P510/2
PHYSICS
Paper 2
Nov, 2020
2½ hours

ST. MARYS' KITENDE

Uganda Advanced Certificate of Education

RESOURCEFUL MOCK EXAMINATIONS 2020

PHYSICS

Paper 2

(Principal Subject)

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

*Answer only **five** questions, taking at least **one** question from each of the sections **A**, **B**, **C**and **D**, but **not** more than **one** question should be chosen from **either** section **A** or section **B**.*
*Any additional question(s) answered will **not** be marked.*
Mathematical tables and squared paper will be provided.
Non-programmable Silent Scientific Calculators may be used.

Assume where necessary:

Acceleration due to gravity,	g	=	$9.81\ m\ s^{-2}$
Specific heat capacity of water,		=	$4.20 \times 10^{3}\ J\ kg^{-1}\ K^{-1}$
Speed of light in Vacuum,	c	=	$3.0 \times 10^{8} m\ s^{-1}$
Speed of sound in air,	v	=	$3.40 \times 10^{2}\ m\ s^{-1}$
Electroniccharge,	e	=	$1.60 \times 10^{-19}\ C$
Electronic mass,	m_e	=	$9.11 \times 10^{-31}\ kg$
Permeability of free space,	μ_o	=	$4\pi \times 10^{-7}\ H\ m^{-1}$
Permittivity of free space,	ε_0	=	$8.85 \times 10^{-12}\ F\ m^{-1}$
The Constant,	$\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9}\ F^{-1}\ m$

SECTION A

1. (a) What is meant by the following terms?

(i) Monochromatic light. (1 mark)

(ii) Absolute refractive index of a material. (1 mark)

(b) (i) Define the term *refracting edge* of a triangular prism. (1 mark)

(ii) Describe an experiment to determine the refractive index of the material of atriangular glass prism of known refracting angle using a spectrometer. (6 marks)

(c) A concave mirror of focal length 6.0 cm is arranged co-axially with a concave lens of focal length 15.0 cm so that the distance between them is 4.0 cm. A point object is placed 10.0 cm in front of the concave lens and remote from the mirror as shown in figure 1.

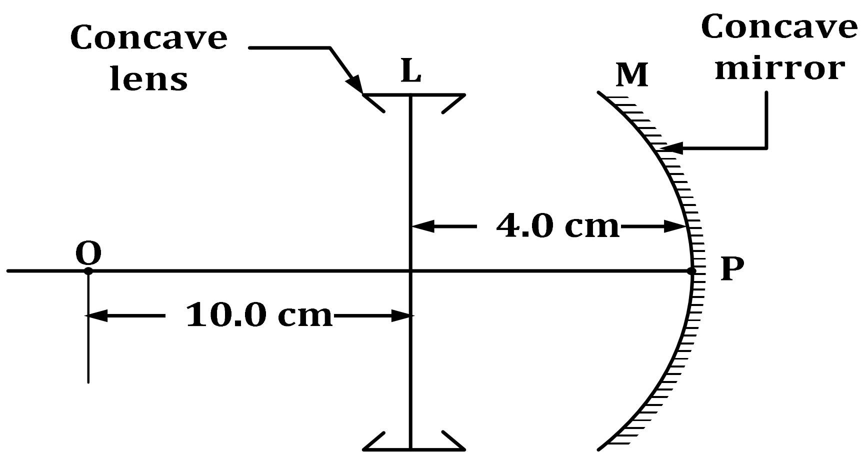

Fig. 1

(i) Determine the position of the final image formed after two refractions by the concave lens and one reflection by the concave mirror. (5 marks)

(ii) Sketch a ray diagram for the action in (i) above. (2 marks)

(d) (i) Draw a labelled diagram showing the essential parts of a photographic camera. (2 marks)

(ii) Explain the role of the diaphragm in a photographic camera. (2 marks)

2. (a) (i) Define the terms *spherical* and *chromaticaberrations* as applied to lenses. (2 marks)

(ii) Explain how spherical and chromatic aberrations are minimized in lenses. (4 marks)

(b) What is meant by the following terms?

(i) Accommodation of the eye. (1 mark)

(ii) Visual angle. (1 mark)

(c) (i) State two advantages and two disadvantagesof Galilean telescopes over Astronomical telescopes. (4 marks)

(ii) An astronomical telescope has a distance of 100 cm between its lenses and forms a final image of a distant object at infinity. If the objective lens has a diameter of 10.0 cm and focal length of 75.0 cm, determine the angular magnification of the instrument and the size of the eye ring. (5 marks)

(d) Distinguish between compound microscopesand Astronomical telescopes. (3 marks)

SECTION B

3. (a) (i) What are forced oscillations? (1 mark)

(ii) Give twoexample of forced oscillations. (2 marks)

(b) Define the terms as applied to piped instruments:

(i) Fundamental frequency. (1 mark)

(ii) Overtones. (1 mark)

(c) Two tuning forks of the same frequency of 512 Hz are sounded near the open ends of two tubes of the same diameter but of different lengths.
Tube **A** is closed at only one end while tube **B** is open at both ends. If they both have the same end correction and are made to sound at their first resonance:

(i) Determine the ratio of the length of tube**A** to the length of tube **B**. (3 marks)

(ii) Suppose the speed of sound in air is 330 m s^{-1} and tube A has a length of 16.0cm, find the value of the end correction. (3 marks)

(d) (i) What is Doppler effect? (1 mark)

(ii) An observer **O** moving along a straight road at a velocity $\mathbf{u_0}$ approaches a source of sound **S** moving in the opposite direction at a velocity $\mathbf{u_S}$. Suppose f is the frequency of the sound waves and V is the speed of sound waves in air, derive an expression for the apparent frequency of waves received by the observer. (3 marks)

(e) (i) What are beats? (1 mark)

(ii) Describe how a musical instrument can be tuned. (4 marks)

4. (a) (i) State Huygens's principle. (1 mark)

(ii) Use Huygens's principle to verify Snell's law of refraction.

(4 marks)

(b) (i) What is optical path difference? (1 mark)

(ii) Explain how interference patterns are formed in Young's double slit experiment. (3 marks)

(c) Derive an expression for the fringe separation in Young's double slit experiment. (4 marks)

(d) Two optically thin, flat glass slides are separated at one end by a wire of diameter 0.20 mm. At the other end, the slides touch each other, giving the air between them a thickness ranging from 0 to 0.20 mm. The plates are 15.0 cm long and are illuminated from above by light of wave length 6.0×10^{-7} m.

(i) Use suitable well defined symbols to derive an expression for the fringe separation observed in the air – wedge. (4 marks)

(ii) Determine the number of bright fringes seen in the reflected light. (3 marks)

SECTION C

5. (a) (i) Define the term *magnetic flux density* and *state* its unit.

(2 marks)

(ii) Write down the expression for the magnetic flux density at a perpendicular distance, d, from a straight wire carrying a current, I in free space. (1 mark)

(iii) Suppose a similar wire of the same length L, is placed parallel to the first wire a distance, d from it and also carrying a current I in opposite direction, derive an expression for the magnetic force itt experiences. (4 marks)

(b) Figure 2 shows a simple device used to measure current, I, flowing through each of the parallel wires QR and WY, each of length 9.81 cm and separated by a distance of 4.0 mm. When I = 2.0 A, the wire frame PQRS is made horizontal by weight Mg.

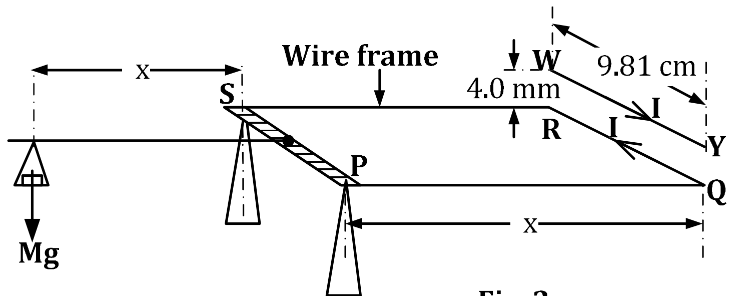

Fig. 2

(i) Determine the value of mass M. (4 marks)

(ii) A third wire **AB** of the same length as QR and WY is placed directly above WY and parallel to it at a distance **y** from WY and is carrying a current of 3.0 A from right to left. Find the value of **y** for which the resultant magnetic flux density along wire WY is zero. (3 marks)

(c) State three structural adjustments necessary to convert a moving coil galvanometer into a ballistic galvanometer. (3 marks)

(d) Explain the occurrence of hall voltage across opposite faces of a conducting slab carrying current when placed across a magnetic field. (3 marks)

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

(ii) Use Lenz's law and the conservation of energy to show that when a straight conductor of length L, is moved across a uniform magnetic field of flux density B, in a closed conducting circuit at a terminal velocity v, an e.m.f, E = BLv is induced across it. (4 marks)

(b) A uniform circular copper discof plane area **A**is placed between the poles of a large U shaped magnet with its plane normal to the field of flux density **B**. The disc is then span about its axle at a frequency **f**.

(i) Derive an expression for the e.m.f. induced between the axle and the rim the disc? (4 marks)

(ii) If the radius of the disc is 2.5 cm, the magnetic flux density in the region of the disc is 0.84 T and the disc is rotated at 3000 revolutions per minute, what is the magnitude of the e.m.f. generated across the disc? (4 marks)

(c) (i) What are Eddy currents? (2 marks)

(ii) With the aid of a labelled diagram, explainone industrial application of Eddy currents. (4 marks)

7. (a) (i) Define ***peak value*** and ***root mean square value*** of alternating current. (2 marks)

(ii) An alternating voltage $V = 2.0 \sin 120\pi t$ is connected across an inductor of self-inductance 0.50 H. Determine the root mean square current flowing through the inductor. (4 marks)

(b) (i) Describe the structure and mode of operation of a hot wire ammeter. (5 marks)

(ii) State two advantages of a.c. meters over moving coil meters. (2 marks)

(c) Figure 3 shows a 5.0 mH inductor and a 10.0 Ω connected in series with a 6.0 V d.c. battery.

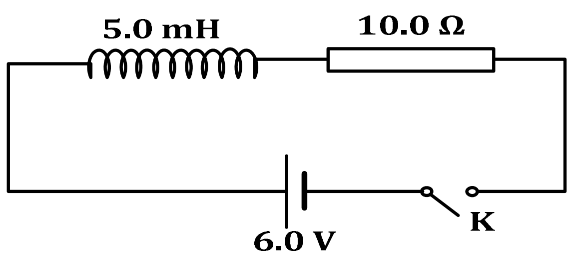

Fig. 3

(i) Determine the voltage across the resistor immediately the switch is just closed. (3 marks)

(ii) What will be the voltage across the 10.0 Ω resistor when the switch has stayed closed for a much longer period of time. (2 marks)

(iii) Explain the difference in the values of the results in (i) and (ii) above. (2 marks)

SECTION D

8. (a) Distinguish between an ***electric field intensity*** and an ***electric potential.*** (2 marks)

(b) Three point charges**P**, **Q** and **R** of $+5\mu C$, $-4\mu C$ and $+25\mu C$ lie along the + x direction in one straight line and in that respective order, equidistant from one another 3.0 cm apart. A point, **S,** is 5.0 cm from both P and R below the line PQR. Determine the resultant electric field intensity at **S.** (6 marks)

(c) (i) Explain the term ***corona discharge***? (3 marks)

(ii) Describe one industrial application of Corona discharge.

(6 marks)

(d) Briefly explain how anElectrophorus works. (3 marks)

9. (a) (i) What is a capacitor? (1 mark)

(ii) Give three industrial uses of a capacitor. (3 marks)

(b) (i) Derive an expression for the energy stored in a capacitor of capacitance C, farads when connected to a d.c. source of e.m.f. V, volts. (3 marks)

(ii) A 200 μF capacitor is connected across a 12.0 V battery and allowed to charge fully. The capacitor is then disconnected from the battery and instead connected to an electric heater immersed in 1000 cm^3 of water at room temperature. Assuming no energy losses occur in the process, determine the temperature change in the water. (4 marks)

(c) Describe how a calibrated gold leaf electroscope can be used to investigate the effect of varying the effective area of overlapof a capacitor on its capacitance. (5 marks)

(d) Figure 4 shows $1.0\mu F$, $4.0\mu F$, $5.0\mu F$, 3.5 μF and 3.0 μF capacitors arranged as shown and connected to a 12.0 V battery.

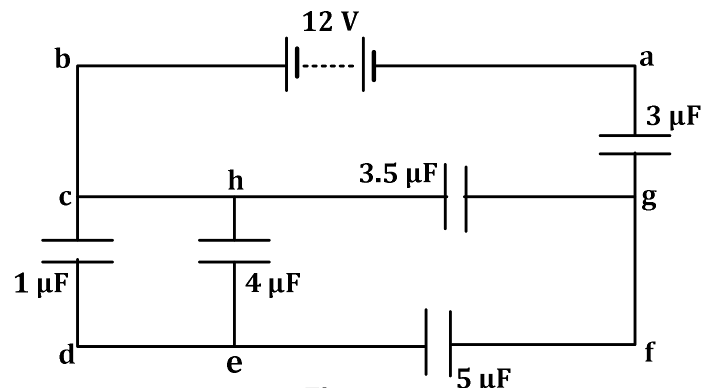

Fig. 4

Determine the total charge stored in the network of the capacitors. (4 marks)

10. (a) (i) Define the *term temperature coefficient of resistance*of a material. (1 mark)

(ii) Explain why conductors have a positive temperature coefficient of resistance, while semi-conductors have a negative value of temperature coefficient of resistance. (4 marks)

(b) (i) Derive a balance condition of a metre bridge. (3 marks)

(ii) Wires AB and PQ in figure 5 are each 100 cm long. Wire AB has a resistance per cm of 0.40 Ωcm^{-1} while PQ has a resistance per cm of 0.50 $\Omega\ cm^{-1}$. Switch K is closed and jockey J moved along PQ until the Centre zero galvanometer G shows no deflection, when AC = 60.0 cm and PJ = 35.0 cm.

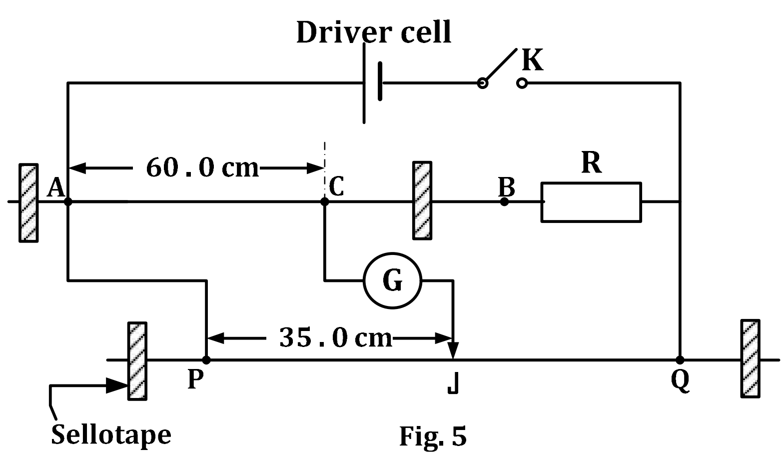

Fig. 5

Determine the resistance of resistor R. (4 marks)

(c) Explain the principle of operation of a slide wire potentiometer. (3 marks)

(d) Describe how a potentiometer can be used to measure the resistance of unknown value. (5 marks)

END