

P510/2

PHYSICS

Paper 2

June/July, 2019

2½ hours

MOCK EXAMINATIONS 2019

Uganda Advanced Certificate of Education

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.

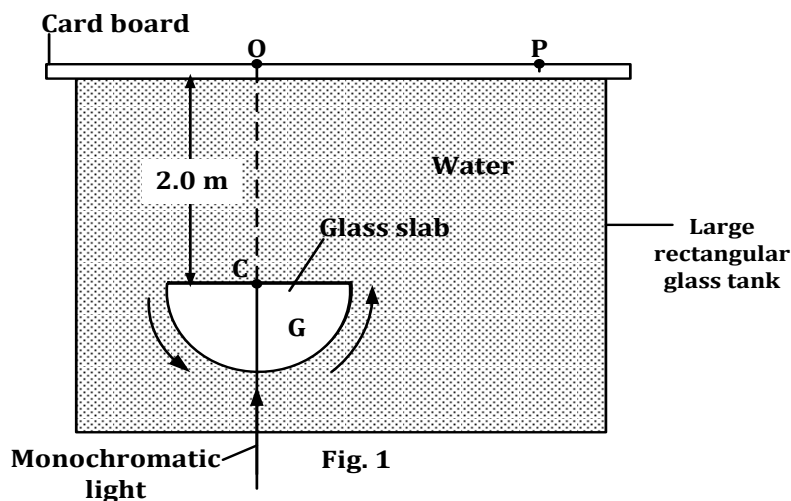
Non-programmable Silent Scientific Calculators may be used.

Assume where necessary:

Acceleration due to gravity,	g	=	9.81 m s^{-2}
Speed of light in Vacuum,	c	=	$3.0 \times 10^8 \text{ m s}^{-1}$
Speed of sound in air,	v	=	$3.40 \times 10^2 \text{ m s}^{-1}$
Electronic charge,	e	=	$1.60 \times 10^{-19} \text{ C}$
Electronic mass,	m_e	=	$9.11 \times 10^{-31} \text{ kg}$
Permeability of free space,	μ_0	=	$4\pi \times 10^{-7} \text{ H m}^{-1}$
Permittivity of free space,	ϵ_0	=	$8.85 \times 10^{-12} \text{ F m}^{-1}$
The Constant,	$\frac{1}{4\pi\epsilon_0}$	=	$9.0 \times 10^9 \text{ F}^{-1} \text{ m}$

SECTION A

1. (a) (i) Define the term principal focus of a concave lens. (1 mark)
- (ii) Describe an experiment to determine the focal length of a concave lens using a concave mirror. (5 marks)
- (b) A concave mirror of focal length 10.0 cm is arranged co-axially with a convex mirror of focal length 12.0 cm so that the distance between them is 24.0 cm. A point object is placed 15.0 cm in front of the concave mirror.
- (i) Determine the position of the final image formed after two successive reflections by the concave and convex mirrors respectively. (4 marks)
- (ii) Sketch a ray diagram for the action in (i) above. (2 marks)
- (c) What is meant by the following terms?
- (i) Absolute refractive index of a material. (1 mark)
- (ii) Monochromatic light. (1 mark)
- (d) A fine beam of monochromatic light is directed towards the Centre C, of a semicircular glass slab of refractive index 1.50 wholly immersed in water of refractive index 1.33 placed in a thin walled glass tank having a white card board covering it at the top as shown in figure 1.



When the glass slab G, is rotated slowly in an anticlockwise direction about point C, as shown by the arrows, the spot of light shifts from position O directly above C to position P and then abruptly disappears.

- (i) Briefly explain the observations. (2 marks)
- (ii) Determine the value of the distance OP. (4 marks)
2. (a) (i) Draw a labelled diagram showing the essential features of a photographic camera. (2 marks)
- (ii) Explain how spherical and chromatic aberrations are minimized in the camera in (i) above. (4 marks)
- (b) What is meant by the following terms as applied to optical instruments?
- (i) Visual angle. (1 mark)
- (ii) Angular magnification. (1 mark)
- (c) (i) State three advantages of reflecting telescopes over refracting telescopes. (3 marks)
- (ii) An astronomical telescope has a distance of 25.0 cm between its lenses and forms a final image of a distant object at infinity. When the distance between the lenses is reduced to 24.5 cm, a final virtual image is formed at a distance of 28.0 cm from the eyepiece lens. Determine the focal length of each lens used. (5 marks)
- (d) Give two advantages and two disadvantages of Galilean telescopes over Astronomical telescopes. (4 marks)

SECTION B

3. (a) (i) Distinguish between free oscillations and forced oscillations. (2 marks)
- (ii) Give one example of each of the oscillations in (i) above. (2 marks)
- (b) Define the terms as applied to piped instruments:
- (i) Resonant frequency. (1 mark)
- (ii) Overtones. (1 mark)
- (c) Two tuning forks **A** and **B**, excite the second lowest resonant frequency in two air columns, in tubes of the same length and diameter, with the tube corresponding to fork **A** being closed at one end while the tube corresponding to fork **B** is open at both ends.
- (i) Assuming negligible end corrections, determine the ratio of the frequency of **A** to the frequency of **B**. (3 marks)

- (ii) Suppose the end corrections are considered and each tube has an end correction of 6.0×10^{-3} m they resonate at their first overtones, determine the lengths of the tubes. (3 marks)
- (d) (i) What is Doppler effect? (1 mark)
(ii) Explain the meaning of “Blue shift” as applied to the motion of stars with respect to the Earth. (3 marks)
- (e) (i) What are beats? (1 mark)
(ii) Describe how a musical instrument can be tuned. (3 marks)
4. (a) (i) What is optical path difference? (1 mark)
(ii) Explain how interference patterns are formed in Young’s double slit experiment. (3 marks)
- (b) (i) State Huygens’s principle. (1 mark)
(ii) Use Huygens’s principle to verify Snell’s law of refraction. (4 marks)
- (c) 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. (4 marks)
(ii) Determine the number of bright fringes seen in the reflected light. (3 marks)
- (d) State two;
- (i) uses of air wedges created in glass surfaces involving lenses and glass slides. (2 marks)
(ii) conditions necessary for interference to occur in an air wedge. (2 marks)

SECTION C

5. (a) (i) Define the terms *magnetic flux density* and *tesla*. (2 marks)
(ii) A straight conductor of length **L**, having **N** free electrons each of charge **e**, is placed perpendicular to a uniform magnetic field of flux

density \mathbf{B} . When current \mathbf{I} passes through the conductor, each electron experiences a magnetic force $\mathbf{F}_1 = \mathbf{Bev}$, where v , is the average drift velocity of an electron. Show that the total force experienced by the whole conductor is given by, $\mathbf{F} = \mathbf{BIL}$.

(3 marks)

- (b) A plane circular coil of 120 turns, each of mean radius 12.5 cm has a magnetometer placed at its center, with its plane vertical and lying in the North – south directions pointing at the $0^\circ - 0^\circ$ on the scale. When a current of 5.0 A is passed through the coil, the pointers deflect through 29.5° and 30.5° . Determine the value of the;
- (i) horizontal component of the earth’s magnetic field. (4 marks)
 - (ii) angle of dip at the location, given that the resultant magnetic field is 1.69×10^{-2} T. (2 marks)
- (c) Explain three structural adjustments necessary to convert a moving coil galvanometer into a ballistic galvanometer. (6 marks)
- (d) Figure 2 shows two long straight parallel wires W_1 and W_2 separated by 8.0 cm and carrying currents of the same magnitude in opposite directions. W_1 and W_2 carry currents out of the plane and into the plane of the paper respectively. Point P is 2.0 cm to the right of W_1 and the magnetic field at P is 1.0×10^{-2} T directed in the + y – direction.

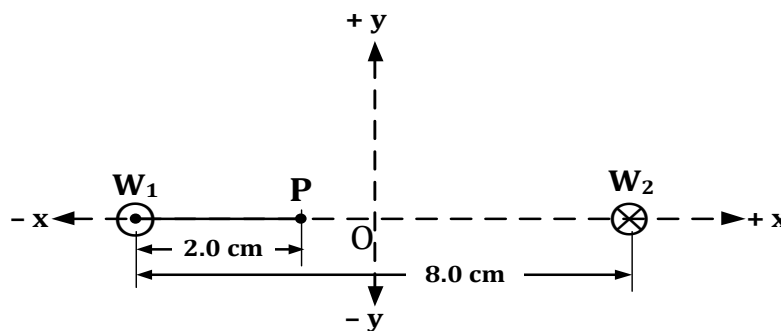


Fig. 2

Determine the magnitude of current in wire W_1 . (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 coil of wire of wire of 40 turns and of mean radius 3.0 cm is placed between the poles of an electromagnet. The magnetic field increases from 0 to 0.75 T at a constant rate in a time interval of 225 s. What is the magnitude of the e.m.f. induced in the coil if the field;
- (i) is perpendicular to the plane of the coil? (3 marks)
- (ii) makes an angle of 30° with the plane of the coil? (3 marks)
- (c) (i) Describe an absolute method of measuring resistance of a material. (6 marks)
- (ii) Mention any two limitations of the method in (i). (2 marks)
7. (a) (i) Define **root mean square value** of alternating current. (1 mark)
- (ii) An alternating voltage $V = 4.0 \sin 100\pi t$ is connected across an inductor of self-inductance 0.2 H. Determine the value of the root mean square current flowing through the inductor. (4 marks)
- (b) (i) Describe the structure and mode of operation of a repulsion type of a moving iron ammeter. (6 marks)
- (ii) State two advantages of a moving iron ammeter over a moving coil ammeter. (2 marks)
- (c) State and explain two energy losses in an a.c generator. (4 marks)
- (d) An ideal $0.56 \mu\text{H}$ inductor is used as part of the tuning circuit in a radio. The audio signal from the radio station resonates with the tuning circuit of the receiver, at a frequency of 90.9 MHz. Determine the capacitance of the tuning capacitor used. (3 marks)

SECTION D

8. (a) (i) Distinguish between an **electric field** and an **electric field line**. (2 marks)
- (ii) Three point charges of $+5\mu\text{C}$, $-10\mu\text{C}$ and $+5\mu\text{C}$ lie along the $+x$ – direction in one straight line and in that respective order, equidistant from one another. Sketch the resultant electric field pattern expected. (3 marks)
- (b) (i) State Coulomb's law of electrostatics. (1 mark)
- (ii) The figure 3 shows three point charges each of $+1.0\mu\text{C}$ placed at the vertices A, B and C of an equilateral triangle of side 2 m. A fourth point charge $-q$ is placed at D, the mid-point of side BC.

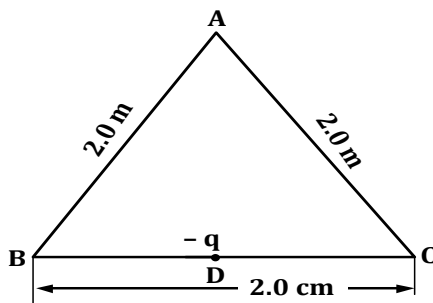


Fig. 3

If the net electric force on the charge at point A is zero. Determine the magnitude of the charge at point D. (6 marks)

- (c) (i) What is meant by the term *corona discharge*? (3 marks)
 (ii) Explain why the metal cap of Gold leaf electroscopes is always smooth and circular. (3 marks)
- (d) Briefly explain how a gold leaf electroscope works. (3 marks)
9. (a) (i) Define the term capacitance of a capacitor. (1 mark)
 (ii) Use the graphical approach to derive an expression for the energy stored in a fully charged capacitor. (3 marks)
- (b) The figure 4 shows the variation between p.d. V with the charge, $Q = 1.11 \times 10^{-9} \text{ C}$ across a parallel plate air capacitor, with each plate having area 0.24 m^2 and a separation between the plates of 8.0 mm .

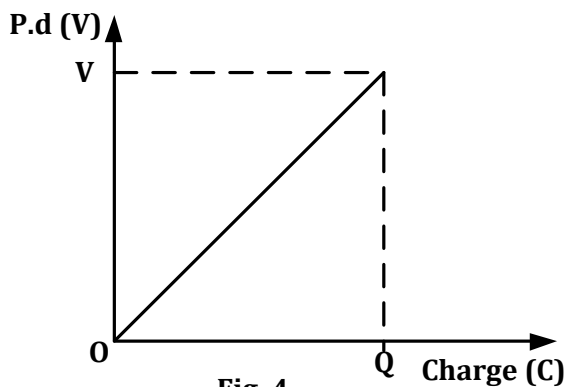


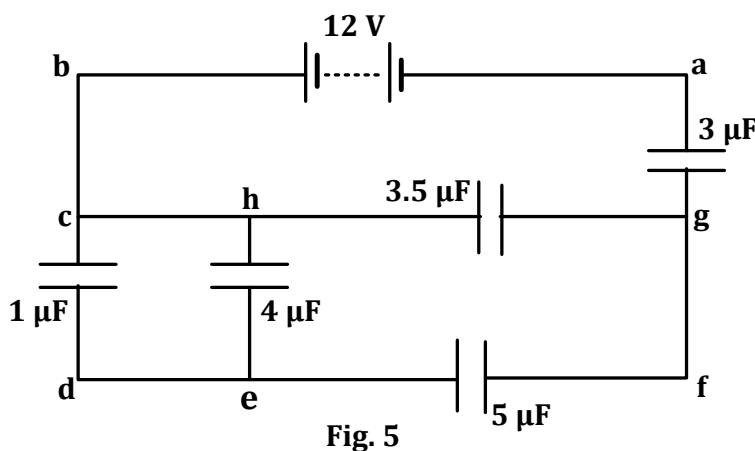
Fig. 4

Determine the energy stored per unit volume in the capacitor. (4 marks)

- (c) Describe an experiment to show the effect of inserting a dielectric between the plates of a charged capacitor on its capacitance. (5 marks)

- (d) (i) Derive an expression for the effective capacitance of three capacitors connected in series across a d.c. source of e.m.f. (3 marks)

- (ii) Figure 5 shows $1.0\mu\text{F}$, $4.0\mu\text{F}$, $5.0\mu\text{F}$, $3.5\mu\text{F}$ and $3.0\mu\text{F}$ capacitors arranged as shown and connected to a 12.0 V battery.



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

10. (a) (i) Define the term electrical resistivity of a material. (1 mark)
- (ii) An electric heater of a kettle consists of 5.0 m of Nichrome wire of diameter 0.58 mm . When connected to a 240 V d.c supply, it takes 5 minutes for the temperature of the 2.0 kg mass of water in the kettle to rise from 25°C to 100°C . If the specific heat capacity of water is $4200\text{ J kg}^{-1}\text{ K}^{-1}$, determine the electrical resistivity of Nichrome. (4 marks)
- (b) (i) Derive a balance condition of a metre bridge. (3 marks)
- (ii) Wires AB and PQ in figure 6 are each 100.0 cm long. Wire AB has a resistance per cm of $0.2\ \Omega\text{cm}^{-1}$ while PQ has a resistance per cm of $0.25\ \Omega\text{cm}^{-1}$. Switch K is closed and jockey J moved along PQ until the centre zero galvanometer G shows no deflection, when $AC = 55.0\text{ cm}$ and $JQ = 64.0\text{ cm}$.

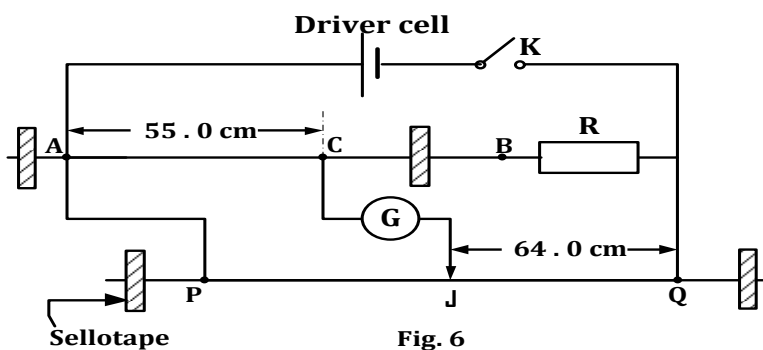


Fig. 6

Determine the resistance of resistor R. (4 marks)

- (c) (i) State Ohm's law. (1 mark)
 (ii) Describe an experiment to verify Ohm's law. (5 marks)
- (d) Explain why a slide wire potentiometer is more accurate than an ordinary voltmeter when used for the measurements of potential differences. (2 marks)

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