SOLUTIONS

PHYSICS 111.01 PRACTICE MIDTERM 1

A. MULTIPLE-CHOICE QUESTIONS. **CIRCLE THE BEST ANSWER** (7 Pts. each):

1. Which of the following is **not** possible:

a) A body has zero velocity and non-zero acceleration
b) A body travels with a northward velocity and a northward acceleration
c) A body travels with a northward velocity and a southward acceleration
d) A body travels with a constant velocity and a time-varying acceleration
e) A body travels with a constant acceleration and a time-varying velocity

2. An airplane is flying relative to the air at 100 m/s in the direction East. The wind velocity relative to the ground is 30 m/s at an angle of 45° North of East. What is the speed of the plane relative to the ground?

a) 130 m/s
b) 123 m/s
c) 102 m/s
d) 78.8 m/s
e) 70 m/s

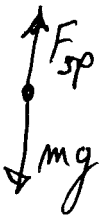
$$\vec{V}_{pG} = \vec{V}_{pa} + \vec{V}_{aG}$$

$$= (100\,m/s)\hat{x} + (30\,m/s)[\cos 45^\circ \hat{x} + \sin 45^\circ \hat{y}]$$

$$= 121\,m/s\,\hat{x} + 21\,m/s\,\hat{y}. \quad V = \sqrt{(121\,m/s)^2 + (21\,m/s)^2} = 123\,m/s$$

3. You place a mass of 10 kg on one end of a spring of original length 1.0 m whose other end is attached to the floor. The mass comes to rest 0.75 m above the floor. What is the spring constant?

a) 13 N/m
b) 40 N/m
c) 98 N/m
d) 130 N/m
e) 390 N/m
f) 980 M/m



$$F_{sp} = mg = kx$$

$$k = \frac{mg}{x} = \frac{(10\,kg)(9.8\,N/kg)}{0.25\,m} = 392\,N/m$$

4. The speed of an object in uniform circular motion in a circle of radius 5m is doubled, but the centripetal force on the object is not changed. Which value below best gives the new radius?

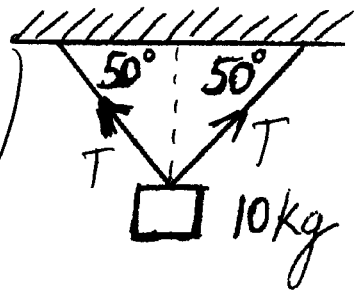
a) 20.0 m
b) 10.0 m
c) 5.00 m
d) 2.50 m
e) 1.25 m

$$\frac{m V_0^2}{r_0} = \frac{m(2V_0)^2}{r} \Rightarrow r = 4r_0$$

$$= 20\,m$$

5. A box of mass 10 kg is supported by two ropes which each make an angle of 50° with the ceiling, as shown. What is the tension in each of the ropes?

a) 49N
b) 64 N
c) 76 N
d) 98 N
e) 128 N
f) 152 N

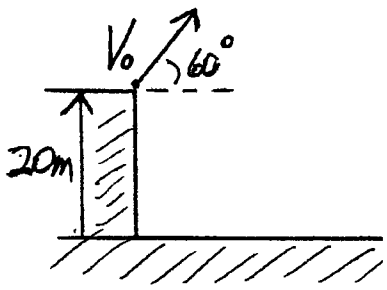


$$2T\sin 50^\circ = mg = (10\,kg)(9.8\,N/kg)$$

$$T = \frac{98\,N}{2\sin 50^\circ} = 64\,N$$

PROBLEMS. BE SURE TO **SHOW YOUR METHOD CLEARLY**. (6 points for each problem part.)

1. A ball is thrown from the top of a hill with a velocity of magnitude 6 m/s at an angle of 60° from horizontal. The hill is 20 m high. Neglect air resistance.



a) What is the acceleration of the ball when it reaches maximum height?

Free Fall $\rightarrow a = a_y = -g$

a = g downward, or $9.8\ m/s^2$ down (be sure to include direction)

b) What is the velocity of the ball when it reaches maximum height?

$V_x = V_{x0} = V_0 \cos 60^\circ = 3.0\ m/s$

$V_y = 0$

v = $(3.0\ m/s)\hat{x}$ or $V_x = 3\ m/s$, $V_y = 0$

c) How long does it take for the ball to reach maximum height?

At top, $V_y = 0 = V_{oy} + a_y t$ $\quad V_{oy} = V_0 \sin 60^\circ = 5.20\ m/s$

$0 = 5.2\ m/s - (9.8\ m/s^2)t$

t = 0.53 s

d) How long does it take for the ball to hit the ground?

Want $y = 0 = y_0 + V_{oy}t + \frac{1}{2}a_y t^2$

$0 = 20m + (5.2\ m/s)t + \frac{1}{2}(-9.8\ m/s^2)t^2$

$$t = \frac{-5.2\ m/s \pm \sqrt{(5.2\ m/s)^2 - 4(-4.9\ m/s^2)(20m)}}{2(-4.9\ m/s^2)}$$

t = 2.625 (or 2.65)

e) How far from the bottom of the hill is the ball when it hits the ground?

$$x = x_0 + v_0 t$$

$$= 0 + \left(3.0 \tfrac{m}{s}\right)(2.625) =$$

x = 7.86 m

f) What is the speed of the ball just as it hits the ground?

$$v_x = v_{0x} = 3.0 \text{ m/s}$$

$$v_y = v_{0y} + at = 5.2 \tfrac{m}{s} - \left(9.8 \tfrac{m}{s^2}\right)(2.6\,s)$$

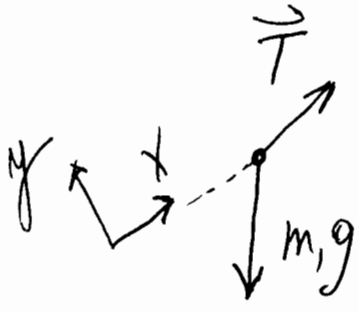
$$= -20.3 \tfrac{m}{s}$$

$$v = \sqrt{\left(3.0 \tfrac{m}{s}\right)^2 + \left(-20.3 \tfrac{m}{s}\right)^2}$$

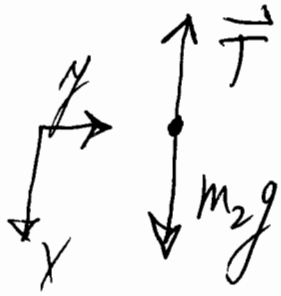
v = 20.5 m/s (or 21 m/s)

2. A mass m_1 of 7 kg on an inclined plane (no friction) of angle θ=60° is connected to a mass m_2 (unknown value) by a rope running over a pulley as shown in the diagram. It is found that the tension in the rope is 80N. Neglect the mass of the rope.

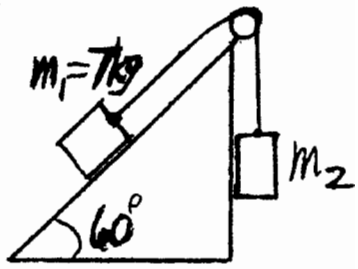
a) Draw a free body diagram for mass m_1 and for mass m_2.
Show all relevant forces.



FBD for m_1



FBD for m_2



b) What will be the magnitude of the acceleration of m_1?

$$\Sigma F_x = T - m_1 g \sin\theta = m_1 a_{1x}$$

$$a_{1x} = a_1 = \frac{T - m_1 g \sin 60^\circ}{m_1}$$

a= $2.94\ m/s^2$

c) What is the mass of m_2

$$\Sigma F_y = m_2 g - T = m_2 a_{2x} = m_2 a$$

$$m_2 = \frac{T}{g - a} = \frac{80N}{9.8\ m/s^2 - 2.9\ m/s^2}$$

m_2 = $11.6\ kg$

d) What is the normal force exerted by the plane on mass m_1?

$$\Sigma F_{y_1} = 0 = N - m_1 g \cos\theta$$

$$N = m_1 g \cos\theta = (7kg)(9.8\ N/kg)\cos 60^\circ$$

F_N = 34.3 N up ⊥ to plane

e) What would be the size of the force of friction on m_1 if the plane had friction coefficients $\mu_s = 0.4$ and $\mu_k = 0.3$?

$$F_k = \mu_k N = (0.3)(34.3N) =$$

F = 10.3N