

# PRACTICE TEST

Problems will have partial credit. Show all work.. Style, neatness, organization, and arrangement are important. Problems will be graded based on whether pictures, coordinate systems, free body diagrams, and basic equations are present. Do not do calculations in your head (unless you plan on turning it in too).

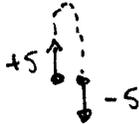
Multiple choice questions may have partial credit. Show work for them if at all possible.

1. The acceleration of a car is zero when it is:

- a) turning left at constant speed.
- b) traveling up a long straight incline at constant speed.**
- c) topping the crest of a hill.
- d) bottoming out at the lowest point of a valley.
- e) speeding up as it descends a long straight decline.

2. A man throws a golf ball vertically upward with a speed of 5 m/s. How long will it take for the ball to return to its starting place?

- a) 0.51 s
- b) 1.02 s**
- c) 1.43 s
- d) 2.04 s
- e) 4.90 s



$$v_y(t) = v_{oy} + a_y t$$

$$-5 = +5 - 9.8t$$

$$t = 1 \text{ sec}$$

$v_{oy} = +5$       $a_y = -9.8$

3. All except one of the following require the application of a net force. Which one is the exception?

- a) to change an object from a state of rest to a state of motion. ✓
- b) to maintain an object in motion at a constant velocity. ✗**
- c) to change an object's speed without changing its direction of motion. ✓
- d) to maintain an object in uniform circular motion. ✓
- e) to change an object's direction of motion without changing its speed. ✓

~~Assumes No friction~~

4. A ball is thrown vertically upward. At the top of its flight, its acceleration is

- a) zero
- b) constantly changing
- c) g, downward**
- d) centripetal
- e) g, upward

5. The pilot of an aircraft traveling North pulls back on the stick and manipulates the throttle so that the craft executes a circular 200-m radius loop while maintaining a constant speed of 100 m/s. When the velocity of the craft is directed straight upward, the acceleration of the craft is:

- a)  $9.8 \text{ m/s}^2$ , straight down
- b)  $41.2 \text{ m/s}^2$ , straight up
- c)  $50.0 \text{ m/s}^2$ , due south**
- d)  $50.0 \text{ m/s}^2$ , straight down
- e)  $50.0 \text{ m/s}^2$  straight up

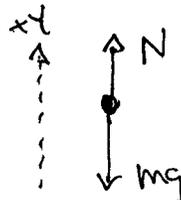
$$a_{\text{rad}} = \frac{v^2}{R}$$

$$= \frac{(100)^2}{200}$$

$$= 50 \text{ m/s}^2$$

6. A girl stands on a bathroom scale in an elevator. When the elevator is accelerating downward at  $2 \text{ m/s}^2$ , the scale reads 390 N. Her mass is:

- a) 25.0 kg
- b) 33.1 kg
- c) 39.8 kg
- d) 50.0 kg**
- e) 195 kg.



$$m a_y = \sum F_y \text{'s}$$

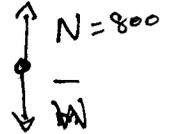
$$m a_y = N - mg$$

$$m(-2) = 390 - m(9.8)$$

$$m = 50 \text{ kg}$$

7. A dog sleeping on a scale is supported by an upward force of 800 N exerted on the dog by the scale. We know that the force of gravity on the dog equals 800 N because:

- a) they form an action-reaction pair *not worded correctly to fit definition*
- b) the dog is in static equilibrium and so the vector sum of the forces on the dog is zero.**
- c) the resultant force on the dog is 800 N.
- d) both forces are conservative.
- e) Newton's law of gravitation applies.



9. When a certain rubber band is stretched a distance  $x$ , it exerts a restoring force of magnitude  $F = ax + bx^2$ . The work done by an outside agent in extending the rubber band from  $x = 0$  to  $x = L$  is:

- A.  $(ax + bx^2)L$
- B.  $a + 2bx$
- C.  $a + 2bL$
- D.  $\frac{1}{2}ax^2 + \frac{1}{3}bx^3$
- E.  $\frac{1}{2}aL^2 + \frac{1}{3}bL^3$**

$$\text{Work by } F = \int_0^L F dx = \int_0^L (ax + bx^2) dx = \left[ \frac{1}{2}ax^2 + \frac{1}{3}bx^3 \right]_0^L$$

MC2. The potential energy of a particle is given by  $U(x) = 3x - 5x^2$ . The  $x$ -component of the force  $F$  acting on the particle obeys

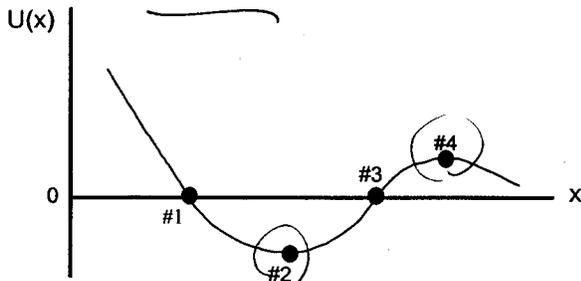
- A)  $F_x = 3x - 5x^2$
- B)  $F_x = 3 - 10x$**
- C)  $F_x = -3 + 10x$
- D)  $F_x = -3x + 5x^2$
- E)  $F_x = 3x + 10x^2$

$$F_x = -\frac{dU}{dx} = 3 - 10x$$

MC3. Which of the following statements about the gravitational and elastic potential energies is true?

- A) An arbitrary constant can be added to each without altering the force. ✓**
- B) An arbitrary constant can be added to neither.
- C) An arbitrary constant can be added to the elastic energy but not the gravitational.
- D) An arbitrary constant can be added to the gravitational energy but not the elastic.
- E) All of the above.

9. Given the plot of potential energy  $U(x)$  versus position  $x$ , as shown in the adjoining graph, at what point or points is the associated force zero?

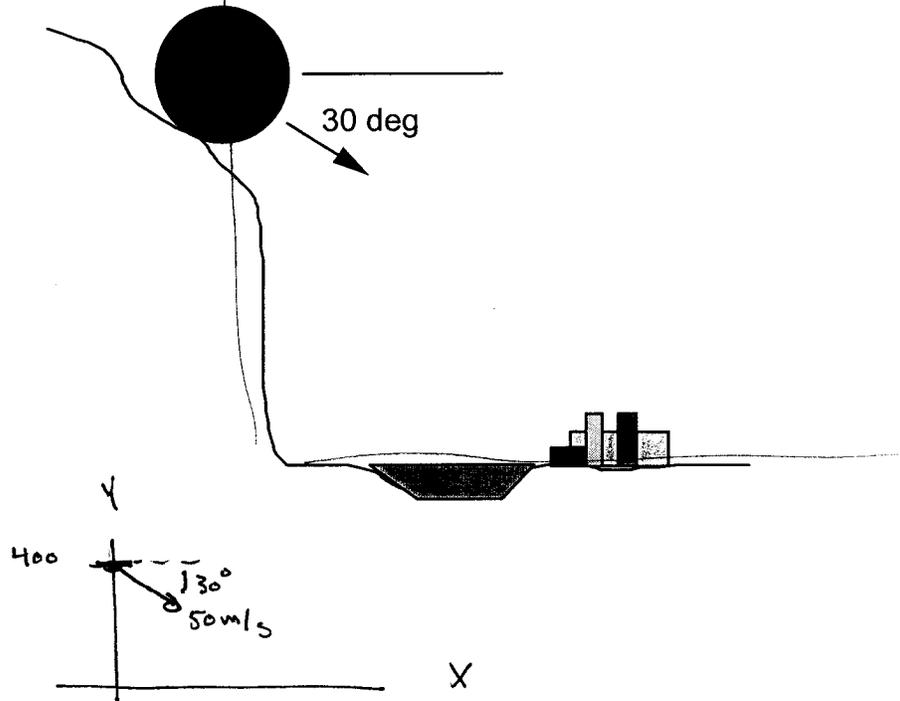


$$F_x = -\frac{dU}{dx}$$

- A. #1 only
- B. #1 and #3
- C. #1, #2, and #3

- D. #2 only
- E. #2 and #4**

9. A large boulder rests on a cliff above a small village in such a position that if it should roll off, it would leave the edge of the cliff at a height of 400 m with a speed of 50 m/s. There is a pond, diameter 200 m, with its edge 100 m from the base of the cliff as shown. The village houses are at the edge of the pond. Where does the boulder land?



$$x(t) = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$$

$$x_0 = 0$$

$$v_{0x} = 50 \cos 30^\circ = 43.3$$

$$a_x = 0$$

$$x(t) = 43.3t$$

Hits ground when  $y(t) = 0$

$$y(t) = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$$

$$y_0 = 400$$

$$v_{0y} = -50 \sin 30^\circ = -25$$

$$a_y = -9.8$$

$$y(t) = 400 - 25t + \frac{1}{2}(-9.8)t^2$$

$$0 = 400 - 25t + \frac{1}{2}(-9.8)t^2$$

$$= 400 - 25t - 4.9t^2$$

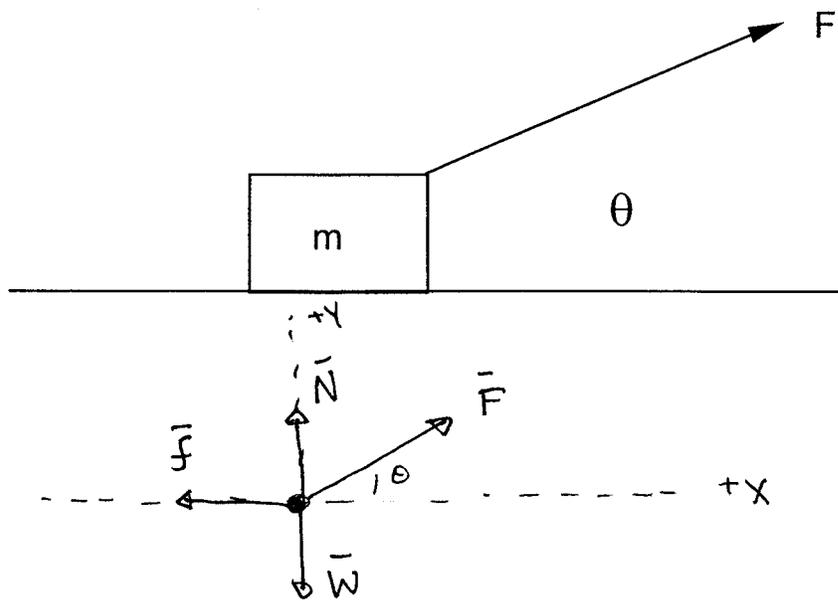
$$t = \frac{25 \pm \sqrt{25^2 + 4(400)(4.9)}}{-2(4.9)}$$

$$t = \frac{25 \pm 92}{-9.8} = -11.9, 6.84 \text{ sec}$$

$$x(t) = 43.3(6.84)$$

$$= 296 \text{ m}$$

11. The box shown below is being dragged across a rough floor by application of a force  $F$  at an angle of  $\theta$  with respect to the horizontal. The coefficient of kinetic friction is  $\mu_k$ . The mass of the box is  $m$ . Find an expression for the acceleration of the box across the floor in terms of the quantities  $F, m, \mu_k$ , and  $\theta$ . (The box remains in contact with the floor).



$$m\vec{a} = \sum \vec{F}$$

$$ma_x = \sum F_x \text{'s}$$

$$ma_x = F\cos\theta - f$$

$$= F\cos\theta - \mu N$$

$$ma_y = \sum F_y \text{'s}$$

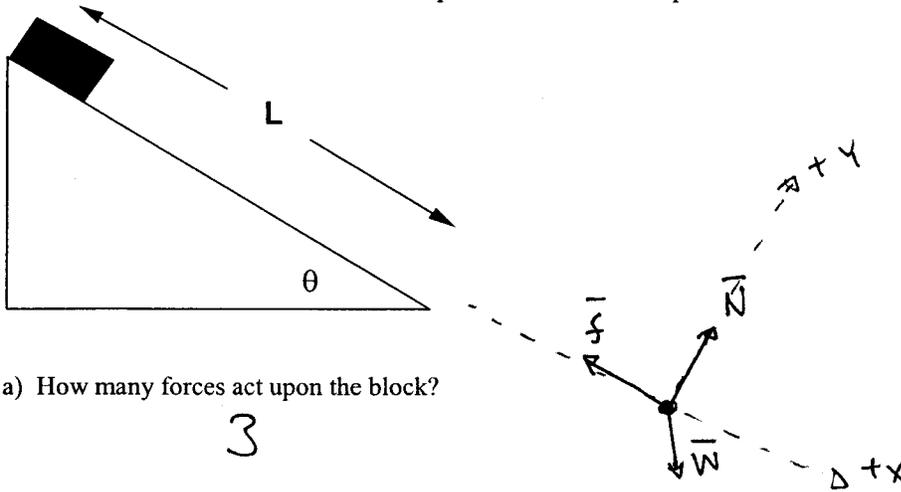
$$ma_y = F\sin\theta + N - mg$$

$$N = mg - F\sin\theta$$

$$ma_x = F\cos\theta - \mu [mg - F\sin\theta]$$

$$ma_x = F[\cos\theta + \mu\sin\theta] - \mu mg$$

6. Consider a block of mass  $m$  on a rough inclined plane. The plane has tilt angle  $\theta$  and coefficient of friction  $\mu$ . The block slides a distance  $L$  from the top to the bottom of the plane.



a) How many forces act upon the block?

3

b) Draw a free body diagram for the block and indicate the direction of each force.

$$\begin{aligned}
 m a_x &= \sum F_x \text{'s} \\
 m a_x &= m g \sin \theta - f \\
 m a_x &= m g \sin \theta - \mu N
 \end{aligned}$$

$$\begin{aligned}
 m a_y &= \sum F_y \text{'s} \\
 m a_y &= N - m g \cos \theta \\
 N &= m g \cos \theta
 \end{aligned}$$

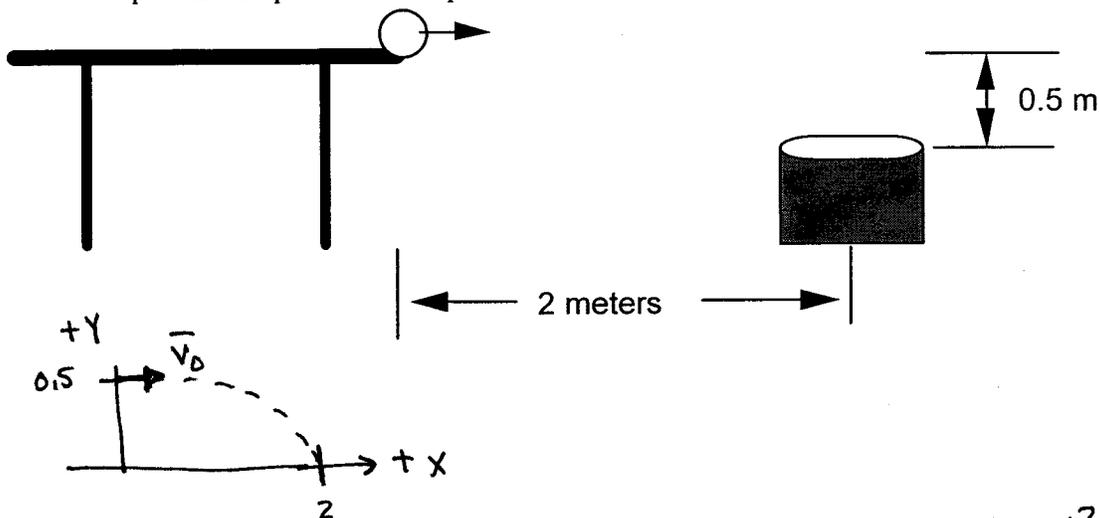
c) For each force, give the amount of work done by that force on the block as it slides down the plane. Express answers in terms of  $m$ ,  $L$ ,  $\theta$ ,  $\mu$  and  $g$  - the acceleration due to gravity.

Work done by Normal force =  $\int_i^f \vec{N} \cdot d\vec{r} = 0$  because  $\vec{N} \perp d\vec{r}$

Work done by  $\vec{W}$  =  $\int_i^f \vec{W} \cdot d\vec{r} = mgh$  because it's only motion in direction of force that contributes to integral  
 $= mg L \sin \theta$

Work done by friction =  $\int_i^f \vec{f} \cdot d\vec{r} = f L \cos 180^\circ$   
 $= \mu N L \cos 180^\circ$   
 $= \mu m g \cos \theta L \cos 180^\circ$   
 $= -\mu m g \cos \theta L$

8. When you were younger you did not like green peas and you would do anything at mealtime to avoid eating them. Now that you are older -- you absolutely despise them. Suppose you are at the dinner table thumping the little green marbles into the trashcan as your family looks on in horror. Being a marksman, the peas enter the top of the trash can dead-center. The peas fly off the tabletop horizontally and drop 0.5 meter (19.7 in) into the trashcan. The center of the trashcan is 2 meters (6.56 ft) away from the edge of the dinnertable. The table top is 1 meter off the floor. Find the speed that the peas enter the top of the trashcan.



$$x(t) = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$$

$$x_0 = 0$$

$$v_{0x} = ?$$

$$a_x = 0$$

$$x(t) = v_{0x}t$$

$$y(t) = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$$

$$y_0 = 0.5$$

$$v_{0y} = 0$$

$$a_y = -9.8$$

$$y(t) = 0.5 + \frac{1}{2}(-9.8)t^2$$

We know pea goes in center of trash can

$$0 = 0.5 + \frac{1}{2}(-9.8)t^2$$

$$2 = v_{0x}t$$

$$2 = v_{0x}(0.319)$$

$$v_{0x} = 6.26 \text{ m/s}$$

$$t = 0.319 \text{ sec}$$

Then to get velocity of pea as it enters trash can

$$v_x(t) = v_{0x} + a_x t$$

$$v_{0x} = 6.26$$

$$a_x = 0$$

$$v_x(t) = 6.26 \text{ m/s}$$

$$v_y(t) = v_{0y} + a_y t$$

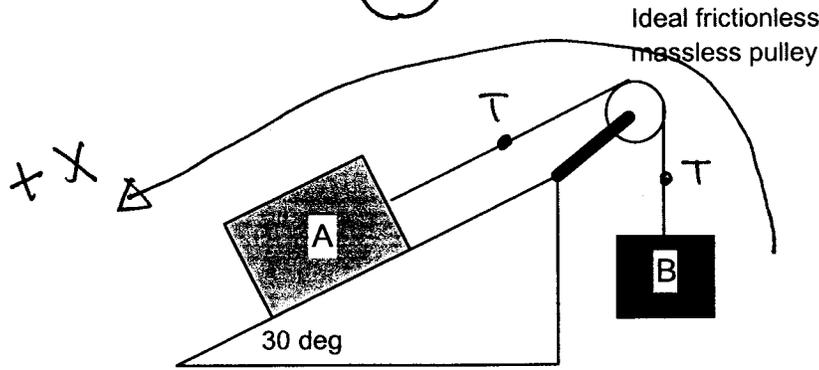
$$v_{0y} = 0$$

$$a_y = -9.8$$

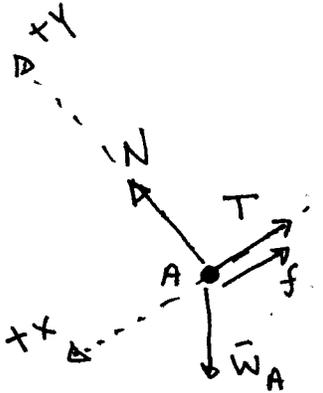
$$v_y(t) = -9.8(0.319) = -3.10 \text{ m/s}$$

$$\text{The speed is then} = \sqrt{(6.26)^2 + (-3.10)^2} = 6.99 \text{ m/s}$$

10. Two blocks are connected over a pulley as shown below. The mass of block A is 10 kg and the coefficient of friction on the incline is 0.20. Block A slides down the incline at constant speed. What is the mass of block B?



Two objects



$$m_A \vec{a} = \sum \vec{F}'s$$

$$m_A a_x = \sum F_x's$$

$$= m_A g \sin \theta - T - f$$

$$= m_A g \sin \theta - T - \mu N$$

$$m_A a_y = N - m_A g \cos \theta$$

$$N = m_A g \cos \theta$$

$$m_A a_x = m_A g \sin \theta - T - \mu m_A g \cos \theta$$

We are told constant speed  $a_x = 0$

$$0 = m_A g \sin \theta - T - \mu m_A g \cos \theta$$

$$0 = m_A g \sin \theta - m_B g - \mu m_A g \cos \theta$$

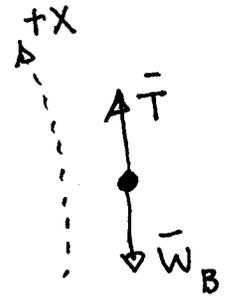
$$0 = T - m_B g$$

$$T = m_B g$$

$$m_B = m_A \left[ \sin \theta - \mu \cos \theta \right]$$

$$= 10 \left[ \sin 30^\circ - 0.2 \cos 30^\circ \right]$$

$$= 3.3 \text{ kg}$$



$$m_B a_x = \sum F_x's$$

$$m_B a_x = T - m_B g$$