TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied and Health Sciences

Department of Mathematics and Physics

UNIVERSITY EXAMINATION FOR:

Bachelor of Technology in Applied Chemistry

APS 4103 Physics for Chemists

END OF SEMESTER EXAMINATION

SERIES: May 2016

TIME: 2 Hours

DATE:

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of five questions. Attempt Question One and any other two questions.

Do not write on the question paper.

Important constants

Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2}$

Acceleration due to gravity g=9.81 ms^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Fm^{-2}$

Electric charge e =1.63 x 10^{-19} *C*

Question 1 (30 marks)

a. Differentiate between basic and derived units. (2 marks)

b. State Newton's law of motion. (3 marks)

c. Differentiate between static and dynamic friction. (2 marks)

d. If θ be the angle of friction, show that the coefficient of static friction μ is given by $\mu = \tan\vartheta$. (4 marks)

e. Determine the net charge on a substance consisting of a combination of 5 x 10^{15} protons and 3 x 10^{15} electrons. (3 marks)

f. List at least three similarities between Coulomb force and gravitational force. (3 marks)

g. State coulombs law, hence use dimensional analysis to derive the SI units of the constant of proportionality. (4 marks)

h. Give the mathematical expression of the principle of superposition as applied to charges (1 mark)

i. Two resistors 2 Ω and 3 Ω are connected in series across a 1.5 V supply. Calculate the current in the circuit. (3 marks).

j. Derive the expression for the capacitance of a parallel plate capacitor. (5 marks)

Question 2 (20 marks)

a. Describe an everyday application of Newton's laws of motion (3 marks).

b. A 0.1kg mass is tied to a string as shown in Figure 1. The string is attached to a 0.5 kg mass and stretched over a pulley, leaving the 0.1kg mass suspended above the floor. If the frictional force between the 0.5 kg object and the plane is 0.2 N

   i. determine the tension in the string (5 marks)
   ii. acceleration (3 marks)
   iii. the time it will take the 0.1kg mass to fall a distance of 1.50 meters if starting from rest (3 mark

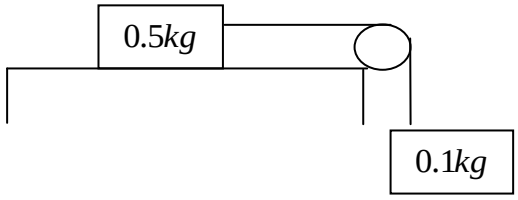

Figure 1: Acceleration

c. A block of mass 5 kg initially at rest slides down a plane at inclined at 30° to the horizontal. If the length of the plane is 2 m, and the frictional force between the plane and the object is 10 N, find

   i. the acceleration of the object (3 marks)
   ii. its speed when it reaches the bottom of the incline (3 marks)

Question 3 (20 marks)

a. Point charges of 2 $x10^{-9}$ C are situated at each of the three corners of a square whose side is 0.2 m. What would be the magnitude and direction of the resultant force on a point charge of -1$x10^{9}$ C if it were placed

   i. at the centre of the square? (4mks)
   ii. at the vacant corner of the square (6 marks)

b. A positive charge of 2$x10^{7}$ C is placed at a distance of 0.15m from another positive charge of 8$x10^{7}$ C. At what point is the electric field zero? (5mks)

c. Two point charges $q_1 = 4 \times 10^8 C$ and $q_2 = -3 \times 10^{-8}$ are 10cm apart. A point A is midway between them, point B is 8cm from q_1 and 6cm from q_2. Find potential at

   i. points A (3 marks)
   ii. point B (2 marks)

Question 4 (20 marks)

a. For the circuit shown in Figure 2, calculate:
   i. capacitance of the combination (5mks)
   ii. the total charge of the combination (2mks)

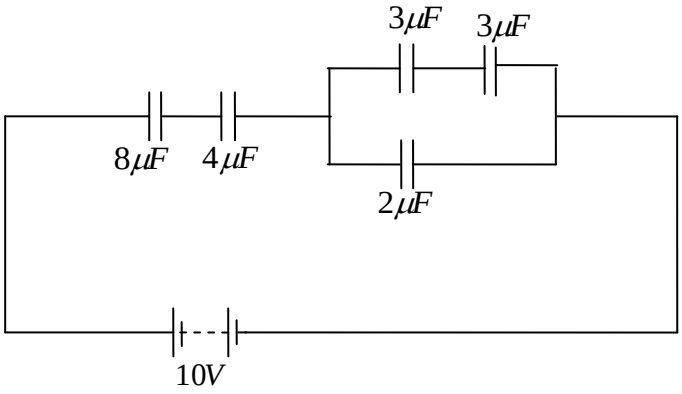

Figure 2 : Capacitors

b. Derive the expression for charging a capacitor through R. (6 marks)
c. Two capacitors C_1 = 2 μF and C_2=5 μFare connected in parallel with a 20 V battery. The battery is removed and plates of opposite signs are connected. Find:
   i. the initial energies of the capacitors (4 marks)
   ii. the final energies of the capacitors (3 marks)

Question 5 (20 marks)

a. Describe the factors on which the resistance of a conductor depends on. (3 marks)
b. A voltmeter is connected in parallel with a variable resistor R which is in series with an ammeter and a cell. For one value of R the meters read 0.3 A and 0.9 V. For another value of R the readings are 0.25 A and 1 V. Find the values of
   i. R (4 marks)
   ii. the EMF of the cell (3 marks)
   iii. the internal resistance (3 marks)
c. Use Kirchhoff's laws to find the currents (Figure 3)
   i. I_1 (3 marks)
   ii. I_2 (2 marks)
   iii. I_3 (2 marks)

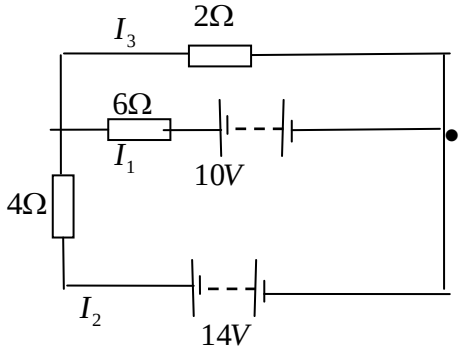

Figure 3: Resistors