Memorial University of Newfoundland

Physics 1020

Final Examination	***Name (Answers)*______________________
December 12, 2011	*MUN NO.*____________________________
Time 2 Hours	**Instructor(Circle)** **Dr Goulding/ Dr Beaulieu**

PAPER NUMBER

INSTRUCTIONS:

1. Non-programmable calculators are permitted. Programmable ones are subject to scrutiny.
2. **Do 7 out of 8 questions in Part A. Question 9 is compulsory. SHOW YOUR WORKINGS.**
3. Questions values are given.
4. Please use **THREE** significant figures in all calculations.
5. **The last page of the exam is a formula sheet. Feel free to tear it off.**
6. **There are 11 pages. Count them before you start.**
7. **Relax!** Good luck!

1	2	3	4	5	6	7	8	9	Total

<u>Part A</u>

Do 7 out of 8 questions in Part A

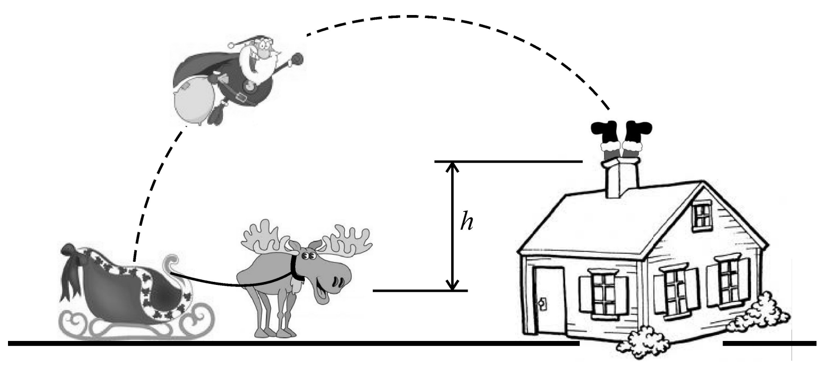
Question 1: (12 marks)
Hot Foot Willie is driving his sports car at 120 km/h when he spots a police car parked 150 m on the road ahead of him. In a panic he hits the brakes and decelerates at a constant rate of 2.00 m/s^2. The posted speed limit is 65 km/h. Determine:

a. Convert 120 km/h into m/s. **[33.3m/s]**
b. The time it takes for the Willie to slow down to the speed limit. **7.60s]**
c. Does he slow down to the speed limit before he reaches the police car? Support your answer. **[x=194m so he does not slow down in time]**

Question 2 (12 marks)

Santa Claus decides that landing on rooftops is too dangerous for his reindeer and so he builds a seat which can launch him from the sleigh, directly into the chimney. The launcher can launch with a velocity of 15.0 m/s at an angle of 52.0 degrees above the horizontal. The height difference between the seat and the chimney is h=6.00 m.

a. What is the maximum height, relative to the seat, that Santa will reach? **[7.10m]**
b. What is his time of flight to the chimney? **[1.68s]**
c. How far is the chimney away? **[15.5m]**
d. One day as they are travelling at 80.0 km/h across an open field, Santa accidentally triggers the seat and is launched airborne. He measures his time of flight to be 2.50 s. How far does he travel horizontally? **[78.5m]**



Question 3 (12 marks)

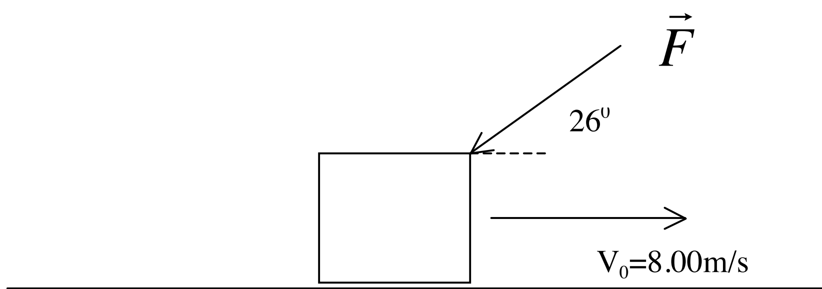
3. A 2.00 kg block initially travelling at 8.00 m/s to the right across a rough surface is slowed down by a F=6.00 N force directed down at an angle of 26 degrees, as shown. The coefficient of kinetic friction between the block and the surface is 0.15.

a. Draw a Free Body diagram for the mass

b. Determine the normal force exerted by the surface on the block **[22.2N]**

c. Determine the frictional force acting upon the block and **[3.33N]**

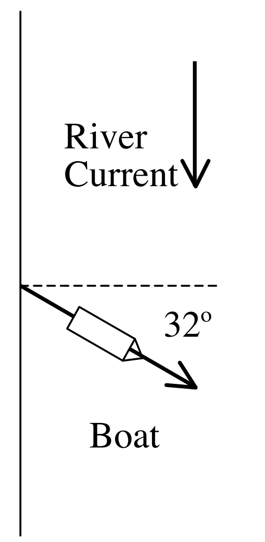
d. The speed of the block after 0.600 s. **[5.38m/s]**



Question4 (12 marks)

A boater attempts to cross a river by pointing his boat 32.0 degrees downstream as shown. The boat can move at 2.00 m/s in still water and the river flows at 4.30 m/s.

a. Draw the vector diagram showing how the velocity vectors of the boat and the river **add**.
b. Determine the velocity (magnitude and direction) of the boat relative to the shore. **[5.62 m/s @72.4^0 below x axis]**
c. If the river is 54.0 m wide how long does it take for the boat to cross the river? **[31.7 s]**



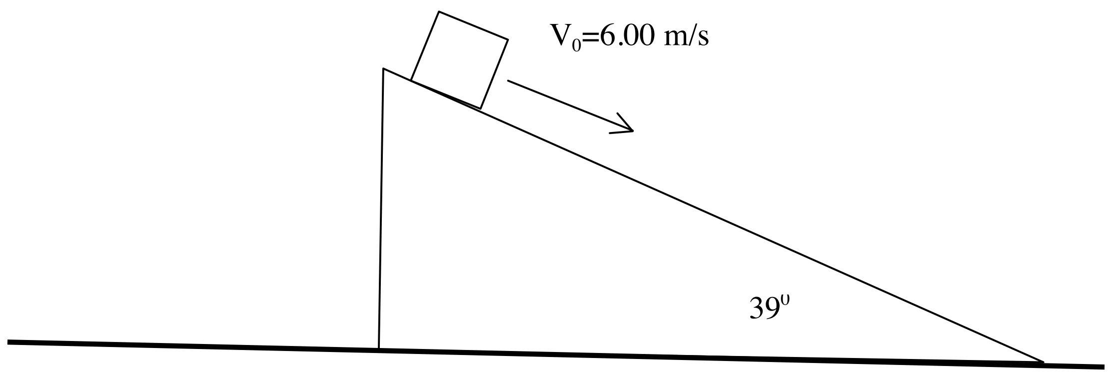
Question 5 (12 marks)

a. Gravity is a conservative force. Why?

The work done by gravity is independentt of the path or the work done by the gravitational force over a closed loop is zero.

b. A box of mass 180 kg moves down a smooth ramp with an initial speed of 6.00 m/s. The ramp is 3.70 m long and is inclined at 39.0 degrees to horizontal. Choose y=0 at the bottom and using **energy** **methods**:

i. Determine the initial gravitational potential energy of the box. **[4110 J]**
ii. Determine the initial kinetic energy of the box. **[3240 J]**
iii. Find the speed of the box when it reaches the bottom of the ramp. **[9.04 m/s]**
iv. Find the distance the box travels on the floor before it stops, if the coefficient of kinetic friction between the box and the floor is 0.28. **[14.9 m]**



Question 6 (12 marks)

a) A 72.0 kg person standing on a scale in a elevator notices that the scale reading is 690 N. What can the person deduce about the motion of the elevator?

The elevator is accelerating downward.

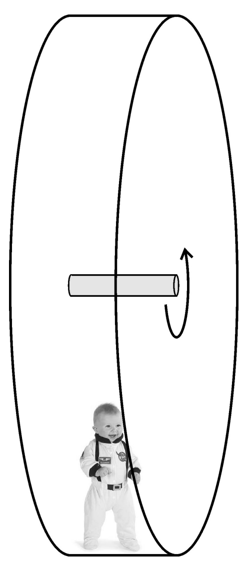
b) Dr Beaulieu enrolls his 3 month old son Patrick in astronaut training school. Part of the training occurs at a spacestation far from the earth, ie. g=0 m/s^2 . The space station is cylindrically shaped and rotates in order to mimic earth's gravity. The radius of the cylinder is 2100 m. If Patrick has a mass of 7.30 kg:

i) What provides the centripetal force? **[F_N]**

ii) Draw a free body diagram for Patrick at the position shown.

iii) What must the speed at the outer rim be so that Patrick feels his usual weight? Show all calculations. **[143 m/s]**

iv) Is there <u>a point on the rim</u> where Patrick would feel weightless? State your logic.
[No, Patrick will feel the same weight at all points on the rim]



Question 7 (12 marks)

a. Daffy duck paddles across Burtons Pond. What force allows the duck to move forward?

The force of the water pushing back on Daffy

b. A 2.00 kg mass hangs on a spring in an elevator. The spring has a spring constant of 405 N/m.

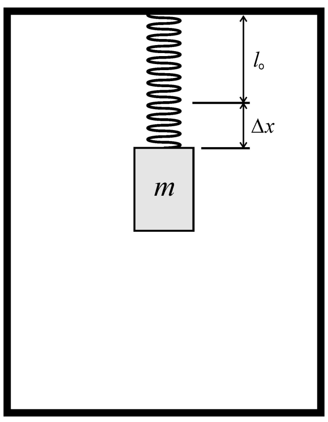
i. Draw a free body diagram for the mass.

How much is the spring stretched if the elevator:

ii. is stationary? **[0.483 m]**

iii. is moving upwards at a constant speed of 4.00 m/s? **[0.483m]**

iv. is accelerating upward with an acceleration of 4.90 m/s^2? **[0.726m]**



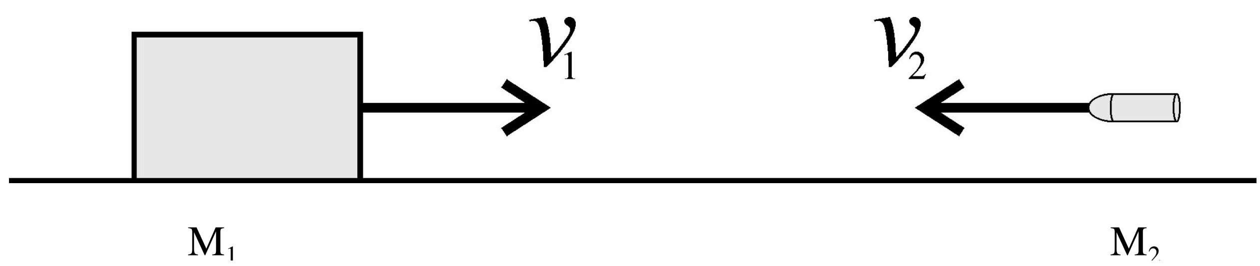
Question 8 (12 marks)

a. Two cars collide and stick together. Why is energy not conserved in this collision? Where does the energy go?

The cars stick together so energy is lost and heat is produced.

b. A bullet(m_2= 12.0 g) travelling to the left collides with a block(m_1= 1.00 kg) travelling to the right. The bullet embeds itself in the block. If $v_1 = 4.00m/s$ and $v_2 = 320m/s$:

i. What is the final velocity of the block-bullet system? [$0.158m/s\hat{x}$]
ii. Is energy conserved in this collision? Support your answer. **[no]**
iii. If the collision occurs in 0.005 s, what force is exerted on the big block ? [$-768\hat{x}$]



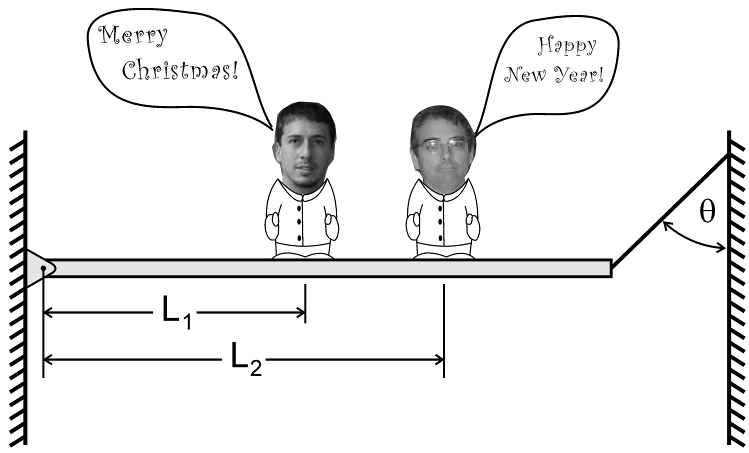
Part B (Compulsory Question)

Question 9 (16 marks)

Dr Goulding and Dr Beaulieu are standing on a 6.00 m uniform long beam. Dr B is L_1=2.00m from the left end and Dr G is L_2= 5.00m from the left end. Dr G and Dr B have masses of 72.0 and 85.0 kg, respectively and the beam has a mass of 40.0 kg. The beam is held by a hinge at the left hand side and a rope at the right hand side. The rope makes an angle of 35.0 degrees with the wall.

a. Determine the tension in the rope. **[1.30x10^3N]**

b. Dr Goulding suddenly remembers that the hinge was bought at Canadian Tire and is rated to support a vertical force of 1100N. Are the two profs safe?Support your answer. **[Yes, F_{HY}=867 which is less than 1100N]**



CONSTANTS AND FORMULAE

$v = v_o + at$

$v_{av} = \frac{v + v_o}{2}$

$\vec{r} = x\hat{x} + y\hat{y}$

$x = x_o + v_o t + \frac{1}{2}at^2$

$\vec{a} = \frac{\Delta\vec{v}}{\Delta t}$

$K = \frac{1}{2}mv^2$

$v^2 = v_o^2 + 2a(x - x_o)$

$\vec{v} = \frac{\Delta\vec{r}}{\Delta t}$

$U = \frac{1}{2}kx^2$

$x = x_0 + v_{av}t$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$E_f = E_i + W_{nc}$

$W = F\Delta x\cos\theta$

$a = \frac{v^2}{r}$

$F = \frac{Gm_1m_2}{r^2}$

$\tau = Fl$

$v_s = \sqrt{\frac{GM_E}{r}}$

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

$W = \Delta K$

$P = \frac{W}{t} = Fv$

$\vec{F}\Delta t = \Delta\vec{p}$

$\vec{F} = -k\vec{x}$

$F = \mu N$

$\vec{P} = m\vec{v}$

$U = mgy$

$c^2 = a^2 + b^2 - 2ab\cos C$

Constants

$g = 9.81 \ \frac{\text{m}}{\text{s}^2}$

$G = 6.67\text{x}10^{-11}\ \text{Nm}^2/\text{kg}^2$

$M_E = 6.00\text{x}10^{24}\ \text{kg}$