P510/1
PHYSICS
(Theory)
Paper 1
Nov. /Dec. 2022
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

PHYSICS

(THEORY)

Paper 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **five** *questions, including at least* **one**, *but not more than* **two** *from each of the sections;* **A**, **B** *and* **C**.

Any additional question(s) answered will **not** *be marked.*

Non-programmable scientific calculators may be used.

Assume where necessary:

Acceleration due to gravity, g	$= 9.81\ ms^{-2}$.
Electron charge, e	$= 1.6 \times 10^{-19}$ C.
Electron mass	$= 9.11 \times 10^{-31}$ kg.
Mass of the earth	$= 5.97 \times 10^{24}$ kg.
Plank's constant, h	$= 6.6 \times 10^{-34}$ Js.
Stefan's Boltzmann's constant, σ	$= 5.67 \times 10^{-8}\ Wm^{-2} K^{-4}$
Radius of the earth	$= 6.4 \times 10^{6}$ m.
Radius of the sun	$= 7 \times 10^{8}$ m.
Radius of the earth's orbit about the sun	$= 1.5 \times 10^{11}$ m.
Speed of light in a vacuum, c	$= 3.0 \times 10^{8}\ m\ s^{-1}$.
Thermal conductivity of copper	$= 390\ Wm^{-1} K^{-1}$.
Thermal conductivity of aluminium	$= 210\ Wm^{-1} K^{-1}$.
Specific heat capacity of water	$= 4200\ J\ kg^{-1} K^{-1}$.
Universal gravitational constant, G	$= 6.67 \times 10^{11}\ Nm^{2} kg^{-2}$.
Avogadro's number, N_A	$= 6.02 \times 10^{23}\ mol^{-1}$.
Surface tension of water	$= 7.0 \times 10^{-2}\ Nm^{-1}$.
Density of water	$= 1000\ kgm^{-3}$.
Gas constant, R	$= 8.31\ J\ mol^{-1} K^{-1}$.
Charge to mass ratio, e / m	$= 1.8 \times 10^{11}\ C\ kg^{-1}$.
The constant $\frac{1}{4\pi\varepsilon_0}$	$= 9.0 \times 10^{9}\ F^{-1}$ m.
Faraday constant, F	$= 9.65 \times 10^{4}\ C\ mol^{-1}$.

SECTION A

1. (a) Define the following:

   (i) Brittleness. *(01 mark)*

   (ii) Elasticity. *(01 mark)*

   (b) State **Hooke's law.** *(01 mark)*

   (c) Figure 1 shows graphs of stress against strain for two metals *X* and *Y*.

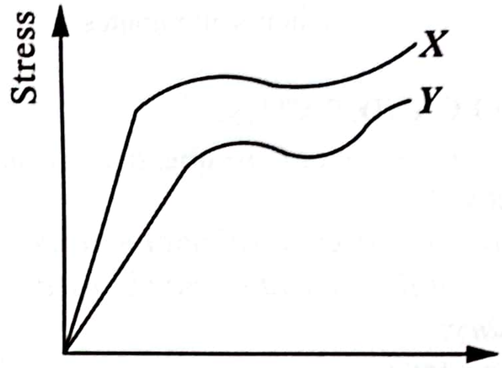

Fig.1

State and explain which metal;

(i) has a greater Young's modulus, *(02 marks)*

(ii) is more ductile, *(02 marks)*

(iii) is stronger than the other. *(02 marks)*

(d) Two wires *P* and *Q* of the same material have equal length but the radius of *P* is twice that of *Q*. Which wire;

(i) can withstand the greater load before breaking? *(02 marks)*

(ii) has the greater strain for a given load? *(02 marks)*

(e) A copper wire of length 4 m and cross sectional area 1.0×10^{-3} mm^2 is fixed between two rigid supports *A* and *B*, 4 m apart. What mass, when suspended at the middle of the wire will produce a sag of 1.5 m at that point? (*Young's modulus of copper* $= 1.2 \times 10^{11}$ *Pa*). *(04 marks)*

(f) Explain why water flowing out of a small hole at the bottom of a wide tank results in a backward force on the tank. *(03 marks)*

2. (a) (i) What is meant by **dimensions of a physical quantity**? (*01 mark*)

(ii) The velocity, v of a wave of wavelength, λ on the surface of a liquid of surface tension, γ and density, ρ, is given by

$v^2 = \frac{\lambda g}{2\pi} + \frac{2\pi\gamma}{\lambda\rho}$, where g is the acceleration due to gravity.

Show that the equation is dimensionally consistent. (*03 marks*)

(b) Figure **2** shows acceleration-time graph for a body of mass 10 kg which starts from rest and moves in a straight line.

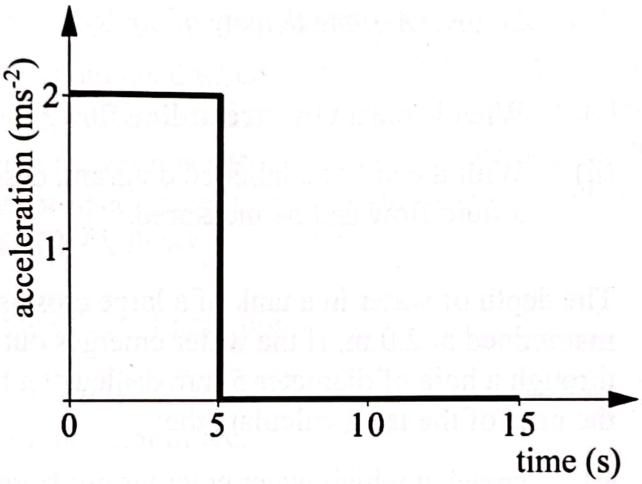

Fig.2

Use the graph to find the;

(i) distance travelled in 15 s. (*04 marks*)

(ii) average force acting on the body over the 15 s. (*03 marks*)

(c) With examples, explain any **two** of Newton's laws of motion. (*04 marks*)

(d) (i) State the principle of conservation of linear momentum. (*01 mark*)

(ii) A particle of mass, M_1 moving with a velocity, U_1 collides with a stationary particle of mass, M_2. The collision is elastic and the velocities of M_1 and M_2 after impact are v_1 and v_2 respectively. If the particles move in the same direction and

$\alpha = \frac{M_2}{M_1}$, show that $U_1 = v_1 \frac{(1+\alpha)}{(1-\alpha)}$. (*04 marks*)

Turn Over

3. (a) (i) State **Bernoulli's principle.** *(02 marks)*

(ii) Explain with the aid of a diagram, why air flows over the wings of an aircraft causes a lift. *(02 marks)*

(b) Air flows over the upper surfaces of an aircraft's wings at a speed of 135 m s^{-1} and passed the lower surfaces of the wing at a speed of 120 m s^{-1}. *(04 marks)*

(i) Calculate the pressure difference due to the flow. *(02 marks)*

(ii) Determine the lift force on the air craft if the total wing area is 28 m^2. (*Assume density of air is 1.2 kg m^{-3}.*) *(02 marks)*

(c) (i) What is meant by **streamline flow**? *(02 marks)*

(ii) With the aid of a labelled diagram, describe how the velocity of a fluid flow can be measured. *(05 marks)*

(d) The depth of water in a tank of a large cross-sectional area is maintained at 2.0 m. If the water emerges out of the tank continuously through a hole of diameter 5 mm drilled at a height of 10.0 cm above the base of the tank, calculate the;

(i) speed at which water emerges out from the hole. *(03 marks)*

(ii) rate of mass flow of water from the hole. *(02 marks)*

4. (a) (i) Define **angular velocity**. *(01 mark)*

(ii) Explain why a body moving with constant speed along a circular path has an acceleration. *(03 marks)*

(iii) Derive an expression for the acceleration of a body moving in a circular path of radius r with a constant speed v. *(04 marks)*

(b) Define the following:

(i) Projectile motion. *(01 mark)*

(ii) Angle of projection. *(01 mark)*

(c) An object P is projected vertically upwards from the ground with a speed of 36 m s^{-1}. If object Q is dropped vertically above P from a height of 90 m above the ground after 2 s, find the;

(i) time when P and Q collide, from the time P was thrown upwards. *(07 marks)*

(ii) height above the ground where P and Q collide. *(03 marks)*

SECTION B

5. (a) Define the following:

(i) specific heat capacity. *(01 mark)*

(ii) specific latent heat of vaporisation. *(01 mark)*

(b) With the aid of a labelled diagram, describe an experiment to determine the specific latent heat of vaporization of a liquid. *(07 marks)*

(c) The inlet and outlet temperatures of water flowing in a continuous flow method are 15.2°C and 17.4°C respectively. A flow rate of 20 g min^{-1} is obtained when a current of 2.3 A flows and a p.d of 3.3 V is applied. When oil, which flows in and out at the same temperature as water is used, the flow rate obtained is 70.0 g min^{-1}. Calculate the specific heat capacity of oil, if a p.d 3.9 V is applied and a current of 2.7A flows. *(05 marks)*

(d) Explain the effect of pressure on:

(i) boiling point of a liquid. *(03 marks)*

(ii) melting point of ice. *(03 marks)*

6. (a) Define the following:

(i) Molar heat capacity of a gas at constant pressure. *(01 mark)*

(ii) Molar heat capacity of a gas at constant volume. *(01 mark)*

(b) Derive the expression $C_P - C_V = R$, where C_P is the molar heat capacity of a gas at constant pressure and C_V is the molar heat capacity of a gas at constant volume and R is the gas constant. *(05 marks)*

(c) (i) Differentiate between **adiabatic** and **isothermal** expansions. *(02 marks)*

(ii) State **two** examples of adiabatic changes. *(01 mark)*

(d) A fixed mass of an ideal gas of volume 400 cm^3 at 15 °C expands adiabatically and its temperature falls to 0 °C. It is then compressed isothermally until the pressure returns to its original value. If the molar heat capacity at constant pressure is 28.6 J $mol^{-1}K^{-1}$, calculate the final volume after isothermal compression. *(05 marks)*

(e) (i) What is **saturated vapour pressure** of a liquid? *(01 mark)*

(ii) Describe an experiment to show that a liquid boils when its saturated vapour pressure equals to the atmospheric pressure. *(04 marks)*

7. (a) Define the following:

(i) Temperature gradient. *(01 mark)*

(ii) Thermal conductivity. *(01 mark)*

(b) Explain why a poor conductor whose thermal conductivity is to be determined, must be thin and fairly of large surface area. *(03 marks)*

(c) With the aid of a labelled diagram, describe how the presence of radiation is detected by a bolometer connected to Wheatstone bridge. *(06 marks)*

(d) A metal sphere whose surface acts as a black body, is placed at the principal focus of a concave mirror of diameter 60 cm, which is directed towards the sun. If the solar radiation falling normally on the earth is 1400 Wm^{-2}, and the mean temperature of the surroundings is 30 °C, find the diameter of the sphere when the maximum temperature it attains is 1870 °C. *(06 marks)*

(e) State **three** properties of radiant energy. *(03 marks)*

SECTION C

8. (a) State any **four** properties of cathode rays. *(02 marks)*

(b) Show that the path of an electron projected at right angles to a uniform electric field is a parabola. *(05 marks)*

(c) Two metal plates each 5.0 cm long are held horizontally 4.0 cm apart in a vacuum, one being vertically above the other. The upper plate is at a potential of 400 V while the lower one is earthed. Electrons having a velocity of $1.0 \times 10^7\ ms^{-1}$ enter horizontally mid-way between the plates and in a direction parallel to the 5.0 cm edge. Calculate the vertical deflection of the electron as it emerges from the plates. *(04 marks)*

(d) (i) With the aid of a labelled diagram, describe how the specific charge of positive rays may be determined. *(06 marks)*

(ii) Explain how the set up in (d) (i) can be used to determine the abundance of isotopes. *(03 marks)*

9. (a) What is meant by **thermionic emission**? *(01 mark)*

(b) (i) Sketch the anode current versus anode voltage characteristics of thermionic diode. *(02 marks)*

(ii) Explain the main features of the curves. *(05 marks)*

(c) (i) With the aid of a diagram, describe the operation of a Cathode ray oscilloscope (C.R.O). *(06 marks)*

(ii) Describe the use of a time base in a C.R.O. *(02 marks)*

(d) Explain the wave form obtained on a C.R.O connected across the resistor R in the circuit shown in Figure **3**. *(04 marks)*

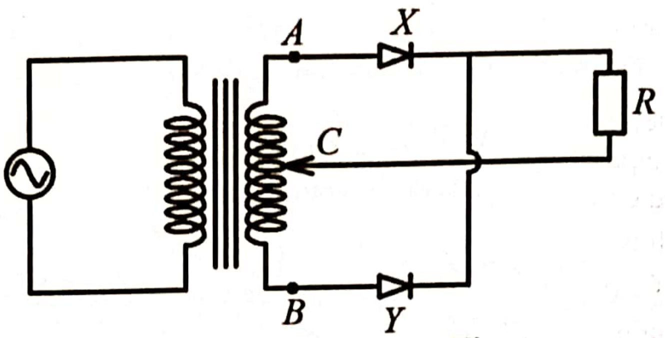

Fig. 3

10. (a) State **two** characteristics of a photo electric emission. *(02 marks)*

(b) (i) State **three** advantages of nuclear fusion over nuclear fission as a potential source of energy. *(03 marks)*

(ii) Why does nuclear fusion take place only at high temperatures? *(01 mark)*

(c) Given that;

mass of a proton = 1.0073 U,
mass of an electron = 0.0005 U,
mass of a neutron = 1.0087 U and
mass of $^{227}_{87}Fr = 223.0198$ U.

(i) Calculate the difference in the mass between $^{227}_{87}Fr$ nucleus and the sum of the masses of its nucleons. *(05 marks)*

(ii) How is the difference in the masses in (c) (i) accounted for? *(02 marks)*

(d) (i) State **three** uses of X - rays. *(03 marks)*

(ii) Explain how quantum theory provides an explanation for the photoelectric effect. *(04 marks)*

END

P510/2
PHYSICS
(Theory)
Paper 2
Nov./Dec. 2022
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

PHYSICS
(THEORY)

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **five** *questions, taking at least* **one** *from each of the sections;* **A, B, C** *and* **D**, *but* **not** *more than* **one** *question should be chosen from either* **A** *or* **B.**

Any additional question(s) answered will **not** *be marked.*

Mathematical tables and graph paper are provided.

Non-programmable scientific calculators may be used.

Assume where necessary:

Speed of light in a vacuum, C	$= 3.0 \times 10^{8}\ ms^{-1}$
Acceleration due to gravity, g	$= 9.81\ ms^{-2}$
Electron charge, e	$= 1.6 \times 10^{-19}\ C$
Electron mass	$= 9.11 \times 10^{-31}\ kg$
Plank's constant, h	$= 6.6 \times 10^{-34}\ Js$
Permeability of free space, μ_0	$= 4.0\pi \times 10^{-7}\ Hm^{-1}$
Permittivity of free space, ε_0	$= 8.85 \times 10^{-12}\ Fm^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	$= 9.0 \times 10^{9}\ m\ F^{-1}$
One electron volt (eV)	$= 1.6 \times 10^{-19}\ J$
Avogadro's number, N_A	$= 6.02 \times 10^{23}\ mol^{-1}$
Resistivity of Nichrome wire at 25 °C	$= 1.2 \times 10^{-6}\ \Omega m$
Specific heat capacity of water	$= 4.2 \times 10^{3}\ Jkg^{-1}\ K^{-1}$

SECTION A

1. (a) With the aid of a diagram explain **diffuse reflection.** *(02 marks)*

(b) Show that for small angles of incidence, the deviation of a ray of light by a small angle prism depends on only the angle of the prism and refractive index of the material. *(05 marks)*

(c) Describe an experiment to determine the angle of minimum deviation by a prism, using optical pins and a plain sheet of paper. *(05 marks)*

(d) Explain why a fish in water has a wide field of view. *(04 marks)*

(e) A layer of transparent oil of thickness 5 cm floats on water in a beaker. The bottom of the beaker appears to be 9.5 cm below the top surface of the oil when viewed directly from above. Find the refractive index of the oil if the depth of the water is 8 cm.
[*Refractive index of water* = *1.33*] *(04 marks)*

2. (a) Define **focal length** of a lens. *(01 mark)*

(b) (i) When an object is placed at O, infront of the lens at A, a sharp image is formed at I, as shown in Figure **1**.

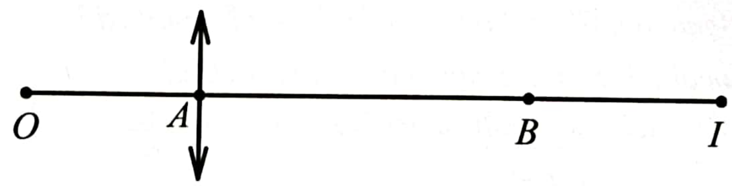

Fig. 1

A sharp image is also formed at I when the lens is moved to B. If $OI = l$ and $AB = d$, show that $l^2 - d^2 = 4lf$, where f is the focal length of the lens. *(05 marks)*

(ii) Using a ray diagram, construct and locate the image position of an object placed at a distance less than the focal length of a converging lens. *(02 marks)*

(iii) State the characteristics of the image formed. *(02 marks)*

(c) A Plano convex lens is placed on a plane mirror on a table with its flat side up. A pin held horizontally above the lens coincides with its image at a point 20.0 cm above the lens. When the lens is placed in the same way on mercury in a trough, the pin coincides with its image at a point 7.0 cm above the lens. Find the radius of curvature of the lens. *(04 marks)*

(d) With respect to the human eye, define the following:

(i) The near point, *(01 mark)*

(ii) Accommodation. *(01 mark)*

(e) Two lenses of focal length 1.2 cm and 4.0 cm are arranged to form a microscope in normal adjustment. If the object is placed 1.5 cm infront of the objective lens, find the distance between the two lenses. *(04 marks)*

SECTION B

3. (a) (i) What is a **progressive wave**? *(01 mark)*

(ii) State the properties of progressive waves. *(03 marks)*

(b) A progressive wave is given by the equation $y = 20\sin\left(300\pi t - \frac{\pi x}{15}\right)$,

where t is time in seconds and x is the displacement in cm.

(i) Write down the equation of a progressive wave that superimposes the above to form a stationary wave. *(01 mark)*

(ii) Using the given progressive wave equation and the equation written in (b)(i) determine the equation of the resulting stationary wave and state its amplitude. *(04 marks)*

(iii) Calculate the wavelength of the stationary wave in (b)(ii). *(02 marks)*

(iv) Determine the phase difference between two points on the progressive wave separated by 25 cm. *(02 marks)*

(c) Show that the frequency of the second harmonic is $3f_0$, where f_0 is the frequency of the fundamental note in a closed pipe. *(04 marks)*

(d) Explain how the unknown frequency of a note can be obtained using beats. *(03 marks)*

4. (a) (i) State **Huygen's principle.** *(01 mark)*

(ii) Using Huygen's principle of secondary wavelets, explain how refracted wavefront is formed when a beam of light travelling in glass medium, traverses the air-glass boundary. *(03 marks)*

(iii) A parallel beam of unpolarised light travelling in liquid of refractive index $\frac{4}{3}$ is incident on a glass block of refractive index 1.52 and is reflected as plane polarised light.
Calculate the angle of refraction in the glass block. *(04 marks)*

$2\cos\frac{\pi x}{15}\sin$ $20[2\cos\frac{\pi x}{15}\sin$ **Turn Over**

(b) (i) Define **interference** as applied to light waves. (*01 mark*)

(ii) What is meant by path difference in reference to interference of two wave motions? (*01 mark*)

(iii) With the aid of a diagram, explain how Newton's rings are formed. (*06 marks*)

(c) In Loyd's mirror experiment, the source slit S_0 and its virtual image lie in a plane 15 cm beyond the left edge of the mirror. The mirror is 36 cm long and the screen is placed vertically at the right edge of the mirror. Calculate the distance from the right edge of the mirror to the position of the first maximum, if the perpendicular distance from S_0 to its image is 6.0 mm and the wavelength of light is 600 nm. (*03 marks*)

(d) State **one** application of interference. (*01 mark*)

SECTION C

5. (a) Define the following terms:

(i) Magnetic flux density. (*01 mark*)

(ii) The tesla. (*01 mark*)

(b) A coil having N turns of the same radius is made from a wire of length x. If a steady current I flows in the coil in a clock wise direction,

(i) show that the magnitude of the magnetic flux density at the centre of the coil is

$$B = \frac{\mu_0 \pi N^2 I}{x}.$$

(*03 marks*)

(ii) determine the direction of the magnetic field at the centre of the coil. (*01 mark*)

(c) A square coil ABCD of length 1.0 m and 100 turns is balanced by a 500 g mass as shown in Figure **2**.

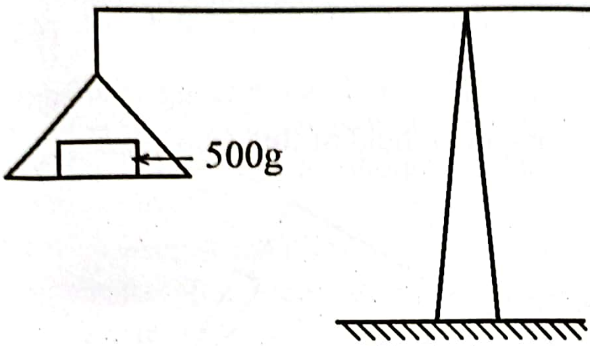

Fig. 2

Find the mass to be added to the 500 g in order to restore balance when a current of 9.8 A is passed through the coil whose side CD is maintained in a constant magnetic field of 0.2 T. *(02 marks)*

(d) Describe an experiment to investigate the variation of magnetic field strength at the centre of a circular coil when current passes through the coil. *(06 marks)*

(e) (i) A square coil of area A and N turns is pivoted between the poles of a magnet as shown in Figure **3**. The magnetic field of flux density B is uniform and a current I is passed through the coil pivoted above the axis of rotation XY perpendicular to the magnetic field.

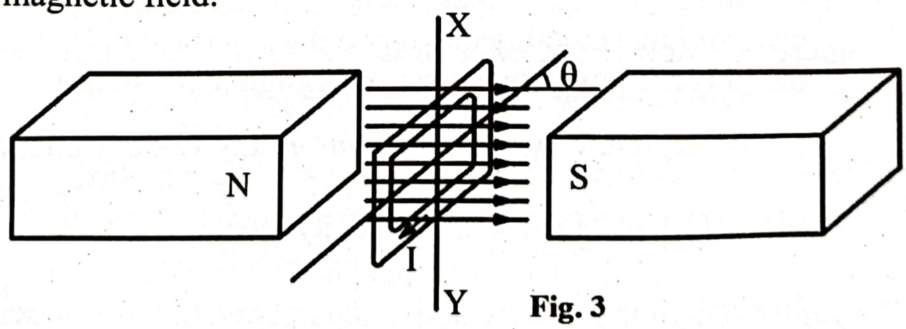

Fig. 3

Derive an expression for the torque on the coil when its plane is at an angle θ to the magnetic field. *(04 marks)*

(ii) An electron moving at 10^7 ms^{-1} is 2 cm from a straight wire carrying a current of 10 A. Find the force acting on the electron. *(02 marks)*

6. (a) (i) What is meant by **mutual induction**? *(01 mark)*

(ii) Describe an experiment to demonstrate mutual induction. *(02 marks)*

(b) Explain how the heat loss in the core of a transformer is reduced. *(02 marks)*

(c) Figure **4** shows a conducting disc of radius r rotating with angular velocity, ω in a uniform magnetic field of flux density, B.

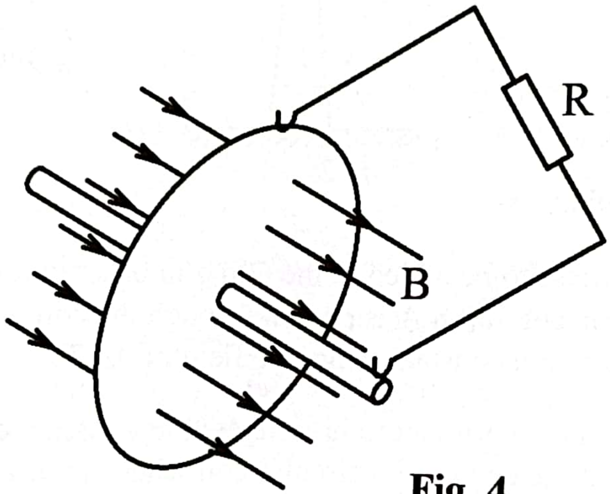

Fig. 4

If the rim and axle are joined by a wire of total resistance R, find the expression for the e.m.f induced in the circuit. *(03 marks)*

(d) A conducting rod 0.5 m long, of resistance 0.04 Ω and mass 0.03 kg falls through a horizontal magnetic field of flux density 0.2 T, with its ends sliding smoothly down two thick vertical rails. The top ends of the rails are joined by a wire of negligible resistance.

(i) Explain why the rod attains steady velocity after a short time. *(03 marks)*

(ii) Calculate the steady velocity attained. *(04 marks)*

(e) Describe the structure and mode of operation of a moving coil loud speaker. *(05 marks)*

7. (a) What is meant by the following;

(i) alternating current, *(01 mark)*

(ii) reactance? *(01 mark)*

(b) An a.c source of frequency, f, is connected across a pure inductor of inductance L. If the current $I = I_0 \sin 2\pi ft$ flows through the inductor,

(i) derive the expression for the reactance of the inductor. (*04 marks*)

(ii) sketch graphs on the same axes, for the variations of current through an inductor and voltage across it with time. (*02 marks*)

(iii) Explain why there is a phase difference between current through the inductor and voltage across it. (*02 marks*)

(c) A lamp is rated at 120 V, 2 A. In order to operate the bulb at its full voltage from the 240 V, 50 Hz mains, a pure inductor is connected in series with the lamp.

Calculate the;

(i) reactance of the inductor, (*03 marks*)

(ii) inductance of the inductor. (*02 marks*)

(d) Describe how a hot wire meter is used to measure alternating current. (*05 marks*)

SECTION D

8. (a) (i) Define **resistance** of a conductor. (*01 mark*)

(ii) An electric hot plate has a coil of manganin wire of length 20 m, diameter 0.54 mm and resistivity $4.6 \times 10^{-7}\ \Omega$ m. The coil is to be replaced with one made of nichrome of diameter 0.5 mm and resistivity $10.0 \times 10^{-7}\ \Omega$ m. Find the length of nichrome required if the power rating is to remain the same. (*03 marks*)

(b) (i) Explain why resistors connected in parallel carry larger current than when they are connected in series. (*03 marks*)

(ii) A milliameter of coil resistance 10 Ω deflects fully when a current of 3 mA flows through it. Calculate the value of the shunt that must be connected to milliameter so that it can measure a maximum current of 1.5 A. (*03 marks*)

(c) (i) Describe with the aid of a diagram how an ammeter may be calibrated using a potentiometer. (*06 marks*)

(ii) Explain the main causes of errors in measurement when using a potentiometer. (*02 marks*)

(iii) State **two** likely causes for failure to get balance point when using a potentiometer. (*02 marks*)

9. (a) What is meant by the following;

(i) electric field, *(01 mark)*

(ii) electric field strength? *(01 mark)*

(b) Sketch a graph showing variation of electric field strength with distance from the centre of a positively charged conducting sphere. *(02 marks)*

(c) (i) Define **electric potential energy**. *(01 mark)*

(ii) Derive an expression for the electric potential energy of two point charges Q_1 and Q_2, x metres apart in a vacuum. *(04 marks)*

(d) A charged sphere X of mass 80 g is suspended using an inelastic thread of length 20 cm. When a uniform electric field **E** of magnitude $1.5 \times 10^6\ N\ C^{-1}$ is applied at an angle of 30° to the horizontal, the sphere is deflected through a distance of 5 cm horizontally, as shown in Figure **5**.

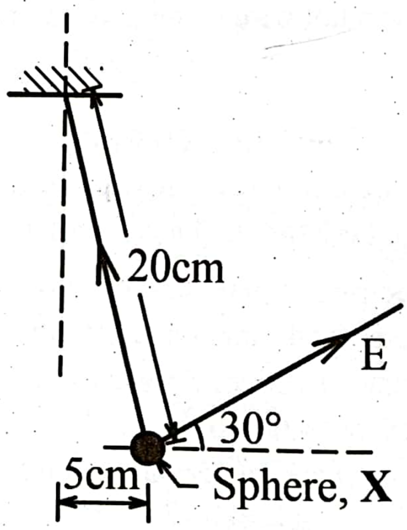

Fig. 5

Determine the:

(i) Tension in the thread. *(02 marks)*

(ii) Magnitude of charge on the sphere. *(03 marks)*

(e) Explain the mechanism of charging a body by friction. *(03 marks)*

(f) Explain what is observed when a body that has a large amount of negative charge is brought slowly from far until it is very close to the cap of the electroscope with a small positive charge. *(03 marks)*

10. (a) Define the following:

(i) The farad. *(01 mark)*

(ii) Dielectric strength. *(01 mark)*

(b) State:

(i) **two** uses of dielectrics in capacitors. *(02 marks)*

(ii) the energy changes that take place when a capacitor is charging from a battery. *(02 marks)*

(c) Two capacitors C_1 and C_2 are connected in series across a battery of e.m.f, E. Show that the p.d, V_1, across the capacitor of capacitance C_1 is given by the expression:

$$V_1 = \left(\frac{C_2}{C_1 + C_2}\right)E.$$

(03 marks)

(d) A rectangular piece of wood of dielectric constant 4 is placed between parallel plates of a capacitor of capacitance 16 μF. If a p.d of 6000 V is connected across the plates:

(i) Find the capacitance of the capacitor when the piece of wood is withdrawn. *(02 marks)*

(ii) Calculate the difference in energy before and after withdrawing the piece of wood from the capacitor. *(04 marks)*

(iii) Account for the difference in the energy in (d) (ii). *(01 mark)*

(e) Describe how the capacitance, C of a capacitor can be determined using a standard capacitor and a ballistic galvanometer. *(04 marks)*

P510/3
PHYSICS
(Practical)
Paper 3
Nov. /Dec. 2022
3¼ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

PHYSICS
(PRACTICAL)

Paper 3

3 hours 15 minutes

INSTRUCTIONS TO CANDIDATES:

Answer question **1** *and* **one** *other question.*

Any additional question answered will **not** *be marked.*

Candidates are **not** *allowed to use the apparatus for the* **first fifteen minutes**.

For each question, candidates will be required to select suitable apparatus from the equipment provided.

Candidates are expected to record in their scripts in **blue** *or* **black** *ink all their observations as these observations are made and to plan for the presentation of the records so that it is* **not** *necessary to make a fair copy of them. The working of the answers is to be handed in. Any work in pencil will* **not** *be marked.*

Marks are given mainly for a clear record of observations actually made, for their suitability, accuracy and for the use made of them.

Details on the question paper should **not** *be repeated in the answer, nor is the theory of the experiment required unless specifically asked for. However, candidates should record any special precautions they have taken and any particular feature of the method of going about the experiment.*

Graph paper is provided.

Mathematical tables and silent non-programmable scientific electronic calculators may be used.

Turn Over

1. In this experiment, you will determine the constant α of a solid labelled Q and constant β of the liquid labelled, L. *(40 marks)*

PART 1

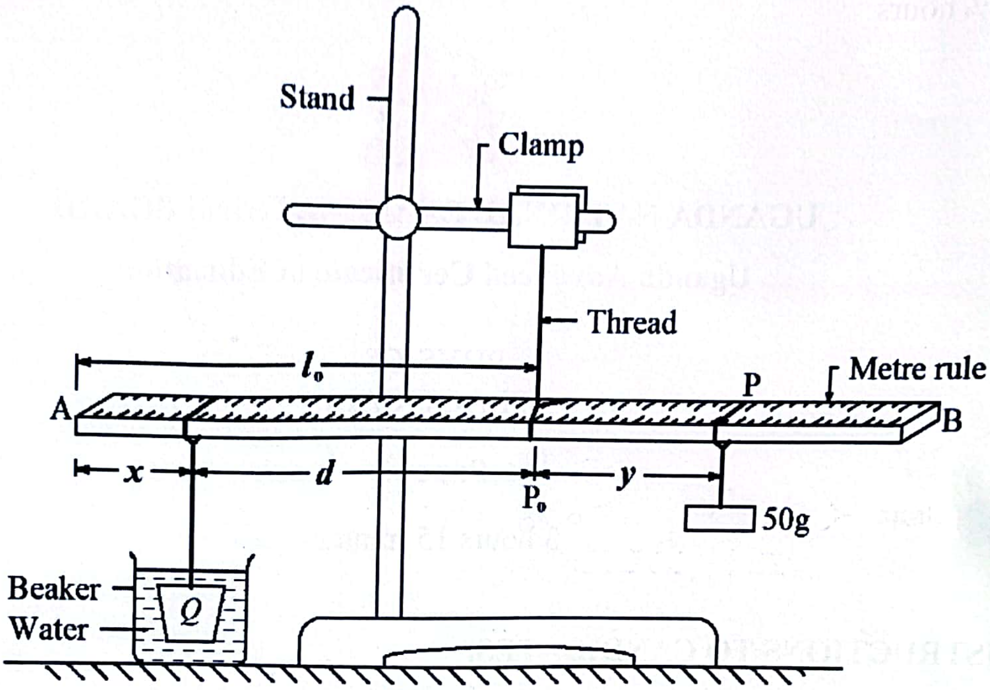

Fig. 1.1

(a) Record the mass, M of the solid Q provided.

(b) Suspend a meter rule from a clamp using a piece of thread.

(c) Adjust the metre rule until it balances horizontally.

(d) Read and record the distance l_0 of the balance point, P_0 of the meter rule from end A.

(e) Pour about 200 cm^3 of water in a beaker.

(f) Suspend the solid Q at a distance x =10.0 cm from end A of the meter rule and submerge it completely in water.

(g) Suspend a 50 g mass at a point P between P_0 and end B of the metre rule.

(h) Adjust the position of P until the meter rule balances horizontally with Q completely immersed and not touching the beaker as shown in Figure **1.1** .

(i) Read and record distance d.

(j) Read and record distance y.

(k) Repeat procedure (f) to (j), for values of x =15.0, 20.0, 25.0, 30.0 and 35.0 cm.

(l) Tabulate your results in a suitable table.

(m) Plot a graph of y against d.

(n) Find the slope, s_1 of the graph.

(o) Calculate the constant, α of the solid Q from the expression;

$$\alpha = \frac{M}{M - 50\, s_1}.$$

PART II

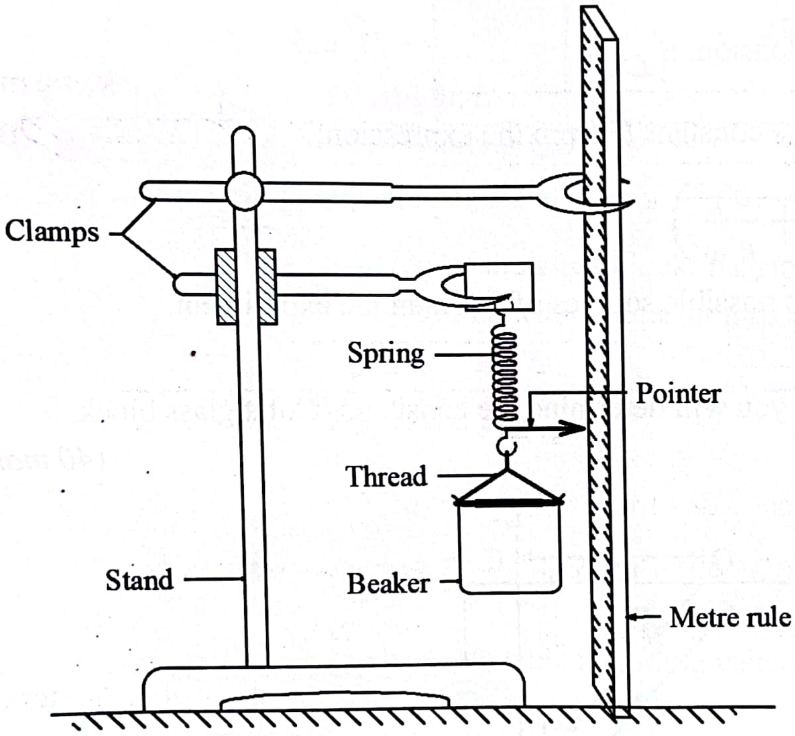

Fig. 1.2

(a) Clamp the spring provided vertically using pieces of wood.

(b) Suspend the beaker from the spring as shown in Figure **1.2**.

(c) Record the initial position, K_0 of the pointer on the meter rule.

(d) Pour 150 cm^3 of water into the beaker.

(e) Read and record the new position, K_w of the pointer.

(f) Find the extension, e_w.

(g) Repeat procedure (d) with 100 cm^3 of water.

(h) Read and record the new position, K'_w of the pointer.

(i) Find the extension, e'_w.

(j) Pour out the water and dry the beaker with a piece of tissue paper provided.

(k) Repeat procedure (b) and (c).

(l) Pour 150 cm^3 of liquid L into the beaker.

(m) Read and record the new position, K_L of the pointer.

(n) Find the extension, e_L

(o) Repeat procedure (l) for 100 cm^3 of liquid L.

(p) Read and record the new position, K'_L of the pointer.

(q) Find the extension, e'_L.

(r) Calculate the constant β from the expression;

$$2\beta = \left(\frac{e_L}{e_w} + \frac{e'_L}{e'_w}\right).$$

(s) Explain **two** possible sources of errors in the experiment.

2. In this experiment you will determine the constant, μ of a glass block provided. *(40 marks)*

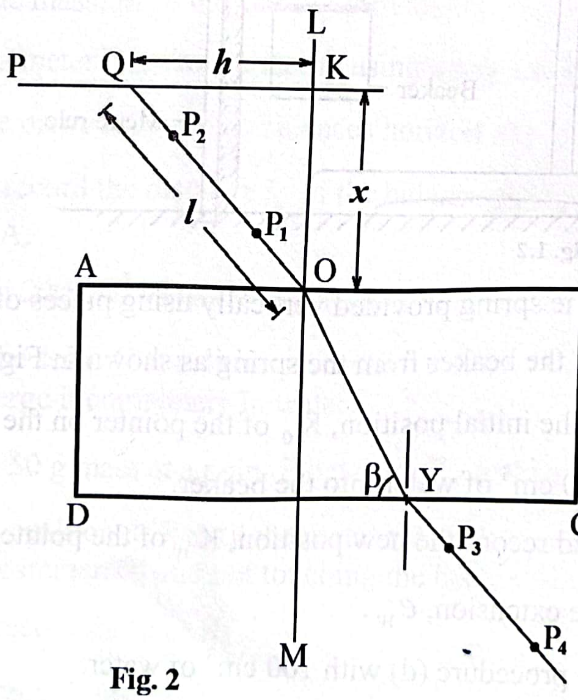

Fig. 2

(a) Fix the white plain sheet of paper on a soft board using drawing pins.

(b) Place the glass block on the paper with its broader face upwards and trace its outline ABCD.

(c) Remove the glass block and draw a normal LOM to AB at a distance of 4.0 cm from end A of the glass block as shown in Figure **2**.

(d) Measure the distance OK = x = 7.0 cm along the normal LOM.

(e) Draw a perpendicular PQK to LOM at point K.

(f) Measure distance $\boldsymbol{h}$ = 2.0 cm on line PK.

(g) Join point Q to O.

(h) Measure and record the length, $\boldsymbol{l}$.

(i) Fix pins P_1 and P_2 vertically along QO.

(j) Replace the glass block on its outline.

(k) While viewing from side DC of the glass block, fix pins P_3 and P_4 such that they appear to be in line with images of pins P_1 and P_2.

(l) Remove the glass block.

(m) Join pins P_3 and P_4 to meet DC at Y.

(n) Join Y to O.

(o) Measure and record angle β.

(p) Repeat procedure (e) to (m), for values of $\boldsymbol{h}$ = 4.0, 6.0, 8.0, 10.0 and 12.0 cm.

(q) Record your results in a suitable table including values of

$$\frac{l^2}{h^2} \text{ and } \frac{1}{Cos^2\beta}.$$

(r) Plot a graph of $\frac{l^2}{h^2}$ against $\frac{1}{Cos^2\beta}$.

19, 21 23 25 27 29 31 33 35

(s) Determine the slope, S, of the graph.

37

(t) Calculate the value of the constant μ from the expression;

$$S = \frac{1}{\mu^2}.$$

(u) Comment on the procedure and your results.

HAND IN YOUR TRACING TOGETHER WITH YOUR SCRIPT

β = 50.3°; 50.2°, 50.1°, 50.0, 49.9°, 49.8°, 49.7

Turn Over

L = 8, 7.5, 6.7, 6.0, 7.0 19 +

3. In this experiment, you will determine the constant γ, of the bare wire labelled W. (*40 marks*)

PART 1

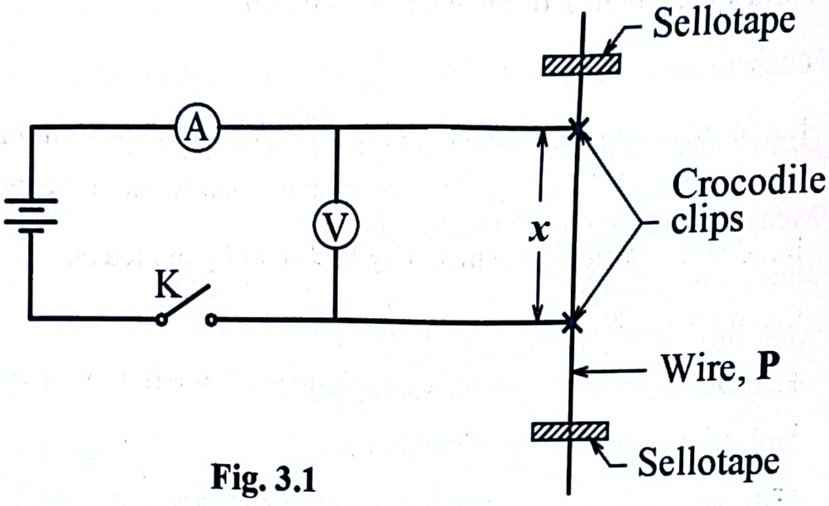

Fig. 3.1

(a) Connect the circuit shown in Figure **3.1.**

(b) Adjust the length x of the wire **P** to 0.400 m .

(c) Close switch K.

(d) Read and record the ammeter reading, I and the voltmeter reading, V.

(e) Open switch K.

(f) Disconnect the circuit.

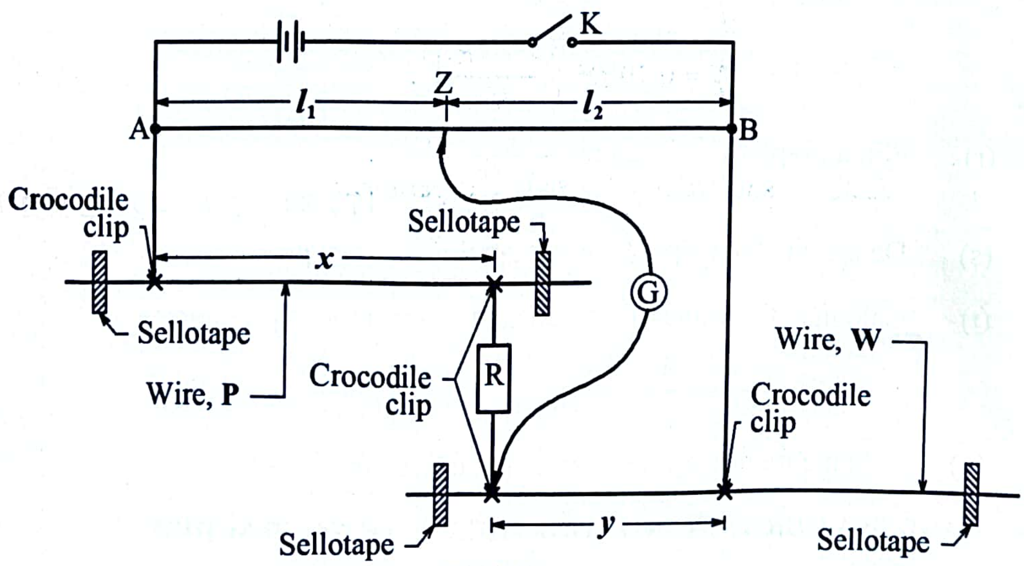

Fig. 3.2

PART II

(a) Connect the circuit shown in the Figure **3.2** with the length x of the wire P equal to 0.400 m.

(b) Adjust the length y of the wire W to 0.200 m.

(c) Close switch K.

(d) Move the sliding contact along the wire AB of the potentiometer and locate point Z for which the galvanometer shows no deflection.

(e) Read and record the balance lengths l_1 and l_2 in meters.

(f) Open switch K.

(g) Repeat the procedure (b) to (f) for values of $y = 0.300$, 0.400, 0.500, 0.600 and 0.700 m.

(h) Tabulate your results including values of $\frac{l_1}{l_2}$ and $\frac{1}{y}$.

(i) Plot a graph of $\frac{l_1}{l_2}$ against $\frac{1}{y}$.

(j) Find the slope, S of the graph.

(k) Measure and record the diameter, D, of the wire W in metres.

(l) Read and record the value of the resistor, R.

(m) Calculate the constant γ of the wire W from the expression;

$$\gamma = 0.79\, D^2 \left(\frac{V + IR}{IS}\right).$$

(n) State **six** sources of errors in the experiment.

END