SHAHARANI SCHOOL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

FORM SIX PRE-NECTA EXAMINATION – 2023

PHYSICS – 1

SERIES – 01

133//1

Date: Tuesday 10th January, 2023 **Time: 3:00 HOURS**

Instructions

1. This paper consists of section A and B with a total of **ten (10)** questions.
2. Answer **all** questions in section A, and **any two (2)** questions from section B
3. Section A carries seventy (70) marks and section B carries thirty (30) marks.
4. Mathematical tables and non – programmable calculators may be used
5. Cellular phones and any unauthorized materials are not allowed in the examination room.
6. Write your *Examination number* on every page of your answer booklet(s)
7. The following information may be useful:

(a)	Acceleration due to gravity,	$g = 9.8\ m/sec^2$
(b)	Stefan's constant	$\sigma = 5.67 \times 10^{-8}\ w/m^2K^4$
(c)	Density of water	$\rho_w = 1000\ kg/m^3$
(d)	Thermal conductivity of the brass	$K_b = 109\ J/sm°C$
(e)	Latent heat of vaporization of water	$L = 2256 \times 10^3\ J/kg$
(f)	Mean density of the earth	$\rho_e = 5520\ kg/m^3$
(g)	Gravitational constant	$G = 6.67 \times 10^{-11} N\ m^2/kg^2$
(h)	Mass of the earth	$M_e = 6.0 \times 10^{24}\ kg$
(i)	Radius of the earth	$R_e = 6.4 \times 10^6\ m$
(j)	Molar gas constant	$R = 8.31\ J\ mol^{-1}K^{-1}$
(k)	Solar constant	$\sigma = 1.4 \times 10^{-8} kW/m^2$
(l)	Specific heat capacity of water	$C = 4200\ J/kg$

SECTION A (70 MARKS)

Answer **ALL** questions from this section

1 (a) (i) State the principle of homogeneity of dimension. (01mark)

(ii) With examples for each, differentiate between dimensional variable and dimensionless constant. (01mark)

(b) (i) If the velocity v" of the particle depends upon the time t" according to the relation: $v = at + \frac{b}{t+c}$ where a", b" and c" are physical quantities. Use dimensional analysis to find the dimension of a", b" and c" (02marks)

(ii) Give any two methods of minimizing systematic error in measurement. (01mark)

(c) If the image formed at least distance of distinct vision then magnifying power is given as: $M = \frac{f_0}{f_e}\left(1 - \frac{f_e}{D}\right)$, then from measurement is observed that: $f_0 = (60 \pm 0.5)\ cm$, $f_e = (3 \pm 0.05)\ cm$ and $D = (25 \pm 0.5)\ cm$. Find the magnifying power of the telescope including with its error. (04marks)

2. (a) Why is it easier to pull than to push a lawn roller? (02marks)

(b) A particle is projected up from the ground with a velocity of 147 m/s at an angle of projection 30° with the horizontal. Find the velocity of the projectile at a height of 98 m (04marks)

(c) A rocket of mass 20 kg has 180 kg of fuel. The exhaust velocity of the fuel is 1.6 km/s. Calculate minimum rate of consumption of fuel so that the rocket may rise from the ground. Also calculate the ultimate vertical speed gained by the rocket when the rate of consumption of fuel is 2 kg/s. (04marks)

3. (a) Define the following terms as used in rotation of rigid body:

(i) Moment of inertia of a rigid body about an axis of rotation, (01mark)

(ii) The radius of gyration of a body. (01mark)

(b) A flywheel with a horizontal axle of diameter 2 cm has a cord wound round the axle to the end of which is attached a 5 kg. the weight is allowed to fall, causing the wheel to rotate. The weight fall from rest a distance of 40 cm in the first 10 seconds. What is the moment of inertia of the flywheel? (04marks)

(c) A satellite of mass 1000 kg moves in a circular orbit of radius 7000 km round the earth, assumed to be a sphere of radius of 64000 km. Calculate the total energy needed to place the satellite in the orbit from the earth (04marks)

4 (a) (i) Why are roadbeds and highways banked on curves? (01mark)

(ii) A particle of mass m" is placed at the highest point of a frictionless hemispherical surface. If the particle is allowed to slide down, find the angular displacement from the vertical at which it will leave the surface. (03marks)

(b) (i) Explain the phenomenon that the velocity and acceleration of a body executing simple harmonic motion are out of phase. (02marks)

(ii) A 100g body hung on a spring, which elongates the spring by 4cm. When a certain object is hung on the spring and set vibrating, its period is 0.568s. What is the mass of the object pulling the spring? (04marks)

5 (a) (i) Why is it necessary to shake a clinical thermometer before measuring body temperature? (02marks)

(ii) A thermocouple with test junction at t°C on gas thermometer scale and reference junction at ice point gives the e.m.f. as $E = 0.20t - 5 \times 10^{-4}t^2$mV. The millivoltmeter is calibrated at ice and steam points. What will be the reading on this thermometer where the gas thermometer reads 70°C ? (04marks)

(b) An iron pan containing water boiling steadily at 100°C stands on a hot plate and heat conducted through the base of the pan evaporates 1.5 g of water per second. If the base of the pan has an area of 0.04m^2 and a uniform thickness of 2×10^{-2}m, calculate the surface temperature of the underside of the pan. (04marks)

6 (a) Explain:

(i) how could you make heat flow from a body at lower temperature to a body at higher temperature. (02marks)

(ii) Why air pressure in a car tyre increases during driving? (02marks)

(b) What is adiabatic reversible change as used in thermodynamics? Give two examples of adiabatic process. (02marks)

(c) A cylinder fitted with a piston which can move without friction contains 0.05 mol of a monoatomic ideal gas at a temperature of 27℃ and a pressure of 1.0×10^5Pa. The temperature of the gas is raised to 77℃, the pressure remaining constant. Calculate, the total heat energy supplied. (04marks)

7 (a) Account two effect of the following in plant growth

(i) Air temperature (02marks)

(ii) wind belts (02marks)

(b) (i) The main interior of the earth core is believed to be in molten form. What seismic evidence supports this belief? (02marks)

(ii) Explain why the small ozone layer on the top of the stratosphere is crucial for human survival. (02marks)

(c) Account any four effects of global warming (02marks)

SECTION B (30 Marks)

Answer **two (2)** questions from this section

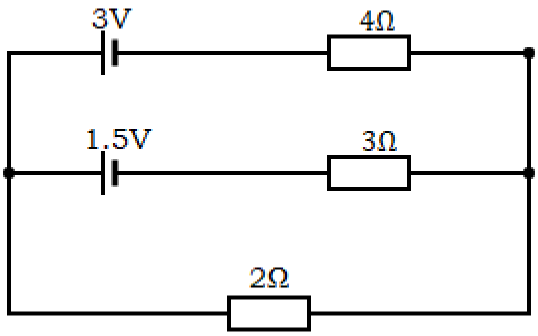
8 (a) (i) Gives four any advantages of potentiometer versus that of voltammeter. (02marks)

(ii) Why is alternating current better for long-distance power transmission than direct current? (02marks)

(b) (i) Explain the conduction of electricity through gases (02marks)

(ii) Give any two (2) application of conduction of electricity through gases. (02marks)

(c) Calculate the current through 4Ω ohm



(03marks)

(d) A 50W, 100V lamp is to be connected to an a.c. mains of 200 V, 50 Hz. What capacitance is essential to be put in series with the lamp? (04marks)

9 (a) (i) Give any two (2) basic features of a hole from valence electrons as used in band theory of an electronics (02marks)

(ii) What is doping? Explain any three method of doping semiconductor. (03marks)

(b) (i) Define the term transistor stabilization (01mark)

(ii) In the p – n – p transistor most positive holes passing from p – type emitter into the base fail to combine with electrons of the n – type base. Suggest two reasons for this. (01mark)

(c) Give two reasons why the collector region is relatively lightly doped compared to the emitter region? (02marks)

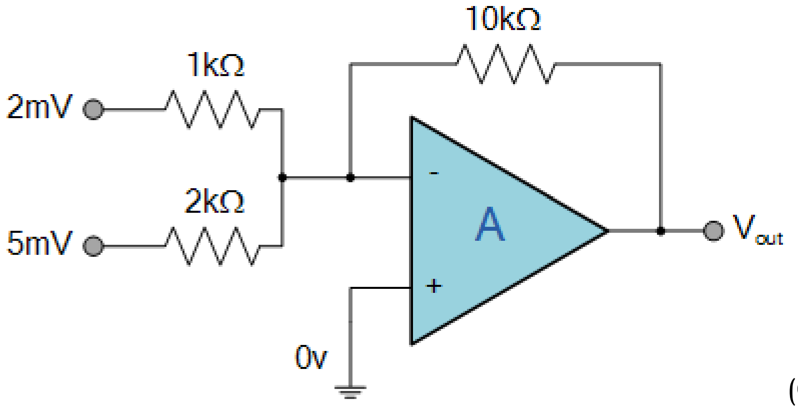
(d) (i) Differentiate between saturation current and quiescent state as used in a transistor. (02marks)

(ii) A common base transistor amplifier has an input resistance of 20 Ω and output resistance of 100 kΩ. The collector load is 1 kΩ. If a signal of 500 mV is applied between emitter and base, find the voltage gain. (04marks)

10 (a) Give any two (2) advantages and two (2) disadvantages of digital signals. (02marks)

(b) (i) Mention any two (2) advantages of the gain with the negative feedback of operational amplifier. (02marks)

(ii) Find the output voltage of the following *Summing Amplifier* circuit.



(04marks)

(c) Explain the following as basic modes of communication:

(i) Point-to-point communication mode (01½mark)

(ii) In broadcast mode (point-to-many point communication) (01½mark)

(d) Explain and give an application of each of the following as used in communication system:

(i) Modulation (02marks)

(ii) Repeater: (02marks)

*******************THE END*******************

"Dream big and dare to fail"

FORM SIX (VI) PHYSICS -1 -EXAMS-2023
ROPOSED MARKING SCHEME

1 (a) (i) **Principle of homogeneity** It states that

"The dimensions of fundamental quantities on a left-hand side of an equation must be equal to the dimensions of the fundamental quantities on the right-hand side of that equation."

(ii) **Dimensional variables:** are those physical quantities which have dimensions but do not have fixed value are called dimensional variables. Examples: force, work, power, velocity etc.

Dimensionless constant: are those physical quantities which do not possess dimensions but possess fixed value are called dimensionless constant. Examples are pi π, *e*, counting number

1 (b) (i) Solution: Given: $v = at + \frac{b}{t+c}$ From the principle of dimensions: "two physical quantities can be added or subtracted one another if they only have the same dimensions"

Now: $[t] = [c] = T$

Also: $[v] = [at] = LT^{-1}$

$[a][t] = LT^{-1}$

$[a]T = LT^{-1}$

$[a] = LT^{-2}$

Again: $[at] = \left[\frac{b}{t+c}\right] = LT^{-1}$

$\frac{[b]}{[t+c]} = LT^{-1}$

$[b] = LT^{-1}[t + c]$

$[b] = LT^{-1}(T) = L$

Hence of physical quantities a" , b" and c" are T, LT^{-2} and L respectively

1 (b) (ii) two method of minimizing systematic errors in any measurement are:

- Careful design of an Instrument and calibration
- Careful reading and interpretation of the instrument.
- Be aware of limitations of the method used for measurement
- Pay much attention of accuracy of the formula being used.

1 (c) Given: $M = \frac{f_o}{f_e}\left(1 - \frac{f_e}{D}\right)$

Where: $f_o = (60 \pm 0.5)\text{cm}$

$f_e = (3 \pm 0.05)\text{cm}$

$D = (25 \pm 0.5)\text{cm}$

Now: $M = \frac{f_o}{f_e}\left(\frac{D - f_e}{D}\right)$

$$M = \frac{60}{3}\left(\frac{25-3}{25}\right) = 17.6$$

Apply natural logarithms both sides

$$\ln M = \ln\left(\frac{f_o}{f_e}\left(\frac{D - f_e}{D}\right)\right)$$

$$\ln M = \ln f_o + \ln(D - f_e) - \ln f_e - \ln D$$

For very small change of their variables then:

$$\frac{\Delta M}{M} = \frac{\Delta f_o}{f_o} + \frac{\Delta f_e}{f_e} + \frac{\Delta D + \Delta f_e}{D - f_e} + \frac{\Delta D}{D}$$

$$\frac{\Delta M}{M} = \frac{0.5}{60} + \frac{0.05}{3} + \frac{0.5+0.05}{2.5-3} + \frac{0.5}{25}$$

$$\frac{\Delta M}{M} = 0.07$$

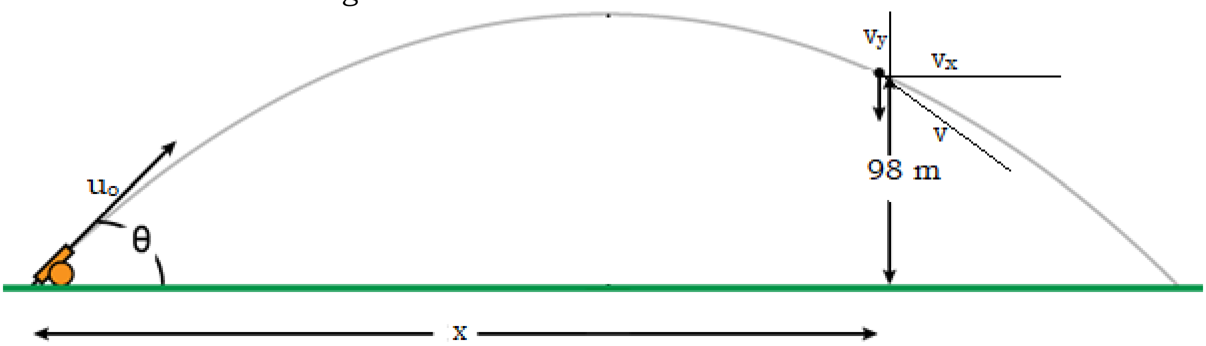
$$\Delta M = 0.07M = 0.07 \times 17.6 = 1.232$$

$$\therefore \mathbf{M = 17.6 \pm 1.232}$$

2 (a) When we pull a lawn roller, the vertical component of the applied pull acts opposite to the weight of the roller and it reduces its effective weight. On the other hand, when a lawn roller is pushed, the vertical component of the applied pull adds to the weight of the roller and hence its effective weight increases. Thus the effective weight is lesser when the lawn roller is pulled. Hence, it is easier to pull than to push a lawn roller

2 (b) Solution:

Let v" and θ" are velocity and magnitude of a projectile at a height, 98 m above the ground:



At point P, $v^2 = {v_y}^2 + {v_x}^2$, where

v_x is the horizontal component velocity of the projection and

v_y is the vertical component velocity of the projection

Where, $v_x = u_o \cos\theta = 147\cos 30° = 127.31\ \text{m/s}$ and

$${v_y}^2 = {u_y}^2 + 2gH = (u_o \sin\theta)^2 - 2gH$$

$${v_y}^2 = {u_y}^2 + 2gH = (147 \sin 30°)^2 - 2 \times 9.8 \times 98$$

$$v_y = 59\ \text{m/s}$$

Now: $v^2 = (127.31)^2 + (59)^2$ then $v = 140.32\ m/s$

Again: $\tan\theta = \frac{V_y}{V_x} = \frac{59}{127.31} = 0.4634$ OR $\theta = \tan^{-1}(0.4634) = 24.9°$

Hence the magnitude and direction of the velocity at a height, 98 m above the ground is $140.32\ m/s$ and $24.9°$ respectively

2 (c) Data given:

- Speed of ejected fuel, $v = 1.6\ km/s = 1.6 \times 10^3 m/s$
- Mass of the rocket, m =20 kg
- Mass of the fuel, M = 180 kg

Solution:

Let $\frac{dm}{dt}$ be minimum rate of consumption of fuel

If , m_o be the total mass of the rocket then , $m_o = m + M$

$$m_o = 20 + 180 = 200\ kg$$

The rate of the consumption of fuel is minimum when the upward acceleration of the rocket is zero i.e. F = 0

From $F = v\frac{dm}{dt} - m_o g$ $\Rightarrow 0 = v\frac{dm}{dt} - m_o g$

$$v\frac{dm}{dt} = m_o g$$

$$\frac{dm}{dt} = \frac{m_0 g}{v} = \frac{200\times9.8}{1.6\times10^3} = 1.225\ kg/s$$

$$\therefore \frac{dm}{dt} = 1.225\ kg/s$$

If the rate of consumption of fuel is, $\frac{dm}{dt} = 2\ kg/s$

The time taken for the consumption will be $t = \frac{180}{2} = 90\ sec$

Now: the ultimate vertical speed ,V gained by the rocket will be given as:

$$V = v\ln\left(\frac{m_0}{m}\right) - gt$$

$$V = 1.6 \times 10^3 \ln\left(\frac{200}{20}\right) - (9.8 \times 90) = 2798\ m/s$$

$$V = 1.6 \times 10^3 \ln\left(\frac{200}{20}\right) - (9.8 \times 90) = 2798\ m/s$$

$$\therefore V = 2798\ m/s$$

When the effect of the gravity is neglected, then: $V = v\ln\left(\frac{m_0}{m}\right)$

$$V = 1.6 \times 10^3 \ln\left(\frac{200}{20}\right) = 3680\ m/s$$

$$\therefore V = 3680\ m/s$$

3 (a) (i) **Moment of inertia of a rigid body about an axis of rotation**: is the sum of the products of the masses its particles and squares of their respective perpendicular distances from the axis of rotation.

$$\text{ie.. } I = \sum_{i=1}^{n} m_i r_i^2$$

(ii) **The radius of gyration of a body**: is the distance from the given axis of rotation at which if the whole mass of the object were concentrated, the moment of inertia would be the same as with the actual distribution of mass.

3 (b) **Data given:**

- Radius of the flywheel, R = 1cm = 0.01
- Mass of weight attached, m = 5kg
- Initial speed of the weight, u = 0
- Distance through which weight falls, h = 40 cm = 0.4m
- Time taken by the weight to fall, t = 10 sec

Solution:

From second equation of motion: $h = ut + \frac{1}{2}at^2 \Rightarrow 0.4 = 0 + \frac{1}{2}a(10)^2$

$a = 0.008 m/s^2$

Again $v = u + at = 0 + (0.008)(10) = 0.08\ m/s$

$v = 0.08\ m/s$

Now $\omega = \frac{v}{R}$ $\omega = \frac{0.08}{0.01} = 8\ rad/sec$ When the mass falls through a distance h, it loses the potential energy which is converted into translational kinetic and rotational potential energy:

$$P{:}E = K{:}E_t + K{:}E_r \qquad \text{then;} \quad mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$2mgh = mv^2 + I\omega^2$$

$$I = \frac{2mgh - mv^2}{\omega^2}$$

$$I = \frac{2\times5\times9.8\times0.4 - 5\times(0.08)^2}{(8)^2}$$

$$I = 0.612\ kgm^2$$

3 (c) **Solution:**

Total energy required, W = Gain in kinetic energy + Gain in potential energy

$$W = \frac{1}{2}mv^2 + \left[\left(-\frac{GMm}{r}\right) - \left(-\frac{GMm}{R}\right)\right]$$

$$W = \frac{1}{2}mv^2 + \frac{GMm}{R} - \frac{GMm}{r}$$

For the satellite to be in a circular orbit of radius r" then

$$\frac{mv^2}{r} = \frac{GMm}{r^2} \text{ or } \frac{1}{2}mv^2 = \frac{GMm}{2r}$$

Now: $W = \frac{GMm}{2r} + \frac{GMm}{R} - \frac{GMm}{r}$

$$W = \frac{GMm}{R} - \frac{GMm}{2r}$$

$$W = GMm\left(\frac{1}{R} - \frac{1}{2r}\right) \quad \text{but } GM = gR^2$$

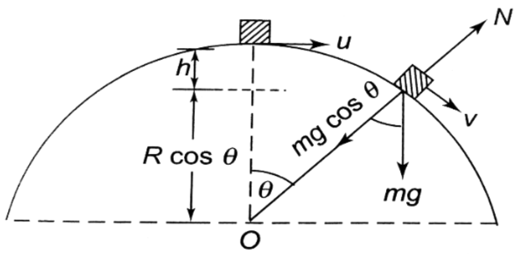
$$W = gR^2m\left(\frac{1}{R} - \frac{1}{2r}\right)$$

$$W = gm\left(R - \frac{R^2}{2r}\right)$$

$$W = 9.8 \times 1000\left(6.4 \times 10^6 - \frac{\left(6.4\times10^6\right)^2}{2\times7\times10^6}\right) = 3.4 \times 10^{10}\text{J}$$

4 (a) (i) If the road is banked, so that the outer edge is above the inner edge, then a portion of the normal force from the road on the tires points towards the center of the track; this fraction of the normal force can provide enough centripetal force to keep the car moving in a circle.

(ii) Solution:



$$mg\cos\theta - N = \frac{mv^2}{r} \quad \text{where } v^2 = 2gh \text{ and } h = r(1-\cos\theta)$$

For the particle to leave the surface N = 0

$$mg\cos\theta = \frac{m(2\,g\,r(1-\cos\theta))}{r}$$

$$\cos\theta = 2(1-\cos\theta)$$

$$\cos\theta = 2 - 2\cos\theta$$

$$3\cos\theta = 2 \text{ OR } \cos\theta = \frac{2}{3} \text{ then: } \theta = 48.2°$$

Hence the angular displacement from the vertical at which it will leave the surface is 48.2°

4 (b) (i) When a body executing simple harmonic motion its acceleration is zero at the mean position and maximum at extreme position. On the other hand, the velocity of the body is maximum at the mean position and zero at extreme positions. For this reasons, the velocity and acceleration of a body executing simple harmonic motion are out of phase

(ii) Data given:

- Mass of a body $m, = 100\ g = 0.1kg$
- Extension produced, $x, = 4\ cm = 0.04\ m$
- Periodic time for oscillation, $T, = 0.568\ sec$

From Hook's law: $F = -kx = mg$

$k = \frac{\mathrm{mg}}{\mathrm{x}} = \frac{0.1\times9.8}{0.04} = 24.5N/m$

Again: $T = 2\pi\sqrt{\frac{\mathrm{m}}{\mathrm{k}}}$, then $\mathrm{m} = \frac{\mathrm{T}^2\mathrm{k}}{4\pi^2} = \frac{(0.568)^2(24.5)}{4\times\pi^2} = 0.2004\ kg$

5 (a) (i) There is a small bend in the mercury channel of a clinical thermometer that uses mercury. You must shake the thermometer to get the mercury from a previous reading from the thermometer back into the bulb so that a new reading can be taken.

(ii) Solution:

- Given Scale equation: $\mathrm{E} = 0.20\mathrm{t} - 5\times10^{-4}\mathrm{t}^2\mathrm{mV}$

At ice point i.e. $\mathrm{t} = 0℃$ $\quad \mathrm{E}_0 = 0$

At steam point i.e. $\mathrm{t} = 100℃$

$$\mathrm{E}_{100} = 0.20(100) - 5\times10^{-4}(100)^2 = 15\ \mathrm{mV}$$

At certain temperature. $\mathrm{t} = 70℃$

$$\mathrm{E}_\theta = 0.20(70) - 5\times10^{-4}(70)^2 = 11.55\ \mathrm{mV}$$

For the gas thermometer: $\mathrm{t} = \left(\frac{\mathrm{E_t} - \mathrm{E_0}}{\mathrm{E_{100}} - \mathrm{E_0}}\right)\times 100℃$

When the gas thermometer read $\mathrm{t} = 70℃$

$$\mathrm{t} = \left(\frac{11.55-0}{15-0}\right)\times100℃ = 77℃$$

Hence when the gas thermometer reads 70°C the thermocouple will read 77℃

(b) **Solution:**

$$\frac{\mathrm{dQ}}{\mathrm{dt}} = \frac{\mathrm{K\,A\,\Delta\theta}}{\mathrm{l}} = \frac{\mathrm{dQ}}{\mathrm{dt}} = \frac{\mathrm{K\,A}\,(\theta - 100)}{\mathrm{x}} = \frac{\mathrm{ML}}{\mathrm{t}}$$

$$\frac{\mathrm{dQ}}{\mathrm{dt}} = \frac{66\times\ 0.04\,(\theta - 100)}{0.02} = 1.5\times10^{-3}\times2.26\times10^{6}$$

$$\theta = 125.7℃$$

Hence surface temperature of the underside of the pan is 125.7℃

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6 (a) (i) But heat transfer by convection can even happen from low temperature to high temperature region. For example, we can pump the liquid with low temperature at one point to other point where the liquid is at higher temperature.

Take another example, refrigerator, heat is taken away from the cold chamber (at low temperature) and given to the atmosphere at higher temperature. It can do this because it is not a closed system. The way it is not closed is that it has energy input, which drives the pump.

(ii) Frictional force acts between the tyres of the car and the road. During driving, the work is done against the frictional force which is converted into heat. Therefore, the temperature and hence the pressure of the air in the tyres increases.

(b) An adiabatic reversible change is that change which goes to and fro through exactly the same intermediate stages without exchange of heat between inner and outer of the system.

Examples of an adiabatic process are:

- Air escaping from the cycle tube on the removing valve
- Quickly air escaping from bust tube tyre of the ca
- Compression and expansion of gases in the cylinders of an automobile engine

(c) Data given:

- Number of mole, $n = 0.05\, mol$
- Initial temperature of a gas: $\mathrm{T_1 = 27°C = 300\ K}$
- Initial pressure $\mathrm{P_1 = 1.0 \times 10^5\ Pa}$
- Final temperature of a gas: $\mathrm{T_2 = 77°C = 350\ K}$
- Molar gas ratio constant for monoatomic gas $\gamma = 5/3$

Solution:

From first law of thermodynamics requires: $\mathrm{Q = \Delta U + P\Delta V}$

Where: $\Delta \mathrm{U}$ is increase in internal energy: $\Delta \mathrm{U} = \frac{3}{2}\, \mathrm{nR\Delta T}$

$\Delta \mathrm{U} = \frac{3}{2}\,(0.05)(8.31)(350 - 300) = 31.163\, J$

Again: From first law of thermodynamics requires: $\mathrm{Q = \Delta U + P\Delta V}$

Where: $P\Delta \mathrm{V}$ is external work done $P\Delta \mathrm{V} = \mathrm{P(V_2 - V_1)}$

$$\mathrm{P\Delta V = P(V_2 - V_1) = nRT_2 - nRT_1 = nR(T_2 - T_1)}$$

$$\mathrm{P\Delta V = nR(T_2 - T_1) = (0.05)(8.31)(350 - 300) = 20.775J}$$

Then: If Q" is the total heat energy supplied, then: $\mathrm{Q = \Delta U + P\Delta V}$

$\mathrm{Q = 31.163 + 20.775 = 51.94J}$

Hence, the total heat energy supplied will be $\mathbf{51.94J}$

7 (a) (i) **Effects of air temperature on plant growth**

- Optimum temperature on plants enhances enzymic activities which in turn gives favourable conditions for plant growth.
- High temperature denature enzymes commonly for photosynthesis and hence the death of plant.
- Low temperature inactivates the plant growth enzymes hence low growth rate.

(ii) **Effects of wind belts to plant:**

- Wind belts cause the loss of plant leaves and flowers hence lower plant productivity and growth. Loss of leaves lowers the rate of photosynthesis.
- Wind belt sometimes cause plants to lean in direction of moving wing. This changes their direction of growth.
- Trees are broken by the strong wind

(b) (i) When P and S seismic waves are sent from one side of earth to the other, only P waves can be detected on the other side. The fact that S waves do not travel through the core provides evidence for the existence of a liquid core.

(ii) Ozone absorbs harmful radiation from the sun. The Ozone projects plant and shield people from skin cancer and eye cataracts.

(c) **Effects of Global warming:**

- Increase in the temperature of the oceans
- Rise in sea levels
- Change in the world's climatic patterns
- Acidification of the oceans
- Extreme weather events like flood, droughts , heat waves, hurricanes and tornadoes.
- Higher or lower agriculture yields
- Melting of arctic ice and snowcaps. This causes landslides, flashfloods and glacial lake overflow.
- Extinction of some animals and plan species,
- Increase in the range of the disease vectors (Organism that transmit diseases)

SECTION B (30 Marks)

Answer **two (2)** questions from this section

8 (a) (i) **advantages of potentiometer versus that of voltammeter**.

- Potentiometers work on the principle of zero deflection method and hence the possibility of error is very small in this case whereas voltmeter draws some amount of current using a high resistance value and measures the voltage. So the voltage measured by the voltmeter might have some errors.
- Also, the standardization of potentiometers can be done directly with standard cells.
- The potentiometer is a highly sensitive device and hence we can measure even a small e.m.f but in case of a voltmeter, we cannot measure a small e.m.f.
- There is an advantage in the case of a potentiometer that we can change the length of the potentiometer wire and increase the accuracy of the instrument according to our requirement which is not possible in case of the voltmeter.
- In voltmeter, the precision is fixed and we cannot change it.
- Potentiometer doesn't draw any current from the circuit in which it is used for the measurement, whereas the voltmeter draws some amount of current in case of high voltages, which results in some errors in the measurements done using a voltmeter.
- In voltmeter, there is always a loss of energy due to the internal resistance of the cell.

(ii) Alternating current better for long-distance power transmission than direct current because, alternating current is has

- cheap and efficient voltage stepping by use of transformers
- Low maintenance costs of high speed AC motors.
- When AC is supplied at higher voltages, the transmission losses are small compared to DC transmission.

(b) Solution:

Resistance of aluminum, $R_{al} = \rho_{al}\dfrac{l_{al}}{A_{al}} = \rho_{al}\dfrac{4l_{al}}{\pi d_{al}^{2}}$

$$R_{al} = \rho_{al}\frac{4l_{al}}{\pi d_{al}^{2}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad \text{(i)}$$

Resistance of copper, $R_{cu} = \rho_{cu}\dfrac{l_{cu}}{A_{cu}} = \rho_{cu}\dfrac{4l_{cu}}{\pi d_{cu}^{2}}$

$$R_{cu} = \rho_{cu}\frac{4l_{cu}}{\pi d_{cu}^{2}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad \text{(ii)}$$

Divide two equations:
$$\frac{R_{al}}{R_{cu}} = \frac{4\,\rho_{al}l_{al}}{\pi d_{al}^{2}} \times \frac{\pi d_{cu}^{2}}{4\,\rho_{cu}l_{cu}}$$
$$\frac{R_{al}}{R_{cu}} = \frac{\rho_{al}}{\rho_{cu}} \times \frac{l_{al}}{l_{cu}} \times \left(\frac{d_{cu}}{d_{al}}\right)^{2}$$

If $I_{al} = 3A$ then $I_{cu} = 5 - 3A = 2A$

Since are parallel: $V_{al} = V_{cu} = I_{al}R_{al} = I_{cu}R_{cu}$

$$\frac{R_{al}}{R_{cu}} = \frac{I_{cu}}{I_{al}} = \frac{2}{3}$$

Now: $$\frac{2}{3} = \frac{0.028}{0.017} \times \frac{7.5}{6} \times \left(\frac{d_{cu}}{d_{al}}\right)^2$$

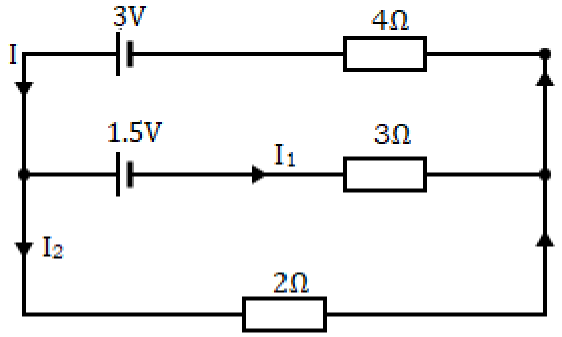
$$\frac{2}{3} = 2.0588 \times \left(\frac{d_{cu}}{d_{al}}\right)^2$$

$$\left(\frac{d_{cu}}{d_{al}}\right)^2 = 0.3238$$

$$\frac{d_{cu}}{d_{al}} = 0.5690$$

$$d_{cu} = 0.5690 \times d_{al} = 0.5690 \times 1\text{mm} = 0.5690\text{ mm}$$

8 (c) Solution:



$I = I_1 + I_2$

$$3V - 1.5V = 4I + 3I_2$$
$$1.5 = 4(I_1 + I_2) + 3I_2$$
$$1.5 = 4I_1 + 4I_2 + 3I_2$$
$$1.5 = 4I_1 + 7I_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(i)}$$

Again:

$$2I_2 + 3(-I_1) = 1.5$$
$$1.5 = -3I_1 + 2I_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(ii)}$$

Solve equation (i) and (ii) simultaneously

$I_1 = -\frac{15}{58}A = -0.2586A$, and $I_2 = \frac{21}{58}A, = 0.3621A$, then

$$I = I_1 + I_2 = \frac{15}{58} + \frac{21}{58} = \frac{6}{58} = \frac{3}{27}$$

Hence the current, passing through 4Ω is $\frac{3}{29}A = 0.1034A$

8 (d) Solution:

A resistance of the lamp, $R = \frac{V_s^{\ 2}}{50} = 200\Omega$ and

the maximum current, $I = \frac{100}{200} = 0.5A$

When the lamp is put in the series with a capacitance and run at 200V a.c, from $V = IZ$ we have $Z = \frac{V}{I} = \frac{200}{0.5} = 400\Omega$

Now in the case of C – R circuit, $Z^2 = R^2 + {X_C}^2$

$$ {X_C}^2 = Z^2 - R^2 = 400^2 - 200^2 = 120000 $$

But $X_C = \frac{1}{\omega C}$ then: $C = \frac{1}{\omega X_C} = \frac{1}{2\pi f X_C} = \frac{1}{2\times\pi\times50\times\sqrt{120000}} = 9.2\mu F$

9 (a) (i) Two (2) basic features of a hole from valence electrons as used in band theory of an electronics

- A hole represents a missing electrons in the covalent bond
- A hole has a positive charge equal to the negative charge on an electron
- The mobility of a hole is less than that of a free electron.

(ii) **Doping:** is the process of deliberate addition of controlled amount of suitable impurity to a pure semiconductor so as to increase its conductivity.

Three methods of doping:

- By adding impurity atoms to pure molten semiconductors
- By heating crystalline semiconductor in an atmosphere containing dopants atoms so that doping atoms diffuse into the semiconductor
- By bombarding the semiconductor by the doping atoms. In this process the doping atoms are implanted into the semiconductor.

(b) (i) Transistor stabilization is the process of making operating point independent of temperature changes or variations in transistor parameters

(ii) The base is very thin
The base is very lightly doped

(c) Reasons why the collector region is relatively lightly doped compared to the emitter region

- To archive high breakdown voltage. The base – emitter junction is normally reverse biased (for minority carriers) light doping increases the electric field in the junction and so lowers the breakdown voltage.
- To act as receiver of emitter carriers.

9 (d) (i) Difference between saturation current and quiescent state as used in a transistor.

Saturation current: is the maximum value of the collector current beyond which a transistor cannot amplify. At this point $V_{CE} = 0$

Quiescent state is the point on the load – line which gives the value of the collector current and collector – emitter voltageV_{CE} for working condition of the transistor

(ii) Input current, $I_E = \frac{V_{in}}{R_{in}} = \frac{500\text{ mV}}{20\Omega} = 25\text{ m A}$

Since $\alpha = 1 = \frac{I_C}{I_E}$ then $I_E = I_C = 25\text{ mA}$

Output voltage, $V_{out} = I_c R_c = 25\text{ mA} \times 1\text{ k}\Omega = 25\text{V}$

Voltage amplification, $A_v = \frac{V_{out}}{V_{in}} = \frac{25\text{ v}}{500\text{ mV}} = 50$

10 (a) **Advantages of digital signals**

- It is easy to store digital information than analogue information.
- It can be transmitted over a long distance without error because their ability to cope with noise.
- Digital signals can be transmitted with minimum loss of its power.
- It is easier to correct errors in digital signals

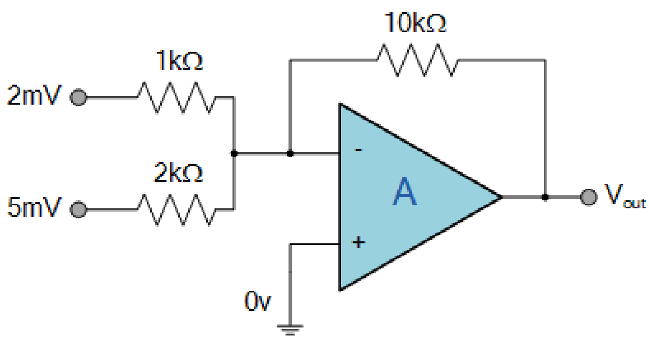
Disadvantages of digital signals

- Real world information are mainly analogue, hence there is need to convert back digital signals to analogue which increase cost of operating systems.
- Signal amplification is easily done in analogue form but not in digital signals.

(b) (i) **Advantages of gain with negative feedback:**

- The gain is more stable. This is because with negative feedback, the gain is independent of the open loop gain of the Op-amp which tends to fluctuate.
- The gain of the circuit can be varied just by changing external components of the circuit e.g. resistor
- The gain is constant over a wider range of frequencies

10 (b) (ii) To find the output voltage of the following *Summing Amplifier* circuit.



Gain: $A_V = \frac{V_{out}}{V_{in}} = -\frac{R_F}{R_{in}}$ We can now substitute the values of the resistors in the circuit as follows,

$A_1 = \frac{10\ k}{1k} = 10$ and $A_2 = \frac{10\ k}{2k} = 5$

$V_{out} = (A_1 \times V_1) + (A_2 \times V_2)$

$V_{out} = (-10 \times 2 \times 10^{-3}) + (-5 \times 5 \times 10^{-3}) = -4.5 \times 10^{-2} V$

Then the output voltage of the **Summing Amplifier** circuit above is given as -45 mV and is negative as its an inverting amplifier.

(c) (i) **Point-to-point communication mode**

In this type of mode of communication, the massage is transmitted over a link between a single transmitter and a single receiver. Conversation between two persons through a telephone is an example of point-to point communication

(ii) **In broadcast mode (point-to-many point communication)**

In this mode of communication, there is single transmitter and a large number of receivers. Radio broadcasting and television telecast are the examples of this mode of communication.

(d) (i) Modulation

Modulation is the process of changing characteristics of a carrier wave includes frequency, amplitude or phase in accordance with the intensity of the signal

Importance of modulation:

- For increasing efficient transmission of the carrier waves.
- For quality and effective power of radiation.

(ii) Repeater:

A repeater is a combination of a receiver and a transmitter. A repeater, picks up the signal from the transmitter, amplifies and retransmits it to the receiver sometimes with a change in carrier frequency. Repeaters are used to extend the range of a communication system. Communication satellite is essentially a repeater station in space.