

# TECHNICAL UNIVERSITY OF MOMBASA

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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.**

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### *Important constants*

Permittivity of free space  $\epsilon_0 = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2}$

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

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 Fm^{-2}$$

Electric charge  $e = 1.63 \times 10^{-19} C$

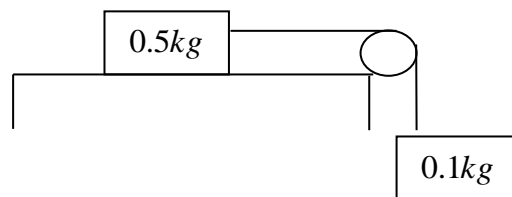
### **Question 1 (30 marks)**

- Differentiate between basic and derived units. (2 marks)
- State Newton's law of motion. (3 marks)
- Differentiate between static and dynamic friction. (2 marks)
- If  $\theta$  be the angle of friction, show that the coefficient of static friction  $\mu$  is given by  $\mu = \tan \theta$ . (4 marks)
- Determine the net charge on a substance consisting of a combination of  $5 \times 10^{15}$  protons and  $3 \times 10^{15}$  electrons. (3 marks)
- List at least three similarities between Coulomb force and gravitational force. (3 marks)
- State coulombs law, hence use dimensional analysis to derive the SI units of the constant of proportionality. (4 marks)
- Give the mathematical expression of the principle of superposition as applied to charges (1 mark)

- i. Two resistors  $2\ \Omega$  and  $3\ \Omega$  are connected in series across a  $1.5\ \text{V}$  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  $0.1\text{kg}$  mass is tied to a string as shown in Figure 1. The string is attached to a  $0.5\ \text{kg}$  mass and stretched over a pulley, leaving the  $0.1\text{kg}$  mass suspended above the floor. If the frictional force between the  $0.5\ \text{kg}$  object and the plane is  $0.2\ \text{N}$ 
  - i. determine the tension in the string (5 marks)
  - ii. acceleration (3 marks)
  - iii. the time it will take the  $0.1\text{kg}$  mass to fall a distance of  $1.50$  meters if starting from rest (3 mark)



**Figure 1: Acceleration**

- c. A block of mass  $5\ \text{kg}$  initially at rest slides down a plane at inclined at  $30^\circ$  to the horizontal. If the length of the plane is  $2\ \text{m}$ , and the frictional force between the plane and the object is  $10\ \text{N}$ , 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  $2 \times 10^{-9}\ \text{C}$  are situated at each of the three corners of a square whose side is  $0.2\ \text{m}$ . What would be the magnitude and direction of the resultant force on a point charge of  $-1 \times 10^{-9}\ \text{C}$  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  $2 \times 10^7\ \text{C}$  is placed at a distance of  $0.15\text{m}$  from another positive charge of  $8 \times 10^7\ \text{C}$ . At what point is the electric field zero? (5mks)
- c. Two point charges  $q_1 = 4 \times 10^8\ \text{C}$  and  $q_2 = -3 \times 10^{-8}$  are  $10\text{cm}$  apart. A point A is midway between them, point B is  $8\text{cm}$  from  $q_1$  and  $6\text{cm}$  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:
- capacitance of the combination (5mks)
  - the total charge of the combination (2mks)

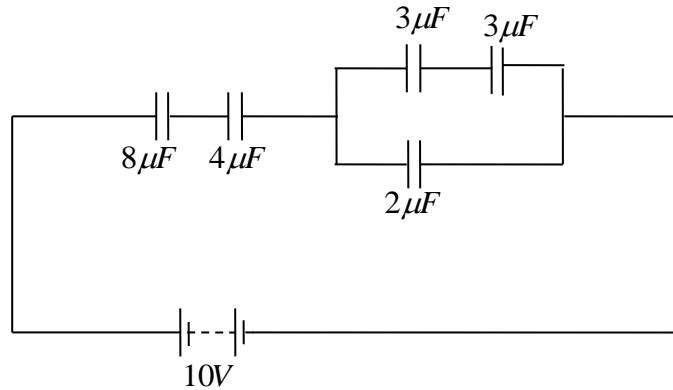


Figure 2 : Capacitors

- Derive the expression for charging a capacitor through R. (6 marks)
- Two capacitors  $C_1 = 2 \mu\text{F}$  and  $C_2 = 5 \mu\text{F}$  are connected in parallel with a 20 V battery. The battery is removed and plates of opposite signs are connected. Find:
  - the initial energies of the capacitors (4 marks)
  - the final energies of the capacitors (3 marks)

**Question 5 (20 marks)**

- Describe the factors on which the resistance of a conductor depends on. (3 marks)
- 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
  - R (4 marks)
  - the EMF of the cell (3 marks)
  - the internal resistance (3 marks)
- Use Kirchoff's laws to find the currents (Figure 3)
  - $I_1$  (3 marks)
  - $I_2$  (2 marks)
  - $I_3$  (2 marks)

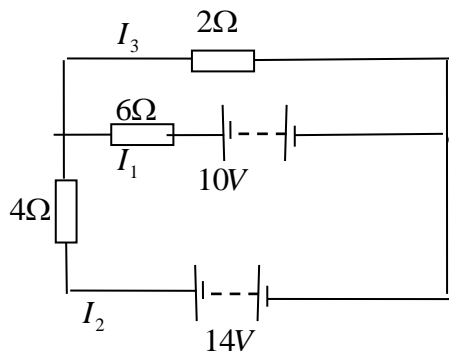


Figure 3: Resistors