NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
BACHELOR OF SCIENCE HONOURS DEGREE
SUPPLEMENTARY EXAMINATIONS – AUGUST 2014
MECHANICAL ENGINEERING – SCH 2205
TIME: 3 HOURS

INSTRUCTIONS TO CANDIDATES
Answer any five (5) Questions. Each question carries 20 marks.
Total Marks – 100

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1. (a) State and define three fundamental quantities, giving their respective S.I. units. (3)

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

(c) A ball is thrown vertically upward with an initial speed of 19.6 m/s. Sketch a graph for:
(i) The position, (3)
(ii) Velocity, and (3)
(iii) Acceleration of the ball for the first five seconds of its motion. (3)

(d) A nylon tennis string on a racquet is under tension of 250 N. If it has a diameter of 1.00 mm, by how much is it lengthened from its un-tensioned length of 30.0cm? (Young's modulus for nylon is 5×10^9 N/m^2). (2)

2. (a) Define the following terms and give two examples for each.
(i) Vector quantity. (2)
(ii) Scalar quantity. (2)

(b) A young woman named Matilda buys a sports car that can accelerate at 6 m/s^2. She decides to test the car by racing another speedster, Stan. Stan is so sneaky that he manages to leave the starting line with an initial velocity of 2.5 m/s while Matilda leaves the same point from rest. If Stan accelerates at 5m/s^2.
Find:
(i) The time it takes Matilda to catch Stan. (3)
(ii) The distance she travels before she catches him. (1)
(iii) The velocities of both cars at the instant she catches Stan. (4)

(c) 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)
(iii) The change in the post's length when the load is applied. (2)

3. (a) Differentiate between:

(i) Distance and Displacement. (2)

(ii) Mass and Weight. (2)

(iii) Speed and Velocity. (2)

(v) Screw dislocation and edge dislocation. (2)

(b) 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? (4)

4.(a) During a rockslide, a 520kg rock slides from rest down a hillside that is 500m long and 300m high. The co-efficient of kinetic friction between the rock and the hill surface is 0.25.

(a) If the gravitational potential energy U of the rock earth system is zero at the bottom of the hill, what is the value of U just before the slide. (4)

b) How much energy is transferred to thermal energy during the slide? (4)

c) What is the kinetic energy of the rock as it reaches the bottom of the hill? (2)

d) What is its speed then? (2)

(b) A pitcher throws a ball at an angle of 37^{o} with the horizontal and observes that the ball stays in the air for 2.5 s before hitting the ground. Neglecting, air friction and the height of the pitcher.

Find:

(i) The initial speed of the ball. (3)

(ii) The maximum height reached by the ball. (3)

(iii) How fast would the pitcher have to run (at constant speed) to catch his own ball? (2)

5. (a) A hydraulic press contains $0.25m^3$ of oil. Find the decrease in the volume of the oil when it is subjected to a pressure increase of 1.6×10^7 Pa. The bulk modulus of the oil is $B = 5.0 \times 10^9$Pa and its compressibility is $K = 20 \times 10^{-6} atm^{-1}$. (4)

(b) A block of mass 6kg slides on a rough horizontal surface with a coefficient of friction of 0.5. This block is attached by an inextensible weightless string to another object of mass 4 kg. The 4kg object is vertically suspended.

Find:

(i) The acceleration and (4)

(ii) The tension in the rope (2)

(c) Explain the different types of stress force. (4)

(d) What do you understand by a conservative force? State the characteristic of the work done by a conservative force. (3)

(e) Differentiate between an elastic and in-elastic collision. (3)

6. (a) State briefly the working principles of a heat engine. (4)

(b) Basing on a simple machine, what is a:

(i) Hot Reservoir

(ii) Working substance

(iii) Cold reservoir. (3)

(c) Takunda threw a baseball at an angle of 53.1^0 above the horizontal with an initial speed of 40.0m/s. Air resistance may be neglected.

(i) At what two times was the ball at a 25.0m above the point from which it was thrown. (4)

(ii) Calculate the vertical and horizontal component of the ball's velocity at each of the two times calculated above. (4)

(iii) What were the magnitude and direction of the ball's velocity when it returned to the level from which it was thrown. (2)

(iv) Find the total time of flight, maximum height and the range. (3)

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. (4)

(ii) In what direction and how far away does the gorilla look to see his trainer? Use vector components to solve this problem (4)

(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) A 12kg block is released from rest on a 30^0 frictionless incline to the horizontal. Below the block is a spring that can be compressed 2.0cm by a force of 270N. The block momentarily stops when it compresses the spring by 5.5cm.

(i) How far does the block move down the incline from its rest position to the stopping point? (3)

(ii) What is the speed of the block just as it touches the spring? (3)

End of Examination!!!!!!!!!!!