P510/2
PHYSICS
Paper 2
8 August 2018
2 ½ hours

ENTEBBE JOINT EXAMINATION BUREAU

Uganda Advanced Certificate of Education

PHYSICS

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **FIVE** *questions, taking at least one from each of the* Sections **A**, **B**, **C** *and* **D but not more than one question** *should be chosen from either* Section **A** or **B**.

Any extra question shall **not** *be assessed.*

Non-programmable scientific electronic calculators may be used.

Assume where necessary

Acceleration due to gravity, g	=	$9.81\ ms^{-2}$
Speed of light in a vacuum, c	=	$3 \times 10^{8}\ ms^{-1}$
Speed of sound in air	=	$330\ ms^{-1}$
Electronic charge, e	=	$1.6 \times 10^{-19}\ C$
Electron mass	=	$9.11 \times 10^{-31}\ kg$
Permeability of free space, μ_0	=	$4\pi \times 10^{-7} Hm^{-1}$
Permittivity of free space, ε_0	=	$8.85 \times 10^{-12}\ Fm^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9}\ mF^{-1}$
One electron volt (eV)	=	$1.6 \times 10^{-19}\ J$
Avogadro's number N_A	=	$6.02 \times 10^{23}\ mol^{-1}$
Planck's constant, h	=	$6.63 \times 10^{-34}\ Js$
Specific heat capacity of water	=	$4.2 \times 10^{3} JKg^{-1} K^{-1}$

SECTION A

1. (a) (i) Define **refractive index of a material**. *(01 mark)*

(ii) What is the refractive index of a material through which light travels at $2.0 \times 10^8\ ms^{-1}$? *(02 marks)*

(b) Show that the refractive index, n of the material of a glass prism is given by

$$n = \frac{Sin\left(\frac{A + Dm}{2}\right)}{Sin\left(\frac{A}{2}\right)}$$

where A is the refracting angle of the prism and Dm is the angle of minimum deviation for light passing through the prism.

(03 marks)

(c) Describe an experiment to determine the refractive index of glass using a triangular prism and optical pins. *(05 marks)*

(d) A thin equiconvex lens of glass of refractive index 1.50 whose surfaces have radius of curvature 24.0 cm is placed on a horizontal plane mirror. When the space between the lens and the mirror is filled with a liquid, a pin held 40.0 cm vertically above the lens is found to coincide with its own image. Calculate the refractive index of the liquid.

(04 marks)

(e) In an experiment to determine focal length of a lens, after tabulating results, a student plotted a graph of magnification, M against image distance; V. Explain how the student used the graph to find the focal length, without calculating the slope. *(03 marks)*

(f) Explain **two** advantages of using prisms instead of plane mirrors in periscopes. *(02 marks)*

2. (a) Define the terms:

(i) **focal plane** of a lens. *(01 mark)*

(ii) **angular magnification** of a telescope. *(01 mark)*

(b) Explain **one** advantage of the Galilean telescope over an astronomical telescope. *(02 marks)*

(c) An astronomical telescope has an objective with a focal length of 100 *cm* and a diameter 5 *cm*. If the eye piece has a focal length of 20 *cm* and the telescope is used in normal adjustment, calculate the:

(i) magnifiying power *(02 marks)*

(ii) diameter of eye ring *(02 marks)*

(iii) separation of the lenses *(02 marks)*

(d) Give **two** advantages of prism binoculars as an optical instrument.

(e) (i) Define **chromatic aberration**. *(01 mark)*

(ii) State **two** properties of lenses used to make an achromatic doublet. *(02 marks)*

(f) Describe an experiment to determine focal length of a diverging lens using a concave mirror. *(05 marks)*

SECTION B

3. (a) (i) Define the terms **fundamental frequency** and **overtone** as applied to a vibrating string. *(01 mark)*

(ii) The second overtone in a closed tube of length 0.4 *m* has the same frequency as the fundamental of a stretched line of length 0.6 *m* and mass per unit length 2.0×10^{-3} Kgm^{-1}. Calculate the tension in the wire. *(04 marks)*

(b) Describe an experiment to determine the end correction of a resonance tube. *(06 marks)*

(c) A stationary wave is represented by the equation

$$y = 5 \text{ Cos } \frac{2\pi x}{5} \text{ Sin } \frac{2\pi t}{5}$$

where x and y are in metres and t in seconds.

Determine:

(i) its maximum amplitude *(02 marks)*

(ii) the speed of either progressive wave overlapping to form the stationary wave. *(04 marks)*

(d) Explain the term **damped oscillations**. *(02 marks)*

4. (a) Distinguish between **diffraction** and **interference of light**. *(02 marks)*

(b) (i) Sketch a graph of variation of intensity with angular position on a screen for the single slit diffraction pattern. *(02 marks)*

(ii) Explain the formation of the single slit diffraction pattern. *(02 marks)*

(c) (i) Describe an experiment to determine wave length of monochromatic light by Newton's rings. *(05 marks)*

(ii) Explain what happens to Newton's rings if water is introduced in the space between the lens and the glass plate. *(02 marks)*

(d) Two glass plates 4 *cm* long touch at one edge and are separated by a piece of paper 0.02 *mm* thick at the other edge. The wedge is illuminated by light of wave length 589 *nm*. Calculate the:

(i) separation of the bright bands produced. *(02 marks)*

(ii) number of bright bands observed. *(02 marks)*

SECTION C

5. (a) Define the term **magnetic flux density**. *(01 mark)*

(b) Write down expressions for the:

(i) magnetic flux density at a perpendicular distance, ***x*** from a long straight conductor carrying current, ***I*** in air. *(01 mark)*

(ii) force on a straight conductor of length ***l*** carrying current ***I*** at an angle, θ to a uniform magnetic field of flux density ***B***. *(01 mark)*

(c) Two straight long and parallel lines of negligible cross – sectional areas carry currents of 6A and 3A in opposite directions as shown in Figure I.

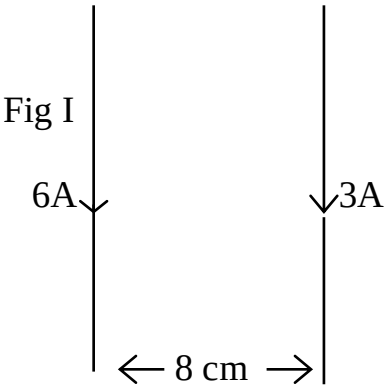

Fig I

If the wires are separated by a distance of 8 *cm*, find the

(i) Magnetic flux density at a point midway between the wires. *(04 marks)*

(ii) the force per metre between the wires. *(03 marks)*

(d) Define:

(i) **angle of dip** *(01 mark)*

(ii) **angle of declination** *(01 mark)*

(e) A straight conductor of length ***l*** is perpendicular to a magnetic field of flux density ***B.*** If the conductor moves with velocity, ***U*** at an angle θ to the magnetic field, derive an expression of the emf induced. *(04 marks)*

(f) An aircraft of wing span 20 m is moving horizontally from West to East at a velocity of 250 ms^{-1} in a place where the angle of dip is 59^0. The emf induced across the tips of the wings is 6 mV. Find the magnetic flux density of the earth's field. *(04 marks)*

6. (a) State **the laws of electromagnetic induction**. *(02 marks)*

(b) (i) Describe an absolute method of determining unknown resistance. *(05 marks)*

(ii) A solenoid of 1000 turns and length 5 cm carries a current of 2A. Inside the solenoid is placed a circular disc of radius 4 cm such that its plane is perpendicular to the axis of the solenoid. Calculate the emf induced between the centre and rim of the disc when the disc is rotated at a frequency of 100 Hz. *(04 marks)*

(c) The coil of a d.c motor is mounted in a radial magnetic field of flux density 1.40 T. The coil has 16 turns, each of area 50 cm^2 and a total resistance of 3 Ω. Calculate the:

(i) maximum angular velocity the motor attains when working on a 230 V mains and drawing a current 0.8 A. *(04 marks)*

(ii) efficiency of the motor. *(02 marks)*

(d) (i) Explain why in a moving coil galvanometer, the magnetic field is radial. *(02 marks)*

(ii) State **two** ways of improving the current sensitivity of a galvanometer. *(01 mark)*

7. (a) (i) Define the terms **root mean square** *(r.m.s)* **value** and **peak value** of an alternating current. *(02 marks)*

(ii) A sinusoidal alternating current $I = 3\text{Sin}(120\pi t)$ amperes flows through a resistor of resistance 2.5Ω. Find the power dissipated in the resistor and sketch a graph of voltage and current through the resistor on the same axes against time. *(04 marks)*

(b) A coil of wire is connected in parallel with an electric bulb to a d.c source a shown in figure 2.

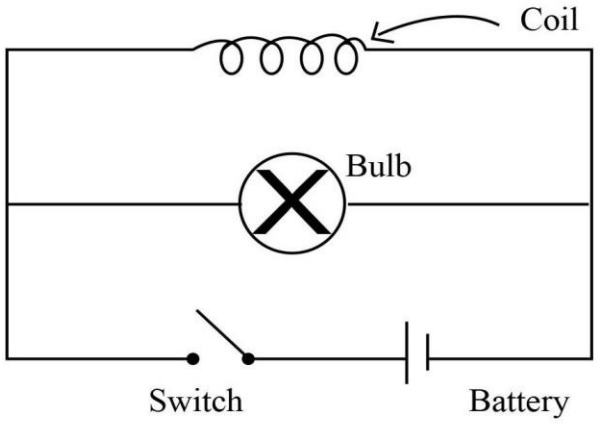

Fig 2

Explain what is observed when the switch is closed. *(04 marks)*

(c) (i) Define **reactance of a capacitor.** *(01 mark)*

(ii) In an experiment to measure the reactance of a capacitor, the root – mean – square current is measured to be 10 *mA*, and the peak – to – peak voltage to be 16 *V*. If the frequency is 10 Hz, find the reactance of the capacitor and its capacitance. *(04 marks)*

(d) (i) With the aid of a diagram, describe the structure and mode of action of attraction type moving iron meter. *(05 marks)*

(ii) State **one** advantage of this type of meter over an ordinary ammeter. *(01 mark)*

SECTION D

8. (a) Define the terms **capacitance** and **dielectric strength**. *(02 marks)*

(b) (i) Describe an experiment to determine the effect of placing a dielectric in a capacitor, on capacitance. *(04 marks)*

(ii) Calculate the capacitance of a parallel plate capacitor whose plates are of dimensions 15 *cm* by 12 *cm* separated by an insulator of thickness 8 mm and relative permittivity 2.3. *(04 marks)*

(c) Two identical capacitors are connected in series across a voltage source. Show that when a dielectric of relative permittivity, εr is inserted in one of the capacitors, the energy stored in the network increases by a factor of

$$\frac{2\varepsilon r}{(1 + \varepsilon r)}$$ *(04 marks)*

(d) Figure 3 shows capacitors C_1, C_2 and C_3 of capacitances 2μF, 3μF and 4μF respectively placed in air. Calculate the total energy stored in the capacitors when a dielectric of constant 2.5 is inserted between the plates of C_1. *(04 marks)*

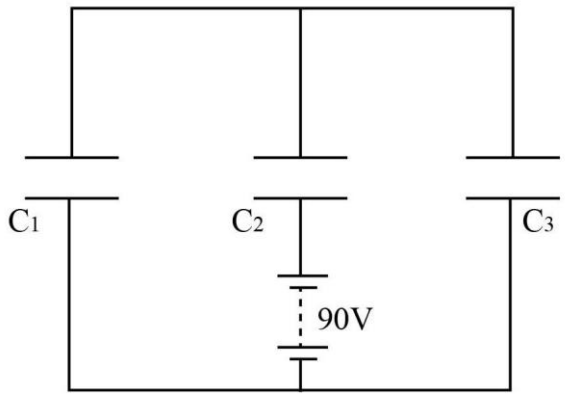

Fig 3

(e) The plate separation of a parallel plate capacitor is 5 *mm*. State and explain what happens to the energy stored when the plate separation is increased to 10 mm. *(02 marks)*

9. (a) (i) Define **electromotive force** and **internal resistance of a cell**. *(02 mark)*

(ii) Two identical cells are connected across a resistor of 3Ω. When the cells are in parallel, the current flowing is 0.57 A. when they are connected in series, the current is 0.8 A. Find the emf and internal resistance of the cells. *(04 marks)*

(b) Describe an experiment to determine the relationship between resistance of a material and diameter of a wire. *(05 marks)*

(c) In a simple metre bridge resistors *A* and *B* have values 5Ω and 3Ω respectively as shown in figure 4.

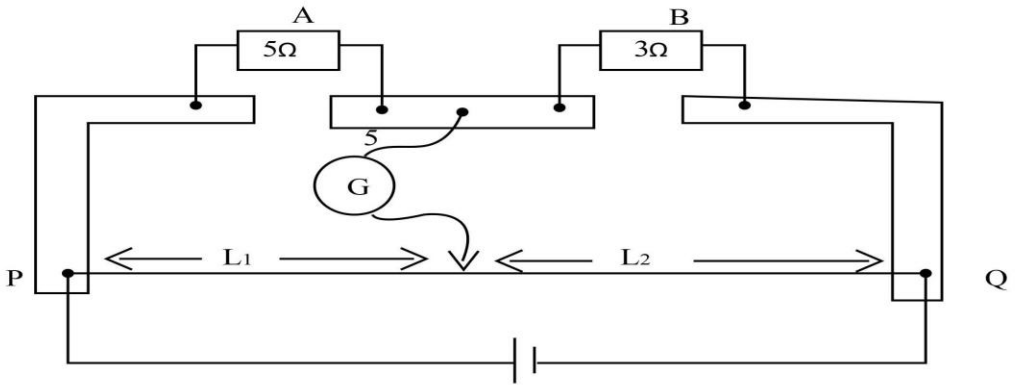

Fig 4

(i) When *A* is shunted by a length of wire, the balance is found to be 0.527 m from *P*. What is the resistance of the shunt? (*04 marks)*

(ii) If the shunt wire is 0.75 m and 0.25 mm in diameter, calculate the resistivity of the material of the wire. *(03 marks)*

(d) Why is a metre bridge not suitable for comparing two resistances that are very small? *(02 marks)*

10. (a) (i) What is meant **a corona discharge**? *(03 marks)*

(ii) Explain how lightning is formed and how it can cause severe damage to buildings. *(04 marks)*

(b) (i) State **Coulomb's law.** *(01 mark)*

(ii) A metal sphere of mass ***m*** is suspended from a rigid support using a nylon thread of length ***h***. The metal sphere is then fixed in position. An identical sphere is suspended from the same support. When the two spheres are given identical charge δ, they repel and at equilibrium, the spheres are a distance *x* apart in air. Show that:

$$\delta = \sqrt{\frac{4\pi\Sigma_0 mgx^3}{h}}$$

(c) In figure 5 below, ***ABCD*** are vertices of a square of side 8 *cm*. Charges of +31.6μC, +27.4 μC and -27.3μC are placed at the vertices ***A***, ***B***, ***C*** and ***D*** respectively.

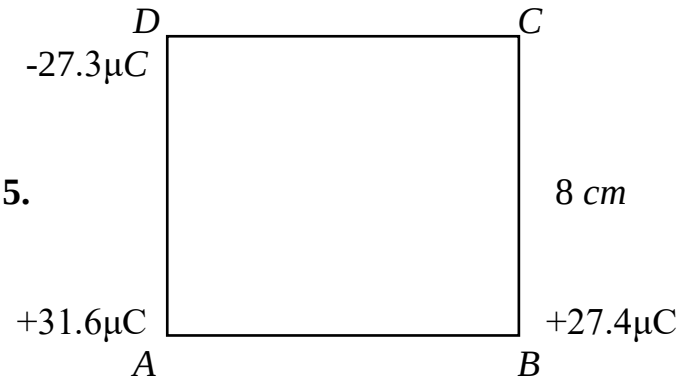

Fig 5.

Find the

(i) electric field intensity at ***C***. *(06 marks)*

(ii) potential energy of the charge at ***D***. *(03 marks)*

END