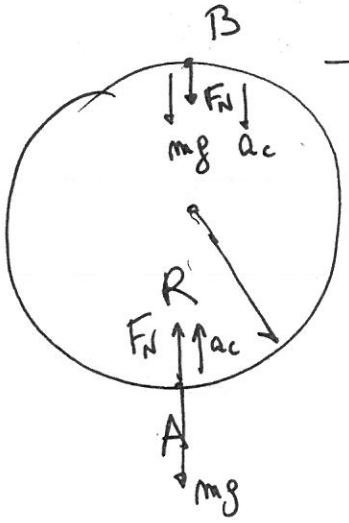
TEST # 2. PHYS 203. Chapters 5-7. FALL 2002. October 22, 2002

NAME:

Problem 1. Dynamics of Uniform Circular Motion (20 points).

A small remote-control car with a mass of 1.20 kg moves at a constant speed of v=12.0 m/s in a vertical circle inside a hollow metal cylinder that has radius of 5.00 m (see figure). What is the magnitude of the normal force exerted on the car by the walls of the cylinder at (a) point A (at the bottom of the circle)? (b) point B (at the top of the circle)?



(B) $\longrightarrow$ $-F_N - mg = -ma_c$

(A) $\longrightarrow$ $F_N - mg = ma_c$

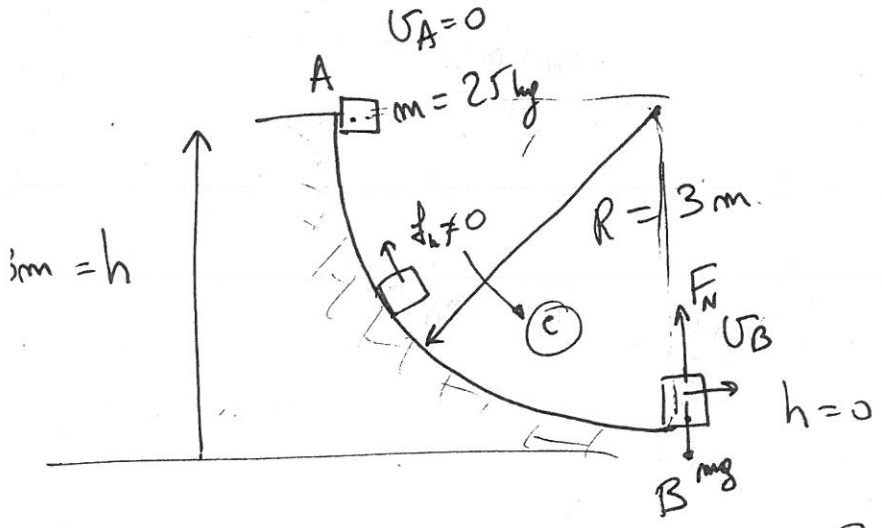
$$a_c = \frac{v^2}{R} = \frac{(12\,m/s)^2}{5\,m}$$

Problem 2. Work, Energy and circular motion (30 points) A package is thrown down a curved ramp as shown in the figure. The package moves from A to B through a quarter-circle with radius R=3.00 m. The mass of the package is 25.0 kg. The package starts from rest at point A and there is no friction.

(a) Find the speed of the package at the bottom of the ramp (point B).

(b) Find the normal force that acts on the package at point B (Hint: Notice that here the Work-energy theorem may not be useful).

(c) Consider now that the ramp is not frictionless and that the speed of the package at the bottom is 6.00 m/s. What work was done by the friction force acting on the package?



(a) $\overbrace{\text{A}}$ $\overbrace{\text{B}}$

$\cancel{mg} \times 3m = \frac{1}{2}\cancel{m} v_B^2$

$v_B = \sqrt{3m \times 9.8\,m/s^2 \times 2}$

$W_{NC} = 0$

(b) $F_N - mg = m\,a_c \longleftarrow a_c = \frac{v_B^2}{3m}$

(c) $\rightarrow v_B = 6\,m/s$

$W_{NC} = \Delta E$

$= \frac{1}{2} m \times (6\,m/s)^2 - mg\,3m$

(m: 25 kg; mg: 25 kg)

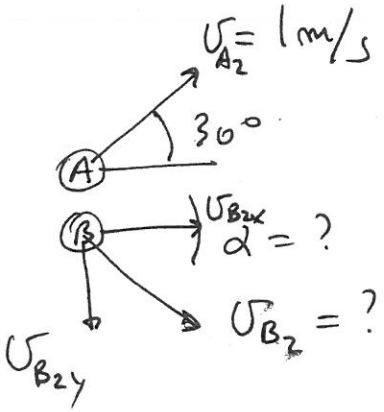
Problem 3. Linear Momentum. Collision in a horizontal plane. (30 points)

Two chunks of ice are sliding on a frictionless frozen pond. Chunk A, with mass $m_A = 5.0$ kg, moves with initial velocity $v_{A1} = 2.0$ m/s parallel to the x-axis. It collides with chunk B, which has mass m_B=3.0 kg and is initially at rest. After the collision, the velocity of chunk A is found to be $v_{A2} = 1.0$ m/s in a direction making an angle $\alpha = 30^o$ with the initial direction. What is the final velocity of chunk B?

in-class example of 2 people ice skating

$v_B = 0$

before coll. $v_{A_1} = 2$ m/s



2 pln

find (α, v_{B_2})

or $(v_{B_{2x}}, v_{B_{2y}})$

get ↑

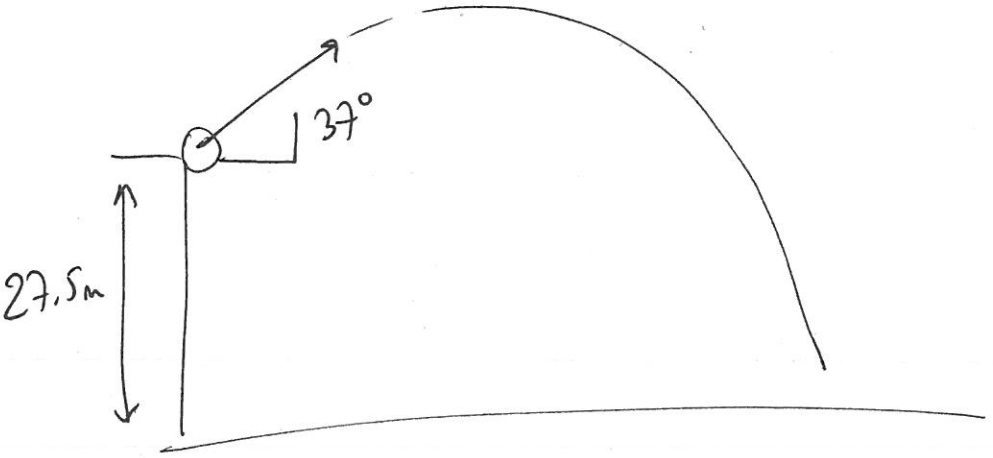
$\hat{x}$: $2\,m/s \cdot 5\,kg + 0 = 1\,m/s \times 5\,kg \times \cos 30° + 3\,kg \times v_{B_2}$

$\hat{y}$: $0 = \underbrace{5\,kg \times 1\,\frac{m}{s} \times \sin 30°}_{A} - \underbrace{3\,kg \times v_{B_{2y}}}_{B}$

Problem 4. Energy conservation (20 points)

A baseball is thrown from the roof of a 27.5 m tall building with an initial velocity of magnitude 16.0 m/s and directed at an angle of 37° above the horizontal.

a) Using energy methods and ignoring air resistance, calculate the speed of the ball just before it strikes the ground.

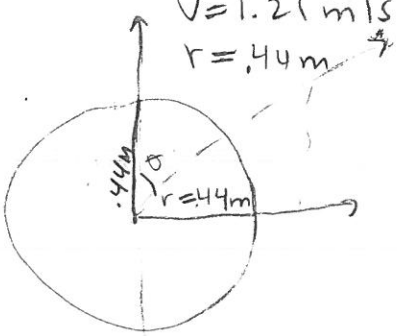


- Review equations chap 5
- review equations chap 6
- review equations chap 7
- Chapter 5: 5, 7, 8
- Chapter 6: 3, 4, 5, 7, 8, 16
- Chapter 7: 6, 8, 9

QUIZ # 4. PHYS 203. Chapter 5. Circular motion

NAME:

* A 0.075 kg toy airplane is tied to the ceiling with a string. When the toy motor is started it moves with a constant velocity of 1.21m/s in a horizontal circle of radius 0.44m. Find the angle the string makes with the vertical and the tension in the string.



$m = .075\,kg$

$V = 1.21\,m/s$

$r = .44\,m$

$V = \frac{2\pi r}{T}$

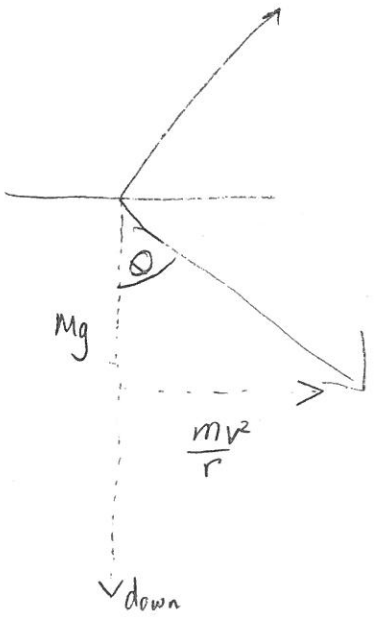
SohCahToa

$T = \frac{2\pi r}{V}$

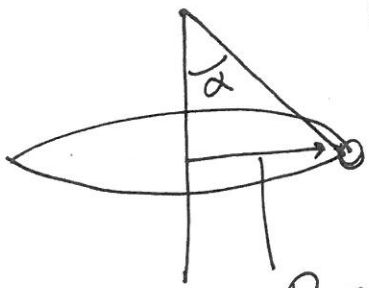
$T = \frac{2(3.14)(.44)}{1.21\,m/s} = 2.28\,N$

$\cos\theta = \frac{.44}{2.28} = .192$

$\theta = 78.9^\circ$



Find α



$R = 0.44\,m$

QUIZ # 5. Chapter 6. Energy and Work. PHYS 203.

NAME:

Consider a track that is one quarter of a circle with radius 1.60 m plus a level surface.

A small 0.200 Kg package is release from rest at point A and slides down the circular track until it reaches point B at the end of the circular track with speed of 4.20 m/s. From point B it slides on a level surface a distance of 3.00 m to point C, where it comes to rest. Consider that there is friction between the package and the track.

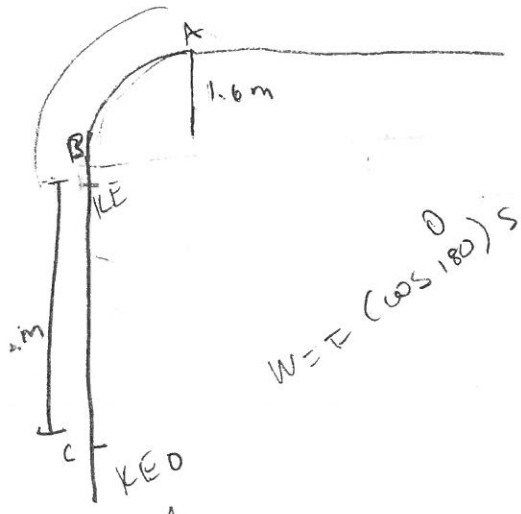
(a) Using energy considerations, calculate the coefficient of kinetic friction on the horizontal surface.

(b) How much work is done on the package by friction as it slides down the circular arc from A to B?

(c) Identify the forces acting on the package when it is on the horizontal surface. Calculate the work done by each of these forces when the package goes from B to C.

(d) Identify the forces acting on the package from A to B and determine which forces are conservatives and which are non conservative. Explain.

PE - KE



$W = F(\cos 180^0)s$

(a) $m = .2$ kg

$v = 4.2$ m/s

$r = 1.6$ m

$a_c = \frac{v^2}{r} = \frac{(4.2)^2}{1.6} = 11.025$

$v_2^2 = v_1^2 + 2ad =$

$-17.64 = 2(a)(d)$

$a = \frac{-17.64}{6}$

$a = -2.94$

$F_F = \mu F_N$

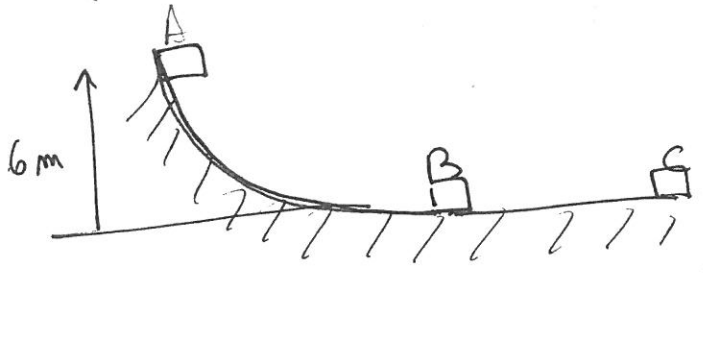
$F_c = \frac{mv^2}{r} = \frac{(.2)(4.2)^2}{1.6\,m} = 2.205$ N

$F_N = mg = (.2)(9.8\,m/s^2) = 1.96$ N

$F_F = ma = (.2)(2.94) = .588$

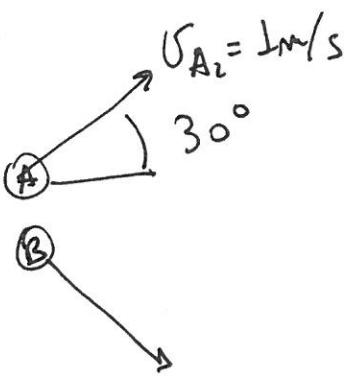
$F_F = \mu F_N$

$\mu = \frac{F_F}{F_N} = \frac{.588}{1.96} = .3$



before

after

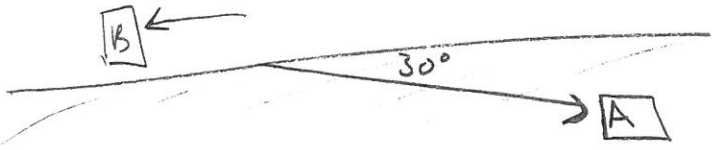


QUIZ # 6. Chapter 7. Linear Momentum PHYS 203

NAME:

Two chunks of ice are sliding on a frictionless frozen pond. Chunk A, with mass $m_A = 5.0$ kg, moves with initial velocity $v_{A1} = 2.0$ m/s parallel to the x-axis. It collides with chunk B, which has mass m_B=3.0 kg and is initially at rest. After the collision, the velocity of chunk A is found to be v_{A2} = 1.0 m/s in a direction making an angle $\alpha = 30°$ with the initial direction. What is the final velocity of chunk B?

A	B
$m = 5$ kg	$m = 3$ kg
$V_0 = 2.0$ m/s	$V_0 = 0$ m/s



A	B
$V_f = 1.00$ m/s	$V_{Bf} = ?$

$V_{B_{2x}} = V_{B_2} \cos\alpha$

$m_1 V_{f1} + m_2 V_{f2} = m_1 V_{01} + m_2 V_{02}$

$(5\text{kg})(1\text{m/s}) + (3\text{kg})(V_{f2}) = (5\text{kg})(2\text{m/s}) + (3\text{kg})(0\text{m/s})$ initial

$5 + 3V_{f2} = 10$

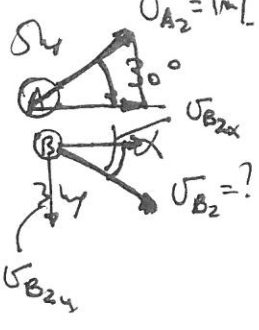
$-5 \quad -5$

$\frac{3V_{f2}}{3} = \frac{5}{3}$

$V_{f2} = 1.67$ m/s

$V_{A_1} = 2$ m/s

$V_{B_1} = 0$



x: $5\text{kg} \times 2\text{m/s} + 0 = 5\text{kg} \times 1\text{m/s} \times \cos 30° + 3\text{kg} \times V_{B_{2x}}$

y:

TEST # 2. PHYS 203. Chapters 5, 6, 7. FALL 2005. 11/02/05

NAME:

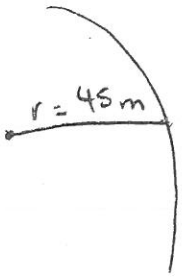
√

Problem 1. (20 points)

A 1200 Kg car rounds a corner of radius $r = 45$ m. If the coefficient of static friction between the tires and the road is $\mu_s = 0.82$, what is the greatest speed the car can have in the corner without skidding?

$m = 1200\ kg$

$\mu_s = .82$



$F_F = \mu F_N$ (max frictional force)

$F_F = F_c$

$F_c = \frac{mv^2}{r}$

$\mu F_N = \frac{mv^2}{r}$

$F_N = mg = (1200\ kg)(9.8\ m/s^2) = 11760\ N$

$(.82)(11760\ N) = \frac{(1200\ kg)v^2}{(45\ m)}$

$\frac{433944}{1200} = v^2$

$361.62 = v^2$

$v = 19.01\ m/s$

$.10\ cm \cdot \frac{1\ m}{100\ cm} = .1\ m$

100 cm = 1 m
1000 mm = 1 m

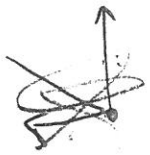
$F_F = .640 \cdot 14.7\ N = 9.4$

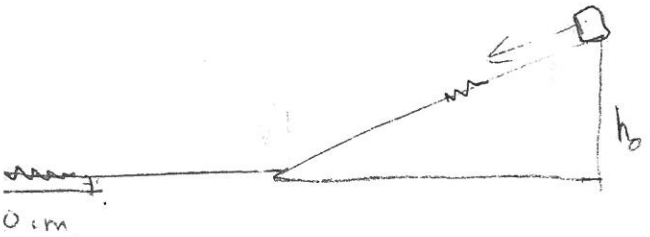
$W = (.1)(9.4) = .94$

$F_N = 14.7\ N$

Problem 2. (40 points)

The figure shows a 1.50-kg block at rest on a ramp of height h. When the block is released, it reaches the bottom of the ramp and moves across a surface that is frictionless except for one section of width 10.0 cm that has a coefficient of kinetic friction $\mu_k = 0.640$. Find h such that the block's speed after crossing the rough patch is 3.50 m/s.





$\mu_K = .640$

$h_0 = ?$ $\quad v_0 = 0\ m/s$

$h_f = 0$ $\quad v_f = 3.5\ m/s$

$\frac{1}{2} m v_f^2 + m g h_f = \frac{1}{2} m v_0^2 + m g h_0$

$\frac{1}{2}(1.5)(3.5)^2 + (1.5)(9.8)(0) = 0 + (1.5)(9.8)(h_0)$

$2.625 = 14.7(h_0)$

$KE = \frac{1}{2} m v^2$

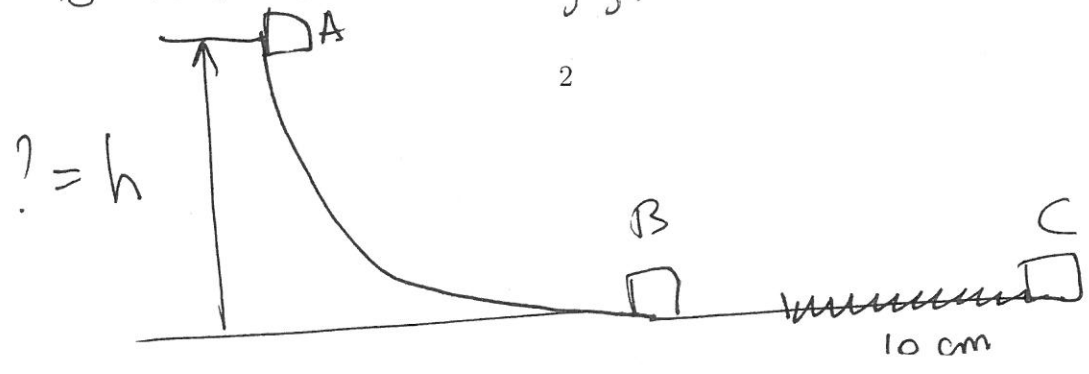
$PE = mgh$

$(\text{Work done (friction)}) + KE_F + PE_F = KE_0 + PE_0$

$.94 + 2.625 = 14.7\ h_0$

$h_0 = .114\ m = 11.4\ cm$

- the initial energy must be equal to the final energy + whatever energy (work) lost (which is added to the final energy.



Problem 3. 40 points

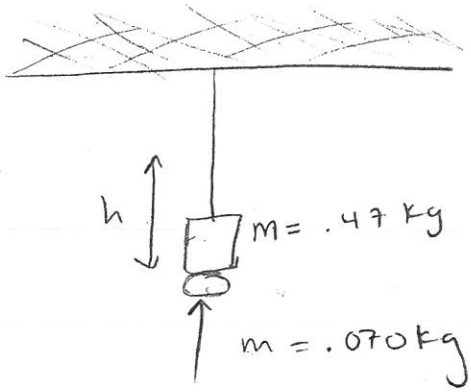
A 0.47 kg block of wood hangs from the ceiling by a string, and a 0.070-kg wad of putty is thrown straight upward, striking the bottom of the block with a speed of 5.60 m/s. The wad of putty sticks to the block.

(a) How high does the putty-block system rise above the original position of the block.

(b) Is the kinetic energy of the system conserved during the collision? no (lost energy)

(c) Is the mechanical energy of this system conserved during the collision?

(d) Is the mechanical energy of this system conserved after the collision?



$F_{block} = mg = (.47\,kg)(9.8\,m/s^2) = 4.6\,N$

$F_{putty} = mg = (.07\,kg)(9.8\,m/s^2) = .686\,N$

(B) $KE = \frac{1}{2}mv^2$

$= 1.0976\,J$

$KE_{system} = \frac{1}{2}mv^2 = .1438$

$P = mv$

(total = block + putty)

$P_i = P_F$ (total = block + putty)

$.07\,kg\,(5.6\,m/s) = (.47\,kg + .07\,kg)V$

$V = .73\,m/s$ → initial velocity of the system

$V_{0\,putty}$ = given

$V_{0\,system} = .73$

$V_F = 0 \quad V_i = .73\,m/s \quad g = 9.8\,m/s^2$

$V_F^2 = V_i^2 + 2gd$

$0 = (.73\,m/s)^2 + 2(9.8\,m/s^2)d$

- Collision
- rollercoaster

TEST # 2. PHYS 203. Chapters 5-7. FALL 2002. October 22, 2002

NAME:

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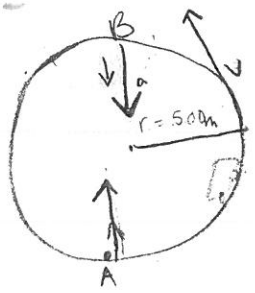
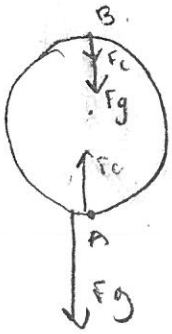


$F_g = 11.76\ N$ $\quad v = 12\ m/s$ $\quad m = 1.2\ kg$



$$F_c = \frac{mv^2}{r} = \frac{(1.2)(12.0\ m/s)^2}{5.00\ m} = 34.56$$

A

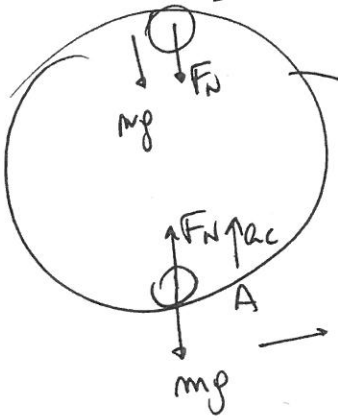
$$F_n = F_c + F_g = 34.56\ N + 11.76\ N = 46.32\ N$$

$F_F = \mu F_n$

B

$$F_n = F_c - F_g = 34.56\ N - 11.76\ N = 22.8\ N$$

F_g



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$$m_1 V_{f_1} + m_2 V_{f_2} = m_1 V_{0_1} + m_2 V_{0_2}$$

$m_A = 5.0\,kg$ $\quad m_B = 3.0\,kg$

$V_{0A} = 2.0\,m/s$ $\quad V_{0B} = 0\,m/s$

$V_{fA} = 1.0\,m/s$ $\quad V_{fB} = ?$

Before collision

After collision

$$(5.0\,kg)(1.0\,m/s) + (3.0\,kg)(V_{f_2}) = (5.0\,kg)(2.0\,m/s) + (3.0\,kg)(0\,m/s)$$

$\cos 30°$

$$5 + 3V_{f_2} = 10$$

$$3V_{f_2} = 5$$

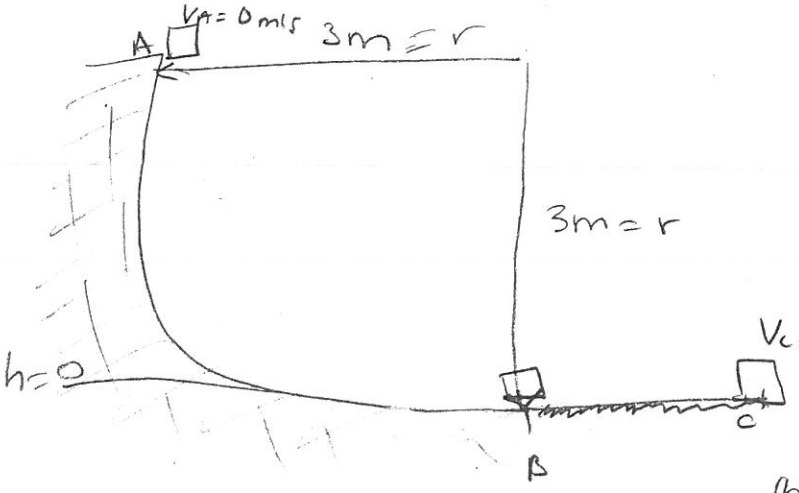
$$V_{f_2} = \frac{5}{3} = 1.67\,m/s$$

Problem 2. Work, Energy and circular motion (30 points) A package is thrown down a curved ramp as shown in the figure. The package moves from A to B through a quarter-circle with radius R=3.00 m. The mass of the package is 25.0 kg. The package starts from rest at point A and there is no friction.

(a) Find the speed of the package at the bottom of the ramp (point B).

(b) Find the normal force that acts on the package at point B (Hint: Notice that here the Work-energy theorem may not be useful).

(c) Consider now that the ramp is not frictionless and that the speed of the package at the bottom is 6.00 m/s. What work was done by the friction force acting on the package?



B → C
friction
m = 25 kg
$V_A = 0$ m/s

(a)

$h_A = 3m$ $\quad h_B = 0$

$V_A = 0$ $\quad V_B = ?$

$E_A = E_B$

$mg(3m) = mV_B^2$

$2g(3m) = V_B^2$

$V_B = \sqrt{2g(3m)} = 58.8 m/s$

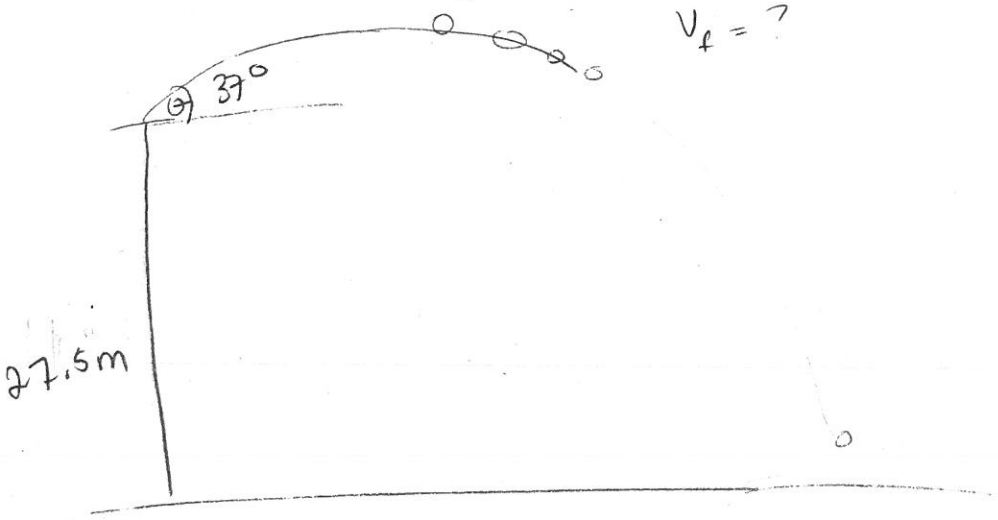
(b) $W_{B \to C}$

$W_{nc} = F_f - E_0$

Problem 4. Energy conservation (20 points)

A baseball is thrown from the roof of a 27.5 m tall building with an initial velocity of magnitude 16.0 m/s and directed at an angle of 37° above the horizontal.

a) Using energy methods and ignoring air resistance, calculate the speed of the ball just before it strikes the ground.



$V_0 = 16 m/s$

distance $= 27.5 m$

$\frac{1}{2} m v_f^2 + mgh_f = \frac{1}{2} m v_0^2 + mgh_0$

$\frac{1}{2} v_f^2 = gh_0$

$\frac{1}{2} v_f^2 = (9.8 m/s^2)(27.5 m)$

$v_f^2 = (2)(9.8 m/s^2)(27.5 m)$

$v_f = \sqrt{(2)(9.8 m/s^2)(27.5 m)}$

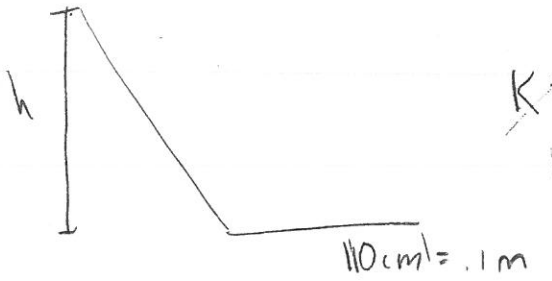
$V_f = 23.216$

2. Energy conservation and dissipation.

A 1.50-kg block is at rest on a ramp of height h. When the block is released (with zero initial velocity), it reaches the bottom of the ramp and moves across a horizontal flat surface that is frictionless except for one section of width 10.0 cm that has a coefficient of kinetic friction $\mu_k = 0.640$. Find h such that the block's speed after crossing the rough patch is 3.50 m/s.

$W = KE_f - KE = \frac{1}{2} m V_f^2 - \frac{1}{2} m v_0^2$

$\frac{1}{2} m V_f^2 + mgh_f = \frac{1}{2} m v_0^2 + mgh_0$



$KE_0 + PE_0 = KE_f + PE_f +$ work of friction

$mgh_0 = \frac{1}{2} m v_f^2 +$ work (energy)

$10(cm) = 1m$

$W = FS = (9.408)(.1) = .9408$

$F_f = \mu F_N = (.640)(14.7) = 9.408$

$F_N = ma = (1.50)(9.8) = 14.7$

$(1.50)(9.8)(h) = \frac{1}{2}(1.50)(3.50)^2 + .94$

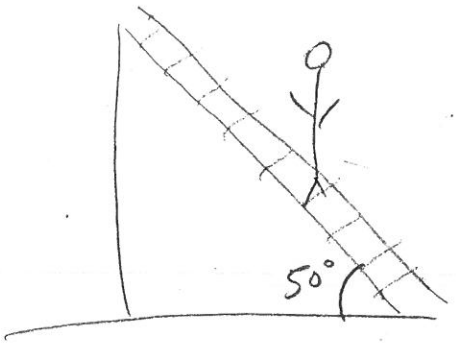
$14.7h = 10.1283$

$\boxed{h = .689\ m}$

??

3. Rigid objects in equilibrium.

An 85-kg person stands in the middle of a lightweight ladder (zero weight). The floor is rough; hence it exerts both a normal force, f_1, and a frictional force, f_2, on the ladder. The wall, on the other hand, is frictionless; it exerts only a normal force, f_3. The length of the ladder is 8 m and the ladder makes an angle of 50^0 with the floor. Find the magnitude of the forces.



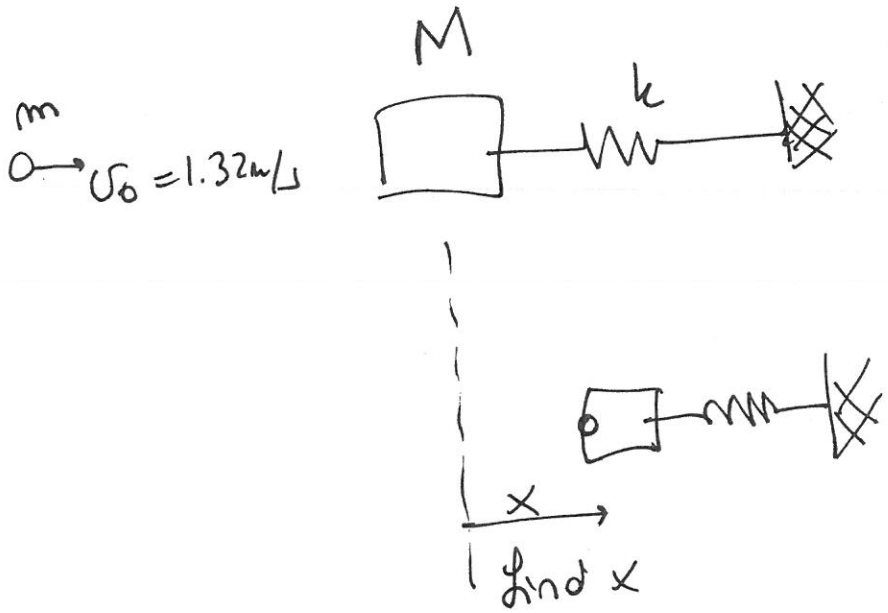
$f_1 = F_N$

$f_2 = F_F$

$f_3 = F_{N\,wall}$

4. Conservation of momentum and energy conservation

A bullet of mass $m = 0.5$ kg embeds itself in a block of mass $M = 1.2$ kg, which is attached to a spring of force constant $k = 245$ N/m. If the initial speed of the bullet is $v_0 = 1.32$ m/s, find the maximum compression of the spring. The spring moves horizontally.

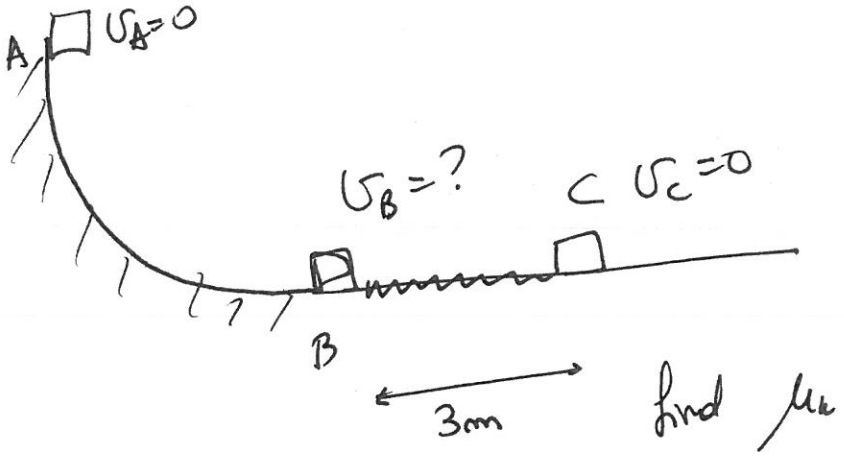


3. Energy conservation and dissipation.

In the track shown in the figure, section AB is a quadrant of a circle of 1m radius. A block is released at A and slides without friction until it reaches B

(a) How fast is it moving at B?

(b) The horizontal part has friction. If the block comes to rest 3m from B, what is the friction coefficient?

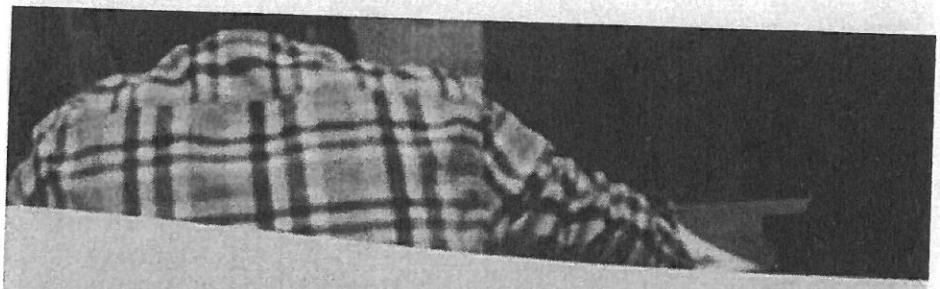


4. Rigid objects in equilibrium.

A uniform 400 N boom is supported as shown in the figure. Find the tension in the tie rope and the force exerted on the bottom by the pin at P.

2.)NEWTON'S EQUATION: 20 POINTS) TEST #1

In the figure of an object m1=20kg moves on a surface with friction coefficient of 0.5. its connected to a mass m2=5kg by a massless cord that passes over a frictionless pulley. Find that acceleration of each body and the tension in the cord.



TEST #1

2. Kinematic in 2D

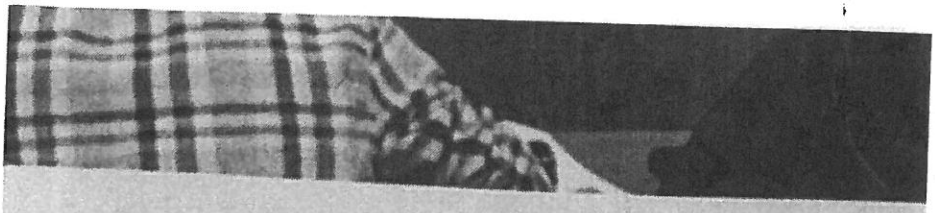
A golf ball is hit off with an initial velocity of 50 m/s at an angle of 35° to the horizontal.

(a) (11 points) What is the maximum height reached by the ball?

(b) (11 points) What is the range?

(c) (6 points) What is the magnitude and direction of the acceleration and velocity at the maximum height?

(d) (6 points) What is the time of flight, that is, the time to reach the ground again?



3. Forces

Two blocks are connected by a string, as shown in the figure. The smooth (frictionless) inclined surface makes an angle of 35° with the horizontal, and the block in teh incline has a mass $m_1 = 5.7$ kg. The mass of the hanging block is $m_2 = 3.2$kg.

(a) (18 points) Find the direction and magnitude of the hanging block's acceleration.

(b) (14 points) Find the tension in the rope.

TEST # 1. PHYS 203. SPRING 2012.

NAME. TEST #1

1. Kinematic in 1D

You throw a ball straight up. The ball has an initial speed of 11.2 m/s when it leaves your hand.

(a) (11 points) What is the maximum height the ball reaches relative to the throwing point.

(b) (11 points) How long does it take the ball to reach this height?

(c) (6 points) What is the position of the ball at $t = 2s$?

(d) (6 points) At what height does the ball have a speed of +5m/s?

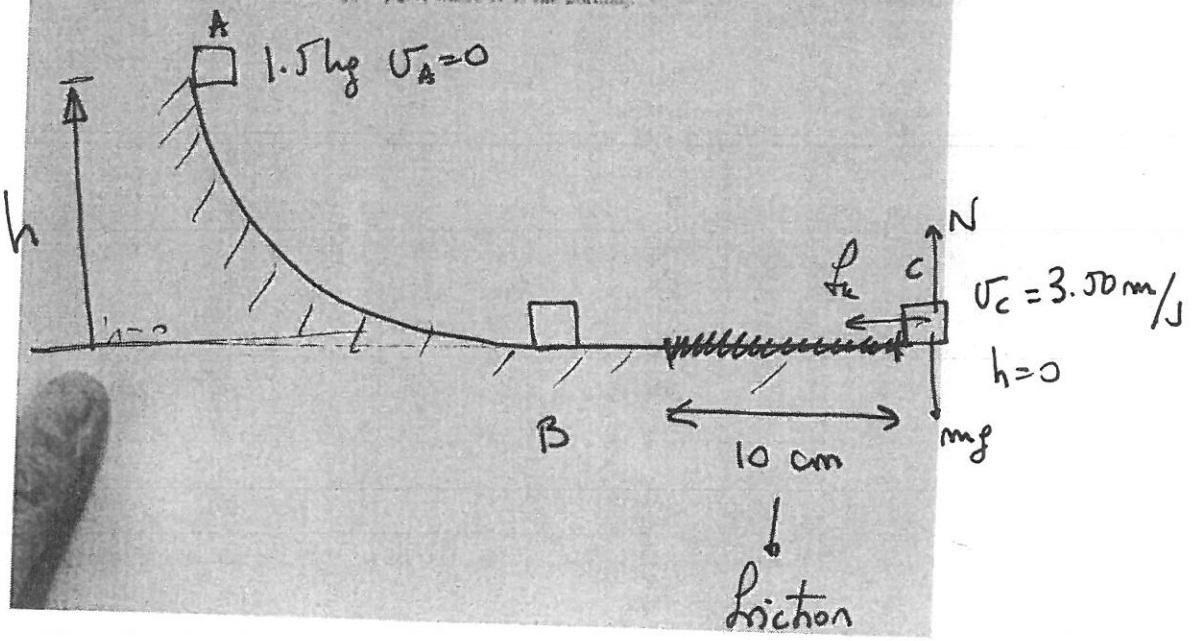
TEST # 2. PHYS 203. SPRING 2012.

TEST #2

NAME:

1. Energy. 35 points.

The figure shows a 1.50-kg block at rest on a ramp of height h. When the block is released, it reaches the bottom of the ramp and moves across a surface that is frictionless except for one section of width 10 cm that has a coefficient of kinetic friction $\mu_k = 0.64$. Find h such that the block's speed after crossing the rough patch is 3.50 m/s. [Remember that the force of friction is $f_k = \mu_k N$, where N is the normal].



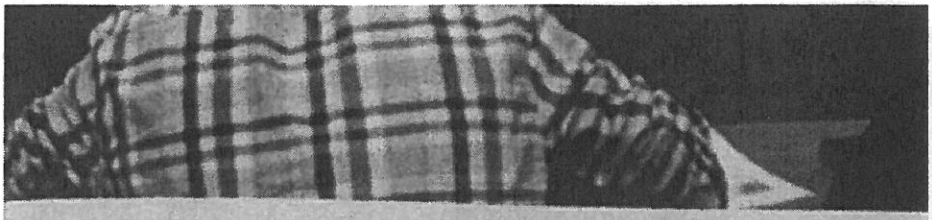
$\mu_k = 0.64$

$W_{NC} = \underline{\Delta E}$

$W_{NC} = E_f - E_0$

$\underline{-\mu_k mg \cdot 0.1m} = \frac{1}{2} m \left(3.5 m/s\right)^2 - mg \cdot h$

get h.



TEST #2

2. Momentum. 35 points.

The picture shows a collision between two pucks. Puck *A* has a mass of 0.025 Kg and is moving along the *x* axis with a velocity of 5 m/s. It makes a collision with puck *B*, which has a mass of 0.05kg and is initially at rest. The collision is not head-on. After the collision, the two pucks fly apart with angles shown in the figure. Find the final speed of puck A and B.

before

$v_A = 5\,m/s$

$v_B = 0$

A

B

after

$v_A = ?$

α

A

B

30°

$v_B = 1\,m/s$

TEST #3

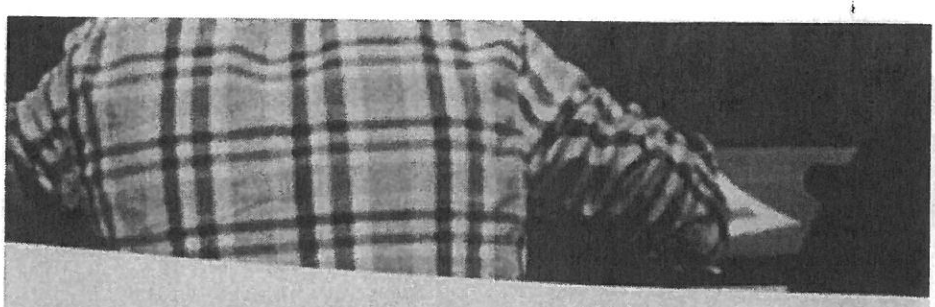
TEST # 3. PHYS 203. Spring 2012

NAME:

1. Springs. (35 points)

A block with mass 5.0 kg is suspended from an ideal spring having negligible mass and stretches the spring 0.20 m to its equilibrium position

(a) (5 points) What is the force constant of the spring ? **(b) (30 points)** The spring is then stretched 0.80 m from its equilibrium position and then released with velocity zero. Calculate the velocity of the mass when the mass passes again through the equilibrium position.



3. Rigid objects in equilibrium. 30 points.

A 5m long diving board of negligible mass is supported by two pillars. One pillar is at the end left of the diving board, the other is 1.50 m away. Find the forces exerted by the pillars when a 90 kg diver stands at the far end of the board.

TEST #2

3. Energy (20 points)

Consider the track plus a level surface as shown in the figure.

A 4 kg package is release from rest at point A and slides down on a frictionless track until it reaches point B with speed of 4.20 m/s. From point B it slides on a level surface with friction coefficient μ_k a distance of 3.00 m to point C, where it comes to rest. (a) (10 points) Calculate the height H. (b) (10 points) Calculate the coefficient of kinetic friction on the horizontal surface.

FINAL. PHYS 203. Spring 2012

NAME:

SEAT NUMBER: TEST #1

1. Kinematics (20 points)

A batter hits a baseball so that it leaves the bat with an initial speed $v_0 = 40.0\,m/s$ at an initial angle $\theta = 42°$ with the horizontal.

Find:

(a) The position of the ball and the magnitude and direction of its velocity at $t=2\,s$. (5 points)

(b) Find the time when the ball reaches the highest point of its flight. (5 points)

(c) Find the height H and the acceleration at this point. (5 points)

(d) Find the horizontal range R. (5 points)