P510/2
PHYSICS
Paper 2
Nov/Dec, 2020
2½ hours

JINJA JOINT EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

MOCK EXAMINATIONS – NOVEMBER 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 may be provided.
Non-programmable silent scientific calculators may be used.

Assume where necessary;

Acceleration due gravity, g	=	$9.81\ m\ s^{-2}$
Speed of light in vacuum, c	=	$3.0 \times 10^{8}\ m\ s^{-1}$
Speed of sound in air	=	$330\ m\ s^{-1}$
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, $\frac{1}{4\pi\varepsilon_o}$	=	$9.0 \times 10^{9}\ F^{-1}\ m$

SECTION A

1. (a) (i) Define the term ***reflection of light.*** (01 mark)

(ii) Distinguish between images of real objects formed by convex mirrors and by plane mirrors. (03 marks)

(b) (i) State the laws of refraction of light. (02 marks)

(ii) The diagram in figure 1 shows three optical media, A, B and C with parallel boundaries and absolute refractive indices n_1, n_2 and n_3 respectively.

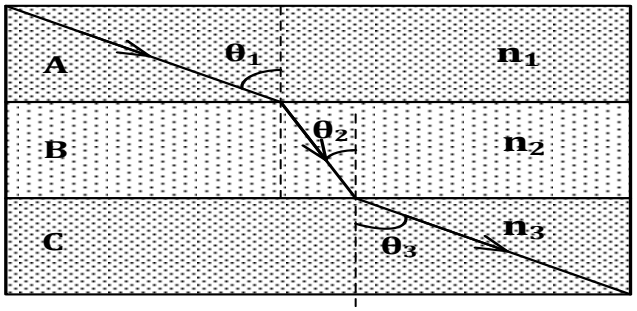

Fig. 1

Use the definition of absolute refractive index of a material medium, to derive Snell's law. (04 marks)

(c) A ray of monochromatic light is incident from air at 30° into a glass slab of refractive index, 1.52. The sides AB and DC of the slab are parallel to a plane mirror placed below the slab as shown in figure 2.

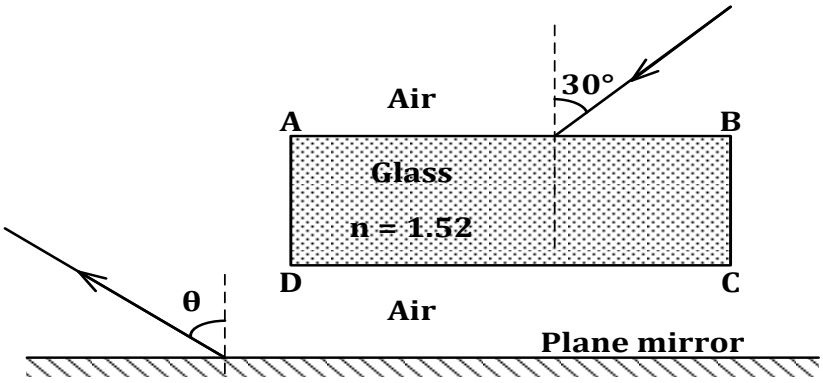

Fig. 2

(i) Draw a diagram showing the whole path of the light ray. (01 mark)

(ii) Determine the angle θ that the ray makes with the normal to the mirror. (04 marks)

(d) Describe an experiment to determine the focal length of a convex mirror, using a converging lens of known focal length. (05 marks)

2. (a) (i) What is meant be the term ***aperture*** of a convex lens. (01 mark)

(ii) Rays from a distant axial object, incident onto a convex lens form a point image, that subtends an angle of 74° at the lens aperture and is a distance of 12.0 cm from the lens. Calculate the size of the lens aperture. (03 marks)

(b) (i) State the preliminary adjustments of an optical spectrometer. (03 marks)

(ii) Describe how an adjusted spectrometer can be used to measure the refractive index of the material of a triangular glass prism of known refracting angle, A. (04 marks)

(c) (i) Draw a ray diagram of a terrestrial telescope in normal adjustment and use it to derive the angular magnification. (05 marks)

(ii) The erecting lens of the telescope in (i) above has a focal length of 10.0 cm and an eyepiece lens of focal length 5.0 cm. If its angular magnification is 4.0, how long is the telescope? (03 marks)

(d) State how you can design of a simple microscope with a bigger magnifying power. (01 mark)

SECTION B

3. (a) Distinguish between;

(i) Pitch and loudness of a sound note. (03 marks)

(ii) Fundamental frequency and overtones of a musical instrument. (02 marks)

(b) An open-ended pipe of length 0.530 m is sounded at its first overtone. A metal wire of a guitar of length 0.810 m, having 9.0×10^{-4} kg m^{-1} is under tension of 100 N. When the wire is plucked in the middle to generate its third harmonic, it resonates with the output of the piped instrument. If the speed of sound in air is 330 m s^{-1}, determine the end correction for the pipe. (04 marks)

(c) (i) What are ***beats***? (02 marks)

(ii) Describe how beats can be used to measure frequency of a given source of sound. (05 marks)

(d) (i) Define the term ***Doppler effect***. (01 mark)

(ii) A bat flying at 10 m s^{-1} emits waves of frequency 78 kHz as if flies away from a tall building. Calculate the apparent frequency of the reflected waves from the wall that are received by the bat. (03 marks)

4. (a) (i) What is plane polarized light? (01 mark)

(ii) Calculate the polarizing angle light incident from air into glass of refractive index 1.52 (02 marks)

(b) (i) State Huygens's principle. (01 mark)

(ii) The incident wave front of plane progressive waves is travelling from deep water to shallow water and makes an angle of 30° with the normal to the interface. The wave front is refracted at an angle of 19.5°. If the wavelength of the waves in deep water is 0.527 m, determine the wavelength of the refracted waves in the shallow water. (03 marks)

(c) (i) Using well defined symbols, write down an expression for the fringe separation in Young's double slit experiment. (01 mark)

(ii) State the effect of reducing the slits separation on the fringe separation. (01 mark)

(d) (i) Distinguish between constructive and destructive interference. (03 marks)

(ii) Explain how interference fringes are formed, in an air wedge film between the two glass slides. (04 marks)

(e) An air – wedge is formed by two glass slides placed in contact at one end and separated by a razorblade at a position a distance of 15.0 cm from their line of contact. The air – wedge is illuminated normally from above by light of wavelength 6.0×10^{-7} m. The interference fringes formed by reflection have a separation 1.8 mm. Find the thickness of the razor blade. (04 marks)

SECTION C

5. (a) (i) Define the term magnetic flux and state its SI unit. (02 marks)

(ii) A coil of 10 turns and mean radius 5.0 cm lies with its plane on a flat horizontal table. The plane of the coil is threaded by a magnetic field of 0.85 T making an angle of 60° with the horizontal. Calculate the magnetic flux linking the coil. (03 marks)

(b) (i) Two parallel wires each of length, **L**, carry currents of the same magnitude, **I**, in opposite directions in free space. The two wires are separated by a distance, **d**. Derive an expression for the magnetic force exerted on any one of the wires. (03 marks)

(ii) The diagram figure 3 shows three parallel wires **P**, **Q** and **R** each of length 0.500 m carrying currents of **6 A**, **5 A** and **2 A** respectively. The distance between **P** and **Q** is 2.0 cm while that between **Q** and **R** is 3.0 cm.

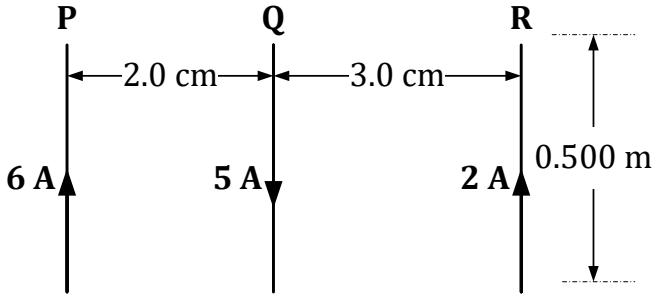

Fig. 3

Calculate the resultant force exerted on wire Q. (05 marks)

(c) Describe how a simple current balance is used to investigate the effect of the number of turns of a coil, on the magnetic flux density at the centre of the same plane circular coil. (06 marks)

(d) Give one industrial application of magnets. (01 mark)

6. (a) (i) State Lenz's law of electromagnetic induction. (01 mark)

(ii) Explain why Lenz's law obeys the principle of conservation of energy. (03 marks)

(b) Describe an experiment for the absolute measurement resistance. (06 marks)

(c) A rectangular loop of wire **WXYZ** measuring 35 cm by 75 cm, has one part inside a uniform magnetic field of flux density, 0.45 T perpendicularly out of the plane of the loop that has a total resistance of 0.23 Ω as shown in figure 4

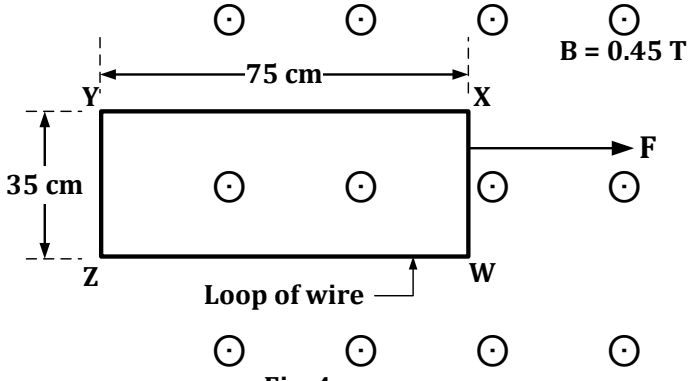

Fig. 4

Calculate the size of the;

(i) E.m.f. induced in the loop when the loop attains a velocity of 3.4 m s^{-1}. (02 marks)

(ii) Force required to pull the loop from the magnetic field at a constant velocity of 3.4 m s^{-1}. (03 marks)

(d) A circular coil of wire of wire of 3 turns is placed near one open end of a solenoid as shown in figure 5.

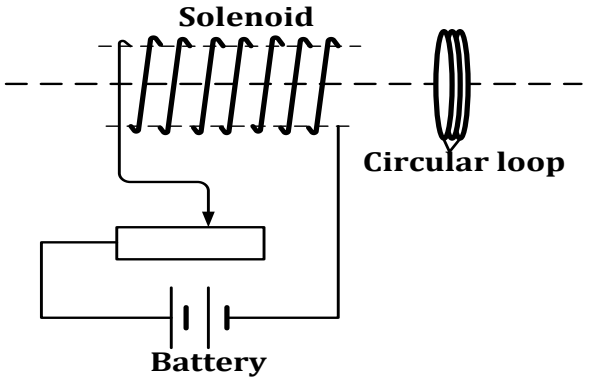

Fig. 5

When the current flowing in the solenoid is 550 mA, the magnetic flux linking the circular coil is 2.7×10^{-5} Wb. When the current in the solenoid changes at a rate of 6.0 A s^{-1}, the induced current in the circular loop is 3.6×10^{-4} A. Determine the;

(i) Mutual inductance of the solenoid – coil magnetic linkage. (02 marks)

(ii) Resistance of the circular loop. (03 marks)

7. (a) (i) Define the term ***root mean square*** value of alternating current. (01 mark)

(ii) Derive an expression for the average power dissipated in a resistor when an alternating current $I = I_0 \sin(2\pi ft)$ is passed through it. (03 marks)

(b) (i) What is meant by ***capacitive reactance***? (01 mark)

(ii) An alternating current $I = 7.07 \sin(100\pi t)$ is connected across a capacitor of 16 μF. Determine the maximum value of charge induced on each plate of the capacitor. (04 marks)

(c) (i) Describe the structure and mode of operation of a repulsion type of a hot iron ammeter. (05 marks)

(ii) Distinguish between a moving coil ammeter and a moving iron ammeter. (03 marks)

(d) A pure inductor having a self-inductance of 2.0 H, is connected in series with a resistor of resistance, 5.0 Ω and to an a.c. source of 240 V, 50 Hz. Calculate the root mean square value of current flowing in the circuit. (03 marks)

SECTION D

8. (a) (i) What is an electric field? (01 mark)

(ii) Sketch an electric field pattern due to two positive point charges $\mathbf{Q_1}$ and $\mathbf{Q_2}$, placed a small distance apart and equidistant from a negatively charged metal plate, with $\mathbf{Q_2}$ having a larger charge than $\mathbf{Q_1}$. (03 marks)

(b) (i) Explain the term corona discharge. (03 marks)

(ii) Describe the structure and action of a Van – de – Graaff generator. (06 marks)

(c) Derive an expression for the electric potential at a point in an electric field. (04 marks)

(d) Sketch using the same axes, graphs of electric potential and electric field intensity against distance from the centre of a positively charged metal sphere. (03 marks)

9. (a) (i) Distinguish between dielectric field strength and dielectric constant. (03 marks)

(ii) Explain the effect of inserting a dielectric material to fill all the space between the plates of a parallel plate capacitor. (04 marks)

(b) Four capacitors of equivalent capacitances of 6 μF are to be connected across a 12 V d.c. supply.

(i) Draw an arrangement that you would set up in order to provide the maximum capacitance in the circuit. (02 marks)

(ii) Calculate the energy stored in the arrangement in (i) above. (03 marks)

(c) A fully charged capacitor is disconnected from the source and isolated in air. The space between its plates is then doubled while the other factors are kept constant. Explain the change in the energy stored in the capacitor as a result of doubling the distance between the plates. (03 marks)

(d) A charged parallel plate capacitor with a plate separation, **d**, and area of overlap **A**, is filled with a dielectric material, of dielectric constant $\boldsymbol{\epsilon_r}$
The dielectric has one third of it pulled out of the plates. Show that the capacitance, **C**, of the resultant capacitor is given by, $C = \frac{\varepsilon_0 A}{3d}(2\epsilon_r + 1)$
where, ε_0 is the permittivity of free space or air. (03 marks)

(e) State two industrial applications of capacitors. (02 marks)

10. (a) (i) Define the term ***electrical resistance*** of a conductor. (01 mark)

(ii) Explain the effect of increase in length on the resistance of a conductor. (03 marks)

(b) (i) Derive the balance condition of a metre bridge. (04 marks)

(ii) Describe the graphical method of the investigating the effect of the cross sectional area of a metal wire on its resistance, using a metre bridge. (06 marks)

(c) In figure 6, **AB** is a uniform resistance wire, 100 cm long and having a resistance of 4 Ω. $\mathbf{E_1}$ is a driver cell of 2.00 V and internal resistance **1** Ω, while $\mathbf{E_2}$ is a source of e.m.f. of 1.50 V and internal, **r**.

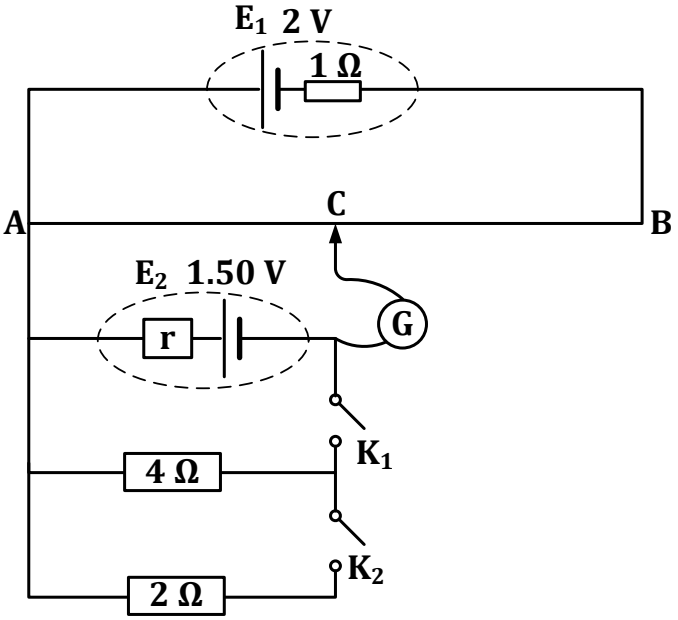

Fig. 6

When switch K_1 is closed while switch K_2 is open, the centre zero galvanometer, G shows no deflection when the balance length, AC = 57.7 cm.

Determine the,

(i) Internal resistance, r, of cell E_2. (03 marks)

(ii) Balance length AC, when both switches K_1 and K_2 are closed. (03 marks)

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