P510/2
PHYSICS
PAPER 2
2½ Hours
July/Aug. 2022

JJEB MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

U.A.C.E. JJEB MOCK EXAMINATIONS, JULY 2022

PHYSICS

PAPER 2

2 hours 30 minutes

INSTRUCTIONS TO THE 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.

Where necessary assume the following constants:

Acceleration due to gravity, g	=	$9.81\ m\ s^{-2}$
Speed of light in Vacuum, c	=	$3.00 \times 10^{8}\ m\ s^{-1}$
Speed of sound in air,	=	$340\ m\ s^{-1}$
Electronic charge, e	=	$1.60 \times 10^{-19}\ C$
Electronic mass, m_e	=	$9.11 \times 10^{-31}\ kg$
Permeability of free space, μ_o	=	$4.0\pi \times 10^{-7}\ H\ m^{-1}$
Permittivity of free space, ε_0	=	$8.85 \times 10^{-12}\ F\ m^{-1}$
The Constant, $\frac{1}{4\pi\varepsilon_o}$	=	$9.00 \times 10^{9}\ F^{-1}\ m$

SECTION A

1. (a) (i) What is affection of light? (1 mark)

(ii) Describe the structure and mode of operation of the Sextant. (3 marks)

(b) Describe an experiment to determine the focal length of a concave lens using a concave mirror. (5 marks)

(c) (i) Derive an expression for the total deviation, **D**, produced by a small angle prism of refracting angle **A** and refractive index, **n**. (4 marks)

(ii) Determine the angular dispersion of Red and Blue lights of refractive indices 1.52 and 1.54 after dispersion of white light produced by a prism of a small refracting angle of 5° (3 marks)

(d) (i) Define the term Power of a lens. (1 mark)

(ii) A converging meniscus made of crown glass of refractive index 1.50 has radii of curvature 20.0 cm and 25.0 cm and is placed in air. Calculate the power of this lens. (3 marks)

2. (a) (i) Define the term ***myopia*** as applied to a human eye. (1 mark)

(ii) Explain with the aid of a ray diagram how the defect in (i) can be corrected using a lens. (4 marks)

(b) (i) A real finite image of a moon subtends an angle of 2° at the objective lens of an astronomical telescope of focal length, 300 cm. The eye piece lens of the instrument has a focal length of 5.0 cm and its position is initially adjusted to form a final image of the moon at infinity. Determine the diameter of the intermediate image of the moon and the angular magnification of the instrument. (5 marks)

(ii) Suppose the eyepiece lens of the instrument in (i) is pulled backwards by 3.0 cm so as to produce a real finite image of the moon that is twice the size of the intermediate image on a screen placed behind the eyepiece lens. How far is the screen from the eye-piece lens? (4 marks)

(c) (i) Draw a labelled ray diagram of a Galilean telescope in normal adjustment and derive the expression for its angular magnification. (5 marks)

(ii) State one advantage of the Galilean telescope over a terrestrial telescope when both are in normal adjustment. (1 mark)

SECTION B

3. (a) (i) Distinguish between free oscillations and damped oscillations. (3 marks)

(ii) Give one example of each of the oscillations in (i) above. (2 marks)

(b) (i) Define the term ***resonance***. (1 mark)

(ii) Describe an experiment to determine the end correction of a pipe open at both ends. (6 marks)

(c) (i) What are ***beats***? (2 marks)

(ii) How are beats formed? (3 marks)

(d) A piano tuner strikes his tuning fork of frequency, 520 Hz and strikes the key on the piano at the same time and he hears 3 beats per second. As he tightens the piano string more, he hears the beat frequency decrease to 2 beats per second when the two sound together. What was the original frequency of the piano string before it was tightened? (3 marks)

4. (a) (i) Distinguish between polarized light and un-polarized of light? (2 marks)

(ii) Describe how polarized light is produced by reflection. (5 marks)

(b) (i) State Huygens's principle. (1 mark)

(ii) Use Huygens's principle to verify Snell's law. (4 marks)

(c) (i) What are coherent sources? (1 mark)

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

(d) The distance between the two slits in Young's experiment is 3 mm while the distance from the plane of the slits to the screen is 1.5 m. If the fringe separation is 0.1 mm, determine the wave length of light used in the experiment. (3 marks)

SECTION C

5. (a) (i) Define the term ***ampere.*** (1 mark)

(ii) Show using a sketch diagram that, two straight parallel wires carrying currents $\mathbf{I_1}$ and $\mathbf{I_2}$ in opposite directions and separated by a distance **d**, in free space, each of length, **L** experiences a force of magnitude

$$F = \frac{\mu_0 I_1 I_2 L}{2\pi d}$$ (5 marks)

(b) Two long straight wires separated by 8.0cm carry currents of equal magnitude perpendicular to the plane of wires as shown in the figure 1.

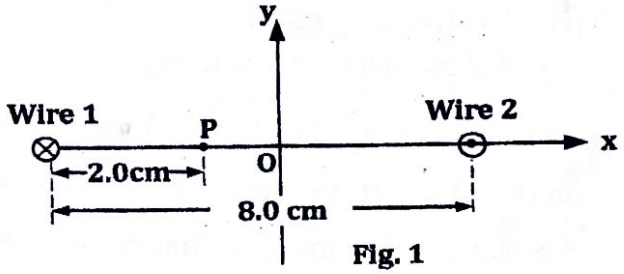


Fig. 1

Point **P** is 2.0 cm from wire 1 and the magnetic flux density at a point P is 1.0×10^{-2} T directed in the negative y-direction.

Calculate the size of current flowing in wire 1. (4 marks)

(c) (i) Describe how a tangent galvanometer can be used to measure the horizontal component of the earth's magnetic field. (6 marks)

(ii) When a current of 5A is passed through the coil of the tangent galvanometer, of 3000 turns and mean radius 4.0 cm, deflections of 20° and 22° are noted on the scale. Calculate the horizontal component of the earth's magnetic field. (4 marks)

6. (a) (i) Distinguish between ***self-induction*** and ***mutual induction.*** (2 marks)

(ii) Describe a simple experiment to demonstrate mutual induction. (4 marks)

(b) (i) Derive the expression for the maximum e.m.f induced in a rectangular coil of wire of **N** turns and plane area **A** and rotated at a constant angular frequency ω in a uniform magnetic flux density, **B.** (4 marks)

(ii) The coil of d.c motor is mounted in a radial magnetic field of flux density 1.0 T. The coil has 20 turns each of area $40cm^2$ and a total resistance of 2 ohms. Calculate the maximum angular velocity that the motor attains when working on a 240V supply and drawing a current of 5A. (3 marks)

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

(ii) Explain the importance of eddy currents in moving coil instruments. (2 marks)

(d) A coil of 100 turns is wound in the middle of a solenoid of 750 turns per metre and of mean radius 8.0 cm. A sinusoidal current $I = I_0 \sin 100\pi t$ amperes is passed through the solenoid windings. Find the amplitude of the e.m.f induced across the coil. (3 marks)

7. (a) Define the term ***reactance*** of an inductor and state its unit. (2 marks)

(b) (i) Derive an expression for reactance X_L of an inductor of self-inductance L connected across an alternating voltage $V = V_0 \cos 2\pi f t \ \ volts$ (4 marks)

(ii) Sketch using the same axes the variation of applied voltage and current flowing through the inductor, with time. (2 marks)

(c) An a.c transformer operated at a frequency of 50Hz has 1200 turns in the primary coil and a current of 5A flowing in it, with an input of root mean square voltage of 240V and an output of root mean square voltage of 12V. If the transformer is 95% efficient. Determine the,

(i) Peak value of current flowing in the secondary circuit. (3 marks)

(ii) Number of turns in the secondary circuit. (3 marks)

(d) Describe the structure and mode of operation of a hot wire ammeter. (6 marks)

SECTION D

8. (a) (i) Define the term ***electric flux*** and state is SI Unit. (2 marks)

(ii) Show that the total electric flux enclosing a charge **+Q** by a surface of radius r, in free space is independent of the radius. (3 marks)

(b) (i) State Coulomb's law of electrostatics. (1 mark)

(ii) The figure 2 shows two point charges **+q** and **+2q** separated by a distance **3d** in air. A third point charge **–q** is placed at appoint **P**, a distance **d** from +q and 2d from +2q respectively.

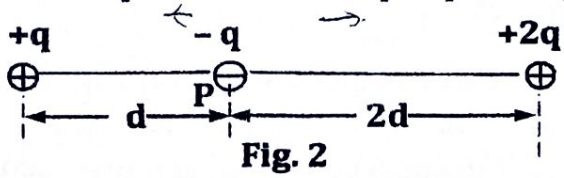


Fig. 2

Determine in terms of k, d and q the magnitude and direction of the resultant force on the charge at point P, due to the two point charges where, $k = \frac{1}{4\pi\varepsilon_0}$ (4 marks)

(c) Explain why;

(i) the hairs of the hand stand, when passed over the screen of an operating television set. (2 marks)

(ii) Electric field lines are always perpendicular to the surface of a charged conductor. (3 marks)

(d) Three point charges of +3.2 μC, – 2.5 μC and 2.7 μC and are placed at the corners of a rectangle ABCD of sides 3cm by 4cm as shown in figure 3.

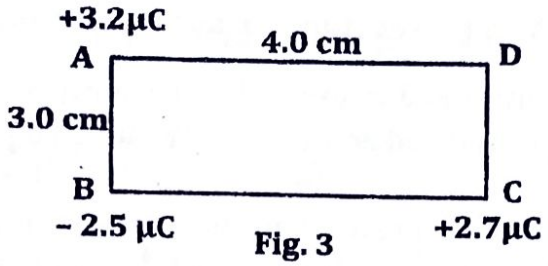
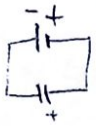


Fig. 3

Determine the electric field intensity at a point D (5 marks)

9. (a) Describe the energy changes that take place during the charging process of a capacitor. (2 marks)

(b) (i) Derive an expression for the energy stored in a capacitor of capacitance, **C** when connected across a battery of e.m.f, **V**.(4 marks)



(ii) The dial of a variable air capacitor is turned continuously from 0° to 120° and changes the capacitance from 10 pF to 400 pF respectively. The dial is set at 120° and first connected to a 12 V d.c. source and later disconnected. Determine the change in energy obtained when the dial is later turned to 0° and account for this change in energy. (6 marks)

(c) (i) Define the term ***dielectric constant*** of a capacitor. (1 mark)

(ii) Describe how the dielectric constant of a parallel plate capacitor can be determined experimentally. (5 marks)

(d) Mention two household devices that involve a capacitor in their modes of operation. (2 marks)

10. (a) (i) Define electrical ***resistance*** of a material. (1 mark)

(ii) Describe an experiment to measure electrical resistance of a conductor using a calibrated ammeter and a calibrated voltmeter. (5 marks)

(b) A d.c source of e.m.f **E**, and internal resistance, **r** is connected in series with an external ammeter and resistance R_1 and R_2 of 3 Ω and 9 Ω respectively.

When R_1 and R_2 are connected in series, to the source, the ammeter registers a current of 1.0 A. When R_1 and R_2 are connected in parallel, the ammeter registers 2.4 A. Determine the,

(i) Internal resistance, r of the battery. (3 marks)

(ii) E.m.f, E of the battery. (2 marks)

(c) Derive the condition for maximum power developed in a circuit containing a battery e.m.f E, internal resistance **r** and variable external resistance **R**. Hence deduce and write down the expression for the maximum power. (5 marks)

(d) Figure 4 shows wires **AB** and **PQ** each 100 cm long. Wire AB has a resistance per cm of 0.40 Ω cm^{-1} while PQ has a resistance per cm of 0.50 Ω 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 JQ = 65.0 cm.

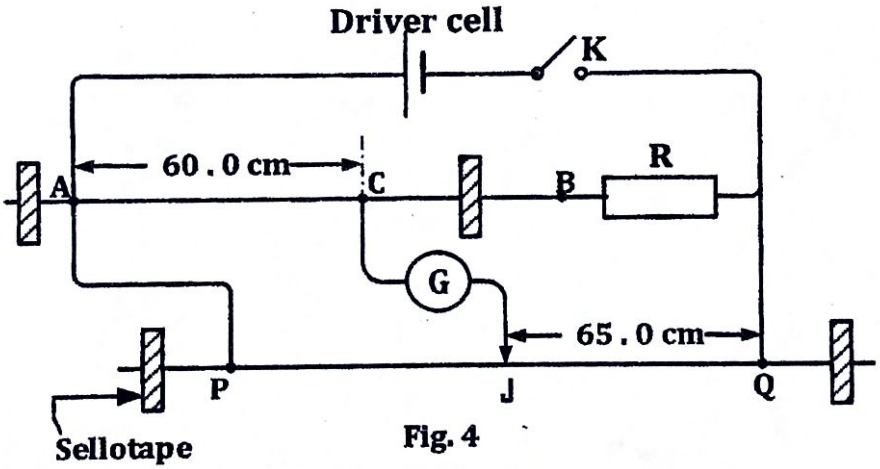


Fig. 4

Determine the resistance of the resistor **R** connected in series with wire, AB. (4 marks)

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