THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA
ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATIONS

131/1 **PHYSICS 1**

(For Both School and Private Candidates)

Time: 3 Hours **Year: 2024**

Instructions

1. This paper consists of sections A and B with a total of **ten (10)** questions.
2. Answer **all** questions in section A and choose **two (2)** questions from section B.
3. Marks for each question or part thereof are indicated.
4. Mathematical tables and non-programmable calculators may be used.
5. All writing must be in **blue** or **black** ink, **except** drawings, which must be in pencil.
6. Communication devices and any other unauthorized materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet(s).
8. The following information may be useful:
   (a) Acceleration due to gravity, $g = 9.8\ m/s^2$
   (b) Gravitational constant, $G = 6.67\times10^{-11}\ Nm^2kg^{-2}$
   (c) Mass of earth, $M_E = 6.0\times10^{24}\ kg$
   (d) Radius of earth, $R_E = 6.4\times10^{6}\ m$
   (e) Distance of the moon from the earth, $r = 3.8\times10^{5}km$
   (f) Density of water at $25^oC = 1000\ kgm^{-3}$
   (g) Specific heat capacity of water is $4200\ Jkg^{-1}K^{-1}$
   (h) Density of ice $= 1\ g/cm^3$
   (i) Thermal conductivity of ice $= 0.005$ cal/sec.cm ^oC
   (j) Latent heat of ice $= 80$ cal/g
   (k) Pie, $\pi = 3.14$

SECTION A (70 Marks)

Answer **all** questions in this section.

1. (a) Use dimensional analysis to find the numerical values of length and mass given that the velocity of light, acceleration due to gravity and normal atmospheric pressure are 3×10^8 ms^{-1}, 10 ms^{-2} and 10^5 N/m^2 respectively. **(04 marks)**

   (b) Give reason for the following phenomenon:

   (i) A racing car travel faster around banked curved trucks than if it were flat. **(03 marks)**

   (ii) An ice skater pulls both arms and legs toward the axis of rotation and sometimes throws out the arms and one leg. **(03 marks)**

2. (a) (i) Provide three examples which illustrate the application of the law of conservation of linear momentum. **(03 marks)**

   (ii) A rocket projected vertically up ward expels its exhaust gases at 5.0×10^4 ms^{-1}. If its mass is 3.5×10^6 kg and the fuel is consumed at a rate of 1.3×10^2 kgs^{-1}; find its thrust acceleration. **(03 marks)**

   (b) An object with frictionless surface of 1 m long is inclined at an angle of 40^o to the horizontal. How fast will it be going if it moves in a positive direction down the plane? **(04 marks)**

3. (a) The motion of simple pendulum will be simple harmonic only if its amplitude of oscillation is small. Use formula to stipulate this statement. **(04 marks)**

   (b) (i) Identify two distinctive examples of bodies executing Simple Harmonic Motion (S.H.M). **(02 marks)**

   (ii) Use mathematical expressions to show that the total energy of a body executing S.H.M is independent of time. **(04 marks)**

4. (a) (i) Assess the motion of a solid sphere dropped from an artificial satellite orbiting around the earth in a circular orbit towards the earths' surface. **(03 marks)**

   (ii) Why space rockets are usually launched from west to east? **(02 marks)**

   (b) A satellite of mass 1000 kg moves in a circular orbit of radius 7000 km around the earth which is assumed to be a sphere.

   (i) Derive an expression for the total energy needed to place the satellite in that orbit. **(03 marks)**

   (ii) Compute the numerical value of total energy described in 4 (b) (i). **(02 marks)**

5. (a) (i) Give two daily life activities which utilize the mechanism of heat transfer by convection. **(03 marks)**

(ii) What are the two necessary conditions for Newton's law of cooling to be valid? **(03 marks)**

(b) A metal box cools in 5 minutes from 65 °C to 45 °C. If the temperature of the surrounding is 10 °C, determine its temperature within next 5 minutes. **(04 marks)**

6. (a) Briefly explain on each of the following phenomenon:

(i) Birds often swell their feathers during winter season. **(03 marks)**

(ii) Animals curl into nearly a ball shape when they feel cold. **(03 marks)**

(b) A layer of ice 10 cm thick is formed on a pond. If the temperature of air is $-10\ ^0$C, how long it will take for the thickness of ice to increase by 1 mm? **(04 marks)**

7. (a) (i) What are the four advantages of tidal energy? **(04 marks)**

(ii) Which characteristic property of seismic waves is used to locate discontinuities in the earth crust? **(02 marks)**

(b) Give two causes and two effect of thermal pollution. **(04 marks)**

SECTION B (30 Marks)

Answer **two (2)** questions in this section.

8. (a) (i) What are the four functions of a pure capacitor in a circuit? **(02 marks)**

(ii) Show that the resonance frequency of L.C circuit is given by the expression $f = \frac{1}{2\pi\sqrt{LC}}$. **(02 marks)**

(b) A capacitor of 0.4 μF, a coil of inductance 0.4 H, a resistor of 10 Ω and a lamp are connected in series with an alternating voltage of 0.01 V (r.m.s). If its frequency is varied from low to high while the magnitude of alternating voltage is kept constant;

(i) Use a relevant circuit diagram to sketch the graphs showing the variation of impedence and current with frequency and briefly explain how the brightness of the lamp will vary. **(04 marks)**

(ii) Calculate the voltage across the capacitor at resonance, neglecting the lamp resistance. **(02 marks)**

(c) (i) Why is the power consumed in a pure inductor or capacitor is zero? **(02 marks)**

(ii) What will happen when a lamp and a capacitor in part (b) are connected in series with a direct voltage of 0.05 V instead of alternating voltage of 0.01 V (r.m.s)? **(03 marks)**

9. (a) (i) How does amplitude modulation (AM) differ from frequency modulation (FM)? **(02 marks)**

(ii) Elaborate two basic functions of a receiver as used in communication system. **(02 marks)**

(b) Figure 1 is an op-amp circuit with negative feedback made through a capacitor C.

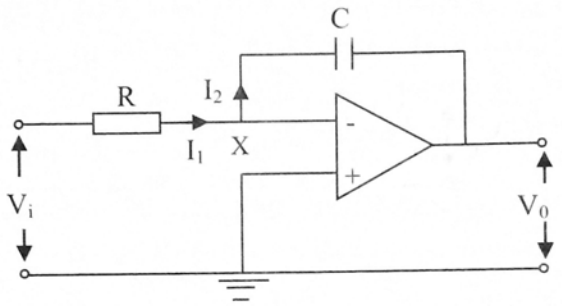

Figure 1

(i) State the practical use of the circuit shown in Figure 1. **(01 mark)**

(ii) If R = 2 kΩ, C = 2 μF and f = 50 Hz; determine the maximum voltage of the circuit at time t = 2 seconds given that V_i = 0.5sin ωt and V_O $= -\frac{1}{RC}\int V_i dt$ **(04 marks)**

(c) (i) Why is the television transmission towers made high? **(03 marks)**

(ii) Describe the methods of transmission and reception of radio signals. **(03 marks)**

10. (a) (i) Apply Boolean Algebra to analyze the logic circuit diagram shown in Figure 2 and create its truth table. **(04 marks)**

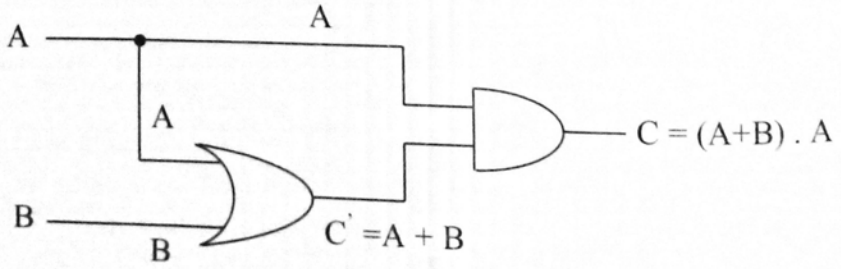

Figure 2

(ii) Why NOT gate is known as an inverter? **(02 marks)**

(b) (i) How do metals differ from semiconductors in terms of energy band and conductivity? **(04 marks)**

(ii) Identify any two factors to be considered when designing a voltage amplifier. **(02 marks)**

(c) Figure 3 is a silicon common–emitter amplifier circuit with base–emitter voltage $V_{BE} = 0.7$ V.

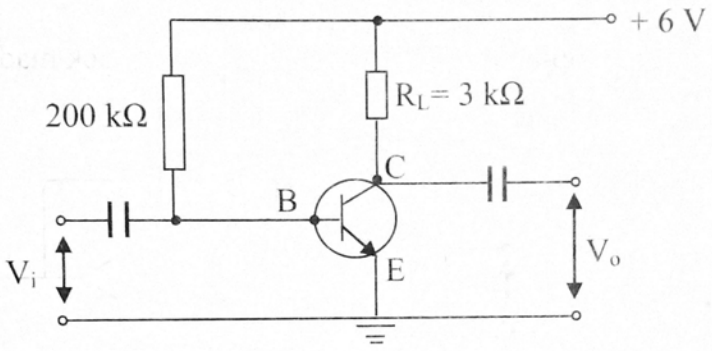

Figure 3

If the current amplification factor, β is 50, calculate the base current I_B and the voltage V_{CE} in the circuit. **(03 marks)**

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131/2 **PHYSICS 2**

(For Both School and Private Candidates)

Time: 3 Hours **Year: 2024**

Instructions

1. This paper contains a total of **six (6)** questions.
2. Answer **five (5)** questions.
3. Each question carries **twenty (20)** marks.
4. Mathematical tables and non-programmable calculators may be used.
5. All writing must be in **blue** or **black** ink, **except** drawings which must be in pencil.
6. Communication devices and any other unauthorized materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet(s).
8. The following information may be useful:

(a) Acceleration due to gravity $g = 9.8\ ms^{-2}$

(b) Pie, $\pi = 3.14$

(c) Speed of light, $c = 3.0 \times 10^{8}\ m\ s^{-1}$

(d) The coefficient of viscosity of water, $\eta = 10^{-3}\ N\ s\ m^{-2}$

(e) Speed of sound in still air $= 340\ m\ s^{-1}$

(f) Charge of an electron, e, $= 1.6 \times 10^{-19}\ C$

(g) Mass of an electron, $m_e = 9.0 \times 10^{-31}\ kg$

(h) Planck's constant, $h = 6.63 \times 10^{-34}\ Js$

(i) Permeability of free space, $\mu_0 = 4\pi \times 10^{-7}\ H\ m^{-1}$

(j) Reydberg constant, $R_H = 1.097 \times 10^{7}\ m^{-1}$

(k) Young's modulus of brass $E_B = 1.0 \times 10^{11}\ N/m^2$

(l) Young's modulus of iron $E_{Fe} = 1.8 \times 10^{11}\ N/m^2$

(m) Permitivity of free space, $\varepsilon_o = 8.85 \times 10^{12}\ Nm^{-2}\ kg^{-2}$

1. (a) (i) What is meant by the term viscosity as applied in fluid dynamics? **(02 marks)**

(ii) Distinguish between streamline flow and turbulent flow of a liquid. Give two points. **(03 marks)**

(b) (i) Identify the principle on which the continuity equation is based? **(01 mark)**

(ii) Why does the velocity increases when water flowing in broader pipe enters a narrow pipe? **(02 marks)**

(c) (i) Briefly explain how the viscosities of two liquids can be compared. **(03 marks)**

(ii) Water flows through a horizontal tube of diameter 0.008 m and a length of 4 km at the rate of 20 litres per second. Assuming that only viscous resistance exist, estimate the pressure difference required to maintain the flow. **(05 marks)**

(d) A horizontal pipe of diameter 20 cm has constriction of diameter 4 cm along its length. If the velocity and pressure of water flowing through it is 2 m/s and 10^7 N/m^2 respectively; determine the pressure at the constriction. **(04 marks)**

2. (a) (i) Stipulate two distinctive properties between travelling and standing waves. **(02 marks)**

(ii) Sound wave of wavelength λ travel from the first medium with a velocity of v into another medium with the velocity of $4v$. Determine the wavelength of sound wave in the second medium. **(03 marks)**

(b) (i) State the principle of superposition as applied to wave motion. **(01 mark)**

(ii) Analyse five differences between interference and diffraction based on superposition of light waves. **(05 marks)**

(c) The transverse displacement of a string which is clamped at its both ends is given by the equation, $y(x, t) = 0.06 \sin\left(\frac{2\pi}{3}x\right)\cos(120\pi t)$, where x and y are in metres and t in seconds. If the length and mass of the string are 1.5 m and 3.0×10^{-2} kg respectively;

(i) What type of the wave does the equation represent? **(04 marks)**

(ii) Determine the tension in the string. **(05 marks)**

3. (a) (i) How is brittle materials differ from ductile materials? **(02 marks)**

(ii) Figure 1 is a sketch graph of force, F against extension, e for two iron wires, X and Y of the same length, l.

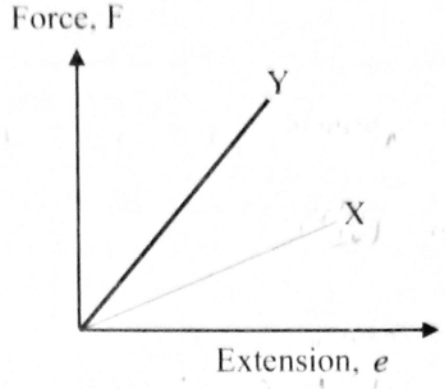

Figure 1

Which wire is expected to extend more when both are subjected to a constant force? Give a reason for your answer. **(04 marks)**

(b) (i) A uniform iron bar of diameter 8.0 mm and initial length 500 mm is heated uniformly until it expands by 0.4 mm. If it is later clamped at its ends and allowed to cool; calculate the tension in the bar. **(04 marks)**

(ii) Compute the increase in energy of the brass bar of length 0.2 m and cross sectional area 1 cm^2 when compressed with a force of 49 N along its length. **(04 marks)**

(c) (i) Why springs are made of steel and not copper? **(02 marks)**

(ii) A copper rod of length 2 m and cross-sectional area 2.0 cm^2 is fastened end to end to a steel rod of length L and cross-sectional area 1.0 cm^2. If the compound rod is subjected to equal and opposite pulls of magnitude 3×10^4 N at its ends and the elongations of the two rods are equal, find the length, L of the steel rod given that the Young's modulus of steel and copper are 1.2×10^{11} N/m^2 and 2×10^{11} N/m^2 respectively. **(04 marks)**

4. (a) (i) Identify three important properties of equipotential surface. **(03 marks)**

(ii) Two protons in a nucleus of U^{238} are separated by 6.0×10^{-15} m. Determine their mutual electric potential energy. **(03 marks)**

(b) (i) Derive an expression for the energy stored inside a charged capacitor. **(04 marks)**

(ii) A $10\times10^6\ \Omega$ resistor is connected in series with a capacitor of $1.0\ \mu F$ and a battery of e.m.f. 12.0 V. If before the switch is closed the capacitor is uncharged; find the fraction of the final charge on the plates and of the initial current remains at time t = 46 seconds. **(06 marks)**

(c) A uniformly charged conducting sphere of diameter 2.4 m has a surface charge density of 80 $\mu C/m^2$. Determine;

(i) The charge on the sphere. **(02 marks)**

(ii) The total electric flux leaving the surface of the sphere. **(02 marks)**

5. (a) (i) Distinguish between magnetic flux density and magnetic field intensity. **(02 marks)**

(ii) Calculate the maximum electromotive force (e.m.f) induced in a coil of 500 turns, each with an area of 4.0 cm^2 making 50 revolutions per second in a uniform magnetic field of flux density 0.04 T. **(03 marks)**

(b) A wire of 2.0 metres long carrying a current of 10 A is placed in a field of flux density 0.15 T. Determine the force on the wire if it is placed;

(i) At right angle to the field. **(03 marks)**

(ii) At 45 degrees to the field. **(01 mark)**

(iii) Along the field. **(02 marks)**

(c) (i) State Lenz's law of electromagnetic induction. **(02 marks)**

(ii) Two identical wires R and S lie parallel in a horizontal plane, their axes being 0.1 m apart. If the current of 10 A flows in wire R in the opposite direction to a current of 30 A in wire S; calculate the magnitude and direction of magnetic flux density at point P midway between R and S. (Neglect the effect of the earth's magnetic flux density). **(07 marks)**

6. (a) (i) Analyse two drawbacks on which Bohr's model of an atom suffered. **(02 marks)**

(ii) State two differences between Rutherford's model and Bohr's model. **(04 marks)**

(b) (i) What do you think would really happen if the electrons in an atom were stationary? **(02 marks)**

(ii) A single electron rotates around a stationary nucleus of charge Ze, where 'Z' and 'e' are constant and electronic charge respectively. If it requires 47.2 eV to excite an electron from the second Bohr's orbit; determine the value of Z. **(06 marks)**

(c) (i) Which series of hydrogen spectrum lie in the visible region of electromagnetic spectrum? **(02 marks)**

(ii) Hydrogen atoms in a discharge tube emit spectral lines whose frequencies are given by the following equation, $f = CR_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ where n_1 and n_2 are any positive whole numbers. Calculate the highest frequency in the Lyman's series. **(04 marks)**

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131/3A **PHYSICS 3A**

(PRACTICAL A)

(For Both School and Private Candidates)

Time: 3:20 Hours **Year: 2024**

Instructions

1. This paper consists of **three (3)** questions.
2. Answer **all** questions.
3. Question **one (1)** carries **twenty (20)** marks and the other **two (2)** carry **fifteen (15)** marks each.
4. Mathematical tables and non-programmable calculators may be used.
5. All writing should be in **blue** or **black** ink, **except** drawings which must be in pencil.
6. Communication devices and any unauthorised materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet(s).

The following information may be useful:

Pie, $\pi = 3.14$.

Specific heat capacity of water = $4.2 \times 10^3 \text{ Jkg}^{-1}\text{K}^{-1}$

Specific heat capacity of copper = $3.8 \times 10^2 \text{ Jkg}^{-1}\text{K}^{-1}$

1. A Physics teacher found you pushing your friend who sat in the metal basin tied to a branch of a tree swinging in a to and fro motion; and he was shocked because there was a practical session going on in the class. Unexpectedly, your teacher took the idea of swinging and brought you to the Physics laboratory. He gave you retort stand and its accessories, two wooden pads, cotton thread of 110 cm long, a pendulum bob, metre rule and stopwatch/clock.

The teacher instructed you to set the given equipment and perform the same way you were doing when playing with your friend outside. But this time, you tie a pendulum bob to a thread of length, L = 1.0 m and attach it to the retort stand. Moreover, you were instructed to displace a bob at a small angle and release it so that it moves to and fro motion and you were required to record the time, t (s) for which to and fro makes 10 oscillations, hence determine its periodic time, T. Repeat the experiment for the length of the thread, L equals to 0.8 m, 0.6 m, 0.4 and 0.2 m.

Questions

(i) Draw a well labelled sketch showing the set-up of your experiment.

(ii) Tabulate your results as shown in the following Table:

L (m)	t (s)	T(s)	Log L	Log T
1.0				
0.8				
0.6				
0.4				
0.2				

(iii) Plot a graph of log T against log L.

(iv) Considering the approximate law given as $T \alpha L^m$ and using the graph you plotted in 1 (iii), deduce the values of m and k correct to one decimal place.

(v) Re-write the values of m and k in the form of a/b where $b \neq 0$ and a is an integer.

(vi) Suggest the equation of the approximate law governing this experiment.

(vii) Validate the value of acceleration due to gravity, g.

(viii) Recommend two possible ways of improving this experiment.

2. You are provided with copper calorimeter, lid, stirrer, liquid **A**, liquid **B**, thermometer (0 – 100°C), beaker of 250 ml and stopwatch.

Proceed as follows:

(a) Assemble the apparatus as shown in Figure 1.

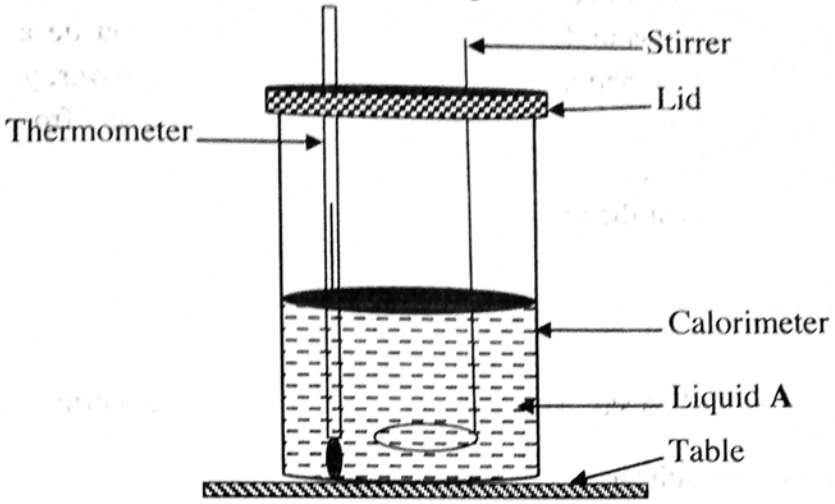

Figure 1

(b) Weigh the calorimeter with its stirrer and lid.

(c) Fill the beaker with liquid **A** and heat it with its content until the temperature is about 80 °C (liquid **A** is inflammable, do not heat beyond 80 °C). Pour 60 ml of liquid **A** into the calorimeter.

(d) Stir the liquid until the temperature falls to 70 °C. Starting at the temperature of 70 °C record the time of the temperature drop at an interval of 2 °C down to 56 °C.

(e) Remove the thermometer and reweigh the calorimeter with its content. Empty and clean the calorimeter.

(f) Repeat the procedures in 2 (c) to (e) using liquid **B** (water).

Questions

(i) Record the pair of values as shown in the following table:

Temperature (°C)	Liquid A (t_A) min)	Liquid B (t_B) (min)

(ii) Plot a graph of t_A against t_B.

(iii) Deduce the slope of the graph.

(iv) Estimate the specific heat capacity of liquid **A** from the equation,

$$\frac{M_1C_1 + M_AC_A}{t_A} = \frac{M_1C_1 + M_BC_B}{t_B}$$

Where;

M_1 = Mass of calorimeter + lid + stirrer
M_A = Mass of liquid A
M_B = Mass of liquid B
C_A = Specific heat capacity of liquid **A**
C_B = Specific heat capacity of liquid **B**
C_1 = Specific heat capacity of copper

(v) Compare the rates of heat loss for the liquid **A** and liquid **B**.

(vi) It is desirable that the experimental values for specific capacities should be close or equal to theoretical values. Recommend two precautions that need to be considered in order to attain this status in the experiment which you have done.

3. A Scientist needed a 5 Ω resistor for fixing a microphone. However, the Scientist managed to get a resistance wire **W** of length 100 cm, aiming to seek an expert to determine exact length of the wire, which will have a resistance equals to 5 Ω. In the Physics laboratory, you managed to get metre bridge, standard resistor of 4 Ω, two dry cells connected in series, zero centred galvanometer, switch, metre rule and several pieces of connecting wires. Perform the following experiment to determine the required length of the wire for the Scientist.

(a) Set up your circuit as shown in Figure 2, where **W** is the wire bought by the Scientist.

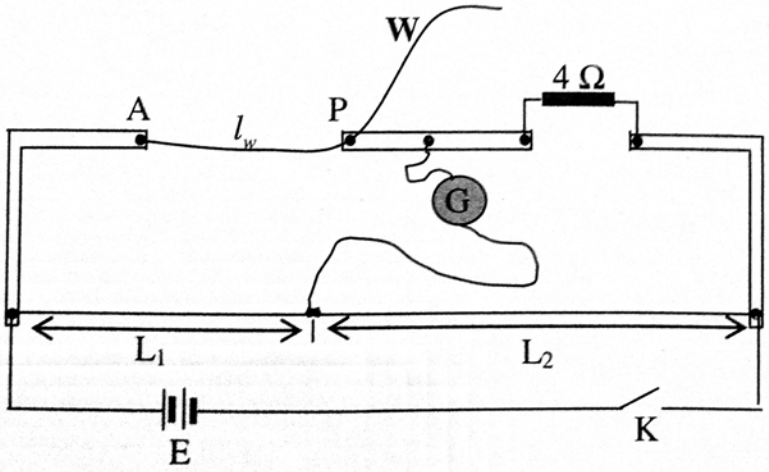

Figure 2

(b) Balance and fix a wire connected to galvanometer in such a way that, length L_1 is exactly 20 cm. Fix one end of wire W at point A, then close a key K. Connect the wire **W** at point P and find the length l_w of the wire which will make the galvanometer read zero (i.e. balance point). Measure and record the length l_w of wire **W** in cm.

(c) Repeat the procedure in 3 (b) for L_1 = 30 cm, 40 cm, 50 cm and 60 cm and record the values of l_w and L_2 in each case.

Questions

(i) Tabulate your result of L_1, L_2, l_w and $\frac{L_1}{L_2}$.

(ii) Plot a graph of l_w against $\frac{L_1}{L_2}$.

(iii) Determine the slope of your graph.

(iv) Using the slope obtained in 3 (iii), calculate the length of a wire, **W** which will produce a resistance required by the Scientist.

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131/3A **PHYSICS 3A**
(PRACTICAL A)

03 HOURS PRACTICAL ADVANCE INSTRUCTIONS

1.0 IMPORTANT

1.1 GREAT CARE MUST BE TAKEN **NOT** TO DIVULGE THIS INFORMATION TO BOTH CANDIDATES AND UNAUTHORIZED PERSONS EITHER DIRECTLY OR INDIRECTLY.

1.2 MAKE SURE THAT THE CANDIDATES ARE PROVIDED WITH THE APPARATUSES INDICATED IN THESE PRACTICAL INSTRUCTIONS ONLY AND **NOT** OTHERWISE.

2.0 PREPARATION OF APPARATUSES

In addition to the normal fitting of a Physics laboratory, each candidate will require the following:

2.1 A stopwatch/clock
Retort stand with its accessories
Cotton thread of length 110 cm
Metre rule
Two cork pads
Pendulum bob.

2.2 Thermometer ($0 - 100^{\circ}C$)
Copper calorimeter (100 ml) and its stirrer
Liquid **A** (olive oil, 80 ml)
Liquid **B** (water, 80 ml)
Beaker of 250 ml
Lid with a hole at the centre for the thermometer to be inserted
A stopwatch/clock
Source of heat.

2.3 2 dry cells (ABC Supper Electric, size D, each of 1.5 V) connected in series and soldered both ends labelled **E**

Standard resistor, **R** of 4 Ω
Galvanometer, **G**
Metre rule
Jockey
A metre bridge
A key, **K**
Nichrome wire (SWG 28) of length 100 cm labeled **W**
Pieces of connecting wires.