KIIRA COLLEGE BUTIKI

Uganda Advanced Certificate of Education

PHYSICS

Paper 2

(Principal Subject)

LOCK DOWN REVISION QUESTIONS

Acceleration due to gravity,	g	=	9.81m s^{-2}
Speed of light in Vacuum,	c	=	$3.0 \times 10^{8}\text{ m s}^{-1}$
Speed of sound in air,	v	=	$3.30 \times 10^{2}\text{ m s}^{-1}$
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_o	=	$4\pi \times 10^{-7}\text{ H m}^{-1}$
Permittivity of free space,	ε_0	=	$8.85 \times 10^{-12}\text{ F m}^{-1}$
The Constant,	$\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9}\text{ F}^{-1}\text{ m}$

SECTION A

1. (a) State the laws of refraction of light. (2 marks)

(b) (i) Define the term *absolute refractive index* of a material. (1 mark)

(ii) Figure 1 shows a glass beaker of height 11.0 cm having an optical liquid in it filled up to a height of 10.0 cm above the base containing an office pin P_1. A plane mirror M and a search pin P_2 are clamped above the beaker, with the mirror facing P_2 at a height of 3.5 cm above the beaker. P_2 is adjusted until its image as seen in M, coincides with that of P_1 as seen through the liquid directly from above at a height of 12.0 cm above M.

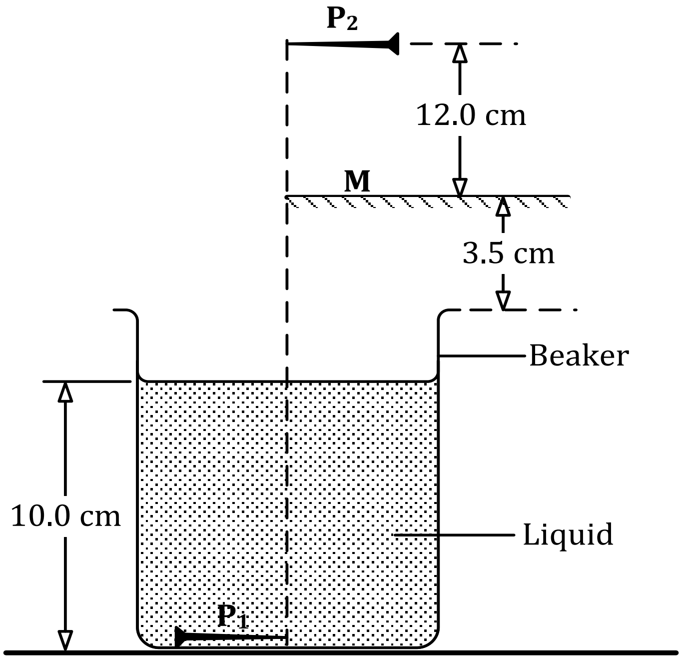

Fig. 1

Determine the refractive index of the liquid, and the apparent displacement of pin P_1 in the liquid. (4 marks)

(c) Describe an experiment to measure the refracting angle of a triangular glass prism in a physics laboratory using optical pins. (5 marks)

(d) (i) With the aid of a ray diagram, derive an expression for the combined focal length, f, of two thin lenses of focal lengths f_1 and f_2 respectively placed in contact with each other. (4 marks)

(ii) A real object placed 15.0 cm in front of a convex lens L_1 of focal length 10.0 cm forms a real image on a screen placed 60.0 cm behind the concave lens L_2 placed in contact with the convex lens.
Determine the focal length of the concave lens. (4 marks)

2. (a) (i) Draw a labelled diagram showing essential features of a photographic camera. (2 marks)

(ii) A telephoto lens of a photographic camera has a convex lens of focal length 15 cm placed 6 cm in front of a concave lens of focal length 20 cm and arranged co-axially with it. An object being photographed is 15 m in front of the convex lens. The system produces a sharp distinct real image on the film. How far is the film from the convex lens? (4 marks)

(b) (i) Define the term *chromatic aberration*. (1 mark)

(ii) Explain why a magnifying glass is said to be free from chromatic aberration when the observer's eye is placed very close to it. (3 marks)

(c) What is meant by the following terms?

(i) *Visual angle,* (1 mark)

(ii) *Accommodation* of the eye. (1 mark)

(d) (i) Draw a ray diagram to show the action of a Galilean telescope in normal use. (2 marks)

(ii) Derive the expression for the angular magnification of the telescope in (i) above. (3 marks)

(e) State two advantages and one disadvantage of a Galilean telescope over Astronomical telescope. (3 marks)

SECTION B

3. (a) (i) Define the terms *wavelength* and *frequency* of a progressive wave. (2 marks)

(ii) Derive an expression for the velocity of a progressive wave in terms of the underlined words in (i) above. (3 marks)

(b) (i) State the laws of vibration of stringed instruments. (3 marks)

(ii) Describe an experiment to show dependence of frequency of vibration of a stringed instrument on the tension in a wire of such instrument when its plucked in the middle. (6 marks)

(c) (i) What is meant by an *end correction* in a pipe? (1 mark)

(ii) Unstopped or open ended pipe of length 0.60 m has air in it vibrating at its second overtone and resonates with a wire of length 0.50 m made of a maternal of density 1780 kg m^{-3} fixed at both ends and at tension of 150 N, when set it into vibration at its first harmonic. If the diameter of the wire is 0.34 mm. Determine the end correction of the pipe. (speed of sound in air = 330 ms^{-1}) (4 marks)

(d) State one advantage of unstopped pipe over stopped piped instruments. (1 mark)

4. (a) (i) Define the term *Doppler effect.* (1 mark)

(ii) Derive an expression for the apparent frequency received by a pedestrian moving on a straight road at speed u_0 towards a receding car moving at a speed u_s while sounding a horn at frequency f, if the speed of sound in air is v. (4 marks)

(b) (i) State the *superposition principle*. (1 mark)

(ii) Use the superposition principle to explain the occurrence of interference in a double slit experiment. (4 marks)

(c) (i) State *Huygens' principle*. (1 mark)

(ii) Plane progressive waves are incident from a less dense optical medium of refractive index n_1 and moving at a speed v_1 to a more dense medium of refractive index n_2 and move through it at a speed v_2. Use a sketch ray diagram to derive an equation to show that, the ratio of the respective speeds in the two media is inversely proportional to the ratio of the absolute refractive indices of the media. (3 marks)

(d) The diagram in figure 2 shows an air wedge film formed between two glass slides separated by an aluminium foil of thickness, t, at a distance of 7.5 cm from the point of contact of the slides. The air-wedge is illuminated almost normally by light of wavelength 5.60×10^{-7} m. Interference fringes of separation 1.20 mm are produced.

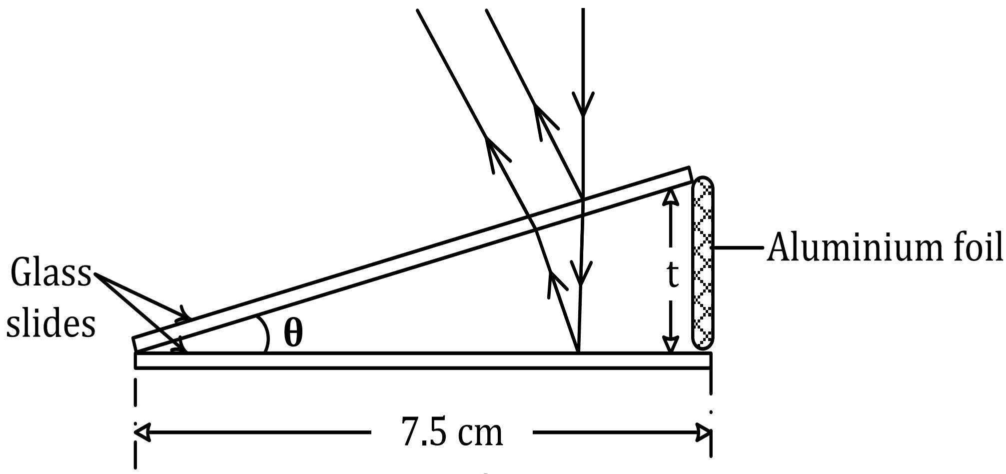

Fig. 2

Determine the;

(i) angle θ of the wedge. (3 marks)

(ii) thickness t, of the aluminium foil. (2 marks)

(iii) State one application of the above experiment. (1 mark)

SECTION C

5. (a) (i) Define the term *magnetic flux density*. (1 mark)

(ii) Describe an experiment to show variation of magnetic flux density at the centre of a plane circular coil with its number of turns. (5 marks)

(b) The diagram in figure 3 shows a straight cylindrical copper wire WY of length 0.450 m placed across smooth parallel copper rods whose plane is normal to a uniform magnetic field of flux density 0.80 T.

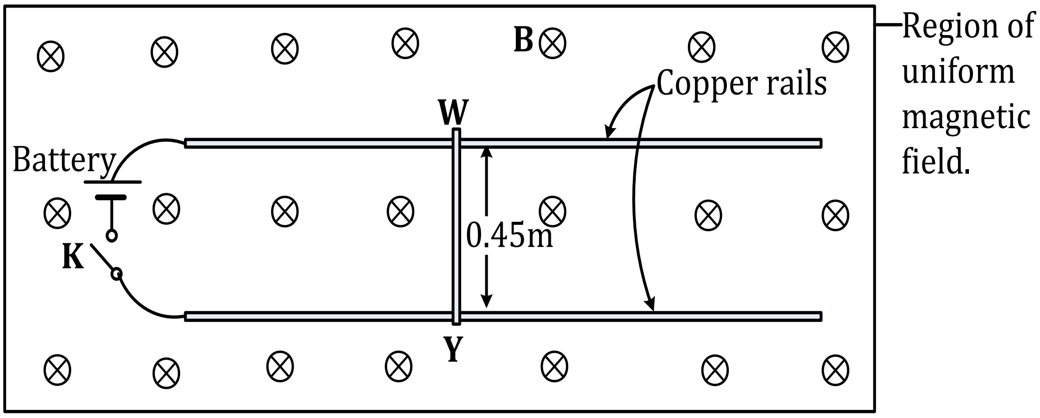

Fig. 3

(i) State and explain what happens to wire WY when switch K is closed. (3 marks)

(ii) If the wire WY has a mass of 50 mg, determine its acceleration when a current of 2.0 A flows through it. (3 marks)

(c) (i) Draw a labelled diagram of a moving coil galvanometer, showing its essential features. (2 marks)

(ii) Explain the role of the concave pole pieces of a strong magnet. (2 marks)

(d) (i) Distinguish between an electric motor and an electric generator. (2 marks)

(ii) Explain the role of a starting resistance often connected in series with the coil of an electric motor. (2 marks)

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

(ii) Use Lenz's law and the principle of conservation of energy to show that when a uniform metal rod of length L, is moved at a speed v, across a uniform magnetic field of flux density B in a closed circuit, a potential difference BLv is generated across its ends. (4 marks)

(b) Explain the term *mutual induction*. (2 marks)

(c) Figure 4 shows two coils C_1 and C_2 arranged coaxially near each other.

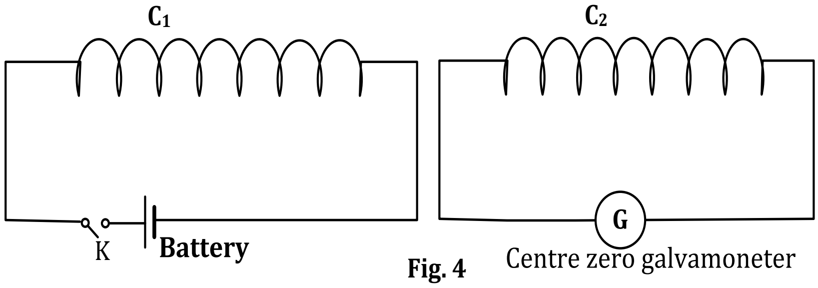

Fig. 4

(i) State and explain what is observed when switch K is closed and later opened. (3 marks)

(ii) A bunch of soft iron rods is then inserted into coil 1. Explain the observations when switch K is closed and then opened. (3 marks)

(d) (i) A uniform circular copper disc of radius, r, has its plane normal to a uniform magnetic field of flux density B and is rotated about its axle at a constant angular speed ω. Show that, the e.m.f. generated between the axle and the rim, $E = \frac{1}{2} Br^2\omega$ (3 marks)

(ii) The disc in (i) has a radius of 7.0 cm and is spun about its axle at 300 revolutions per minute in a magnetic field of 18 μT. Calculate the e.m.f. generated in the process. (3 marks)

7. (a) (i) Distinguish between *peak value* and *root mean square value* of an alternating voltage. (2 marks)

(ii) Derive the relationship between the two terms in (i) above when an a.c voltage $V = V_0 \sin \omega t$ is applied across a resistor of resistance R ohms. (3 marks)

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

(ii) State one advantage and one disadvantage of the ammeter in (i) over a moving coil ammeter. (2 marks)

(c) (i) Define the terms *inductive reactance* and *impedance*. (2 marks)

(ii) A coil of wire having a resistance of 2 Ω and self inductance of 4 H is connected across an a.c voltage of 20 V r.m.s value. Determine the peak value current flowing through the inductor. (3 marks)

(d) The circuit in figure 5 shows a pure inductor, L of 0.8 H connected to a variable capacitance, C.

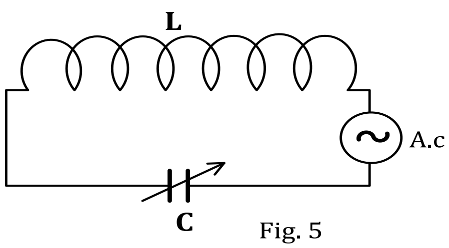

Fig. 5

Determine the capacitance of the capacitor for which the resonant frequency attained in the circuit is 50Hz. (3 marks)

SECTION D

8. (a) (i) Define the term *electric field intensity*. (1 mark)

(ii) A neutral polythene ball of 90 mg is hanged at one end of a light uniform wooden beam at the 35.0 cm mark from the knife edge while a charged parallel plate air capacitor is at 15.0 cm from the knife edge; as shown in figure 6 below.

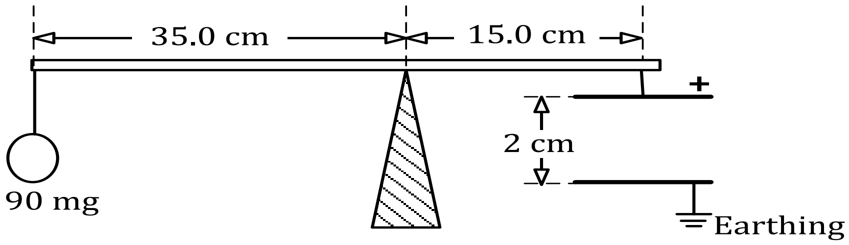

Fig. 6

Given that, the p.d between the plates of the capacitor is 12.0 V and the plate separation is 2.0 cm, determine the magnitude of charge on either plates of the capacitor. (4 marks)

(b) (i) What is meant by the term *corona discharge*? (3 marks)

(ii) Explain why the metal cap of a Gold leaf electroscope is always made smooth and circular. (2 marks)

(c) (i) Explain the effect of inserting a dielectric to fill the space between the plates of an isolated charged parallel plate capacitor. (3 marks)

(ii) A parallel plate capacitor originally having plates of area A and all the space between the plates filled with a dielectric of dielectric constant ε_r has the two thirds of the dielectric pulled out of the plates.
Show that the effective capacitance of the new capacitor is given by the expression, $\frac{\varepsilon_0 A}{3d}(2+\varepsilon_r)$. Where d is the separation of the plates of the capacitor. (3 marks)

(d) An electron is liberated from the lower of two large parallel metal plates separated by a distance of 2.0 cm. The upper plate has a potential of +2400 V while the lower plate is earthed. Given that the charge to mass ratio of an electron is $1.8 \times 10^{11}\ \mathrm{C\,kg^{-1}}$, determine the time taken by the electron just to reach the upper plate. (4 marks)

9. (a) (i) State *Coulomb's law* of electrostatics. (1 mark)

(ii) Figure 7 below shows two small spheres A and B of the same size, each of mass 20g and carrying the same type of charge. The spheres establish equilibrium positions when the strings make an angle of 60° with each other.

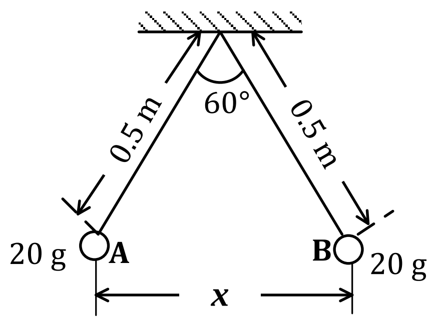

Fig. 7

Find the magnitude of charge on each sphere. (4 marks)

(b) A neutral conductor Q is placed just besides but not in contact with a positively charged metal sphere, P.

(i) Explain what happens to the conductor Q. (3 marks)

(ii) Sketch a graph of electric potential against distance for the set up in Part (i) above. (2 marks)

(c) (i) Two capacitors of capacitances C_1 and C_2 respectively are connected in series to a d.c source of e.m.f. V, volts. Show that the net charge in the network is given by the expression $\frac{C_1 C_2 V}{(C_1 + C_2)}$ (4 marks)

(ii) State three factors that affect the capacitance of a parallel plate capacitor. (3 marks)

(d) (i) Give ***two*** industrial uses of capacitors. (2 marks)

(ii) Sketch electric field pattern due to a charged parallel plate capacitor. (1 mark)

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

(ii) Figure 8 shows a uniform metal wire of length L made into a loop, so that current enters the loop at X and leaves at Z.

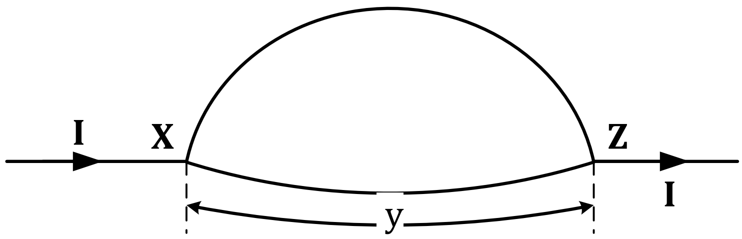

Fig. 8

If R, is the effective resistance of the loop of the wire and A is its cross-sectional area,

Show that $\rho = \frac{R\,A\,L}{y(L-y)}$ (4 marks)

(b) Two wires W_1 and W_2 have lengths in the ratio 4:5, diameters in the ratio 4:3 and have their resistances in the ratio 3:20 respectively. Determine the ratio of the corresponding resistivities of their materials. (3 marks)

(c) (i) Explain the working principle of a slide with potentiometer. (3 marks)

(ii) Describe how a slide wire potentiometer can be used to measure the e.m.f of a cell. (4 marks)

(d) The circuit in figure 9 is used to measure the e.m.f of a thermocouple, T. AB is a uniform wire of length 1.00 m and resistance 2.00 Ω. With switch K_1 closed and K_2 open, the balance length AJ is 90.0cm. With K_2 closed and K_1 open, the balance length 45.0 cm. If the driver cell has negligible internal resistance.

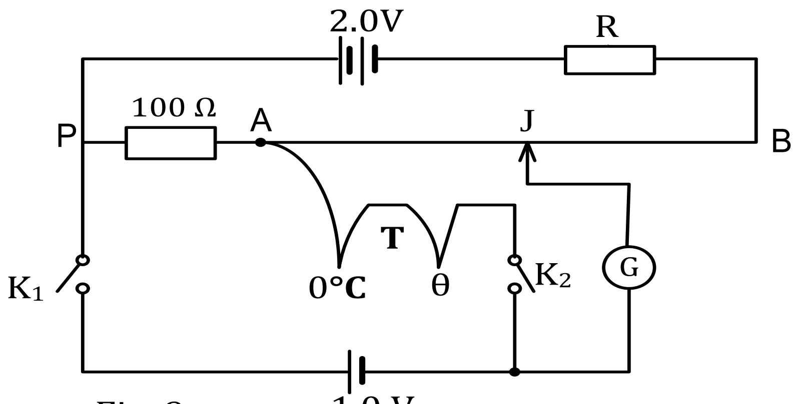

Fig. 9

Determine the;

(i) e.m.f of the thermocouple T. (3 marks)

(ii) Value of the resistance, R. (2 marks)

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