TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF SCIENCE IN MARINE RESOURCE MANAGEMENT

APS 4109: FUNDAMENTALS OF PHYSICS

END OF SEMESTER EXAMINATION
SERIES: APRIL 2015
TIME ALLOWED: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FIVE** questions
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **FOUR** printed pages

Where necessary take:

- Acceleration due to gravity, g = 9.8m/s^2
- Permittivity of free space, ε_o = 8.854 x 10^{-12}Fm^{-1}
- Charge an electron, $e = -1.602\times10^{-19} C$
- Mass of an electron , Me = 9.1 x 10^{-31}kg

Question One (Compulsory)

a) (i) State TWO limitations of dimensional analysis **(2 marks)**

(ii) Show that the equation of motion $v^2 = u^2 + 2as$ is dimensionally correct (the symbols have their usual meaning) **(3 marks)**

b) (i) State the Coulomb's Law **(1 mark)**

(ii) Two point charges are located in the positive x-axis of a coordinate system. Charge $q_1 = 1.0nC$ and is 2.0cm from the origin and $q_2 = -3.0nC$ is 4.0cm from the origin. What is the total force exerted by those two charges on a charge $q_3 = 5.0nC$ located at the origin **(4 marks)**

c) (i) State TWO factors affecting frictional force on a body **(2 marks)**

(ii) A 3.1 x 10^5kg train is travelling up a plane inclined at 30°. If the coefficient of dynamic friction is $\mu k = 0.25$, calculate the force that the train engine should apply to maintain the motion at a constant velocity **(4 marks)**

d) (i) A body moving with a constant speed in a uniform circular path is said to be accelerating. Explain **(2 marks)**

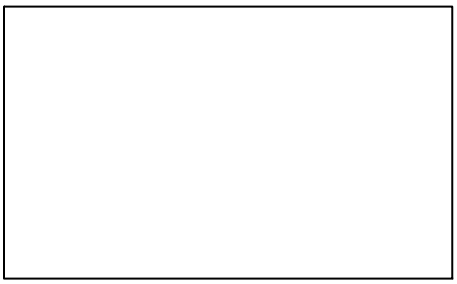
(ii) A bus travelling at 80m/s is negotiating a curve. Calculate the force exerted on a 60kg person leaning on the inner wall of the bus 50m from the centre of the curve. **(2 marks)**

e) (i) Show that for two resistors, R1 and R2 connected in parallel, the effective resistance R is given by:

$$R = \frac{R_1 R_2}{R_1 + R_2}$$

(3 marks)

(ii) The figure below shows a circuit diagram of resistors connected to a 24v battery of negligible internal resistance



Determine the potential difference across the 3Ω resistor **(3 marks)**

f) Define the following terms:

(i) Amplitude **(1 mark)**

(ii) Wavelength **(1 mark)**

g) A radiowave has a frequence of 3mHz and travels with a velocity of 3.0 x 10^8m/s. What is its wavelength **(2 marks)**

Question Two

a) (i) What is an electric field? **(2 marks)**

(ii) Given that the electric force between two charges is given by:

$$F = \frac{1}{4\pi\varepsilon_o}\frac{Q_1 Q_2}{r^2}$$

. Show that the electric field between the test charge, Q1 and the point charge Q_2 is given by:

$$E = \frac{1}{4\pi\varepsilon_o}\frac{Q_1}{r^2}$$

hence find the electric field of a particle of charge 1.26 x 10^{-17}C at a radius of 6.2 x 10^{-15}m **(6 marks)**

(iii) What is the magnitude of the electric field, E such that an electron placed in the field, would experience an electrical force equal to its weight? **(3 marks)**

b) (i) In figure 2 below, the energy stored in C4 is 27J. Calculate the total energy stored in the system **(7 marks)**

Figure 2

(ii) State TWO factors affecting the capacitance of a capacitor **(2 marks)**

Question Three

a) (i) Differentiate between elastic and inelastic collisions **(3 marks)**

(ii) Two balls A and B are involved in a collision. If B is initially at rest while A was initially moving to the right when it collides with B then both stick and more off with a velocity of 2m/s to the right. Calculate the initial speed of A if its mass is half that of B **(5 marks)**

b) A body of mass 5kg is attached to the hook of a spring balance hanging from the roof of a lift. What is the reading on spring balance when the lift is:

(i) Ascending at an acceleration of 0.6m/s^2? **(2 marks)**

(ii) Descending at an acceleration of 0.5m/s^2 **(2 marks)**

(iii) Ascending at a constant velocity **(2 marks)**

c) A block of mass 5kg is connected by a string over a frictionless pulley to a 10kg block that is sliding on a frictionless table as shown:

(i) Draw a free body diagram for each mass **(2 marks)**
(ii) Determine the acceleration of the system **(4 marks)**

Question Four

a) (i) Define electromotive force **(1 marks)**

(ii) State the Ohm's law **(2 marks)**

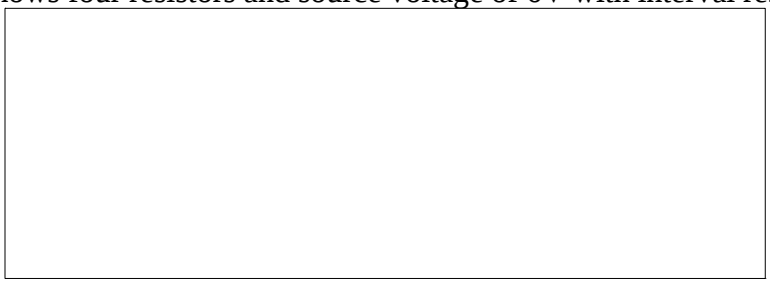
(iii) A rectangular carbon block has dimensions 1.0cm x 1.0cm x 50cm. What is the resistance measured between the two square ends. The resistivity of carbon at 20^oC is $5 \times 10^{-5}\Omega m$ **(2 marks)**

b) (i) A current of 0.2A exists in 10 ohms resistor for 2 minutes. Find the number of electrons that passes through the cross-section of the resistor in this time **(2 marks)**

(ii) At what temperature would the resistance of a copper conductor be double its resistance at O^oC? The temperature of coefficient for copper is 0.0039^oC^{-1} **(3 marks)**

c) A cell drives a current of 2.0A through a 0.6Ω resistor. When the same cell is connected to a 0.9 Ω resistor, the current flow is 1.5A. Find the interval resistance and the e.m.f of the cell **(4 marks)**

d) The figure 3 below shows four resistors and source voltage of 6V with interval resistance of 0.2 Ω



(i) Find the effective resistance of the circuit **(3 marks)**
(ii) Calculate the current through the 2 Ω resistance **(3 marks)**

Question Five

a) Arrange the following electromagnetic waves in order of increasing frequency **(2 marks)**
Radiowaves, x-rays, visible light, microwaves

$$y = 20\sin(40t - 20x)$$

b) The equation represents a plane wave travelling in the positive x-axis direction, y being the displacement of the particle at a point x. Find:

(i) The frequency of the wave

(ii) The wavelength of the wave

(iii) The speed of the wave **(6 marks)**

c) (i) Define the term radioactivity **(2 marks)**

(ii) The half-life of a certain radioactive element is 16 years. What fraction of the element will be remaining after 48 years **(3 marks)**

d) (i) State TWO factors that affects the magnitude of induced e.m.f **(2 marks)**

(ii) A flat coil of a wire with 50 turns and a cross-sectional area of $50cm^2$ is placed in a magnetic field with its plane perpendicular to the magnetic field $B = 0.45T$. If the field is changing at the rate of 0.04T/S, find the magnitude of the induced e.m.f at the terminals of the coil **(5 marks)**