NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF TEXTILE TECHNOLOGY

END OF SECOND SEMESTER EXAMINATIONS – MAY 2011

TXT 1209 – APPLIED MECHANICS

TIME: 3 HOURS

TOTAL MARKS: 100

INSTRUCTIONS

1. Answer **ANY FIVE** questions**.** Each question carries **20 marks**.
2. The first fifteen minutes should be spent reading the question paper and making notes.
3. Do not open your answer sheet until told to do so.
4. Marks will be awarded for skill in appreciating the scope of questions, clarity of argument and conciseness of presentation as well as for the knowledge displayed by the candidate.

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QUESTION 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 t = 1,26s. **(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)**

QUESTION 2

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

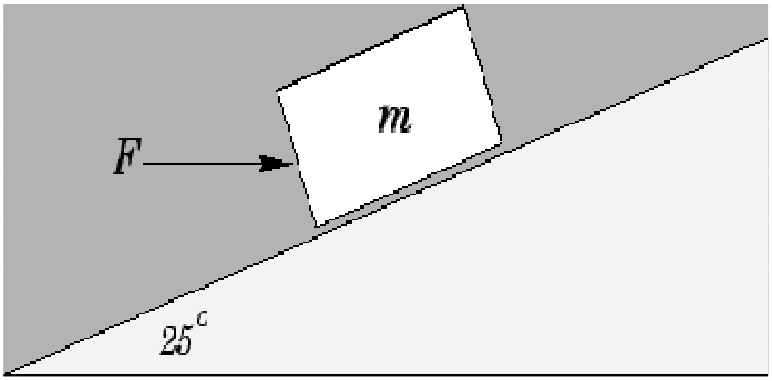


Figure Q2 (1)

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:

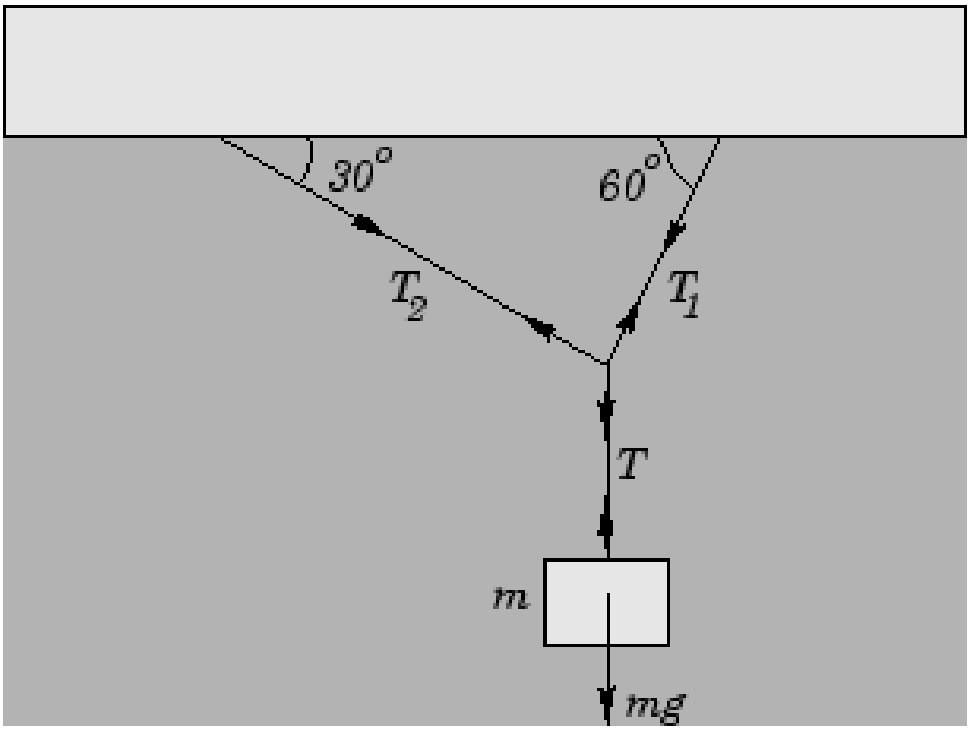
i. Distance and Displacement **(2)**

ii. Mass and Weight. **(2)**

iii. Speed and Velocity. **(2)**

QUESTION 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)**

QUESTION 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. Solve 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 x 10^{10}Pa) .

Calculate:

i. The stress in the post. **(4)**

ii. The strain on the post. **(2)**

QUESTION 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)**

vi. 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. **(4)**

QUESTION 6

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

i. express the height above the ground as a function of time for each stone. **(4)**

ii. find the time when the stones pass each other. **(2)**

iii. find the height above the ground at which the stones pass each other. **(2)**

iv. 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 at a pressure of 170kPa. If the pipe tapers to 1.2cm and rises to the second floor 7.6m above the input point, what is:

i. the speed of water at the second floor. **(5)**

ii. the water pressure at the second floor. **(5)**

QUESTION 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 are 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 EXAMINATION QUESTION PAPER