Physics 201 MWF9:10 Fall 2009 (Ford)

Name (printed) Version 2

Name (signature as on ID) Key

Lab Section Number

Exam I Chapts. 1-5 in Young&Geller

The formula sheet is the last page of the exam. It can be torn off from the rest of the exam and doesn't have to be turned in.

Multiple Choice questions. Circle the correct answer. No work needs to be shown.

(6 pts) 1. A small rock is projected from ground level with a speed of 20.0 m/s at an angle of 53.0° above the horizontal. Air resistance can be neglected. When the rock is at its maximum height above the ground, its speed is

b

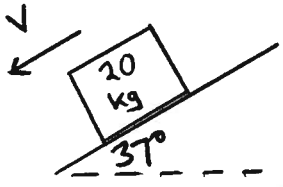
(a) zero
(b) 12.0 m/s
(c) 16.0 m/s
(d) 20.0 m/s
(e) none of the above

$V = V_{0x} = V_0 \cos\theta = (20\ m/s)\cos 53° = 12.0\ m/s$

(6 pts) 2. A ramp is inclined at 37° above the horizontal. A box with mass 20.0 kg is sliding down the ramp. The coefficient of kinetic friction between the box and the ramp is $\mu_k = 0.20$. The magnitude of the friction force that acts on the box is

c

(a) zero
(b) 23.6 N
(c) 31.3 N
(d) 39.2 N
(e) none of the above



$n = mg\cos\theta$

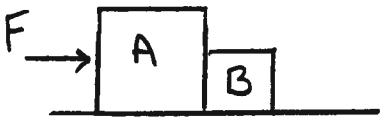
$n = (20kg)(9.8\ m/s^2)\cos 37°$

$n = 157N$

$f_k = \mu_k n = 31.3N$

(6 pts) 3. Box A with mass 20.0 kg and box B with mass 5.0 kg are in contact on a horizontal frictionless surface. A horizontal force $F = 50.0$ N is applied to box A. What force does box B apply to box A?

b
(a) zero
(b) 10 N
(c) 15 N
(d) 20 N
(e) 50 N
(f) 75 N
(g) 100 N
(h) none of the above



$\Sigma F_x = ma_x$

$50N = (25kg)a$

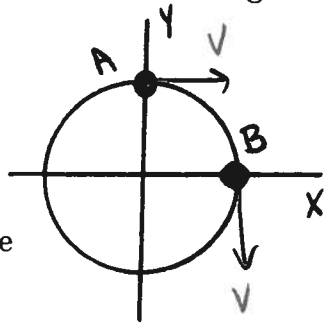
$a = 2 m/s^2$

For B, $F_A = (5kg)(2 m/s^2) = 10N$

B on A is 10 N

(6 pts) 4. A sprinter runs around a circular track with a constant speed of 5.0 m/s. It takes the sprinter 20.0 s to run from point A to point B. For the motion from A to B, what is the x-component of the average acceleration?

a
(a) -0.25 m/s^2
(b) $+0.25$ m/s^2
(c) -0.40 m/s^2
(d) $+0.40$ m/s^2
(e) zero
(f) none of the above

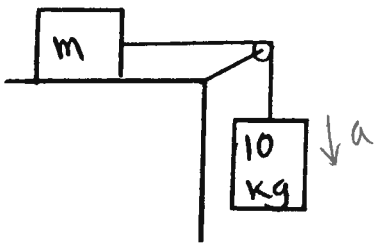


$a_{av-x} = \frac{\Delta v_x}{\Delta t} = \frac{0 - 5 m/s}{20 s}$

$a_{av-x} = -0.25 m/s^2$

(6 pts) 5. A block of mass m rests on a horizontal frictionless tabletop. The block is connected by a light rope that passes over a light frictionless pulley to a block of mass 10.0 kg that hangs suspended from the end of the rope. When the system is released, the 10.0 kg block moves downward with an acceleration of 2.0 m/s^2. What is the mass m of the block on the table?

e
(a) zero
(b) 98.0 kg
(c) 5.0 kg
(d) 20.0 kg
(e) 39.0 kg
(f) none of the above



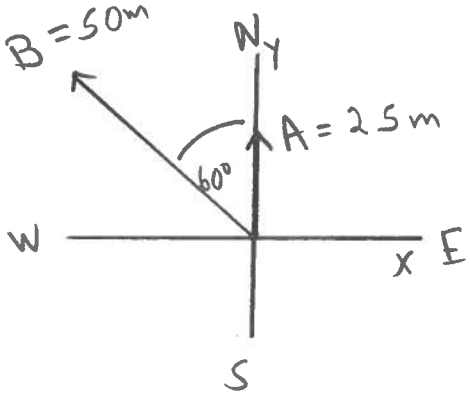
$(10kg)(9.8 m/s^2) = (10kg + m)(2 m/s^2)$

$98N = 20N + m(2 m/s^2)$

$m = 39 kg$

On the following four problems show all your work. Partial credit will be given if earned. Write your answers in the blanks provided.

(16 pts) 6. You are standing next to a tall cactus in the Nevada desert. You walk 25.0 m due north and then 50.0 m in a direction 60.0° west of north. What are the magnitude and direction of the third displacement that will return you to the cactus?



Ans. magnitude 66.1 m

direction 49.1° south of east
(40.9° east of south)

$\vec{A}+\vec{B}+\vec{C}=0$

$A_x+B_x+C_x=0$

$A_x=0,\ B_x=-B\sin 60°=-(50m)\sin 60°=-43.3m$

$C_x=-(A_x+B_x)=43.3m$

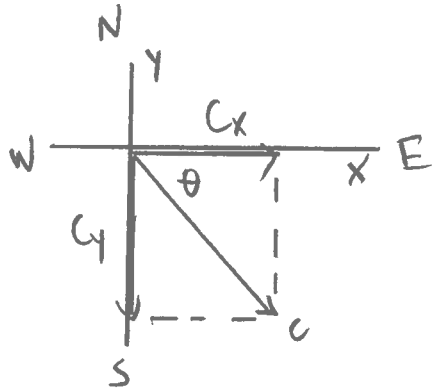
$A_y+B_y+C_y=0$

$C_y=-(A_y+B_y)$

$A_y=25m,\ B_y=B\cos 60°=(50m)\cos 60°=25m$

$C_y=-(25m+25m)=-50m$

$C=\sqrt{C_x^2+C_y^2}=\sqrt{(43.3m)^2+(-50m)^2}=66.1m$



$\tan\theta=\frac{50\ m}{43.3\ m}$ so $\theta=49.1°$ south of east

(40.9° east of south)

(18 pts) 7. A small rock is thrown straight up with a speed of 16.0 m/s from the roof of a building. The roof is 16.0 m above the ground. The rock misses the roof on the way down and falls to the ground. Air resistance can be neglected.

(a) What is the maximum height above the roof that is reached by the rock during its motion?

$v_y = 0$

$+y$ ↑ → $+x$ $v_{0y} = 16\ m/s$

$a_y = -9.8\ m/s^2$

$y - y_0 = ?$

Ans. 13.1 m

$$v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$$

$$y - y_0 = \frac{v_y^2 - v_{0y}^2}{2a_y} = \frac{0 - (16\ m/s)^2}{2(-9.8\ m/s^2)} = 13.1\ m$$

b) What is the speed of the rock just before it hits the ground?

$v_y = ?$

$v_{0y} = +16\ m/s$

$a_y = -98\ m/s^2$

$y - y_0 = -16\ m$

Ans. 23.9 m/s

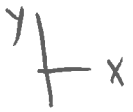
$$v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$$

$$v_y = -\sqrt{(16\ m/s)^2 + 2(-9.8\ m/s^2)(-16\ m)}$$

$$v_y = 23.9\ m/s$$

(18 pts) 8. A small rock is suspended from the roof of an express elevator by a light rope. Starting from rest, the elevator moves upward a distance of 24.0 m in 4.0 s. While the elevator is moving, the tension in the rope is 36.0 N. What is the mass of the rock?

Ans. 2.81 kg



$v_{0y} = 0$

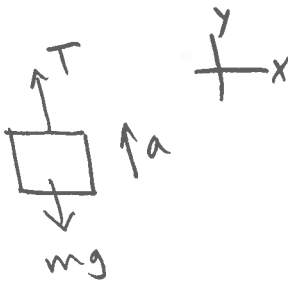
$y - y_0 = 24\,m$

$t = 4\,s$

$a_y = ?$

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

$a_y = \frac{2(y-y_0)}{t^2} = \frac{2(24\,m)}{(4\,s)^2} = 3.0\,m/s^2$



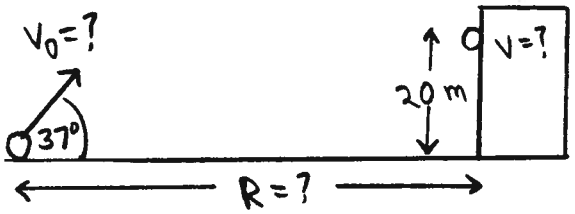
$\Sigma F_y = ma_y$

$T - mg = ma$

$T = m(a+g)$

$m = \frac{T}{a+g} = \frac{36\,N}{3\,m/s^2 + 9.8\,m/s^2} = 2.81\,kg$

(18 pts) 9. A small rock is projected from ground level toward a tall building. The initial velocity of the rock has magnitude v_0 and is directed at an angle of 37.0° above the horizontal. The rock strikes the building at a vertical height of 20.0 m in a time of 4.0 s after it leaves the ground. Air resistance can be neglected.



(a) What is v_0, the magnitude of the initial velocity of the rock?

$V_{0y} = V_0 \sin 37°$

$t = 4\,s$

$y - y_0 = 20\,m$

$a_y = -9.8\,m/s^2$

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

$V_{0y} = \frac{y - y_0}{t} - \frac{1}{2} a_y t$

$V_{0y} = \frac{20\,m}{4\,s} - \frac{1}{2}(-9.8\,m/s^2)(4\,s)$

$V_{0y} = 5\,m/s + 19.6\,m/s = 24.6\,m/s$

$V_0 = \frac{V_{0y}}{\sin 37°} = 40.9\,m/s$

Ans. 40.9 m/s

(b) What is the horizontal distance R from the initial position of the rock to the base of the building?

$x - x_0 = ?$

$V_{0x} = V_0 \cos 37° = 32.7\,m/s$

$t = 4\,s$

$a_x = 0$

$x - x_0 = V_{0x} t + \frac{1}{2} a_x t^2$

$x - x_0 = (32.7\,m/s)(4\,s) = 131\,m$

Ans. 131 m

(c) What is the magnitude of the velocity of the rock just before it strikes the building?

$V_x = V_{0x} = 32.7\,m/s$

$V_y = V_{0y} + a_y t = 24.6\,m/s + (-9.8\,m/s^2)(4\,s) = -14.6\,m/s$

$V = \sqrt{V_x^2 + V_y^2} = \sqrt{(32.7\,m/s)^2 + (-14.6\,m/s)^2} = 35.8\,m/s$

Ans. 35.8 m/s