Physics 2414 Afternoon
Midterm #3 – Fall 2005
Version A

Multiple Choice (7 pts each)

1) A ball of putty with mass M is fired at initial velocity v to the right towards an identical mass of putty at rest. The two putty balls stick together. What is the final velocity of the pair?
   a) v to the right
   b) v to the left
   c) zero
   d) \( \frac{v}{2} \) to the right
   e) \( \frac{v}{2} \) to the left

\[
\frac{Mv}{0} = (M + m) \frac{v_f}{0}
\]

\[
\frac{Mv}{M} = mv_f
\]

\[
v_f = \frac{v}{2}
\]

2) Identical red and blue balls are launched with the same initial speed but different angles. The red ball travels a further horizontal distance than the blue ball. How do the final mechanical energies compare when they hit the ground? Ignore friction.
   a) The red ball has more mechanical energy at the end.
   b) The blue ball has more mechanical energy at the end.
   c) The balls have the same mechanical energy at the end.
   d) The initial angles must be known to answer this question
   e) The initial speed must be known to answer this question.

3) A golf ball is fired at a bowling ball initially at rest and sticks to it. Compared to the bowling ball, the golf ball after the collision has
   A) more momentum but less kinetic energy.
   B) more momentum and more kinetic energy.
   C) less momentum and less kinetic energy.
   D) less momentum but more kinetic energy.
   E) none of the above.

\[
k_r = \frac{P_r^2}{2m_r} - \left(\frac{mv_r}{2}\right)^2
\]

\[
k_b = \frac{P_b^2}{2m_b} - \left(\frac{mv_b}{2}\right)^2
\]

4) You slam on the brakes of your car in a panic, lock your tires up, and skid a certain distance on a straight level road. If you had been traveling twice as fast, what distance would the car have skidded under the same conditions?
   A) the same distance
   B) \( \sqrt{2} \) times as far
   C) twice as far
   D) four times as far
   E) More information is needed to solve this.
5) A slingshot shoots a rock, and then a steel ball with twice the mass of the rock. The force exerted by the slingshot in each case is the same and lasts for the same amount of time. What can we say about the momentum and velocity of the rock and the ball.

A) the ball has a greater momentum and a greater velocity.
B) the ball has a greater momentum, but the rock has a greater velocity.
C) the ball has a greater momentum, but they have the same velocity.
D) they have the same momentum and the same velocity.
E) they have the same momentum, but the rock has a greater velocity.

6) A young girl wishes to select one of the frictionless playground slides illustrated below to give her the greatest possible speed when she reaches the bottom of the slide.

Which of the slides illustrated in the diagram above should she choose?

A) A
B) B
C) C
D) D
E) It doesn’t matter. Her speed would be the same for each.

7) A woman pulls a crate up a rough inclined plane at a constant speed. Which statement concerning this situation is not true?

A) The work done on the object by gravity is zero.
B) The gravitational potential energy of the crate is increasing.
C) The net work done by all the forces acting on the crate is zero.
D) The work done on the crate by the normal force of the plane is zero.
E) The woman does “positive” work in pulling the crate up the incline.
8) An object at rest slides down a frictionless plane of height $h=10$ m. At the bottom of the plane the object encounters a flat rough surface ($\mu_k=0.2$) and continues to slide. How far from the bottom of the plane (d) does the object come to rest?

A) 25 m  
B) 10 m  
C) 30 m  
D) 50 m  
E) It depends on the mass of the object

\[
\begin{align*}
\text{mg}h &= \frac{1}{2}mv^2 = F_k d \\
\text{mg}h &= \mu_k \text{mg} d \\
d &= \frac{h}{\mu_k} = \frac{10\text{m}}{0.2} = 50\text{m}
\end{align*}
\]

9) A spring-powered dart gun is un-stretched and has a spring constant 16.0 N/m. The spring is compressed by 8.0 cm and a 5.0 gram projectile is placed in the gun. The velocity of the projectile when it is shot from the gun is,

a) 2.04 m/s  
b) 2.75 m/s  
c) 3.50 m/s  
d) 3.75 m/s  
\(\text{e) 4.53 m/s}\)

\[
\begin{align*}
\frac{1}{2}kx^2 &= \frac{1}{2}mv^2 \\
v &= \sqrt{\frac{16}{0.05}} \cos^2 \theta = 4.53\text{m/s}
\end{align*}
\]

10) A 4.0 kg object is moving at 5.0 m/s NORTH. It strikes a 6.0 kg object that is moving EAST at 2.0 m/s. The objects have a completely inelastic (stick together) collision. The velocity of the 6.0 kg object after the collision is,

a) 2.33 m/s at an angle of 35.0 degrees NORTH of EAST  
\(\text{b) 2.33 m/s at an angle of 59.0 degrees NORTH of EAST}\)  
c) 2.00 m/s at an angle of 59.0 degrees NORTH of EAST  
d) 2.00 m/s at an angle of 45.0 degrees NORTH of EAST  
e) 2.33 m/s at an angle of 45.0 degrees NORTH of EAST

\[
\begin{align*}
\mathbf{P}_{x,1} &= 12 \\
\mathbf{P}_{y,1} &= 0 \\
\mathbf{P}_{x,2} &= (m_1, v_{x,2}) \\
\mathbf{P}_{y,2} &= (m_2, v_{y,2}) \\
v &= \sqrt{(12)^2 + (2)^2} = 2.33\text{m/s} \\
\theta &= \tan^{-1}\left(\frac{2}{12}\right) = 5.9^\circ \text{ NORTH of EAST}
\end{align*}
\]
11) A ball of mass 4 kg and speed 5 m/s bounces off the floor as shown. What is the magnitude of the change in the momentum of the ball?
A) 0
B) 20 kg m/s
C) 25.7 kg m/s
D) 40.0 kg m/s
\[ \Delta P = \Delta P_x = -2 \cdot m \cdot v \sin 50^\circ \]
\[ \Delta P_y = 2 \cdot m \cdot v \sin 50^\circ \]
\[ \Delta P = 2 \cdot m \cdot v \sin 50^\circ = 30.6 \text{ kg m/s} \]

12) A 5.0 kg object is moving at 2.0 m/s EAST. It strikes a 5.0 kg object that is moving WEST at 2.0 m/s. The objects have a completely inelastic (stick together) collision. The kinetic energy lost in the collision is,
a) 10 J
b) 40 J
c) 20 J
d) 30 J
e) 14.5 J
\[ \Delta K = \frac{1}{2} m v_i^2 + \frac{1}{2} m v_f^2 \]
\[ \Delta K = 5 \cdot (2)^2 = 10 \text{ J} \]

13) A skier with mass 100 kg starts from rest and skis down a frictionless hill of height 20 meters. At the bottom of the hill, the skier picks up a box of mass 20 kg. What is the speed of the skier and box immediately after the skier picks up the box?
A) 19.8 m/s
B) 16.5 m/s
C) 99 m/s
D) 12.3 m/s
E) 10.1 m/s
\[ m g h = \frac{1}{2} m v^2 \]
\[ v = \sqrt{2 g h} = 17.8 \text{ m/s} \]
\[ m v = (m_1 m_2) v_f \]
\[ v_f = \frac{m_1 v_1}{m_1 + m_2} = \frac{100 \cdot 17.8}{120} = 16.5 \text{ m/s} \]

14) A 3.0 kg mass is located at \( x = 2.0 \text{ cm} \) and \( y = 0.0 \). A 3.0 kg mass is located at \( x = 0.0 \) and \( y = 2.0 \text{ cm} \). A 4.0 kg mass is located at \( x = 3.0 \text{ cm} \) and \( y = -3.0 \text{ cm} \). Where is the location of the center of mass?
a) \( x_{cm} = +1.8 \text{ cm} \), \( y_{cm} = -0.6 \text{ cm} \)
b) \( x_{cm} = +1.8 \text{ cm} \), \( y_{cm} = +0.6 \text{ cm} \)
c) \( x_{cm} = +0.6 \text{ cm} \), \( y_{cm} = -1.8 \text{ cm} \)
d) \( x_{cm} = +3.5 \text{ cm} \), \( y_{cm} = -0.6 \text{ cm} \)
e) \( x_{cm} = +1.8 \text{ cm} \), \( y_{cm} = +1.6 \text{ cm} \)
\[ x = \frac{3 \cdot 2 + 3 \cdot 0 + 4 \cdot -3}{3 + 3 + 3} = 1.8 \]
\[ y = \frac{3 \cdot 0 + 3 \cdot 2 + 4 \cdot (-3)}{3 + 3 + 3} = -0.6 \]