Department of Physics

PHY1331A
I MIDTERM TEST
October 3, 2012
Duration: 100 min

uOttawa
L'Université canadienne
Canada's university

Student ID _____

verB

STUDENT'S NAME: _____

PART I Multiple choice. (48% of the test grade). Enter all your answers in the scantron sheet.

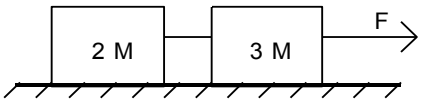
1. Two balls are thrown from a height of 20 m. Ball one is thrown upward with a speed of $2\ m/s$. Ball two is thrown downward with a speed of $2\ m/s$. What is the ratio of the speed of ball one with the speed of ball two when each hits the ground?
a. 1:2 b. 1:1 c. 2:1 d. 20:1 e. 1:20
ANS: b

2. A car is moving with a speed of $3.2\ m/s$ when brakes are applied. If the car stops after it has moved 1.8 m, what was its average acceleration in m/s^2?
a. –2.7 b. –2.8 c. –2.9 d. –3.0 e. –3.1
ANS: b

3 Two students A and B are pulling on the rope from opposite ends. While doing that they remain in rest.
If Student A exerts the force F=200N, which of the following is true
a) Student B exerts force of magnitude 200N and the tension in the rope is 0
b) Student B exerts force of magnitude 200N and the tension in the rope is 200N
c) Student B exerts force of magnitude 200N and the tension in the rope is 400N
d) Student B exerts no force and the tension in the rope is 200N
e) None of the above
ANS b

4. A particle moving in a circle is subjected to a total acceleration that has a magnitude of 8.2 m/s^2 . If its radial acceleration has a magnitude of 3.3 m/s^2 , what is the magnitude of its tangential acceleration in m/s^2 ?
a. 8.8 b. 8.5 c. 7.7 d. 7.5 e. 7.3
ANS:d

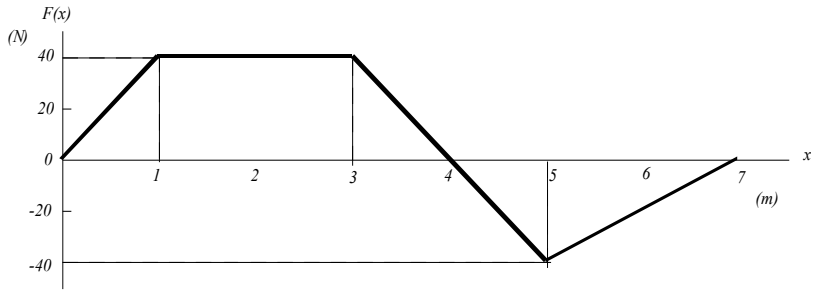
5. When M = 4 kg, the acceleration of the blocks is 1 m/s^2. If the coefficient of friction between each block and the surface is 0.4, determine *F* in N. (Take $g=10m/s^2$)



a. 120 b.100 c. 80
d. 60 e. 40
ANS:b

6. A body moves in a circle of radius r at constant speed v. The work done on the body by the centripetal force F in two revolutions is:
a. $F(4\pi r)$. b. Ft c. v^2/r d. $m\,v^2/r$. e. zero
ANS: e

7 An object moves from $x = 0$ m to $x = 7$ m subject to the force shown in the diagram. How much work in J is done on the object by the force when the object moves from x=3m to x=5m
a. –40
b. –20
c. 0
d. 20
e. 40



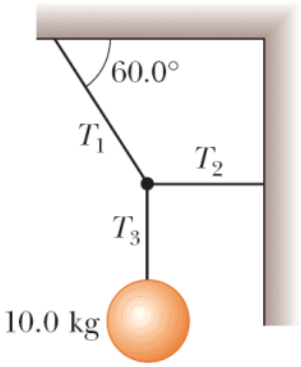
Part II In the exam booklet provide full solutions to 5 out of 6 problems .
Each problem is worth 10 points.
On the cover of your exam booklet indicate clearly which problems are to be marked.
Provide full solutions with clear diagrams. Clarity of your solution is important!

1. A cannon with a muzzle speed of 1 000 m/s is used to start an avalanche on a mountain slope. The target is 2 000 m from the cannon horizontally and 800 m above the cannon. At what angle, above the horizontal, should the cannon be fired?

2. The pilot of an airplane notes that the compass indicates a heading due west. The airplane's speed relative to the air is 150 km/h. The air is moving in a wind at 30.0 km/h toward the north. Find the velocity of the airplane relative to the ground.

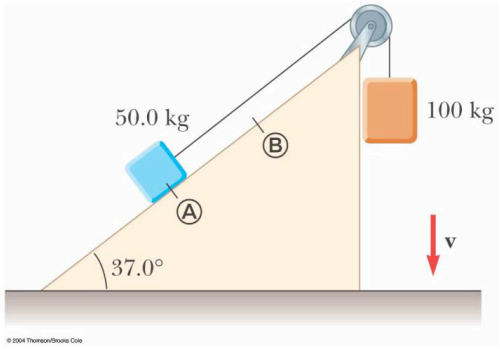
3. A point on a rotating turntable 20.0 cm from the center accelerates from rest to a final speed of 0.700 m/s in 1.75 s. At t = 1.25 s, find the magnitude and direction of
(a) the radial acceleration(4p),
(b) the tangential acceleration,(4p)
(c) the total acceleration of the point. (2p)

4

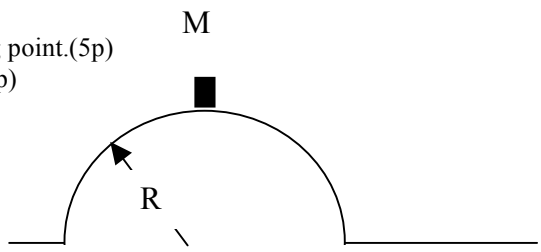


The load is hanging from the ceiling of an elevator that is moving down at constant acceleration a=1m/s²
a) Draw relevant free body diagrams (4 points)
b) Write down the Newton's Equations (4 points)
c) Find the tension in each of the three strands of cord supporting the load. (2 points)

5 A 50.0-kg block and 100-kg block are connected by a string as shown. The pulley is frictionless and of negligible mass. The coefficient of kinetic friction between the 50-kg block and incline is 0.250. Determine the change in the kinetic energy of the 50-kg block as it moves from A to B, a distance of 20.0 m



6
The skier of mass M slides from on an icy (frictionless) hemispherical mountain of radius R.
a) Draw the free body diagram, and write Newton's Second Law for the block of mass M as it is at some point on the slope below the starting point.(5p)
b) At what angle α with vertical will she loose contact with the surface ? (5p)
The skier is at rest on the top of the mountain.



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PART I Multiple choice. (48% of the test grade). Enter all your answers in the scantron sheet.

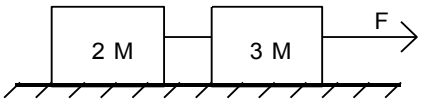
1. Two balls are thrown from a height of 10 m. Ball one is thrown upward with a speed of 1m/s. Ball two is thrown downward with a speed of 1m/s. What is the ratio of the speed of ball one with the speed of ball two when each hits the ground?
a. 1:2 b. 2:1 c. 1:1 d. 20:1 e. 1:20
ANS: c

2. A car is moving with a speed of 3.2 m/s when brakes are applied. If the car stops after it has moved 1.7m , what was its average acceleration in m/s^2?
a. –2.7 b. –2.8 c. –2.9 d. –3.0 e. –3.1
ANS: d

3 Two students A and B are pulling on the rope from opposite ends. While doing that they remain in rest.
If Student A exerts the force F=400N, which of the following is true
a) Student B exerts force of magnitude 400N and the tension in the rope is 0
b) Student B exerts force of magnitude 400N and the tension in the rope is 800N
c) Student B exerts force of magnitude 400N and the tension in the rope is 400N
d) Student B exerts no force and the tension in the rope is 400N
e) None of the above
ANS: c

4. A particle moving in a circle is subjected to a total acceleration that has a magnitude of 8.2 m/s^2 . If its radial acceleration has a magnitude of 2.8 m/s^2 , what is the magnitude of its tangential acceleration in m/s^2 ?
a. 8.8 b. 8.5 c. 7.7 d. 7.5 e. 7.3
ANS:c

5. When M = 4 kg, the acceleration of the blocks is 3 m/s^2. If the coefficient of friction between each block and the surface is 0.4, determine *F* in N. (Take $g=10m/s^2$)

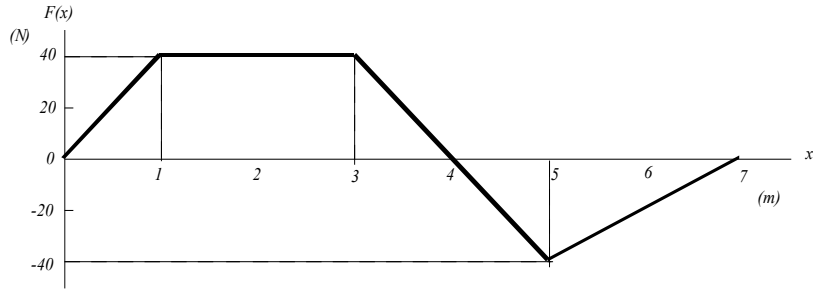


a. 120 b.100 c. 80
d. 60 e. 140
ANS: e

6. A body moves in a circle of radius r at constant speed v. The work done on the body by the centripetal force F in two revolutions is:
a. $F\ (4\pi r)$. b. Ft c. v^2/r d. 0 e) $m\ v^2/r$.

ANS: d

7 An object moves from $x = 0$ m to $x = 7$ m subject to the force shown in the diagram. How much work in J is done on the object by the force when the object moves from x=3m to x=7m



a. –40
b. –20
c. 0
d. 20
e. 80
ANS:a

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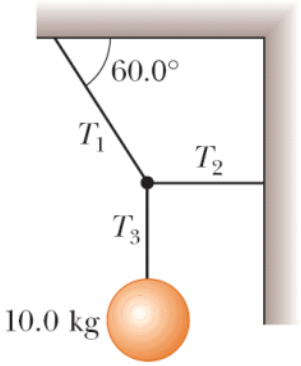
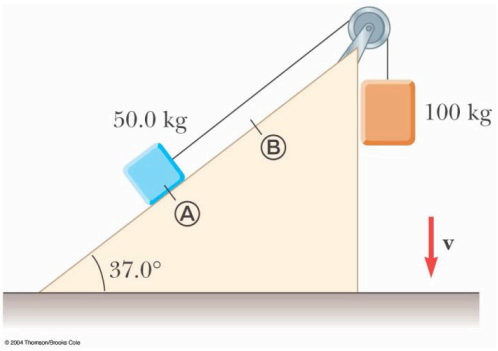


The load is hanging from the ceiling of an elevator that is moving up at constant acceleration = 2m/s².
d) Draw relevant free body diagrams (4 points)
e) Write down the Newton's Equations (4 points)
f) Find the tension in each of the three strands of cord supporting the load. (2 points)

5 A 50.0-kg block and 100-kg block are connected by a string as shown. The pulley is frictionless and of negligible mass. The coefficient of kinetic friction between the 50-kg block and incline is 0.150. Determine the change in the kinetic energy of the 50-kg block as it moves from A to B, a distance of 30.0 m



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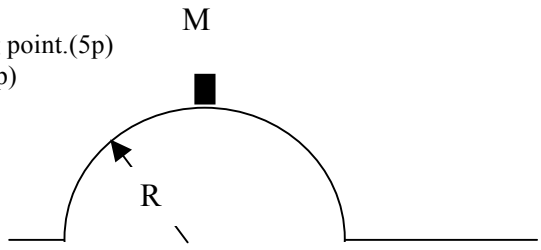
The skier is at rest on the top of the mountain.



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ANS: a

2. A car is moving with a speed of $3.2\ \mathrm{m/s}$ when brakes are applied. If the car stops after it has moved 1.9 m, what was its average acceleration in $\mathrm{m/s^2}$?
a. –2.7 b. –2.8 c. –2.9 d. –3.0 e. –3.1
ANS: a

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ANS d

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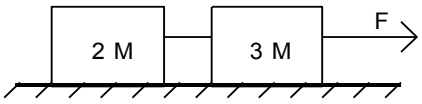

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ANS: e

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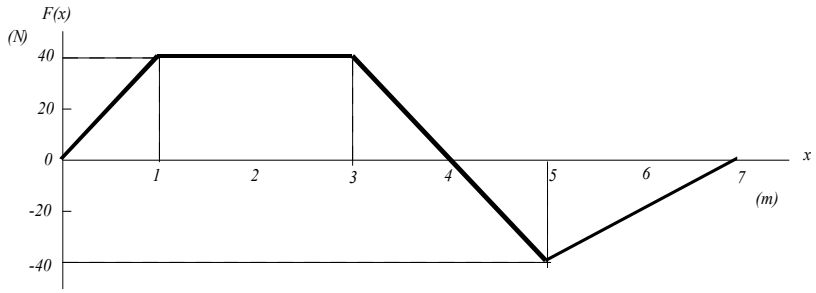

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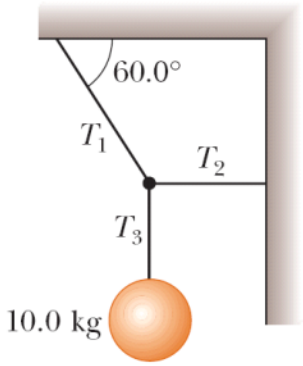

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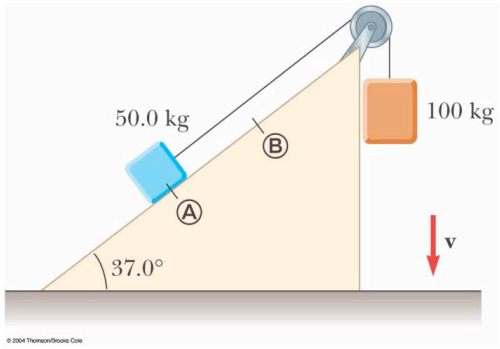

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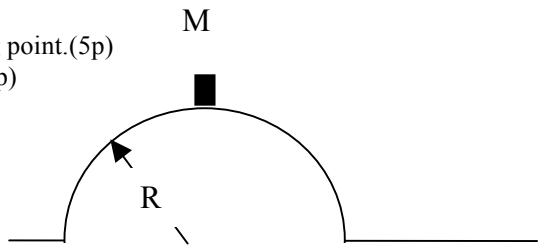


SOLUTIONS TO **ONE VERSION** OF PROBLEMS IN PHY1331 MIDTERM
Use this template to obtain numerical answers for other versions.

1 This is Assignment 2 problem

Take the origin at the mouth of the cannon.

$x_f = v_{xi}\,t$ $\qquad 2\,000\ \text{m} = (1\,000\ \text{m/s})\cos\theta_i t$

Therefore, $\qquad t = \dfrac{2.00\ \text{s}}{\cos\theta_i}$

$y_f = v_{yi}\,t + \dfrac{1}{2}a_y\,t^2$: $\qquad 800\ \text{m} = (1\,000\ \text{m/s})\sin\theta_i\,t + \dfrac{1}{2}\left(-9.80\ \text{m/s}^2\right)t^2$

$$800\ \text{m} = (1\,000\ \text{m/s})\sin\theta_i\left(\frac{2.00\ \text{s}}{\cos\theta_i}\right) - \frac{1}{2}\left(9.80\ \text{m/s}^2\right)\left(\frac{2.00\ \text{s}}{\cos\theta_i}\right)^2$$

$$800\ \text{m}\left(\cos^2\theta_i\right) = 2\,000\ \text{m}\left(\sin\theta_i\cos\theta_i\right) - 19.6\ \text{m}$$

$$19.6\ \text{m} + 800\ \text{m}\left(\cos^2\theta_i\right) = 2\,000\ \text{m}\sqrt{1-\cos^2\theta_i}\left(\cos\theta_i\right)$$

$$384 + (31\,360)\cos^2\theta_i + (640\,000)\cos^4\theta_i = (4\,000\,000)\cos^2\theta_i - (4\,000\,000)\cos^4\theta_i$$

$$4\,640\,000\cos^4\theta_i - 3\,968\,640\cos^2\theta_i + 384 = 0$$

$$\cos^2\theta_i = \frac{3\,968\,640 \pm \sqrt{(3\,968\,640)^2 - 4(4\,640\,000)(384)}}{9\,280\,000}$$

$$\cos\theta_i = 0.925 \text{ or } \qquad 0.00984$$

$\theta_i =$ $\boxed{22.4° \text{ or } 89.4°}$ (Both solutions are valid.)

2 **This is vector problem similar to the ones addressed in first DGD**

$v = \sqrt{150^2 + 30.0^2} =$ $\boxed{153\ \text{km/h}}$

$\theta = \tan^{-1}\left(\dfrac{30.0}{150}\right) =$ $\boxed{11.3° \text{ north of west}}$

3 (b) We do part (b) first. The tangential speed is described by $v_f = v_i + a_t t$

$0.7\ \text{m/s} = 0 + a_t(1.75\ \text{s})$ so $\boxed{a_t = 0.400\ \text{m/s}^2\ \text{forward}}$

(a) Now at $t = 1.25\ \text{s}$, $v_f = v_i + a_t t = 0 + \left(0.4\ \text{m/s}^2\right)1.25\ \text{s}$

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

so $a_c = \dfrac{v^2}{r} = \dfrac{(0.5\ \text{m/s})^2}{0.2\ \text{m}} = \boxed{1.25\ \text{m/s}^2\ \text{toward the center}}$

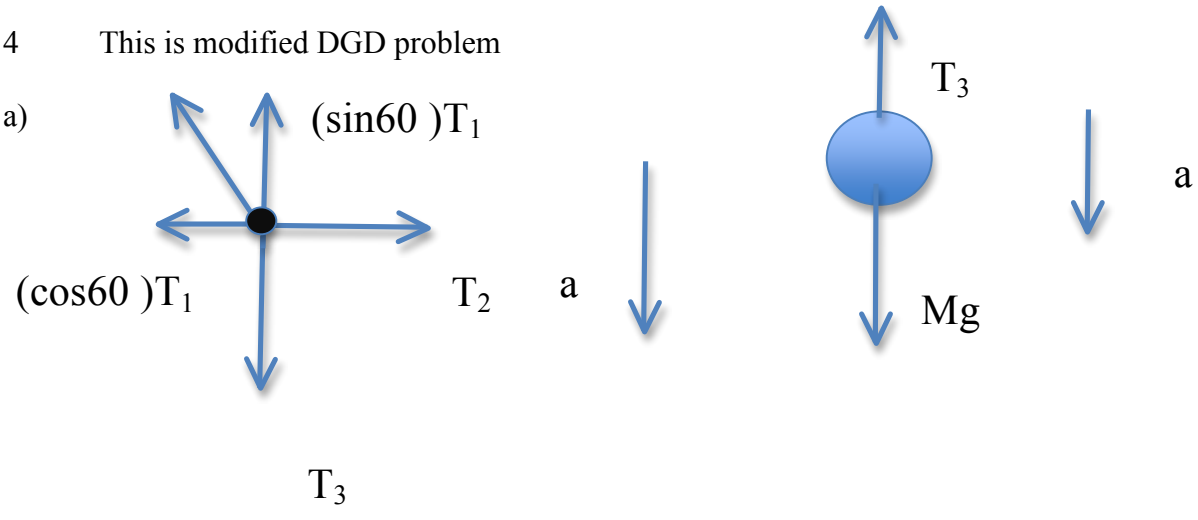
(c) $\vec{\mathbf{a}} = \vec{\mathbf{a}}_r + \vec{\mathbf{a}}_t = 0.4\ \text{m/s}^2\ \text{forward} + 1.25\ \text{m/s}^2\ \text{inward}$

$\vec{\mathbf{a}} = \sqrt{0.4^2 + 1.25^2}$ forward and inward at $\theta = \tan^{-1}\left(\dfrac{1.25}{0.4}\right)$

$\vec{\mathbf{a}} = \boxed{1.31\ \text{m/s}^2\ \text{forward and } 72.3°\ \text{inward}}$

4 This is modified DGD problem

a)



T_3

b)

$\sum F_y = -ma \Rightarrow T_1 \sin 60 - T_3 = -ma$

$\sum F_x = 0 \quad \Rightarrow T_2 - T_1 \cos 60 = 0$

$\sum F_y = -ma \Rightarrow T_3 - mg_3 = -ma$

$T_3 = mg - ma = m(g - a) = (10)\cdot(8.8) = 88N$

$T_1 \sin 60 = T_3 - m_{knot}a = T_3 = 88N$

c) $T_1 = \dfrac{88N}{\sin 60} =$

$T_2 = T_1 \cos 60 = \dfrac{88N}{\sin 60}\cos 60 = 88 \tan 60 =$

5 DGD problem

$$\sum F_y = n - mg\cos 37.0° = 0$$
$$\therefore n = mg\cos 37.0° = 391 \text{ N}$$
$$f = \mu n = 0.250(391 \text{ N}) = 97.8 \text{ N}$$
$$-f\Delta x = \Delta E_{\text{mech}}$$
$$(-97.8)(20.0) = \Delta U_A + \Delta U_B + \Delta K_A + \Delta K_B$$
$$\Delta U_A = m_A g\left(h_f - h_i\right) = (50.0)(9.80)(20.0\sin 37.0°) = 5.90 \times 10^3$$
$$\Delta U_B = m_B g\left(h_f - h_i\right) = (100)(9.80)(-20.0) = -1.96 \times 10^4$$
$$\Delta K_A = \frac{1}{2} m_A \left(v_f^2 - v_i^2\right)$$
$$\Delta K_B = \frac{1}{2} m_B \left(v_f^2 - v_i^2\right) = \frac{m_B}{m_A}\Delta K_A = 2\Delta K_A$$

Adding and solving, $\Delta K_A =$ $\boxed{3.92 \text{ kJ}}$.

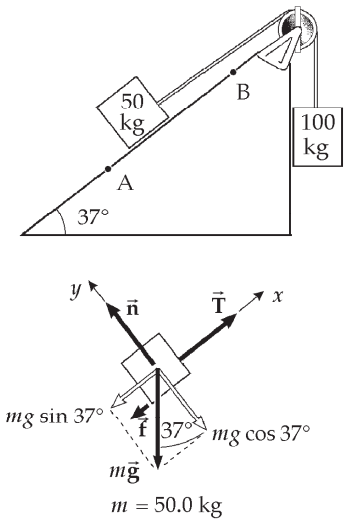


FIG. P7.28

6 Problem was solved in class

A) $n - mg\cos\alpha = -m\frac{v^2}{r} \quad n = mg\cos\alpha - m\frac{v^2}{r}$

B) $when\ n = 0 \Rightarrow mg\cos\alpha - m\frac{v^2}{r} \Rightarrow mg\cos\alpha = m\frac{v^2}{r} \Rightarrow \cos\alpha = \frac{v^2}{gr}$

From the conservation of mechanical energy

$$mgR = mgh + m\frac{v^2}{2}$$
$$mgR - mgR\cos\alpha = m\frac{v^2}{2}$$
$$gR - gR\cos\alpha = \frac{v^2}{2}$$
$$gR - gR\cos\alpha = \frac{1}{2}gR\cos\alpha$$
$$gR = \frac{3}{2}gR\cos\alpha$$
$$1 = \frac{3}{2}\cos\alpha \Rightarrow \cos\alpha = \frac{2}{3}$$