PHYS 101 Midterm Examination #1 (version A)

June 25, 2010

Time: 50 minutes

Last Name : Key

First Name : _____

Student No. : _____

Computing ID : _____

	score	***Maximum***
Multiple Choice		***5***
Written # 1		***5***
Written # 2		***5***
Written # 3		***5***
Total		***20***

Part I (Multiple choice questions. 1 mark each.)

C

1. When an object is moving in one dimension, The slope at a point on a position-versus-time graph of the object represents
   (A) the speed of the object at that point.
   (B) the average velocity of the object at that point.
   (C) the instantaneous velocity of the object at that point.
   (D) the acceleration of the object at that point.
   (E) the distance traveled by the object to that point.

2. A block of mass *m* rests on the floor of an elevator that is moving downward at constant speed. What is the relationship between the force due to gravity and the normal force on the block?

B

   (A) $N > mg$
   (B) $N = mg$
   (C) $N < mg$ (but not zero)
   (D) $N = 0$
   (E) depends on the size of the elevator

3. An object is in a uniform circular motion. Which of the following statements must be true?

D

   A) The acceleration of the object is zero.
   B) The acceleration of the object is constant.
   C) The velocity of the object is constant.
   D) The speed of the object is constant.
   E) A net force pointing along the direction of motion is acting on the object.

4. You and your friend both solve a problem involving a skier going down a slope, starting from rest. The two of you have chosen different levels for y = 0 in this problem. Which of the following quantities will you and your friend agree on?
   I) skier's potential energy
   II) skier's change in potential energy
   III) skier's final kinetic energy

E

   (A) only II
   (B) only III
   (C) I, II, and III
   (D) only I and III
   (E) only II and III

5. A 0.10-kg baseball is dropped from rest. It has a speed of 2.0 m/s just before it hits the ground. It rebounds with a speed of 1.0 m/s. The ball is in contact with the ground for 0.010 s. What is the average force exerted by the ground on the ball during that time?

D

   A) 2.0 N
   B) 10 N
   C) 20 N
   D) 30 N
   E) 22 N

$F_{av} \cdot \Delta t = m(v_f - v_i)$

$F_{av} = \dfrac{m(v_f - v_i)}{\Delta t}$

$= \dfrac{0.1\,(1 - (-2))}{0.01}$

$= 10 \times 3 = 30\ N$.

Part II (Full solution questions, 5 marks each. **SHOW ALL WORK FOR FULL MARKS!**)

6. Mary is capable of swimming 0.30 m/s in still water.

(*a*) If she aims her body directly across a 75-m-wide river whose current is 0.40 m/s, what is her velocity relative to an observer on the river bank (us a diagram to specify the direction)?

(b) How long does it take for her to reach the other side of the river?

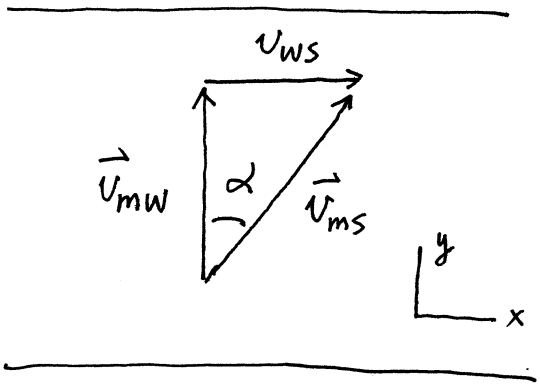
(a).

$$\vec{v}_{ms} = \vec{v}_{mw} + \vec{v}_{ws}$$

$$v_{ms} = \sqrt{v_{mw}^2 + v_{ws}^2}$$

$$= \sqrt{(0.3)^2 + (0.4)^2}$$

$$= 0.5 \text{ m/s}$$



$$\alpha = \tan^{-1}\frac{v_{ws}}{v_{mw}} = \tan^{-1}\frac{0.4}{0.3} = 53^\circ$$

(b). $$\Delta t = \frac{\Delta y}{v_y} = \frac{75 \text{ m}}{0.3 \text{ m/s}} = 250 \text{ sec.}$$

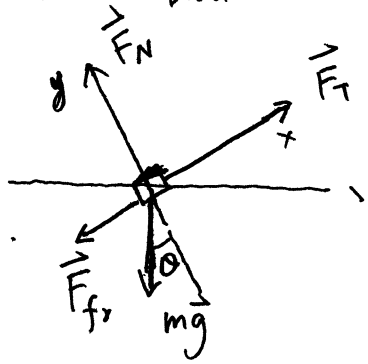
7. Suppose the coefficient of kinetic friction between block 2 and the plane in the figure is 0.10, and the mass of block 1 is the same as that of block 2, (m_1=m_2=5.0kg). Ignore the mass of cable and the friction in the pulley.

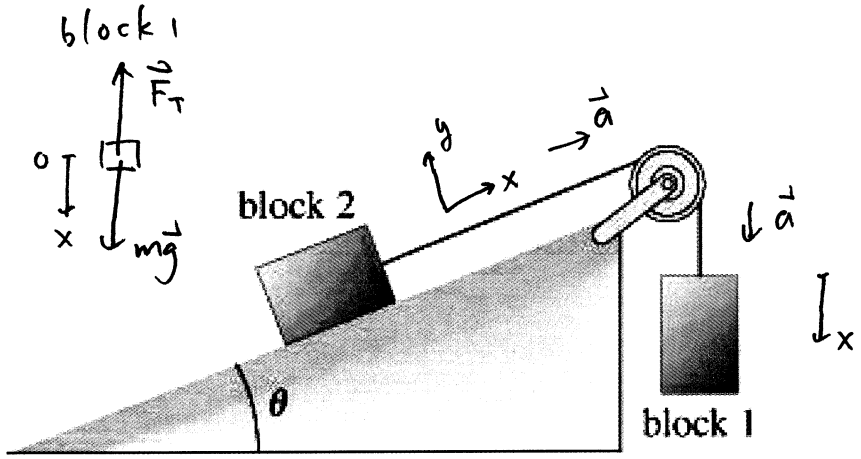
(a) Draw a free body diagram for each block;

(b) As block 1moves down, determine the magnitude of the acceleration of m_1 and m_2, given $\theta = 30°$.

(c) Determine the magnitude of the tension in the cable.

(a). block 2.





(b). $\vec{F} = m\vec{a}$

block 1: $mg - F_T = ma$ (1)

block 2: $F_T - F_{fr} - mg\sin\theta = ma$. (2)

$F_N - mg\cos\theta = 0$. $\Rightarrow$ $F_N = mg\cos\theta$, $F_{fr} = \mu F_N$

$= \mu mg\cos\theta$.

(2) becomes: $F_T - \mu mg\cos\theta - mg\sin\theta = ma$ —(3)

(1) + (3): $mg - \mu mg\cos\theta - mg\sin\theta = 2ma$.

$$a = \frac{g}{2}(1 - \mu\cos\theta - \sin\theta) = \frac{9.8}{2}(1 - 0.1\cos 30° - \sin 30°)$$

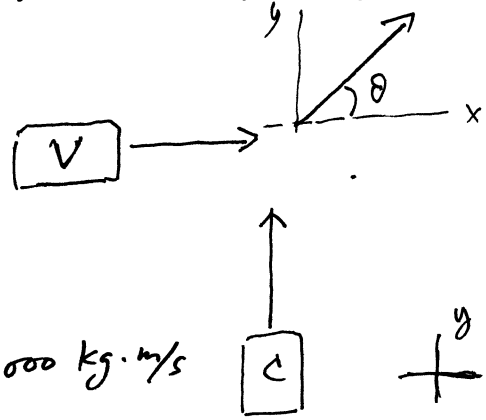
$= 4.05\ m/s^2$ 2.03 m/s^2

(c). $F_T = mg - ma$

$= m(g-a) = 5.0(9.8 - 2.03) = 38.9\ N$.

8. A car with a mass of 1000 kg and a speed of 15 m/s heading north approaches an intersection. At the same time, a minivan with a mass of 2000 kg and speed of 10 m/s heading east is also approaching the intersection. The car and the minivan collide and stick together.
(a) Determine the velocity of the wrecked vehicles just after the collision. Use a schematic diagram to indicate the direction.
(b) After the collision, the wrecked vehicles will skid on the road and finally stop because of the friction between the tires and the road. If the coefficient of kinetic friction is 0.50, how far will the wrecked vehicles skid before they come to a complete stop?

(a). conservation of momentum for the collision:



$$\vec{p}_c + \vec{p}_v = \vec{p}_R'$$

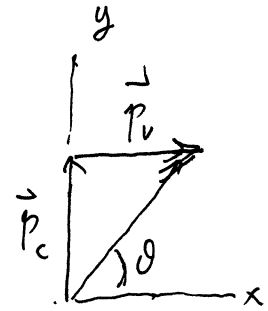
$$p_{Rx}' = p_v = m_v v_v = 2000 \times 10 = 20{,}000 \text{ kg·m/s}$$

$$p_{Ry}' = p_c = m_c v_c = 1000 \times 15 = 15{,}000 \text{ kg·m/s}$$

$$p_R' = \sqrt{p_{Rx}'^2 + p_{Ry}'^2} = \sqrt{(20000)^2 + (15000)^2} = 25{,}000 \text{ kg·m/s}.$$

$$v_R = \frac{p_R'}{m_v + m_c} = \frac{25{,}000}{2000 + 1000} = 8.3 \text{ m/s}.$$

$$\theta = \tan^{-1}\frac{p_{Ry}'}{p_{Rx}'} = \tan^{-1}\frac{15000}{20000} = 37^\circ.$$



(b). $W = \Delta K$.

$$-\mu F_N \cdot d = 0 - \frac{1}{2} M_R v_R^2 \qquad F_N = M_R g.$$

$$d = \frac{M_R v_R^2}{2\mu F_N} = \frac{M_R v_R^2}{2\mu M_R g} = \frac{v_R^2}{2\mu g}$$

$$d = \frac{8.3^2}{2 \times 0.5 \times 9.8} = 7.0 \text{ m}.$$