THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of JKUAT)

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR BACHELOR OF B.TECH IN INDUSTRIAL CHEMISTRY

APS 4103: PHYSICS FOR CHEMISTS

END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2011
TIME: 2HOURS

Instructions to Candidates:
You should have the following for this examination
- *Answer booklet*

This paper consists of **FIVE** questions
Answer Question **ONE** (**Compulsory**) from **SECTION A** and any other **TWO** questions from **SECTION B**
Maximum marks for each part of a question are clearly shown
This paper consists of **THREE** printed pages

Take   Acceleration due to gravity, $g = 10$ m/s^2

Permeability of free space, $\mu_o = 4\ \pi \times 10^{-7}$ NA^{-2}

Permittivity of free space, $\varepsilon_o = 8.85 \times 10^{-12}$ C/(Nm^2)

SECTION A (Compulsory)

QUESTION ONE (30 Marks)

a) Below is an equation for real gases

$$\left(P + \frac{a}{V^2}\right) = \frac{RT}{(V-b)}$$

                     where V - volume, T- temperature, R – universal molar gas constant, a and b are constants. Find the dimensions of a and b (5 marks)

b) State the Newton's first law of motion   (2 marks)

c) A force A acting along the x-axis has a magnitude of 10N. If another force B equal to 8N makes an angle of 120^0 with force A, find their resultant force. Sketch the three forces.

(5 marks)

d) A block of mass m is supported by an inextensible string from the ceiling. Another string is attached to the bottom of the block. Explain what would happen when : -

(i) The lower string is given a sudden jack

(ii) The lower string is pulled steadily

e) Show that the number of nuclides N yet to undergo radioactive decay at any time t is given by $N = N_0 e^{-\lambda t}$ where N_o is the initial number of nuclides at time t=0 and ⬜ is the decay constant.

(5 marks)

f) A cubical box of identical surfaces is placed in a uniform electric field **E**. What is the net flux on the box

(3 marks)

g) Two isolated metal spheres of radii r_1 and r_2 are connected by a long conductor. Find the ratio their final charge densities σ_1 and σ_2 respectively

(6 marks)

SECTION B (Attempt any TWO questions)

QUESTION TWO (20 Marks)

a) (i) Distinguish static friction and kinetic friction (2 marks)

(ii) Explain why the coefficient of static friction μ_s is always greater than the coefficient of kinetic friction μ_k (3 marks)

(iii) A block is resting on an inclined plane that makes an angle Θ with the horizontal. As the angle of incline is increased, it was found that the block just begins to slide down the plane at an angle Θ_s, show that $\mu s = \tan \theta_s$

(5 marks)

b) The figure below shows two masses M_1 and M_2 attached to each other using an inextensible string of negligible mass.
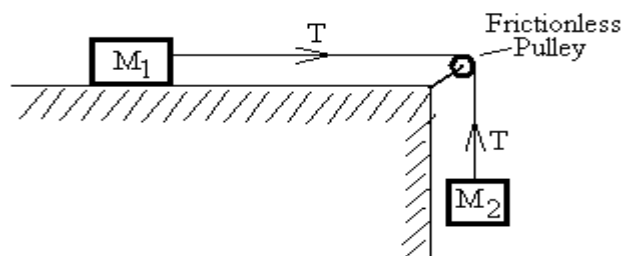
If the masses accelerate over a frictionless table at a m/s^2 when the tension on the string is T, show that : - (i) $a = \dfrac{M_1}{M_1 + M_2} g$ (6 marks)

(ii) $T = \dfrac{M_1 M_2}{M_1 + M_2} g$ (4 marks)

QUESTION THREE (20 Marks)

a) Use the Gauss law to derive the Coulomb law (6 marks)

b) Determine the electric potential for all the points at a distance r on the axis of a uniformly charged circular disc of radius a whose surface charge density is σ. Show that such a disc behaves as a point charge when r $\gg$ a. (14 marks)

QUESTION FOUR (20 Marks)

Three charges are placed in free space such that q_2 is 5 cm from q_1 along the positive x-axis. The line joining q_1 to q_3 makes an angle -30^0 with the positive y-axis when the distance between q_2 and q_3 is 5cm. Given that $q_1 = -3 \times 10^{-7} C$, $q_2 = 4 \times 10^{-7} C$ and $q_2 = -2 \times 10^{-7} C$, find : -

(a) The resultant force on q_1 and its direction (7 marks)

(b) The electric field at O, the centre of the configuration (7 marks)

(c) The electric potential at O (3 marks)

(d) The net electrical potential energy due to the configuration (3 marks)

QUESTION FIVE (20 Marks)

a) If the potential at a certain region is given by $V = 6 x^2 y - 40 x z^2 - 20$, find the components of the electric field **E** at the point (1,0,2) metres (6 marks)

b) Derive the expression for the equivalent capacitance of three capacitors in series (6 marks)

c) The circuit below is connected to a 2V battery as shown

10Ω   5Ω   3Ω   2 V
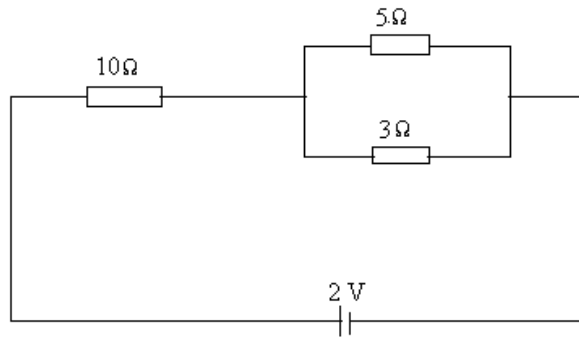
i)   Determine the equivalent resistance in the circuit   (3 marks)

ii) Determine the potential drop in the 3Ω resistor   (2 marks)

iii) Calculate the current through the 5 Ω resistor   (2 marks)

iv) Find the power dissipated at the 10 Ω resistor   (2 marks)