J.
e. 4.67×10^{10} J.

8. A 8000 N car is traveling at 12 m/s along a horizontal road when the brakes are applied. The car skids to a stop in 4.0 s. How much kinetic energy does the car lose in this time?

a. $4.8 \text{x} 10^{4}$ J.
b. $5.9 \text{x} 10^{4}$ J.
c. $1.2 \text{x} 10^{5}$ J.
d. $5.8 \text{x} 10^{5}$ J.
e. $1.2 \text{x} 10^{6}$ J.

Equations and constants:

$\begin{Bmatrix} x = r\cos\theta \\ y = r\sin\theta \end{Bmatrix}$; $\begin{Bmatrix} r = \sqrt{x^2+y^2} \\ \theta = \tan^{-1}\left(\frac{y}{x}\right) \end{Bmatrix}$; $\begin{Bmatrix} v_x = v_{ox} + a_x t \\ \Delta x = \frac{1}{2}(v_{ox}+v_x)t \\ \Delta x = v_{ox}t + \frac{1}{2}a_x t^2 \\ v_x^2 = (v_{ox})^2 + 2a_x\Delta x \end{Bmatrix}$; $\begin{Bmatrix} v_y = v_{oy} + a_y t \\ \Delta y = \frac{1}{2}(v_{oy}+v_y)t \\ \Delta y = v_{oy}t + \frac{1}{2}a_y t^2 \\ v_y^2 = (v_{oy})^2 + 2a_y\Delta y \end{Bmatrix}$; $\begin{Bmatrix} \Delta x = x_f - x_i \\ speed_{avg} = \frac{d}{\Delta t} \end{Bmatrix}$;

$\begin{Bmatrix} a_{avg} = \frac{\Delta v}{\Delta t} \\ v_{avg} = \frac{\Delta x}{\Delta t} \end{Bmatrix}$; $\begin{Bmatrix} a = \lim_{\Delta t\to 0}\frac{\Delta v}{\Delta t} \\ v = \lim_{\Delta t\to 0}\frac{\Delta x}{\Delta t} \end{Bmatrix}$; $\begin{Bmatrix} 0 \le f_s \le \mu_s F_N \\ f_k = \mu_k F_N \\ F_g = mg \end{Bmatrix}$; $\begin{Bmatrix} \sum \vec{\mathbf{F}} = 0;\ \vec{\mathbf{a}} = 0 \\ \sum \vec{\mathbf{F}} = m\vec{\mathbf{a}} \\ \vec{\mathbf{F}}_{2on1} = -\vec{\mathbf{F}}_{1on2} \end{Bmatrix}$; $PE_{grav} = mgh$; $KE = \frac{1}{2}mv^2$;

$PE_{spring} = \frac{1}{2}k(\Delta x)^2$; $W = |\vec{F}||\Delta\vec{x}|\cos\theta$; $W_{\text{net}} = W_1 + W_2 + W_3 \ldots$; $W_{\text{nc}} = \Delta E_{mec}$;

$E_{mec} = KE + PE_{grav} + PE_{spring}$; $\mathcal{P} = \vec{\mathbf{F}}\cdot\vec{\mathbf{v}} = \frac{W}{\Delta t}$;

$\vec{\mathbf{p}} = m\vec{\mathbf{v}}$; $\vec{\mathbf{I}} = \vec{F}\Delta t = \Delta\vec{\mathbf{p}} = m(\vec{\mathbf{v}}_f - \vec{\mathbf{v}}_i)$; $v_{1i} - v_{2i} = -(v_{1f} - v_{2f})$; $\vec{p}_i = \vec{p}_f$;

$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$; $\sum \vec{F}_{external} = \frac{\Delta\vec{p}}{\Delta t}$;

$\begin{Bmatrix} F = G\frac{m_1 m_2}{r^2} \\ G = 6.67\times 10^{-11}\ \text{N}\cdot\text{m}^2/\text{kg}^2 \end{Bmatrix}$; $\begin{Bmatrix} M_{Earth} = 5.98\times 10^{24}\ \text{kg} \\ R_{Earth} = 6.37\times 10^{6}\ \text{m} \end{Bmatrix}$; $PE = -G\frac{m_1 m_2}{r}$; $g = 9.80\ \text{m/s}^2$;

$g = G\frac{M}{r^2}$; 100 cm = 1 m; 1,000 m = 1 km; 60 s = 1 min; 60 min = 1 hr; 2.54 cm = 1 in;

12 in = 1 ft; 5,280 ft = 1 mi; 1,609 m = 1 mi; 0.3048 m = 1 ft; 2π rad = 1 rev = 360 deg.