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

1. Lonnie 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 Lonnie with a return speed of 60 m/s. If the bat is in contact with the ball for 0.050 s, what is the magnitude of the impulse experienced by the ball?

a. 360 N·s.
b. 20 N·s.
c. 400 N·s.
d. 9.0 N·s.
e. 240 N·s.

2. A ball with a mass of 0.25 kg moving at +5.0 m/s makes a head-on collision with a second ball of mass 0.50 kg that is initially at rest. We define the direction of motion of the first ball as the positive x-direction. If the collision is elastic, what is the velocity of the first ball after the collision?

a. –1.7 m/s.
b. –2.2 m/s.
c. –3.8 m/s.
d. 2.5 m/s.
e. 3.8 m/s.

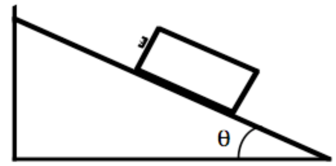
3. Blocks A and B are moving toward each other. Block A has a mass of 2.0 kg and a velocity of 50 m/s, while block B has a mass of 4.0 kg and a velocity of –25 m/s. The blocks stick together after the collision. The kinetic energy lost during the collision is:

a. 0.
b. 1250 J.
c. 3750 J.
d. 5000 J.
e. 5600 J.

4. Consider two vehicles approaching a right angle intersection and colliding. After the collision, they become entangled. Initially, car A has a mass of M and a velocity of (14.0 m/s) in the positive x-direction. Initially, car B has a mass of $3M$ and a velocity of (13.0 m/s) in the positive y-direction. What is the direction of the final velocity of the wreck with respect to the $+x$ axis?

a. 19.7°.
b. 21.0°.
c. 47.1°.
d. 69.0°.
e. 70.3°.

5. A 20-N crate starting at rest slides down a rough 5.0-m long ramp, inclined at 25° with the horizontal. 20 J of energy is lost to friction. What will be the speed of the crate at the bottom of the incline?



a. 7.8 m/s.
b. 1.9 m/s.
c. 5.5 m/s.
d. 4.7 m/s.
e. 6.4 m/s.

6. A particle experiences a force given by $F = \alpha - \beta x^3$ in the x direction. Find the potential energy the particle is in. (Assume that the zero potential energy is located at $x = 0$.)

a. $\Delta U(x) = 3\beta x^2$.
b. $\Delta U(x) = -\alpha x + \frac{\beta}{4}x^4$.
c. $\Delta U(x) = \alpha x - \frac{\beta}{4}x^4$.
d. $\Delta U(x) = -3\beta x^2$.
e. $\Delta U(x) = -6\beta x$.

7. A satellite of the Earth has a mass of 200 kg and is at an altitude equal to the radius of the Earth. What is the potential energy of the satellite-Earth system?

a. -6.27×10^9 J.
b. -1.12×10^9 J.
c. -3.14×10^9 J.
d. -2.34×10^{10} J.
e. -1.25×10^{10} J.

8. A 45 kg box is pushed 17.4 m up a frictionless plane at an angle of 37° above the horizontal. Calculate its increase in potential energy.

a. 560 J.
b. 2900 J.
c. 3100 J.
d. 4600 J.
e. 1120 J.

Equations and constants:

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

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

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

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

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

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

$\begin{cases} F = G\frac{m_1 m_2}{r^2} \\ G = 6.67\times10^{-11}\ \text{N}\cdot\text{m}^2/\text{kg}^2 \end{cases}$; $\begin{cases} M_{Earth} = 5.98\times10^{24}\ \text{kg} \\ R_{Earth} = 6.37\times10^{6}\ \text{m} \end{cases}$; $PE = -G\frac{m_1 m_2}{r}$; $g = 9.80\ \text{m/s}^2$;

$g = G\frac{M}{r^2}$; 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.