P510/2

PHYSICS

Paper 2

Jul/ Aug 2018

3 Hours

MUKONO EXAMINATIONS COUNCIL

Uganda Advanced Certificate of Education

PHYSICS

Paper 2

3 Hours

INSTRUCTIONS TO CANDIDATES

*Answer **five** questions, including at least **one** from each section, but **not more** than **one** from any of the sections **A** and **B**.*

Where necessary assume the following constants:

Acceleration due to gravity,	g	=	$9.81 ms^{-2}$
Speed of light in vacuum,	c	=	$3.0 \times 10^{8} ms^{-1}$
Speed of sound in air	v	=	$340 ms^{-1}$
Electronic Charge,	e	=	$1.6 \times 10^{-19} C$
Electronic mass,	m_e	=	$9.1 \times 10^{-31} kg$
Permeability of free space,	μ_0	=	$4.0\pi \times 10^{-7} Hm^{-1}$
Permittivity of free space,	ε_0	=	$8.85 \times 10^{-12} Fm^{-1}$
The Constant,	$\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9} F^{-1} m$

SECTION A

1.(a) Define principal focus of a concave lens. ***(1mark)***

(b) (i) Show that the focal length, f, of a convex lens can be given by

$\frac{1}{f}$ = (n-1) ($\frac{1}{r1}$ +$\frac{1}{r2}$), where n is the refractive index of the material of the lens, and r_1, r_2, are the radii of curvature of the lens surfaces. ***(4marks)***

(ii) A diverging meniscus of focal length 115.4cm, is made of material of refractive index 1.52. If the radius of curvature of its concave surface is 12cm, find the radius of curvature of the other surface. ***(3marks)***

(c) Describe how you can determine the refractive index of a transparent liquid using a convex lens of known radii of curvature and plane mirror. ***(6marks)***

(d) (i) Draw a ray diagram to show the image formation by Galilean telescope with the final image at the near point. ***(2marks)***

(ii) A Galilean telescope is used to focus a distant object with the eye piece placed 50cm from the objective lens. The focal lengths of the objective and the eye piece are 100cm and 10cm respectively. Find the distance of the final image from the objective lens. ***(3marks)***

(iii) Describe one disadvantage of a Galilean telescope. ***(1mark)***

2. (a)(i) Define principal focus of a convex mirror. ***(1mark)***

(ii) Using a convex mirror, derive the mirror formula. ***(5marks)***

(b) A concave mirror forms an inverted image $\frac{9}{5}$ times the size of the object, when the object is placed in front of it. When the object is moved 18cm towards the mirror, the image formed is upright and three times the size of the object. Find the:

(i) focal length of the mirror. ***(4marks)***

(ii) displacement of the image. ***(3marks)***

(c) With the aid of a sketch ray diagram, describe how a prism binocular works. ***(4marks)***

(d) (i) What is accommodation as applied to vision by the eye? ***(1mark)***

(ii) Explain why when two poles of equal height are placed at different points in line with the observer they appear to differ in size. ***(2marks)***

SECTION B

3 (a) (i) List two differences between mechanical and electromagnetic waves. ***(2marks)***

(ii) Describe a simple experiment to show that sound is a mechanical wave. ***(4marks)***

(b) (i) What are harmonics as applied to sound notes? ***(1mark)***

(ii) Show that the frequency of the n^{th} harmonic produced by an open pipe of length, l , and end correction, e, is given by

$f_n = \frac{nV}{2(l+2e)}$, where V is the velocity of sound in air. ***(3marks)***

(iii) Explain why two open pipes of the same length may produce fundamental notes of different frequencies. ***(3marks)***

(c)(i) A car moving towards a high cliff passes a stationary observer with a speed of 18km/h, while sounding a horn of frequency 205Hz. If the velocity of sound at the time is 340m/s, find the frequency of beats head by the observer. ***(4marks)***

(ii) Describe one application of Doppler Effect. ***(3marks)***

4. (a) What are coherent sources of waves? ***(1mark)***

(b) Explain how two coherent sources are obtained

(i) using a bi-prism. ***(2marks)***

(ii) using Lloyd's mirror. ***(2marks)***

(c) (i) Two coherent sources of waves a distance, d, apart produce light of wavelength,λ, which interfere on a screen, a distance, D, from the source forming an interference pattern. Show that the width, x, of each fringe is given by $x = \frac{\lambda D}{d}$. ***(4marks)***

(ii) Two glass slides in contact at one end are separated by a sheet of paper 15cm from the line of contact, to form an air wedge. When the air wedge is illuminated almost normally by light of wavelength 600nm, interference fringes of separation 1.8mm are formed. Find the thickness of the paper. ***(4marks)***

(d) (i) Describe how plane polarised light can be produced by double refraction. (4marks)

(ii) Describe briefly one application of plane polarised light. ***(3marks)***

SECTION C

5 (a) What are magnetic field lines and magnetic field strength? ***(2marks)***

(b) (i) With the aid of a sketch diagram of magnetic field pattern due to two wires carrying currents in opposite directions, explain why force acts between the wires. ***(3marks)***

(ii) A rectangular coil of, N, turns, length, l, and width, w, carrying current, I, is placed in a uniform magnetic field of flux density, B, with its plane parallel to the field. Derive the expression for the torque on the coil. ***(4marks)***

(c) What is magnetic meridian and angle of dip? ***(2marks)***

(d) Describe how you can determine the horizontal component of the earth's magnetic flux density using a deflection magnetometer. ***(4marks)***

(e) A vertical wire of length 15cm carries current of 5A in a plane where the earth's total intensity is $54.2Am^{-1}$. If the angle of dip at the location is 49.5^0, find the

(i) force experienced by the wire. ***(3marks)***

(ii) Vertical component of the field strength. ***(2marks)***

6 (a)State the laws of electromagnetic induction. ***(2marks)***

(b) A coil of 100turns is wound round the middle of a long solenoid of 500turns per metre and radius 8.0cm. A sinusoidal current of I = $10\sin(120\pi t)$, amperes is passed through the solenoid winding. Find the amplitude of the emf induced across the terminals of the coil. ***(5marks)***

(c) (i) With the aid of a diagram, describe how a simple d.c motor works. ***(5marks)***

(ii) Explain the term back emf in a motor and derive its relation to the efficiency of the motor. ***(3marks)***

(iii) When a motor is connected to a supply voltage of 210V and is running freely, the supply current is 3.0A. If the motor is 97% efficient, find the armature resistance. ***(2marks)***

(d) Briefly explain one application of eddy currents. ***(3marks)***

7. (a) (i) Why is alternating current referred to as sinusoidal? ***(1mark)***

(ii) Derive the expression for the average power dissipated in a resistor when a sinusoidal current is passed through it. ***(3marks)***

(b) (i) A current of $I = I_o \sin 2\pi ft$ is supplied in a circuit containing a capacitor of capacitance, C. Derive the expression for the p.d across the capacitor. ***(2marks)***

(ii) Draw on the same axes graphs showing the variations of voltage across the capacitor and the current supplied against time. ***(2marks)***

(iii) Explain the phase relationship between the current and voltage in b(i) above. ***(2marks)***

(c)(i) Describe how a hot wire ammeter works. ***(4marks)***

(ii) List the differences in the principle of operation of the ammeter in c(i) above with a repulsion type of ammeter. ***(3marks)***

(d)(i) Define the term impedance. ***(1mark)***

(ii) A pure inductor of inductance 15mH is connected in series with a resistor of 3.0Ω, across an a.c mains of frequency 50Hz. Determine the impedance of the circuit.

(3marks)

SECTION D

8 (a) (i) Draw the I – V characteristic graphs for filament lamp and semi – conductor diode. ***(2marks)***

(ii) Explain the features in the graphs in a(i) above. ***(3marks)***

(b) (i) outline the principle of operation of a slide wire potentiometer. ***(3marks)***

(ii) Describe an experiment to determine the emf of a thermo – couple using a potentiometer. ***(5marks)***

(c)

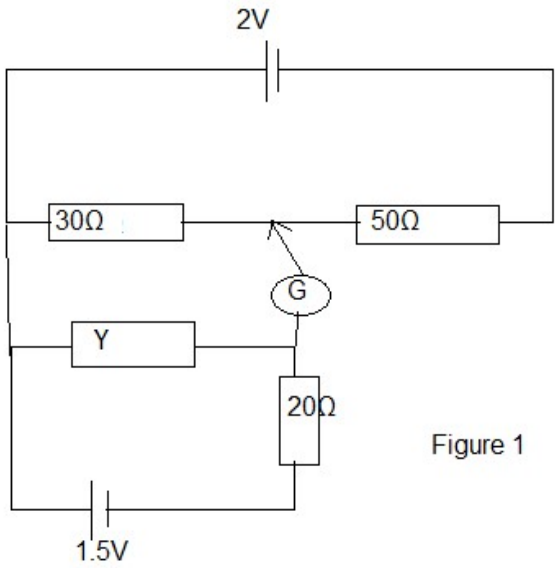

Figure 1

In figure 1, the cells of 2V and 1.5V have negligible internal resistance. If the centre zero galvanometer, G, shows no deflection, find the value of resistance, Y. ***(4marks)***

(d) A coil of wire has resistance of 35Ω at 28^0C and 37.4Ω at 50^0C. Calculate the temperature coefficient of resistance of the wire. ***(3marks)***

9. (a) State Coulomb's law of electrostatics. ***(1mark)***

(b)

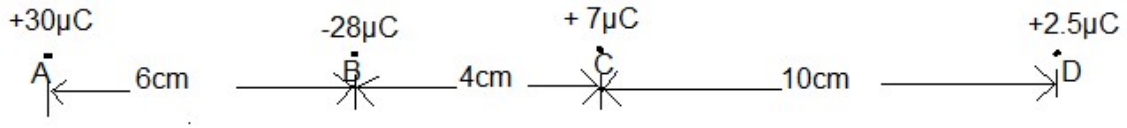

Figure 2

Charges of +30μC, -2.8μC, +7μC and +2.5μC are placed in a straight line in air as above.

Find the;

(i) Force acting on the +2.5μC charge. ***(4marks)***

(ii) Electric potential energy of the -2.8μC charge. ***(3marks)***

(c) (i) Explain why the potential of a positively charged body reduces when a neutral conductor is brought near it. ***(3marks)***

(ii) A gold leaf electroscope is positively charged and isolated. When a thumb pin is placed on the cap of the electroscope with its pointed end facing away, the leaf of the electroscope is seen to collapse after a short time. Explain this observation. ***(2marks)***

(d) (i) Describe how a Van de Graaff generator works. ***(6marks)***

(ii) Account for the energy stored in the generator. ***(1mark)***

10. (a) (i) Define capacitance of a capacitor. ***(1mark)***

(ii)

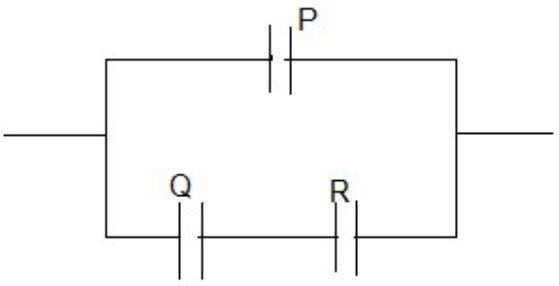

Figure 3

Figure 3, is a network of three identical capacitors of capacitance, C, Show that when a dielectric of relative permittivity ε_r is inserted in the capacitors R and P, the total capacitance in the network becomes $\frac{(2+\varepsilon r)\varepsilon rC}{(1+\varepsilon r)}$. ***(3marks)***

(b) (i) Describe how you would determine capacitance of a capacitor. ***(4marks)***

(ii) State two uses of a dielectric in a capacitor. ***(1mark)***

(c) Two capacitors of capacitances 16μF and 20μF are connected in series and charged by a battery of 40V. The two capacitors are then connected across an uncharged capacitor, B, of capacitance 8μF, and then the plates of B are filled with a dielectric of relative permittivity 1.5.

Calculate :

(i) the final p.d across B. ***(4marks)***

(ii) the final energy stored in the network. ***(3marks)***

(d) Explain how placing a dielectric between the plates of a capacitor changes the capacitance. ***(4marks)***

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