P510/2
Physics
Paper 2
June/July 2019
2½ hours

Uganda Advanced Certificate of Education
MOCK EXAMINATIONS 2019
PHYSICS
Paper 2
2 Hours 30minutes

INSTRUCTIONS TO CANDIDATES

- Attempt any *five* questions, including at least one from each section but not more than **one** question from each of the sections A and B.
- Silent non-programmable electronic scientific calculators may be used.
- Mathematical tables and squared papers will be provided.

The following values of physical constants may be necessary.

Acceleration due to gravity, g	=	$9.81 ms^{-2}$
Speed of light in vacuum, C	=	$3.0x10^{8} ms^{-1}$
Electron charge, e	=	$1.6x10^{-19} C$
Electron mass, m_e	=	$9.1x10^{-31} kg$
Planks constant, h	=	$6.63x10^{-34} Js$
Permeability of free space, μ_0	=	$4\pi x10^{-7} Hm^{-1}$
Permittivity of free space, ε_0	=	$8.85x10^{-12} Fm^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	=	$9.0x10^{9} mF^{-1}$
One electron volt, 1eV	=	$1.6x10^{-19} J$
Speed of light in air,	=	$330 ms^{-1}$

Turn Over

SECTION A

1(a) Define the following terms as applied to lenses.

(i) **Focal length** *(1 mark)*

(ii) **Focal plane** *(1 mark)*

(b) Describe how you would determine the focal length of a convex lens basing on Newton's lens formula. *(5 marks)*

(c) A thin Plano - convex lens of focal length 15cm is placed on top of thin layer of liquid poured on a plane mirror as shown in figure 1 below.

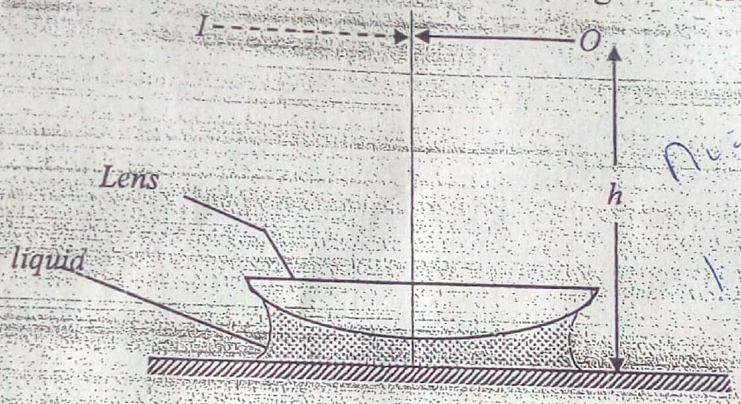


Fig1

An optical pin O clamped horizontally above the lens coincides with its image by no parallax when it is a distance ***h*** above the plane mirror as shown above. If the refractive index of liquid is 1.4 and that of lens material is 1.5, find the value of ***h***. *(5 marks)*

(d) (i) What is meant by **visual angle** and **magnifying power** as applied to optical instruments? *(2 marks)*

(ii) Derive an expression for magnifying power of a Galilean telescope in normal adjustment. *(4 marks)*

(e) Explain the significance of a convex mirror in a cassegrain reflecting telescope. *(2 marks)*

2 (a) (i) State the laws of reflection of light. *(2 marks)*

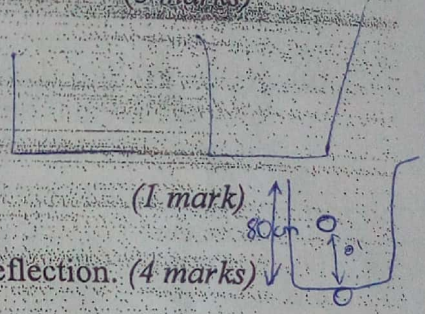
(ii) Describe how rotation of plane mirrors is applied in an optical lever galvanometer to measure current. *(5 marks)*

(b) A concave mirror forms a real image of magnification 3, of an object placed at point A, in front of it. When the object is moved to point B, a virtual image of same magnification is obtained. Find the radius of curvature of the mirror if the distance AB= 10cm. *(4 marks)*

(c) (i) Define **refraction** and **refractive index**. *(2 marks)*

(ii) An object is placed at the bottom of parallel-sided glass slab of thickness, t and refractive index, n. Derive an expression for the apparent displacement of the object when viewed normally from above. *(4 marks)*

(d) A small bulb is placed at the bottom of a tank containing water of refractive index 1.33 to a depth of 80cm. Find the area of the surface of water through which light from the bulb can emerge out. *(3 marks)*



SECTION B

3(a) (i) State Huygens principle. *(1 mark)*

(ii) Use the principle in (i) above to verify the laws of reflection. *(4 marks)*

(b) What is meant by **diffraction** and **interference** of waves? *(2 marks)*

(c) A diffraction grating has 600 lines per mm. When it is illuminated normally by monochromatic light, the angle between the central maximum and the first maximum is 18.9°. Find

(i) wave length of light. *(3 marks)*

(ii) the number of diffraction maxima obtainable. *(2 marks)*

(d) (i) With the aid of a diagram describe the experimental set up for observing Newton's rings. *(4 marks)*

(ii) Explain qualitatively how Newton's rings are formed. *(4 marks)*

4(a) (i) Distinguish between **transverse** and **longitudinal** waves. *(2 marks)*

(ii) Describe how the velocity of sound in air can be determined using a Kundt's tube. *(5 marks)*

(b) A wire held under tension between two bridges is plucked at its midpoint.

(i) Explain how the wire generates sound waves. *(3 marks)*

(ii) What is the effect of plucking the wire when it is mounted on a hollow wooden box? *(1 mark)*

(c) A closed pipe is of length 68cm and of end correction of 1.3cm. The pipe is blown to sound its second harmonic.

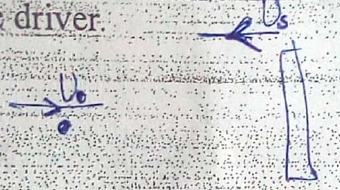
(i) Find the frequency of the note produced by the pipe. *(3 marks)*

(ii) Sketch the standing wave in the pipe. *(1 mark)*

(iii) State the effect of increasing temperature of air on the pitch of the note produced by the pipe. *(1 mark)*

(d) What is meant by Doppler effect? *(1 mark)*

(e) A car travelling directly towards a cliff at a speed of 30m s^{-1} sounds its horn which emits a note of frequency 100Hz. Find the apparent frequency of the echo heard by the driver. *(3 marks)*



SECTION C

5 (a) State the laws of electromagnetic induction? *(2 marks)*

(b) (i) Show that the *emf* induced in a motor rotating at ω radians per second in a radial magnetic field of flux density B is $E = \omega NAB$, where N is the number of turns and A is the area of the coil. *(3 marks)*

(ii) A coil of a motor has 500 turns each of area $20cm^2$ and of total resistance 10Ω. The coil is mounted in a radial magnetic field of flux density 1.8T. When the coil is connected to a d.c supply of 240V, it draws a current of 5.0A. Calculate the maximum angular velocity the motor attains. *(4 marks)*

(c) A metal plate is placed in a magnetic field with its plane perpendicular to the magnetic field. Explain why when the plate is set to oscillate about an axis through its plane, the oscillation gets damped. *(3 marks)*

(d) A copper disc of radius 10cm is set in a uniform magnetic field of flux density 1.6×10^{-2}T with its plane perpendicular to the field. The disc is rotated about an axis through its centre parallel to the field at 2400revolutions per minute. Calculate the emf induced between the rim and centre of the disc. *(3 marks)*

(e) With aid of a labelled diagram, describe the structure and mode of operation of a dc motor. *(5 marks)*

6 (a) Define the following terms as applied to earth's magnetism

(i) Angle of dip. *(1 mark)*

(ii) Magnetic north. *(1 mark)*

(b) Describe an experiment to determine the angle of dip in a particular place using a search coil and a calibrated ballistic galvanometer. *(5 marks)*

(c) The plane of a vertical circular coil of 50 turns each carrying 8A in air is in the magnetic meridian and is threaded by the Earth's magnetic field of 3.2×10^{-5} T, at a location whose angle of dip is 60°. The scale readings of the magnetometer are 38° and 40° respectively.

(i) Determine the radius of the coil. *(3 marks)*

(ii) Explain the effect of increasing the radius of the coil on the deflections of the magnetometer when the other factors are kept constant. *(2 marks)*

(d) Figure 2 below shows a rectangular slice of a semiconductor pulled horizontally along a frictionless table at a uniform speed of $6mms^{-1}$ while keeping the magnetic field of flux density B normal to the table.

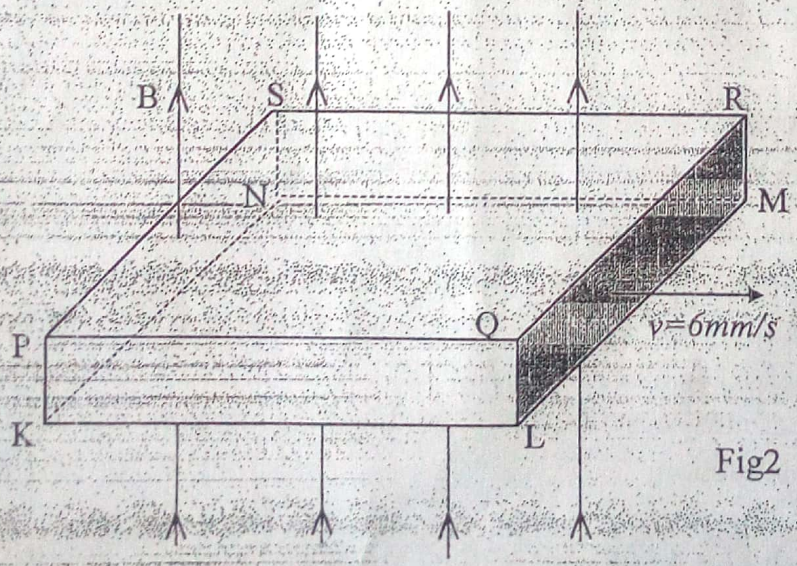


Fig2

(i) Explain how a potential difference develops between R and Q. *(3 marks)*

(ii) Explain the effect of increasing temperature of the slice on the voltage which develops between Q and R. *(2 marks)*

(iii) If a potential difference of $5\mu V$ develops between Q and R, and $\overline{PS} = 40mm$, find the value of B. *(3 marks)*

7. (a) Define ***root mean square (rms)*** value and ***frequency*** of an alternating current. *(2 marks)*

(b) Describe how the repulsion type iron meter measures current. *(5 marks)*

(c) A capacitor of capacitance C is connected to an a.c supply source of frequency, f.

(i) On the same axes sketch the time variation graphs of voltage across the capacitor and current in the circuit. Explain the phase relationship between current and voltage. *(4 marks)*

(ii) Show that the maximum voltage V_o across the capacitor is given by

$$V_o = \frac{I_o}{2\pi f C},$$

where I_o is the peak value of current through the capacitor. *(3 marks)*

(d) (i) What is meant by **self-induction** and **mutual induction**? *(2 marks)*

(ii) A pure inductor of inductance 0.4H, is connected in series with a resistor of 500 Ω across a 240 V ,1k Hz ac supply. Calculate the potential difference across the resistor. *(4 marks)*

SECTION D

8 (a) (i) Define *electric potential energy of* a charge. *(1 mark)*

(ii) Derive an expression for the electric potential energy of two point charges of Q_1 and Q_2 a distance x apart, in air. *(4 marks)*

(b) With aid of diagrams, describe how a gold leaf electroscope can be charged negatively by induction. *(5 marks)*

(c) Charges of **-3.0μC, +4.5μC** and **+5.0μC** are placed at the corners P, Q and R of a rectangular frame PQRS in which PQ = 3 cm and QR = 4 cm as shown in the figure 3 below

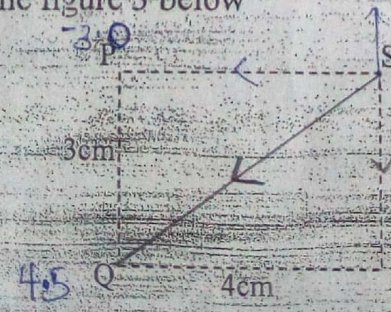


Fig 3

If the charges are in vacuum, calculate the electric intensity at S due to the charges. *(5 marks)*

(d) (i) What is meant by an equipotential surface? *(1 mark)*

(ii) Sketch an electric field pattern a positively charged sphere and indicate on it the equipotential surfaces. *(2 marks)*

(e) Explain why enormous energy produced during lightening can't be used to generate electricity. *(2 marks)*

9 (a) (i) State Ohm's law. *(1 mark)*

(ii) With aid of a sketch graph, describe the I – V characteristic of a vacuum diode. *(2 marks)*

(b) A conductor of length l and of cross sectional area A has n electrons each of charge e per unit volume. These free electrons are drifting at a mean velocity v.

(i) Derive an expression for current flowing through the wire. *(3 marks)*

(i) Given that the p.d across the conductor is fixed, explain the effect of increasing temperature on v. *(2 marks)*

(c) Figure 4 below shows a circuit,

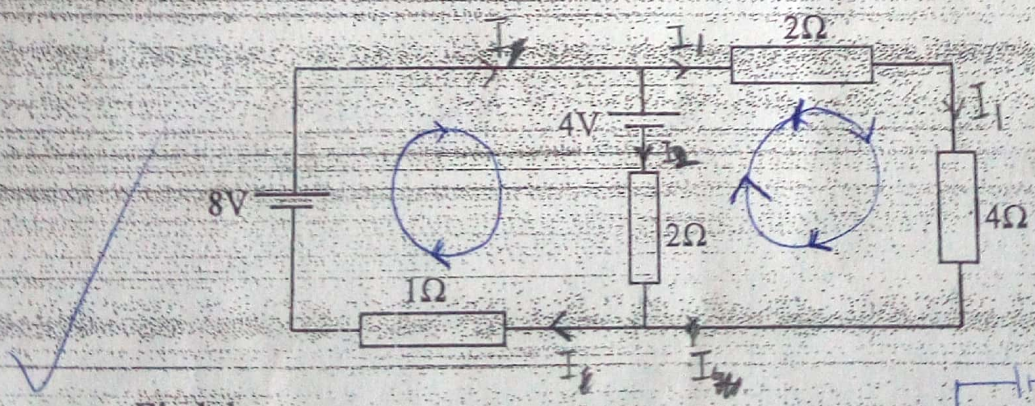


Fig 4

Find the,

(i) current through 1Ω resistor. *(3 marks)*

(ii) Power dissipated in 4Ω resistor. *(3 marks)*

(d) (i) Describe how you would use a potentiometer to calibrate an ammeter. *(5 marks)*

(ii) State one advantage of using a potentiometer to measure voltage over an ordinary voltmeter. *(1 mark)*

10(a) What is meant by *Dielectric constant* and *capacitance*? *(2 marks)*

(b) A capacitor consists of two concentric spheres. The inner sphere of radius r_1 carries a positive charge Q while the outer sphere of radius r_2 is earthed with vacuum between them.

(i) Derive an expression for the capacitance of the capacitor *(3 marks)*

(ii) Calculate the energy stored in the capacitor if $r_1 = 20.0$ cm, $r_2 = 50.0$ cm and $Q = 8.5 \times 10^{-7}$ C. *(4 marks)*

(c) A capacitor C, a bulb and switch S are connected in series with a bulb as shown in figure 5 below.

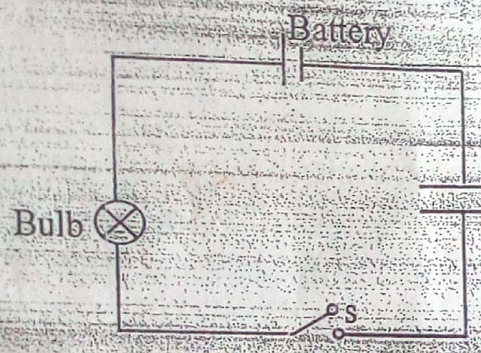


Fig 5

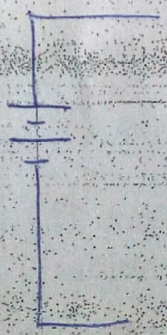
Explain what is observed when

(i) switch S is closed. *(3 marks)*

(ii) the battery is replaced with a conducting wire and switch S closed again. *(3 marks)*

(d) Describe an experiment to determine the relative permittivity of an ebonite slab using a reed switch. *(5 marks)*

$\frac{IV}{f} = \frac{A\varepsilon}{d}$ END



$\frac{A\varepsilon}{d} = \frac{IV}{f}$