G.C.E. (Advanced Level) Examination - August 2010

PHYSICS - II

Three hours

Answer all four questions. **PART A - Structured Essay** $[g = 10\ N\ kg^{-1}]$

01. A student has designed an experiment to find out the spring constant k of a spring attached to a ball launcher. He placed the ball launcher in a horizontal table and connected it to a frictionless curved ramp as shown in figure 1.

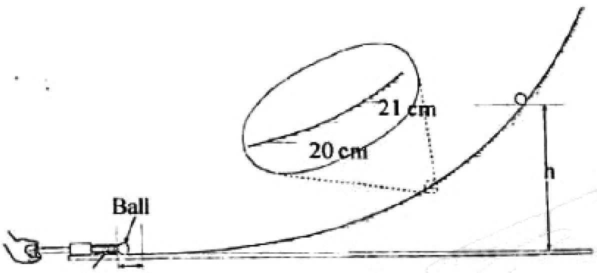

Figure 1.

The student compressed the spring by a distance x from ist natural length and placed a ball of mass M as shown in the figure. He subsequently ejected the ball by releasing the spring so that the ball climbs along the ramp to a maximum vertical height h without tolling.

To measure the vertical height h, student has used a properly calibrated scale marked along the ramp as shown in the figure.

(a) Write down the least count of the scale marked on the ramp.

....

(b) When the spring is compressed by a distance x, write down an expression for the stored energy (E) in the spring in terms of k and x.

....

(c) Write down an expression for the gravitational potential energy (U) that the ball will gain when it reached the height h after the spring is released.

....

(d) Using your expressions in (b) and (c) obtain an expression for the height h, in terms of M, x, k and acceleration due to gravity g. (Assume that the entire stored energy in the spring is transferred to the ball.)

....

....

(e) Name the principle that you have used to obtain the expression in (d).

....

(f) To find the spring constant k, the student has plotted a graph of h vs x2 as shown in figure 2.

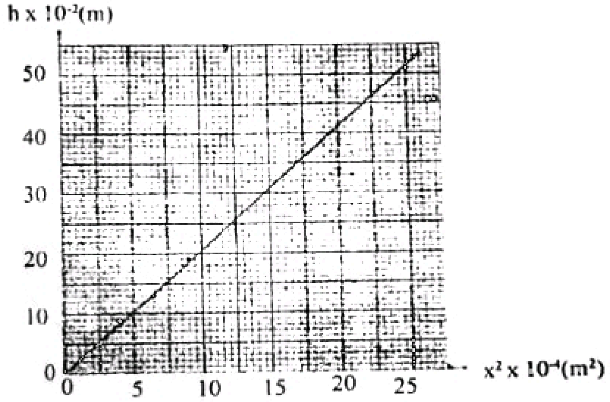

Figure 2.

(i) The teacher says that the graph is unsatisfactory. Why do you think it is unsatisfactory?

....

....

(ii) What measure would you take in this experiment to improve the graph?

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(g) If the gradient obtained from the improved graph is 200m-1 and the value of M is 0.125kg find the spring constant k.

....

....

....

(h) In this experiment the student measures the compression x and the corresponding height h. Which one of these tow measurements has to be taken more accurately than the other?What is the reason for this?

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02. The variation of saturated vapour pressure of water with temperature can be investigated using a narrow glass tube with one end closed, and having a column of air trapped between the closed end and a thread of water.

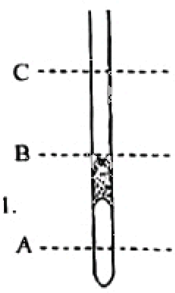

Figure 1.

(a) In this experiment, the tube is mounted in a beaker of water. Figure I shows three possible positions A, B and C for the water level of the beaker.

(i) Which one of these should be the correct position at the begining of the experiment?

....

(ii) Give the reason for your choice.

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(b) An incomplete diagram of the expeimental setup is shown is figure 2. Complete the diagram and label the items inside the beaker.

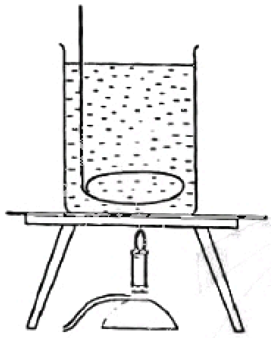

Figure 2

(c) Write down the measurements that you would take after properly setting up the apparatus.

....

....

(d) A student carried out this experiment with an air column of length 3cm at 27°C temperature and 100 kPa atmospheric pressure. Saturated vapour pressure of water at 27 °C is 5 kPa.

(i) Using the above data, obtain an equation relating the length of the air column l (cm) and the saturated vapour pressure of water p (kPa) at temperature θ (°C). (Assume that the pressure due to the water thread is negligible.)

....

....

....

(ii) Assuming that the water thread was 1cm long, calculate the pressure exerted by the water thread and show that its effect on the results of the experiment is negligible.
(Density of water = 10^3 kg m^{-3})

....

....

....

(e) Another student did this experiment with the same apparetus, but used a small volume of mercury and a small water thread to trap air as shown in figure 3.

When this student plotted the measured length l of the air column with temperature θ, he obtained a curve with the shape shown in figure 4.

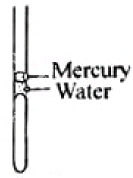

Figure 3

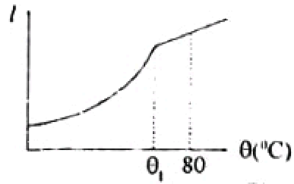

Figure 4

What could be the reason for the change in shape of the graph at θ_1?

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03.

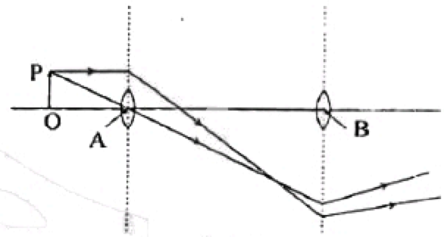

Figure I

Figure I shows the paths of two rays from the object *OP* placed in front of a compound microcope at normal adjustment. The least distance of distinct vision of the observer is 25cm.

(a) Draw the image formed by the objective lens on the diagram and label it as *O'P'*

(b) Draw the final image formed by the microscope and label it as *O" P"*.

(c) (i) Mark the location (f_1) of the focus of the objective lens on the object side.

(ii) What is the reason for selecting the object distance in such a way as shown is the figure?

....

....

(d) Assume that the eye is kept very close to the eyepiece. The focal length of the eyepiece is 5 cm.

(i) What should be the distance to the final image From the eyepiece (*BO"*)?

....

(ii) Calculate the pbject distance (*BO'*) to the eyepiece.

....

....

....

(iii) A student argues that, if the eyepiece is moved together with the eye towards *O'P'* the final image should be closer to the observer and larger. But the student says that when he does that, the image gets blurred.

(1) Why does the image get blurred?

....

....

(2) Is the student's argument correct?

....

(e) Give a reason for selecting an objective lens of short focal length in the compound microscope.

....

....

(f) Figure 2 shows the way a square ruled paper can be seen when a **simple microscope** is placed close to it. What is the magnifying power of the lens?

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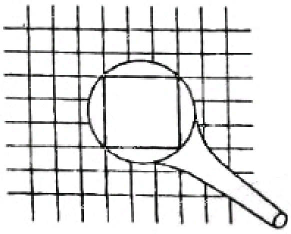


Figure 2

04. You are asked to investigate the cariation of the resistance of a coil of a metal wire with temperature, and to determine the temperature coefficient of resistance. The coil is formed by winding the wire on a wooden rod in such a way that no two turns touch each other. A Wheatstone bridge is to be used to measure the resistance of the coil.

(a) Resistance of the wire at a given temperature is given by the equation

$$R_\theta = R_0 (1 + \alpha\theta)$$

All the symbols have their usual meaning. Identify all the symbols.

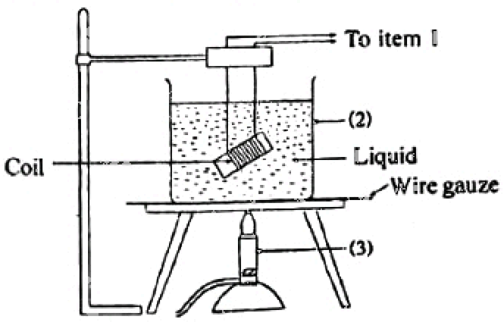
R_θ = ...

R_0 = ...

α = ...

θ = ...

(b) The figure shows a rough sketch of an incomplete setup that can be used for this experiment.



(i) What are the items marked as 1, 2 and 3?

1. ....

2. ....

3. ....

(ii) What is the main purpose of using a wire gauze when heating the liquid?

....

(iii) Apart from the Wheatstone bridge arrangement and stands, two other items which are not shown in the above figure are necessary to perform this experiment. What are they?

(1) ....

(2) ....

(c) It has been decided to use coconut oil instead of water as the liquid in this experiment. Give two scientific reasons for this decision.

(1) ....

(2) ....

(d) A student argues that when using a Wheatstone bridge arrangement a current has to be setup through the coil, and that current may affect the accuracy of the measurements. Would you agree with this argument? (Yes / No)

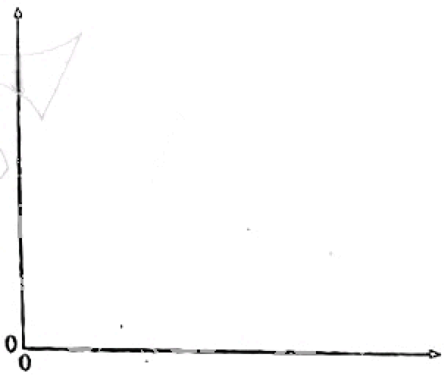
....

Explain your answre.

....

....

(e) Draw a rough sketch of a graph that shown the expected variation of the resistance of the coil with temperature. Label the axes with appropriate symbols identified in (a) above.



(f) Write down an expression for the temperature coefficient of resistance in terms of the quantities that can be extracted from the graph above.

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PART B

Answer all four questions on this paper itself. $[g = 10\ N\ kg^{-1}]$

01.

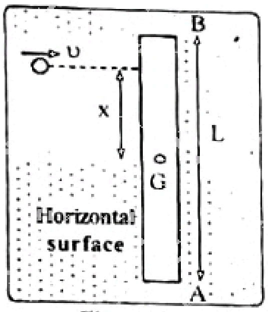


Figure 1

A uniform rod, AB, of square cross section, mass M and length L rests on a horizontal frictionless surface as shown in figure 1. The moment of inertia of the rod about as axis perpendicular to the surface and passing through its centre of gravity, G is I.

The rod is struck by a ball of mass m travelling along the surface without spinning, with a velocity perpendicular to the rod. The motion of the rod due to the impact of the ball can be studied in terms of the linear motion of the centre of gravity of the rod and the rotation about its centre of gravity. Assume that the rod does not topple. After the impact the ball recoils in the opposite direction with the same speed. First consider the linear motion of the rod that occurs due to the impact of the ball.

(a) (i) Write down an expression for the linear momentum of the ball before the impact.

(ii) Considering **only** the linear motion of the rod, obtain an expression for the velocity, V, of the rod after the impact.

(b) Now consider the rotational motion of the rod around its centre of gravity.

(i) If the ball strikes the rod at a distance x from its centre of gravity, write down an expression for the angular momentum of the ball about the centre of gravity of the rod before the impact.

(ii) considering **only** the rotational motion of the rod about its centre of gravity, obtain an expression for the angular velocity, ω of the rod about its centre of gravity after the impact.

(c) (i) Using the expression obtained in (*b*) (*ii*) above, write down an expression for the linear velocity, υ' of the end A of the rod due to the rotational motion of the rod.

(ii) Are the directions of V and υ' same or opposite?

(iii) For a certain value x_s of x the end A of the rod remains at rest as the rod begins to move. Derive an expression for x_s.

(d) The moment of inertia, I, of the rod about its centre of gravity is given by

$$I = \frac{1}{12}ML^2$$

If $L = 0.6$m, determine the value for x_s obtained in (c) (iii) above.

(e) Consider a player holding a tennis racket at the end of its handle (see figure 2). When the ball is struck at the special point at distance x_s from the centre of gravity of the racket, no force is produced on the palm of the player and it minimizes the 'sting' the player experiences on the palm. Indicate on your answer script, by drawing an arrow, the direction of the force on the palm experienced by the player when

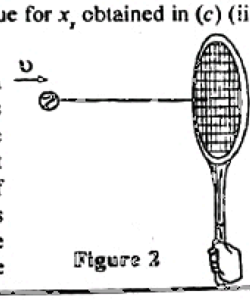


Figure 2

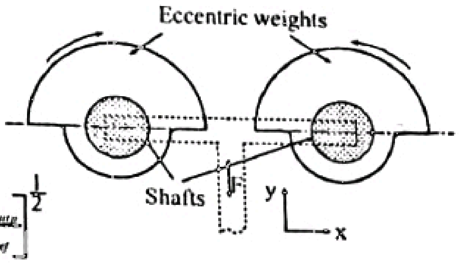
(i) $x > x_s$ (ii) $x < x_s$

02. Read the following passage and answer the questions below.

Activities used in construction such as blasting generate ground vibration. If its amplitudes are sufficiently large, ground vibration has the capability of damaging structures such as buildings, monuments and ruins, cause cosmetic damage such as cracking of plaster, or disrupt the operation of vibration sensitive equipment such as electron microscopes. Pile driving using pile drivers, demolition activity and blasting are some of the primary sources of vibration. Traffic, including heavy trucks traveling on a highways which are in good condition rarely generates vibration amplitudes high enough to cause structural or cosmetic damage. However, there have been cases in which heavy trucks traveling over potholes or other discontinuties on the road have caused vibrations high enough to result in complaints from nearby residents. In describing vibrations in the ground and in structures, the motion of a particle (i.e. a point in or on the ground or structure) is used. The concept of particle displacement, velocity, and acceleration are used to describe how the ground or structure respond to excitation. Although displacement is generally, easier to understand than velocity or acceleration, it is rarely used to describe ground and structureborne vibration because most transducers used to measure vibration directly measure velocity or acceleration, not displacement. Accordingly vibratory motion is commonly described by identifying the peak particle Velocity (*PPV*) or Peak Particle Acceleration (*PPA*). *PPV* is generally accepted as the most appropriate descriptor for evaluating the potential for building damage. To determine human response, however, an average of vibration amplitudes is more appropriate because it takes time for the human body to respond to the excitation (the human body respond to an average of vibration amplitudes, not a peak amplitude.) However as the average particle velocity over time is zero, the root-mean- square (r.m.s.) of the velocity amplitude is typically used to assess human response. Displacement is generally measured in millimeters (mm). Velocity is measured in mm s^{-1}.

One of the methods to assess the potential to damage structures by vibration is to estimate or predict the PPV from various sources at various distances. One such vibratory source is a vibratory pile driver. Pile driving has potential to damage surface and buried structures even at greater distances. Vibratory pile driver is a machine that installs piling into the ground by applying an alternating force. This force is generally generated by a pair of identical eccentric weights rotating about shafts. The figure shows the basic setup for the rotating eccentric weights used in modern vibratory pile equipment. Each rotating weights produces a force acting in a single plane and directed toward the axis of the shaft. However, when a pair of identical eccentric weights are used the resultant force F will act along ±y direction.

Vibration amplitudes produced by vibrating pile drivers can be estimated by the following equation.



$$PPV = PPV_{Ref}\left[\frac{10}{D}\right]\left[\frac{E_{Equip}}{E_{Ref}}\right]^{\frac{1}{2}}$$

Where PPV_{Ref} represents PPV value for a reference pile driver at 10m from the driver

D = distance from pile driver to the structure in m.

E_{Equip} = Rated energy of the pile driver;

E_{Ref} = Rated energy of a reference pile driver

To assess the damage potential from ground vibration produced by a vibratory pile driver, the criteria given in following table can be used.

Maximum PPV (mms^{-1})	Structure and condition
2	Extremely fragile historic buildings, ruins, ancient monuments
2.5	Fragile Buildings
6.5	Historic and some old buoldings
7.5	Old residential structures
12.5	New residential structures, Modern industrial buildings

(a) Write down three sources of vibrations which can cause damage to historic monuments.

(b) Write down a physical parameter associated with vibrations which causes damage to structures.

(c) Write down three structures most vulnerable to ground vibrations.

(d) State a reason why heavy trucks travelling over potholes can cause more damage to structures then heavy trucks travelling in highways which are in good condition.

(e) State the reason for using the velocity to describe ground vibrations instead of displacement.

(f) Draw a rough sketch of a velocity (υa) - tine (t) curve for a particle executing simple harmonic motion and mark its PPV value.

(g) Give a reason for using the average value of the vibration amplitude to describe the human response to vibration.

(h) (i) Direction of the resultant force F created by a rotating pair of identical eccentric weights on the shafts is along the $\pm y$ direction. Give the reason for this.

(ii) Draw a rough sketch to show haw F varies with time (t).

(i) A vibratory pile driver (E_{Equip} = 112.5kN) will be operated at 30m from a new office complex and 30m from an ancient monument known to be very fragile. Assess the potential for damage

(i) to the office complex,

(ii) to the ancient monument.

Take PPV_{Ref} = 12.5mm s^{-1} for a reference pile driver at 10m. (E_{Ref} = 50kN)

(j) The pile driver mentioned in (i) above has to be used in a construction of a new building close to an ancient and fragile monument at Polonnaruwa. Calculate the minimum separation that has to be maintained between the monument and the new building.

03. (a) Radii of water droplets in low-lying rain clouds is in the range of 10 μm to 60 μm. Under certain conditions smaller water droplets coalesce to form larger water drops and these water drops are released from clouds as rain. How many water droplets, each having a radius of 10 μm, must coalesce to form a water droplet of radius 40 μm?

(b) When a water drop is falling through air, a drag force is acting on the drop, in addition to the other two forces, weight and the upthrust. Only if the radius of the water droplet is less than 50 μm, the water droplet retains its spherical shape and the drag force is due to the viscosity of air which is given by Stokes' law. Consider a water droplet of radius 40μm, released from a rain cloud located at an altitude of 2 km.

(i) Assuming that the air remains at rest and the upthrust on the water droplet can be neglected, calculate the terminal velocity (υ_t) of the water droplet of radius 40 μm.

(Viscosity of air = 1.6 x 10^{-5} Pa s, Density of water = ρ_w = 10^3 kgm^{-3})

(ii) It has been found that, in general, a water droplet of radius 40 μm would evaporate completely within a period of 600s. As the radius of this droplet decreases due to evaporation, the terminal velocity also decreases, and the mean velocity of the droplet for its entire motion can be considered to be $\frac{\upsilon_t}{2}$. Show that this water droplet will evaporate completely before reaching the ground.

(c) When the radius of the raindrop is larger (greater than about 100μm) the shape of the raindrop tends to deviate appreciably from spherical shape. Now, consider a raindrop which has a vertical length h (> 100μm) and is falling vertically through air at a constant speed. Assume that the atmospheric pressure (Π) and the density of air remain constant. Take the radius of courvature of the drop as R_1 at the upper end of the drop and R_2 at the lower end.

(i) If the pressure at a point just below the upper end of the water drop is p_1 (> Π), write down an expression for ($P_1 - \Pi$) in terms of R_1 and the surface tension of water (γ).

(ii) What is the pressure at a point just above the lower end of the raindrop? Express your answer in terms of P_1, h, the density of water (ρ_w) and acceleration due to gravity g.

(iii) Show that $R_1 > R_2$.

(iv) Calculate the value of ($R_1 - R_2$) for a raindrop of vertical length h = 4mm. Take R_1R_2 = 4 x 10^{-6} m^2 for this case. surface tension of water is 7.5 x 10^{-2} Nm^{-1}.

(d) When the maximum hydrostatic pressure inside the raindrop becomes greater than the pressure difference due to surface tension at the lower surface of the raindrop, the raindrop becomes unstable and breaks into smaller droplets. Assuming $h = 2R_2$, calculate the maximum value of vertical length h_{max} a raindrop can have. Take $\sqrt{7.5} = 2.7$

04. A uniform magnetic field of flux density B exists in a certain region of space. As shown in figure 1 an electron of mass m and charge e is projected with velocity υ perpendicular to the field. The electron moves along a circle of radius R.

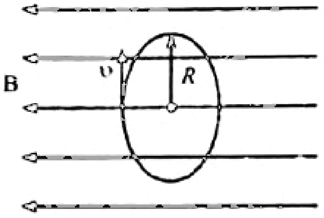


Figure 1

(a) (i) Derive an expression for R.

(ii) Obtain an expression for the number of revolutions, f, per unit time that the electron makes.

(b) When a charged particle like an electron moves along a circle it emits electromagnetic waves with a frequency which is equal to its own frequency, f, of revolution. Microwaves in a microwave oven are produced by allowing electrons to move in circular paths in a magnetic field as described above. The unit which produces microwaves in a microwave oven is known as a magnetron.

(i) A magnetron in a microwave oven emits microwaves with frequency 2450 MHz. Determine the magnetic flux density, B, needed to produce such microwaves. ($m = 9.0 \times 10^{-31}$kg, $e = 1.6 \times 10^{-19}$ C) Round off your answer to the second decimal place.

(ii) Such a uniform magnetic field could be produced inside a current carrying solenoid.

(1) Long, closely wound solenoid with n turns per unit length carries a current I. Write down an expression for the magnetic flux density B in the solenoid along its axis.

(2) For a current of $I = 10$A, what should be the value of n in order to produce B calculated in (b) (i) above. (Take $\mu_0 = 10^{-6}$ T m A^{-1})

(3) Calculate the diameter of the wire used to wind the solenoid.

(4) Sketch the magnetic flux lines in and around such a solenoid.

(c) If the direction of the initial velocity of the projected electron in (a) above makes an angle θ to the direction of the uniform magnetic field, the path of the electron is a helix as shown in figure (2).

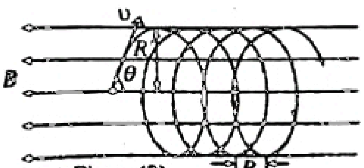


Figure (2)

(i) Build arguments to prove that the path of the electron is a helix.

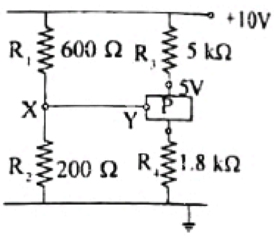
(ii) Deduce an expression for the radius R' of the helical path.

(iii) as shown in the figure the distance travelled by the electron along the axis of the helix per revolution is called the pitch p of the helix. Obtain an expression for p.

(iv) Show that the ratio $\frac{R'}{P}$ depends only on θ.

05. Answer either part (A) or part (B) only.

(A) (a) Write down an expression for the power dissipated by a resistor of resistance R when subjected to a potential difference of V.



(b) The circuit shown is powered by a battery of e.m.f. 10. V. P is a three-terminal element.

[Assume that the internal resistance of the battery is negligible when answering the parts (i), (ii) and (iii)].

(i) Calculate the power dissipated by the resistors R_1, R_2, R_3 and R_4 separately. Give your answers to the nearest integer in mW. Assume that the current through the path XY is negligible.

(ii) Resistors are available with different power ratings, and the price of resistors go up with the power rating value. Some of the standard ratings for resistors are 0.125W, 0.25W, 0.5W, 1W, 2w, etc Considering the above information indicate suitable power ratings for R_1, R_2, R_3 and R_4.

(iii) Find the total power consumed by the circuit. You may assume P also as a purely resistive element.

(iv) If the entire circuit is constructed in IC form in a small piece of silicon of mass 0.9 mg and there is no heat dissipation to surroundings, find the temperature of the circuit 5 minutes after connecting the power supply. Take the room temperature as 30°C. Specific heat capacity of silicon is 600 J kg^{-1} K^{-1}.

(v) When 5 such circuits are connected to a battery of e.m.f. 10V it is found that the terminal voltage drops to 9.9 V. Calculate the internal resistance of the battery.

05. (B) (a) In the circuit shown in figure 1, A and B are two identical light dependent resistors (LDR). The resistance of each LDR at complete darkness is 50MΩ. The operational amplifier has saturation voltages of ±5V and an open loop voltage gain of 10^5.

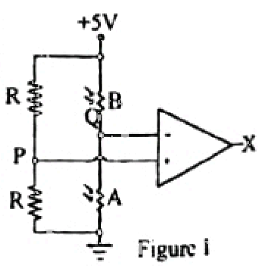


Figure 1

(i) Calculate the minimum voltage difference between P and Q that would saturate the operational amplifier at +5V.

(ii) What would be the voltage V_x at X when both LDRs are at complete darkness?

(iii) When both LDRs are in a place where the ambient light level causes the resistance of each LDR to drop to 200Ω, what would be the value of V_x?

(iv) When both LDRs are kept in the place mentioned in (iii) above, light from a small light source is allowed to fall on A only. This reduces the resistance of A to 50Ω. Calculate the new V_x value.

(v) If this circuit is used for detecting an external light source, is there an advantage of using an *LDR* for *B*, without using of a fixed resistor? Explain the reason for your answer.

(b) Figure 2 shows three different positions of an opaque piece of cardboard with a hole, placed near the two LDRs. S is a light source. The cardboard is moved slowly at a constant speed starting from position

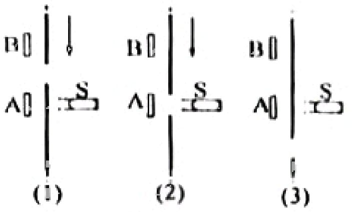


Figure 2

(1) until it reaches position (3) via position (2). The resistance of A when it receives light through the hole is 50Ω. At other positions, due to ambient light, its resistance is 200Ω. Resistance of B remains at 200Ω in all positions.

(i) Sketch the variation of V_x with time (t), when the cardboard is moving.

(ii) Sketch the variation of the V_x with time (t), when the speed of the cardboard is doubled.

(c) An 'optical encoder' which is used to determine the position of a moving part of a device such as a robot is based on the above principle. Figure 3 shows a robot arm that moves back and forth and a metal plate with two rows of holes, attached to it. The metal plate is moving between light sources and LDRs as shown in the figure. The two LDRs *B* and *B'* (not shown in the figure) are kept away from the light sources and they only receive the same ambient light as A and A'. The two LDRs *A* and *B* are connected to the circuit shown in figure 1 while LDRs *A'* and *B'* connected to another identical circuit which has output *Y*. Assume that one of the four section (1 -4) of the metal plate is always between the LDRs and the light sources.

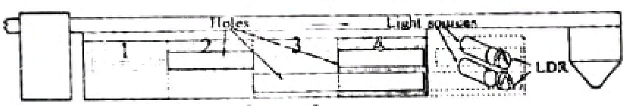


Figure 3

(i) Assuming that the light levels received by the LDRs are identical to those mentioned in part (b) above, draw a rough sketch of a graph to show the variations of voltage at the outputs X and Y with time (t) when the metal plate is moving from section 4 to section 1 at a constant speed past *A* and *A'*. Draw the variation of *Y* underneath that of *X* on the same time axis.

(ii) If the outputs of *X* and *Y* are interpreted as logic signals, write down the binary numbers obtained from *X* and *Y*, when each of the four sections of the metal plate are facing *A* and *A'*.

06. Answer either part (A) or part (B) only.

(A) A helium filled gas balloon, which carries an instrument has been placed at a certain altitude of the earth surface for a research purpose. The atmospheric conditions at the said altitude are as follows.

Temperature (T) = 240 K, the pressure (P) = 420 Pa and density (ρ_A) = 58.4 x 10^{-3} kg m^{-3}

Assume that the pressure inside and outside the balloon are the same. Derive any formulae you may use, starting from the equation of state for an ideal gas, when answering the following questions. Assume that helium behaves as an ideal gas.

(a) Calculate the density of the helium gas inside the balloon. Mass of a helium atom is 6.64 x 10^{-27} kg. Avogadro number N_A = 6 x 10^{23} mol^{-1} and universal gas constant R = 8.3 $JK^{-1}mol^{-1}$

(b) If V_B is the volume of he balloon and ρ is the density of the helium inside the balloon at the said altitude, show that, to keep the balloon at the altitude

$$V_B = \frac{M}{\rho_A - \rho}$$ where *M* is the total mass of the empty balloon and instrument.

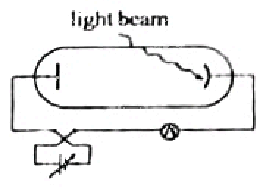
(c) If *M* is 10kg using (a) and (b) calculate the volume of the balloon V_B.

(d) Also determine the number of helium atoms inside the balloon.

(e) Calculate the volume of the balloon before it is released from the earth surface. The atmospheric pressure and temperature of the earth surface are 10^5 Pa and 300K respectively.

(f) If the atmospheric temperature at the said altitude decreases, what effect would you expect on the balloon's altitude? Explain your answer.

06. (B) The apparatus shown in the figure can be used to compare the intensities of the radiation corresponding to colours of green (frequency f_G = 5.6 x 10^{14} Hz) and violet (frequency f_V = 7.2 x 10^{14}Hz) in the electromagnetic spectrum of the Sun, incident on the Earth. The two monochromatic light beams corresponding to the two frequencies are frequencies are obtained using filters. Each beam has a cross-sectional area of 5 x 10^{-5} m^2 and is allowed to incident normally on the photocathode, one beam at a time.



(a) (i) When the beam of violet light was incident on the photocathode, the stopping potential was found to be 0.05 V. Calculate the work function of the photocathode material. Take Planck's constant h = 6.6 x 10^{-34} Js and the magnitude of the electronic charge, e = 1.6 x 10^{-19}C.

(ii) Show that there will be no current in the circuit when green light is incident on the photocathode described in (a) (i) above.

(b) (i) Three other photocathodes A, B and C made of materials with work functions 3.4 x 10^{-19}J, 5.1 x 10^{-19}J, and 7.2 x 10^{-19}J, respectively, are available. If it is desirable to use only one photocathode to compare both green and violet light beams, which photocathode must be selected? Give reasons for your choice.

(ii) For the photocathode you selected in (b) (i) above, which colour produces photoelectrons with higher maximum kinetic energy? Calculate that value of maximum kinetic energy of photoelectrons.

(c) When photons are incident on the photocathode, only a part of the incident photons contributes for the emission of photoelectrons. Assume that only 10% and 15% of incident photons emit photoelectrons for green light and violet light, respectively.

(i) The maximum currents observed in the circuit for green and violet light beams are 400μA and 240μA, respectively. Taking N_G and N_V to be the number of photons incident on the photocathode per second for green and violet colours, respectively, calculate the ratio $\frac{N_G}{N_V}$.

(ii) Draw a sketch to indicate the variation of photoelectric current (I) with the applied potential difference (V). For both green colour and violet colour light, in the same graph.

(iii) The average value of the energy of the solar radiation incident per unit time per unit area on the surface of the Earth is $1200 \mathrm{W m^{-2}}$ during the day time. Calculate the percentage of this energy which is due to the photons corresponding to green colour.