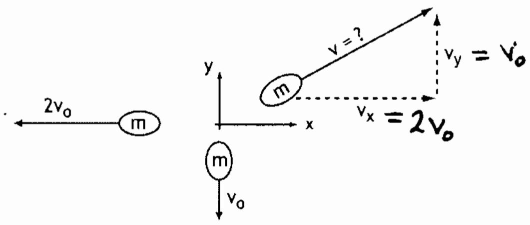
Exam #3 **PS150**
April 21, 2009 **Dr. Darrel Smith**

Show your work !!

Answer Key
Name

10 points

1. An explosive device fragments into three equal masses as shown in the figure to the right.



a. Calculate the velocity of the fragment moving in the direction of the 1[st] quadrant

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(2v_0)^2 + (v_0)^2} = \sqrt{5}\ v_0$$

$v =$ 2.24 v_0

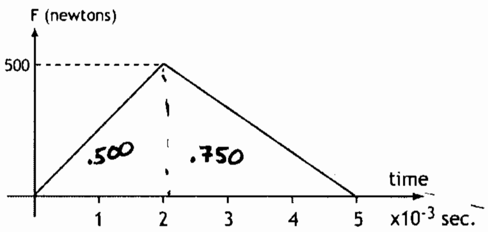
b. Calculate the total kinetic energy of the three fragments.

$$KE = \tfrac{1}{2}(m)(2v_0)^2 + \tfrac{1}{2}mv_0^2 + \tfrac{1}{2}m(5v_0^2) = 5\ mv_0^2$$

$KE =$ 5.00 mv_0^2

10 points

2. An external force (as shown in the figure to the right) is applied to a 2.00-kg mass for 5.00×10^{-3} seconds. If the 2.00-kg mass is initially at rest and the force and motion is constrained to be along the $+x$ direction, what is the final velocity of the mass?



impulse

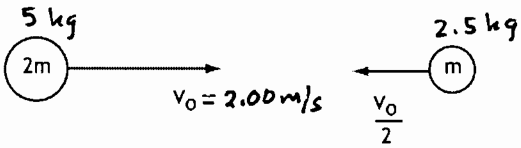
$$I = \int F\,dt = 1.250\ \text{N}\cdot\text{s} = m(v_f - \underbrace{v_i}_{=0})$$

$$v_f = \frac{1.250\ \text{N}\cdot\text{s}}{2.0\ \text{kg}} = 0.625\ \text{m/s}$$

$v =$ 0.625 m/s

10 points

3. Two masses (2m = 5.00-kg , m = 2.50-kg) are initially moving as shown in the figure to the right. After the two masses collide, they "stick" together.



a. If v_o is 2.00 m/s, what is the final velocity of the newly-formed mass?

$$P_{TOTAL} = P_1 + P_2 = (5\ \text{kg})(2.0\ \text{m/s}) + (2.5\ \text{kg})(-1.00\ \text{m/s}) = (10 - 2.5)\ \text{kg}\cdot\text{m/s} \qquad P_{TOTAL} = 7.5\ \text{kg}\cdot\text{m/s}$$

$$P_{TOTAL} = (m_1 + m_2)v_f \qquad v_f = \frac{P_{TOTAL}}{m_1+m_2} = \frac{7.5\ \text{kg}\cdot\text{m/s}}{7.5\ \text{kg}} = 1.00$$

$v_f =$ 1.00 m/s

b. How much work was required for the two masses to stick together? In other words, what was the change in KE?

$$\Delta K = K_f - K_i = \tfrac{1}{2}(7.5\ \text{kg})(1.00\ \text{m/s})^2 - \left(\tfrac{1}{2}\,5\ \text{kg}\,(2.0\ \text{m/s})^2 + \tfrac{1}{2}\,2.5\ \text{kg}\,(-1.0\ \text{m/s})^2\right)$$

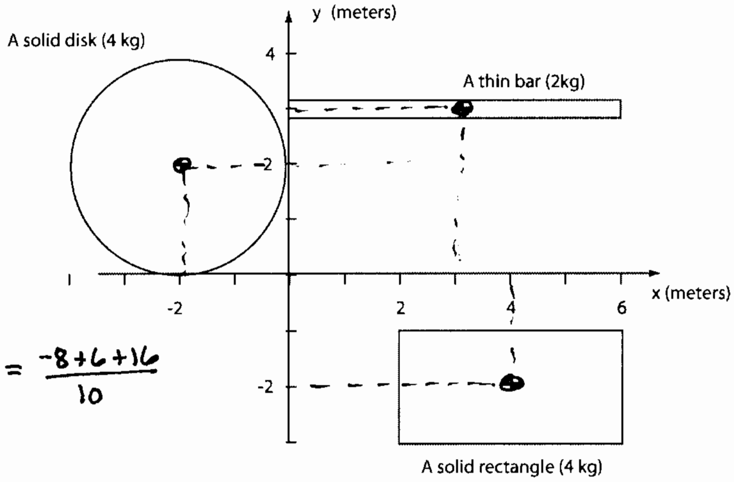
$$\Delta K = 3.75\ \text{J} - (10\ \text{J} + 1.25\ \text{J}) = (3.75 - 11.25)\ \text{J}$$

$$\Delta K = -7.50\ \text{J}$$

$\Delta KE =$ −7.50 J

10 points

4. The following objects are located on a Cartesian grid as shown in the figure below. Calculate the center of mass coordinate for the "combined" set of 3 objects.



$$X_{cm} = \frac{4(-2)+2(3)+4(4)}{4+2+4} = \frac{-8+6+16}{10}$$

$$X_{cm} = \frac{14}{10}\,m = 1.40\,m$$

$$y_{cm} = \frac{4(2)+2(3)+4(-2)}{4+2+4} = \frac{8+6-8}{10}$$

$$y_{cm} = \frac{6}{10} = 0.60\ m$$

x_{cm} = 1.40 m

y_{cm} = 0.60 m

10 points

5. The flywheel in your car is initially idling at 1,000 rpms (revolutions per minute). After turning your car "off," the flywheel comes to rest in 0.75 seconds.

   a. Assuming that the deceleration is constant, what is the angular deceleration of the flywheel?

ω final

$$\alpha = \frac{\omega - \omega_o}{t} = \frac{-1{,}000(\text{rev/min})\left(\frac{2\pi\ \text{rad}}{\text{rev}}\right)\left(\frac{1\ \text{min}}{60\ \text{s}}\right) + 0}{0.75\ \text{s}} = -139.6\ \text{rad/s}^2$$

α = -139.6 rad/s^2

   b. How many revolutions did the flywheel make in the 0.75-second interval?

$$\theta = \frac{1}{2}(\omega+\omega_o)t = \frac{1}{2}\left(0 + 1{,}000\,\frac{\text{rev}}{\text{min}}\left(\frac{2\pi\ \text{rad}}{\text{rev}}\right)\left(\frac{1\ \text{min}}{60\ \text{s}}\right)\right)0.75\ \text{s} = 39.27\ \text{rad}\left(\frac{\text{rev}}{2\pi\ \text{rad}}\right) = 6.25\ \text{rev}$$

θ = 6.25 revolutions