NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
BACHELOR OF SCIENCE HONOURS DEGREE
END OF SECOND SEMESTER EXAMINATIONS – MAY 2011
MECHANICAL ENGINEERING – SCH 2205
TIME: 3 HOURS

Instructions to candidates

Answer any five (5) Questions. Each question carries 20 marks.

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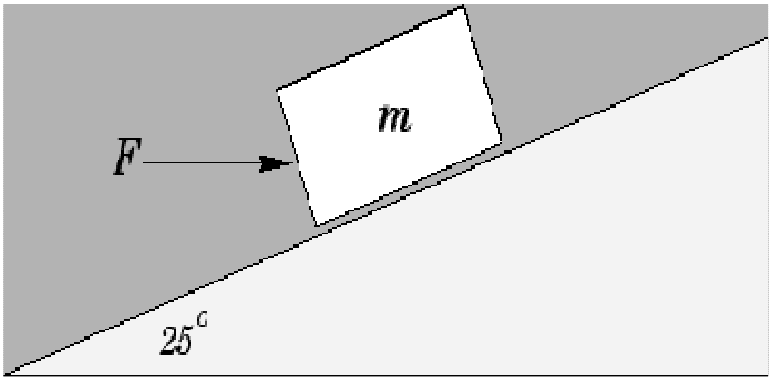
1. (a) The position of a softball tossed vertically upward is described by the Equation $\mathbf{y = 7.00t - 4.90t^2}$, where **y** is in meters and **t** is in seconds. Find:
   - (i) The ball's initial speed v_0 at t_0. [2]
   - (ii) Its velocity at t=1.26s. [2]
   - (iii) Its acceleration at that time. [2]

   (b) Draw a well labeled stress- strain diagram for a material of your choice. Explain the meaning of all important terms on the graph. [6]

   (c) Define the following terms and give two examples for each.
   - (i) Vector quantity. [4]
   - (ii) Scalar quantity. [4]

2. (a) Consider the diagram below. Suppose that the block, mass m = 5kg , is subject to a horizontal force (F= 20N).



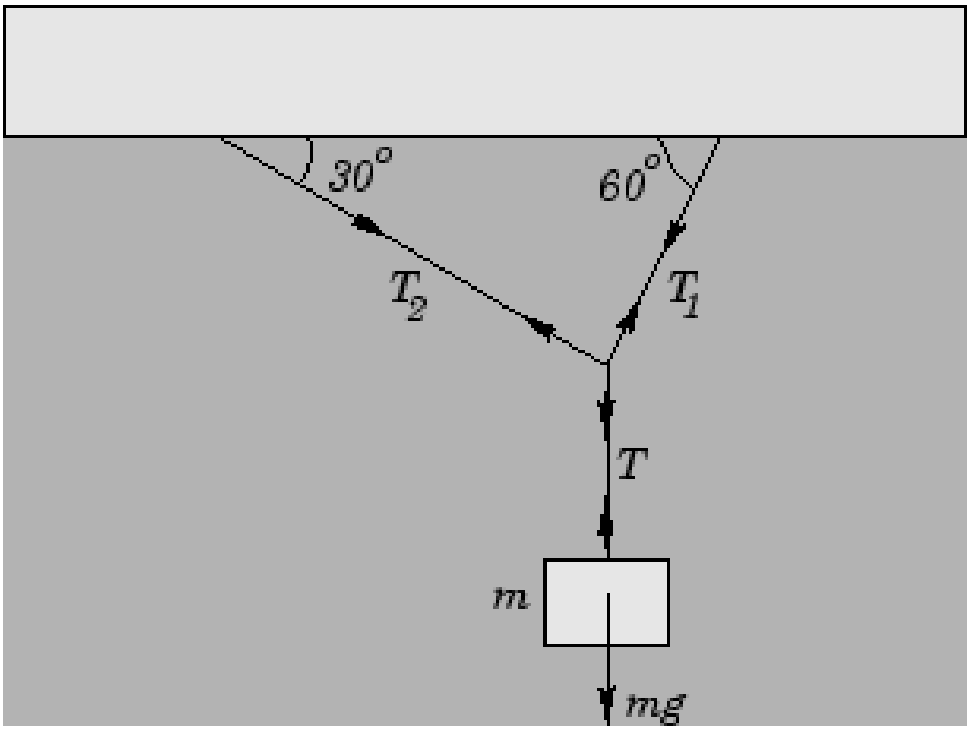
   (i) What is the acceleration of the block up the slope if the co-efficient of dynamic friction is 0.5. [8]

   (ii) What is the acceleration of the block up the (frictionless) slope? [6]

(b) Differentiate between:

(i) Distance and Displacement [2]
(ii) Mass and Weight. [2]
(iii) Speed and Velocity. [2]

3. (a) A block of mass m= 10kg hangs from a system of mass less strings as shown below.



Find:

(i) The Tension T [2]
(ii) The Tension T_1 [4]
(iii) The Tension T_2. [4]

(b) Oil flows through a pipe in which the pipe contracts from 450mm diameter at A to 300mm diameter at B and then forks. One branch with,150mm diameter, discharges at C and the other branch 225mm diameter discharges at D. If the velocity at A is 1.8m/s and the velocity at D is 3.6m/s.

(i) What will be the discharge at C? [3]
(ii) What will be the discharge at D? [3]
(iii) What will be the velocity at B? [2]
(iv) What will be the velocity at C? [2]

4. (a) A block of mass m=3kg starts at rest at a height of h = 5m on a plane that has an angle of inclination of $\theta = 35^0$ with respect to the horizontal. The block slides down the plane, and, upon reaching the bottom, then slides along a horizontal surface. The coefficient of kinetic friction of the block on both surfaces is 0.5.

(i) How far does the block slide along the horizontal surface before coming to rest? [8]

(ii) Do the same problem considering that both surfaces are smooth. [6]

(b) A vertical solid steel post 15cm in diameter and 3.00m long is required to support a load of 800kg. The weight of the pole can be neglected. (Young's Modulus for steel: 20×10^{10}Pa)
What is:-

(i) The stress in the post. [4]

(ii) The strain on the post. [2]

5. (a) A crate of mass 10.0kg is pulled up a rough incline with an initial speed of 1.50m/s. The pulling force is 100N parallel to the incline which makes an angle of 20^0 with the horizontal. The co efficient of kinetic friction is 0.400 and the crate is pulled 5.00m.

(i) How much work is done by the gravitational force on the crate? [4]

(ii) Determine the increase in the internal energy due to friction. [4]

(iii) How much work is done by the 100N force on the crate? [2]

(iv) What is the change of the kinetic energy on the crate? [2]

(v) What is the speed of the crate after being pulled 5.00m? [2]

(b) A 3.0kg mass starts from rest and slides a distances **d** down a frictionless 30^0 incline, where it contacts an unstressed spring of negligible mass. The mass slides an additional 0.20m as it is brought momentarily to rest by compressing the spring (k = 400N/m). Find the initial separation d between mass and spring. [6]

6. (a) A rock is thrown vertically upwards with an initial speed of 100m/s. At the same instant another rock is thrown vertically downwards from the top of a 280m cliff with an initial speed of 40m/s. Neglect air friction.

(i) Express the height above the ground as a function of time for each stone. [4]

(ii) Find the time when the rocks pass each other. [2]

(iii) Find the height above the ground at which the rocks pass each other. [2]

(v) What are the speeds of the rocks at the same time? [2]

(b) A water pipe having a 2.5cm inside diameter carries water into the basement of a house at a speed of 0.90m/s and a pressure of 170kPa. If the pipe tapers to 1.2cm and rises to the second floor 7.6m above the input point, what are:

(i) The speed [5]

(ii) The water pressure at the second floor. [5]

7. (a) A gorilla walks 20m due north and then walks 30m due west. At the same time his trainer walks 75m at 65^{o} South of East.

(i) Make a careful vector diagram showing the displacements of the gorilla and the trainer. [5]

(ii) In what direction and how far away does the gorilla look to see his trainer? Use vector components to solve this problem [5]

(b) Two chunks of ice sliding on a frictionless frozen pond. Chunk, A, with mass of 5.0kg moves with initial velocity of 2.0m/s parallel to the x- axis. It collides with chunk, B, which has a mass of 3.0kg and is initially at rest. After the collision, the velocity of chunk A is found to be 1.0m/s in a direction making an angle of 30^{0} with the initial direction. What is the final velocity of Chunk B? [6]

(c) What do you understand by a conservative and a non conservative force? State the characteristic of the work done by a conservative force. [4]

END OF QUESTION PAPER!!!!!!!