TANZANIA HEADS OF ISLAMIC SCHOOLS COUNCIL.

FORM SIX INTER ISLAMIC MOCK EXAMINATION

131/1

PHYSICS 1.

(For both Schools and Private Candidates)

PROPOSED MARKING GUIDE.

1 (a) (i) The dimensional Consistency is a necessary Condition for a physical relation to be Correct. However it is not sufficient because of the following reasons:-

⇒ A physical relation may be dimensionally correct but dimensionless numerical factors (eg 2π) could be wrong. (01 mark)

⇒ A given relation may be dimensionally Correct without describing any physical situation. (01 mark)

(ii) Given the equation,

$$V = Xt^2 + Yt + Z.$$

Applying the principle of homogeneity.

$$[V] = [Xt^2]$$

$$[X] = \frac{[V]}{[t^2]}$$ (01/2 mark)

$$= \frac{[LT^{-1}]}{[T^2]}$$ (00 1/2 mark)

$$[X] = [LT^{-3}] \text{ or } [M^0LT^{-3}]$$

Therefore, the unit of X is m/s^3 or ms^{-3} (00 1/2 Mark)

Again, from the given equation

$$[V] = [Yt].$$

$$[Y] = \frac{[V]}{[t]}.$$ (01/2 mark)

$$[Y] = \frac{[LT^{-1}]}{[T]}.$$ (01/2 mark)

1 (a)(i) The dimensional Consistency is a necessary condition for a physical relation to be correct. However it is not sufficient because of the following reasons:

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$$[V] = [Yt]$$

$$[Y] = \frac{[V]}{[t]}$$ (01/2 mark)

$$[Y] = \frac{[LT^{-1}]}{[T]}$$ (01/2 mark)

(ii) $[Y] = [LT^{-2}]$

Therefore, the unit of Y is ms^{-2} (0½ mark)

Also:

$[V] = [Z]$

$[Z] = [LT^{-1}]$ (0½ mark)

Therefore, the unit of Z is ms^{-1} or m/s (0½ mark)

(b)(i) We generally define error as the maximum amount by which a physical quantity is expected to differ from its true value. Therefore we indicate maximum error in the result. (01 mark)

(ii) From the equation,

$$V = 2f(L_2 - L_1)$$ (0½ mark)

Apply natural logarithm both sides

$$\ln V = \ln(2f(L_2 - L_1))$$

$$\ln V = \ln 2 + \ln f + \ln(L_2 - L_1)$$ (0½ mark)

Differentiate and maximize errors.

$$\frac{\Delta V}{V} = \frac{\Delta f}{f} + \frac{\Delta(L_2 + L_1)}{L_2 - L_1}$$ (0½ mark)

$$\frac{\Delta V}{V} = \left(\frac{3.00}{300}\right) + \frac{(0.1 + 0.1)}{81.1 - 26.1}$$ (0½ mark)

$$\frac{\Delta V}{V} = \frac{3}{300} + \frac{0.2}{55}$$

$$\Delta V/V = 0.01 + 3.636 \times 10^{-3}$$

(b)(ii)

$\frac{\Delta V}{V} = 0.0136$ (0½ mark)

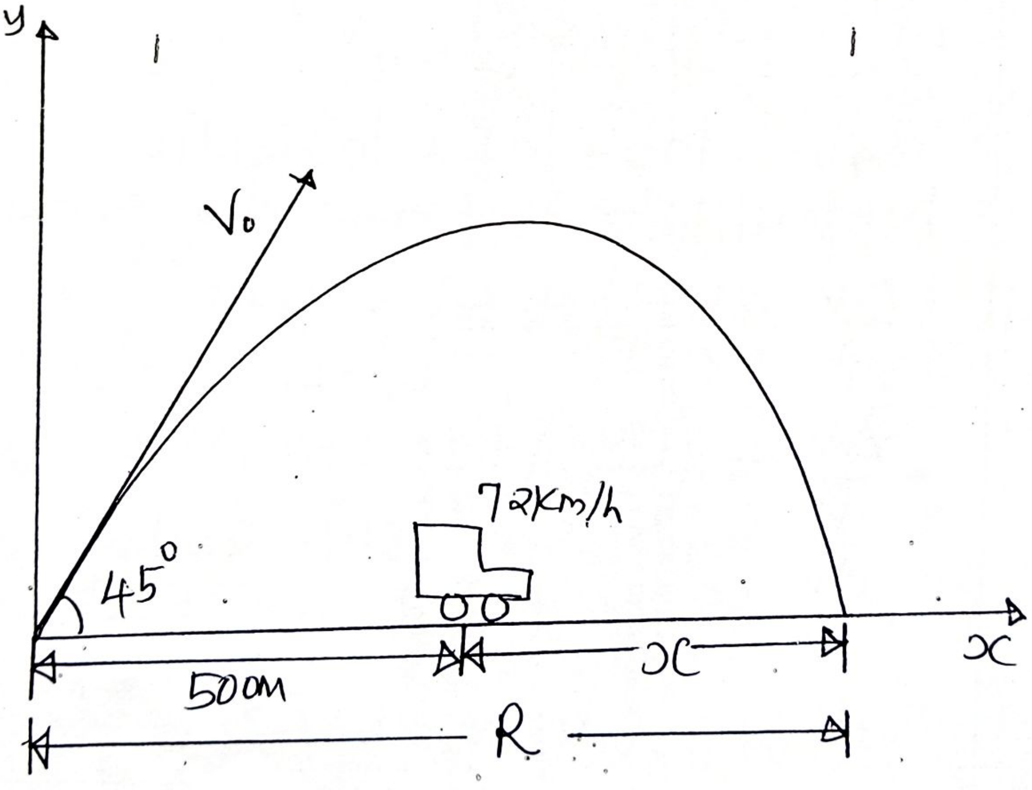
$\frac{\Delta V}{V} \times 100 = 0.0136 \times 100$

$\frac{\Delta V}{V} = 1.36\%$

$\therefore$ The percentage error is 1.36% (0½ mark)

2 (a)(i) A rocket donot undergo projectile motion because motion of rocket is depending on thrust provided by engine, dynamic lift and force of gravity but projectile motion is under the influence of force of gravity only. (02 marks)

(ii) Consider the figure below showing the condition for problem.



(0½ mark)

2 a(ii) Given:-

Speed of the Car $= 72 Km/h = 20 m/s$.
Distance of the Car from the gun $= 500m$.
Angle of projection $= 45°$.

Let t, be the time taken by the shell to hit the Car, In this time the Car has travelled a horizontal distance $x = 20t$.

Horizontal range of the shell,

$$R = (500 + 20t) m$$

From $t = \frac{2V_0 \sin\theta}{g}$ .... $(0\frac{1}{2}$ mark)

$$= \frac{2V_0 \sin 45}{g}$$

$$t = \frac{\sqrt{2} V_0}{g}$$

But $R = 500 + 20t$

$R = 500 + 20\left(\frac{\sqrt{2} V_0}{g}\right)$ ----(i) $(0\frac{1}{2}$ mark)

From $R = \frac{V_0^2 \sin 2\theta}{g}$ .... $(0\frac{1}{2}$ mark)

$$R = \frac{V_0^2 \sin 2\times45}{g}$$

$$= \frac{V_0^2 \sin 90}{g}$$

$R = \frac{V_0^2}{g}$ --- (ii) $(0\frac{1}{2}$ mark)

Substitute eqn (ii) Into eqn (i)

2 a(ii)

$$\frac{V_0^2}{g} = 500 + \frac{20\sqrt{2V_0}}{g}$$ (01/2 marks)

Upon solving

$V_0 = 85.56 m/s$ (01/2 marks)

$$R = \frac{V_0^2}{g}$$

$$R = \frac{(85.56)^2}{9.8}$$

$R = 746.9 m$ (01/2 marks)

$\therefore$ The horizontal distance is 746.9m.

(b)(i) For the motion of Electron around the nucleus Centripetal force is provided by electrostatic Force of attraction. (01 mark)

For the motion of planet around the sun, Centripetal Force is provided by gravitational Force of attraction. (01 mark)

(ii) Given

Speed (V) of the Car = 30m/s

Radius (r) of the track = 500m

Tangential acceleration (a_T) = $2 m/s^2$

From $a_c = V^2/r$ (01/2 mark)

2 (b) (ii) a_c = Is Centripetal acceleration.

$$a_c = \frac{(30)^2}{500}$$

$$a_c = 1.8 m/s^2$$ (01/2 mark

Resultant acceleration, a.

$$a = \sqrt{(a_T)^2 + (a_c)^2}$$ (01/2 mark

$$a = \sqrt{(2)^2 + (1.8)^2}$$

$$a = 2.69 m/s^2$$ (01/2 mark

∴ The Value of acceleration is $2.69 m/s^2$

3 (a) (i) For small masses and distance, the gravitational pull of building to a person is less compared to his weight hence cannot be felt. (02 mark

(ii) Object (satellites) in orbit are in a free fall and the only force acting on the object is the gravitational attraction of the earth. (03 mark

So I agree with Asha.

3 (b) Given,

Radius (R) of the orbit of the earth $6.37 \times 10^6 m$

Height (h) of satellite above the earth's surface is $35850 \times 10^3 m$ — $\left(0\frac{1}{2}\text{ mark}\right)$

$G = 6.67 \times 10^{-11} Nm^2 kg^{-2}$

$g = 9.8 m/s^2$

(i) To find T

$$T = 2\pi \sqrt{\frac{r^3}{GM}}$$ $\left(0\frac{1}{2}\text{ mark}\right)$

$$T = 2\pi \sqrt{\frac{r^3}{gR^2}}$$

03

$$T = 2\pi \sqrt{\frac{(R+h)^3}{gR^2}}$$ $\left(0\frac{1}{2}\text{ mar}\right)$

$$= 2\pi \sqrt{\frac{(6.37 \times 10^6 + 35850 \times 10^3)^3}{9.8 \times (6.37 \times 10^6)^2}}$$ $\left(0\frac{1}{2}\text{ mar}\right)$

$T = 86394$ sec.

$T = 24$ hrs. (01 ma)

∴ Therefore the period of the satellite is 24hrs.

(ii) Such a satellite moves in the same direction as that of rotation of the earth (west to East) and its orbit is parallel with the equatorial plane (01 ma)

02

3 (b) (ii) if this satellite orbit is not parallel with the equatorial plane it will appear to move up and down of the equatorial plane and thus it will not be stationery with respect to an observer on the earth. (01 mark)

4 (a) (i) You can't shield a body from gravitational influence of nearby matter by any means, it is because the gravitational force on a body due to nearby matter is not altered due to the presence of other bodies.
In other words gravitational field cannot be shielded by any means. (02 mark)

(ii) From the relation,

$$V = \sqrt{2Rg} \quad \text{- - - - - (i)}$$ (01 mark)

Where V = escape velocity.
R = radius of the earth.

Clearly the eqn (i) above shows that escape velocity (V) is independent to mass of object. Therefore the escape speed of elephant of mass 200Kg will be equal to 11.2 km/s (01 mark)

4 (b)(i) The egg which spins at a lower rate will be the raw egg. In a raw egg the liquid matter inside tries to get away from the axis of rotation thereby increasing the moment of inertia. (02 mar

On the other hand, the hard boiled egg will rotate faster like a rigid body.

(ii) Given.

Radius (R) = 4 cm = 4×10^{-2} m.

Mass (M) = 250g = 0.25Kg.

$\sin\theta = 1/10$

t = 5 sec

for linear acceleration a,

$\bar{a} = \frac{2}{3} g \sin\theta$. (01/2 mar

$= \frac{2}{3} \times 9.8 \times \sin\theta$. (01/2 mark

$= \frac{2}{3} \times 9.8 \times \frac{1}{10}$.

$a = \underline{0.653 m/s^2}$. (01/2 mar

04

for Kinetic energy (KE)

$KE = \frac{1}{2} mv^2 + \frac{1}{2} I w^2$. (01/2 mark

But, $v^2 = ?$

Recall, $v = u + at$ (01/2 mark

since $u = 0$.

4 b(ii) $V = at$

$= 0.653 \times 5$

$V = 3.265 m/s$ $\left(\frac{01}{2} \text{mark}\right)$

Now

$KE = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$= \frac{1}{2} \times 0.25 \times (3.265)^2 + \frac{1}{2} I\omega^2$

But also

$I = \frac{1}{2}MR^2$ $\left(\frac{01}{2} \text{mark}\right)$

and $\omega = V/R$

$KE = \frac{1}{2} \times 0.25 \times (3.265)^2 + \frac{1}{2}\left(\frac{1}{2}MR^2 \times \frac{V^2}{R^2}\right)$

$= \frac{1}{2} \times 0.25 \times (3.265)^2 + \frac{1}{4}Mv^2$

$= \frac{1}{2} \times 0.25 \times (3.265)^2 + \frac{1}{4} \times 0.25 \times (3.265)^2$ $\left(\frac{01}{2} \text{mark}\right)$

$KE = 2J$

$\therefore$ Therefore, Kinetic energy is 2 Joules

5 (a) (i) Snow has trapped air (in ice there is no air) which acts as a heat insulator. Therefore, the snow prevents the transmission of heat from the body of the animal to the outside. (02 marks)

(ii) The spoon that feels hot first when lowered into hot water is the silver spoon. This is because silver has higher thermal conductivity compared to stainless steel. (02 marks)

(b) (i) For a given volume, the surface area of sphere is minimum and that of disc is maximum. Therefore circular disc will cool the fastest and the sphere will cool the slowest, according to the equation (02 marks)

$$\frac{dQ}{dt} \propto A$$

Where A = surface area

$\frac{dQ}{dt}$ = Rate of heat loss.

5 (b) (ii)

Case I. Series arrangement

Rate of heat flow $\left(\frac{dQ}{dt}\right)$ is constant

$$\left(\frac{dQ}{dt}\right)_X = \left(\frac{dQ}{dt}\right)_Y \quad ---- \quad \left(0\frac{1}{2} \text{ mark}\right)$$

$$400A\left(\frac{90-\theta}{L}\right) = 200A\left(\frac{\theta-30}{L}\right)$$

$\theta = 70^\circ C$. is the junction temperature $\left(0\frac{1}{2} \text{ mark}\right)$

Now, rate of heat flow $\left(\frac{dQ}{dt}\right)_1$ for series arrangement

$$\left(\frac{dQ}{dt}\right)_1 = \frac{400A(90-70)}{L}$$

$$\left(\frac{dQ}{dt}\right)_1 = \frac{8000A}{L} \quad ---- (i) \quad \left(0\frac{1}{2} \text{ mark}\right)$$

Case II: For parallel arrangement.

$$\left(\frac{dQ}{dt}\right)_X = \frac{400A}{L}(90-30) = \frac{24000A}{L} \quad \left(0\frac{1}{2} \text{ mark}\right)$$

$$\left(\frac{dQ}{dt}\right)_y = \frac{200A}{L}(90-30) = \frac{12000A}{L} \quad \left(0\frac{1}{2} \text{ marks}\right)$$

Total rate of heat flow $\left(\frac{dQ}{dt}\right)_2$ for parallel arrangement.

$$\left(\frac{dQ}{dt}\right)_2 = \left(\frac{dQ}{dt}\right)_X + \left(\frac{dQ}{dt}\right)_y$$

5 b (ii) $\left(\frac{dQ}{dt}\right)_2 = \frac{24000A}{L} + \frac{12000A}{L}$ $\left(0\frac{1}{2}\text{ mark}\right)$

$= \frac{36000A}{L}$

Ratio of rates of heat flow is therefore

$\left(\frac{dQ}{dt}\right)_2 \Big/ \left(\frac{dQ}{dt}\right)_1$. $\left(0\frac{1}{2}\text{ mark}\right)$

$\frac{36000A}{L} \Big/ \frac{8000A}{L} = 4.5$ $\left(0\frac{1}{2}\text{ mark}\right)$

The ratio of the rates of heat flow is 4.5.

6(a) (i) In a compressed (real) gas the mutual attraction between molecules increases as the molecules come close. Therefore potential energy is added to the internal energy. Since the potential energy is negative the total internal energy of the gas decreases (01 mark)

(ii) When milk is mixed in tea, certain amount of work is done on the system which appears in the form of heat. The milk cannot be separated from tea with the recovery of same work from heat. Hence this process is not reversible. (01 mark)

6 (b) (i) The clouds reflect heat radiations falling on them.
So on cloud night, the radiations from the earth's surface reaching the clouds are reflected back so the temperature of the earth does not fall.
But on clear night, the radiation from the earth surface escape out so earth temperature falls. That's why a clear night is colder than a cloudy night. (01 mark)

(ii) Energy per second $\left(\frac{dQ}{dt}\right)$ radiated by sphere;

$$\left(\frac{dQ}{dt}\right)_1 = \sigma A\left(T^4 - T_0^4\right)$$ $\left(0\frac{1}{2}\text{ mark}\right)$

Energy absorbed per second $\left(\frac{dQ}{dt}\right)_2$ by enclosure,

$$\left(\frac{dQ}{dt}\right)_2 = \frac{MC\Delta\theta}{t}$$

Now $\left(dQ/dt\right)_1 = \left(dQ/dt\right)_2$.

$$\frac{MC\Delta\theta}{t} = \sigma A\left(T^4 - T_0^4\right)$$ $\left(0\frac{1}{2}\text{ mark}\right)$

But $M = \rho \times$ Volume of sphere.

$$= \rho \times V$$

$$= \rho\left(\tfrac{4}{3}\pi r^3\right)$$

Thus

$$\rho\left(\tfrac{4}{3}\pi r^3\right) c\left(\frac{\Delta\theta}{t}\right) = \sigma A\left(T^4 - T_0^4\right)$$ $\left(0\frac{1}{2}\text{ mark}\right)$

6 (b)(ii)

$$\frac{4}{3}\pi r^3 \rho c\left(\frac{\Delta\theta}{t}\right) = \sigma(4\pi r^2)(T^4 - T_0^4).$$

$$\left(\frac{\Delta\theta}{t}\right) = \frac{3\sigma(T^4 - T_0^4)}{\rho r c.}$$ (0½ mark)

$$= \frac{3 \times 5.7 \times 10^{-8} \times (300^4 - 200^4)}{8000 \times (30 \times 10^{-3}) \times 400.}$$ (0½ mark)

$$\left(\frac{\Delta\theta}{t}\right) = 0.012\ °C/sec.$$ (0½ mark)

∴ The initial rate of temperature rise is 0.012 °c/s.

6 (c). From stefan's Law

$$\frac{dq}{dt} = \sigma A(T_b^4 - T_s^4) \quad \text{but } T_b = \Delta T + T_s$$ (0½ marks)

$$\frac{dq}{dt} = \sigma A\left(T_s^4\left(1 + \frac{\Delta T}{T_s}\right)^4 - T_s^4\right]$$ (01 mark)

From Binormial expansion

$$\frac{dq}{dt} = \sigma A\left(T_s^4\left(1 + \frac{4\Delta T}{T_s}\right) - T_s^4\right)$$ (0½ mark)

$$\frac{dq}{dt} = \sigma A\left(\cancel{T_s^4} - 4T_s^3\Delta T\right) - \cancel{T_s^4}\right]$$ (01 mark)

$$dq/dt = 4\sigma A T_s^3 \Delta T \quad \text{as } 4\sigma A T_s^4 = K$$

$$\frac{dq}{dt} = K\Delta T$$ From $\Delta T = (\theta_b + 273 - \theta_s - 273)$ (0½ mark)

$\Delta T = \theta_b - \theta_s$

Then;

$$\frac{dq}{dt} \propto (\theta_b - \theta_s)$$ hence proved. (0½ mark)

7 (a) (i) Green house gases are crucial to keep our planet at a suitable temperature for life, without the natural green house effect, the heat emitted by the earth would simply pass outwards from the earth's surface into space and the earth would have an average temperature of about $-20^{\circ}C$! (03 marks)

(ii) The heat flux across a sand soil column is expressed as:-

$$G = \frac{-K(T_1 - T_0)}{X} \quad \text{(01 mrk)}$$

Where X = thickness

K = thermal conductivity

$$G = \frac{(0.27)(23)}{0.43} \quad \left(\frac{01}{2}\text{ mrk}\right)$$

$$G = 14.4\ W/m^2$$

Total heat transfer $= G \times t$ $\left(\frac{01}{2}\text{ mrk}\right)$

$= 14.4 \times 3 \times 3600$

$= 1.6 \times 10^5\ J/m^2$ (01 mark)

7 (b) Two causes of thermal pollution.

⇒ Hot waste liquid from Industries running to the water bodies causes thermal pollution. (02mrks)

⇒ Volcanic eruption.

⇒ oil spills.

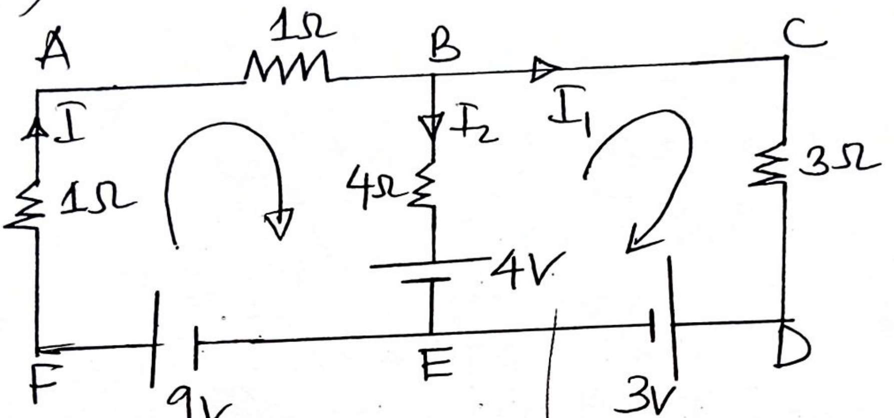
Two effects of thermal pollution.

⇒ Death of aquatic animals, hence loss of biodiversity. (02marks)

⇒ Water pollution, hence eruptions of deseases such as Cholera.

8 (a)(i) Potentiometer is preferred over Voltmeter because it measures accurate emf of the cell. It uses null method, so no current is drawn by the galvanometer from the cell in balanced condition of potentiometer. (02mrks)

(ii) Given the Circuit diagram,



From KCL

$I = I_1 + I_2$ ($\frac{01}{2}$mrk)

Consider loop: ABEFA.

Apply KVL.

$\Sigma emf = \Sigma pd.$

$9-4 = I + I + 4I_2$

$5 = 2I + 4I_2$

But $I = I_1 + I_2$

$5 = 2(I_1 + I_2) + 4I_2$

$5 = 2I_1 + 2I_2 + 4I_2$

$5 = 2I_1 + 6I_2$ - - - (1) ($\frac{01}{2}$mrk)

8 (a) (ii)

Consider the loop BCDEB

Apply KVL

$\sum emf = \sum pd$

$-3+4 = 3I_1 - 4I_2$

$1 = 3I_1 - 4I_2$

$3I_1 - 4I_2 = 1$ ----- (ii) (01 mark)

On solving eqn (i) and (ii)

$I_1 = 1A$

$I_2 = \frac{1}{2}A$

$I = I_1 + I_2$

$= (1 + \frac{1}{2})A$

$I = \frac{3}{2}A$

Therefore the current passing through 3Ω resistor is 1 A. (01 mark)

8 (b)(i) The drift velocity of the electron In a wire is very small. Therefore, drifting electrons have a low value of Inertia of motion. For this reason, they are able to go round the bends easily. (02 mrks)

(ii)

Mass of silver = m,

$m = \rho \times Volume$

$= \rho A L$

$m = (10.5\times10^{-6}) \times (3.14\times10^{-6}) \times 1$

$m = 3.297\times10^{-2}\ kg$ (01 mrk)

Number of atoms (N) in silver wire,

$N = \left(\frac{M}{M_r}\right) \times N_A$

$N = \left(\frac{3.297\times10^{-2}}{0.108}\right) \times 6.02\times10^{23}$

$N = 1.838\times10^{23}$ atoms. (01 mrk)

Number of electron density (n).

$n = N/V$

$= \frac{1.838\times10^{-2}}{3.14\times10^{-2}\times1}$

$n = 5.854\times10^{28}\ m^{-3}$

Drift velocity (V_d) $= \frac{I}{neA} = \frac{10}{5.854\times10^{28}\times e\times A}$ (02 mrk)

$V_d = 3.4\times10^{-4}\ m/s$.

8 (c)

from

$$Z^2 = R^2 + X_L^2$$

from $E = IZ$

Case I

$$Z_1^2 = R^2 + (X_{L_1})^2$$

$$E = I_1 Z_1$$

$$10 = 0.7 Z_1$$

$$Z_1 = 10/0.7$$

$$Z_1 = 100/7\ \Omega$$

Now

$$Z_1^2 = R^2 + (X_{L_1})^2$$

$$\left(\frac{100}{7}\right)^2 = R^2 + (2\pi \times 50 L)^2 \quad \text{---} (1)$$ (01 mark)

Case II

$$Z_2^2 = R^2 + (X_{L_2})^2$$

$$E = I_2 Z_2$$

$$Z_2 = E/I_2 = \frac{10}{0.5}$$

$$Z_2 = 20\Omega$$

$$Z_2^2 = R^2 + (X_{L_2})^2$$

$$20^2 = R^2 + (2\pi \times 75 L)^2 \quad \text{——} (ii)$$ (01 mark)

On solving

$R = 6.82\Omega$ (01 mark)

$L = 0.0399\,H = 3.99 \times 10^{-2}\,H$ (01 mark)

9 (a) (i)

⇒ Silicon can withstand high temperature without being destroyed compared to Germanium. 01

⇒ The leakage current for silicon is very small compared to Germanium. 01

(ii) Differences between intrinsic and extrinsic semiconductor.

Intrinsic semiconductor	Extrinsic semiconductor
(i) It's a pure semiconductor with equal number of holes and free electrons.	(i) Impure semiconductor with different number or unequal number of holes and free electrons.
(ii) Its conductivity depends on temperature only.	(ii) Its conductivity depends on temperature and amount (Level) of doping.
(iii) Has no practical use.	(iii) It is applicable for many practical use.
(iv) It is elemental semiconductor	(iv) It is compound semiconductor.

02

(a) (iii) Given:

Resistivity, $\rho = 0.01 \Omega m$

Conductivity, $\sigma = \frac{1}{\rho}$

$= \frac{1}{0.01}$

$\sigma = 100 S/m$ 01

Mobility, $\mu_e = 0.39 m^2 V^{-1} s^{-1}$, for electron.

from $\sigma = en\mu_e$ 01

$n = \frac{\sigma}{e\mu_e}$

$= \frac{100}{1.6 \times 10^{-19} \times 0.39}$

$n = 1.6 \times 10^{21} / m^3$

$\therefore$ Donor Concentration is $1.6 \times 10^{21} / m^3$. 01

9 (b) (i)

⇒ To achieve high breakdown Voltage. The base-emitter junction is normally reverse biased and lightly doped in order to increase the electric field strength in the junction and so Lowers the breakdown Voltage. 0

9 (b) (ii)

Voltage drop across Load resistor $= I_C R_L$.

$$I_C = \frac{\text{Voltage drop across Load resistor}}{R_L}$$

$$= \frac{0.8V}{800}$$

$$I_C = 1 \times 10^{-3} A$$ 01

from $V_{CC} = V_{CE} + I_C R_L$.

$$V_{CE} = V_{CC} - I_C R_L$$

$$= 8 - 0.8$$

$$V_{CE} = 7.2V$$

Similarly.

$$\beta = \frac{I_C}{I_B}$$ 01/2

$$I_B = \frac{I_C}{\beta}$$

$$I_B = \frac{1 \times 10^{-3}}{25}$$ 01/2

$$I_B = 4 \times 10^{-5} A$$ 01/2

$$\text{Voltage gain} = \frac{\beta \times R_L}{R_B}$$ 01/2

$$= \frac{25 \times 800}{200}$$

Voltage gain $= 100$ 01

9 (b)(ii) Power gain $= \beta^2 \left(\frac{R_L}{R_B}\right)$ - - - - - - 0 $\frac{1}{2}$ mrk

$= 25^2 \times \frac{800}{200}$ - - - - 0 $\frac{1}{2}$ mrk

Power gain $= 2500$ - - - - 01 mrk

10 (i) open loop gain is the gain without applying any feedback. 01 mrk
Its value is around 1×10^5.

(ii) the factors are:-

$\Rightarrow$ The voltage gain of an opamp
Thats $A_o = 10^5$. 01 mrk

$\Rightarrow$ Polarity relationship between voltage of Inverting Input V_1 and non-Inverting input V_2. 01 mrk
Thats $V_o = A_o(V_2 - V_1)$.

$\Rightarrow$ Voltage supplied from the power supply, thats $\pm V_s$ 01 mrk

10

(b) (i)

Let V_1 = Voltage at inverting Input (x).

Apply potential divider theory.

let, Pd across 100kΩ be $V_R = V_1$.

$$V_1 = V_R = \frac{100k\Omega}{(100+47)k\Omega} \times 15V.$$

$$V_1 = \underline{10.2V}$$ . . . . . . $\frac{01}{2}$ mrk

let Pd across 47kΩ be V_2.

$$V_2 = \frac{47k\Omega \times 15}{(100+47)k\Omega}$$

$$V_2 = 4.8V.$$ . . . . . . $\frac{01}{2}$ mrk

Now, Voltage at inverting Input V_x is given by:—

$$V_x = V_1 - V_2$$ - - - $\frac{01}{2}$ mrk

$$V_x = (10.2 - 4.8)\ V$$

$$V_x = 5.4V.$$ - - - - $\frac{01}{2}$ mrk

Therefore voltage across inverting Input is 5.4V.

10 (b)(ii)

Let V_y = Voltage at non-Inverting and V_x = voltage at inverting.

Now

$V_o = A_o (V_y - V_x)$. - - - - $\frac{0}{2}$ mrk.

But $V_o = +15V$.

So, for $V_o = +15V$ then $V_y > V_x$.

Therefore $V_y > 5.4V$. - - - - $\frac{0}{2}$ mrk

(iii) Apply Potential divider rule.

Potential across T_H = Potential at $47k\Omega$

$$\left(\frac{R_{TH}}{R_{TH}+2.2K}\right) \times 15V = \left(\frac{47}{47+100}\right) \times 15V$$ $\frac{0}{2}$ mrk.

$$\frac{R_{TH}}{R_{TH}+2.2K} = \frac{47}{147}$$. - - - $\frac{0}{2}$ mrk

on solving.

$$R_{TH} = 1.034 K\Omega$$

Therefore, resistance of thermistor (R_{TH}) is $1.034 K\Omega$. 0 mrk

10 (c)(i)

Given

$f_m = 12 KHz$.

Inductance $L = 100\mu H = 100 \times 10^{-6} H$.

Capacitance $C = 100 PF = 100 \times 10^{-12} F$.

Carrier wave frequency (f_c) is obtained when the system is at resonance
That's carrier frequency is equal to resonance frequency. 0 1/2

$$f_c = \frac{1}{2\pi\sqrt{LC}}$$ - - - - 0 1/2

$$f_c = \frac{1}{2\pi\sqrt{10^{-4} \times 10^{-10}}}$$

$$f_c = 1592 KHz$$ - - - - 01

Lower side band (LSB) $= f_c - f_m$

$= (1592 - 12) KHz$

LSB $= 1580 KHz$ - - - 0 1/2

Upper side band (USB) $= f_c + f_m$

$= (1592 + 12) KHz$

USB $= 1604 KHz$ - - - 0 1/2

10 (c) (ii) From the given truth table

$Q = \bar{A}\cdot\bar{B} + A\cdot\bar{B} + AB$ - - - $0\frac{1}{2}$ mrk.

$= (\bar{A}+A)\cdot\bar{B} + AB$

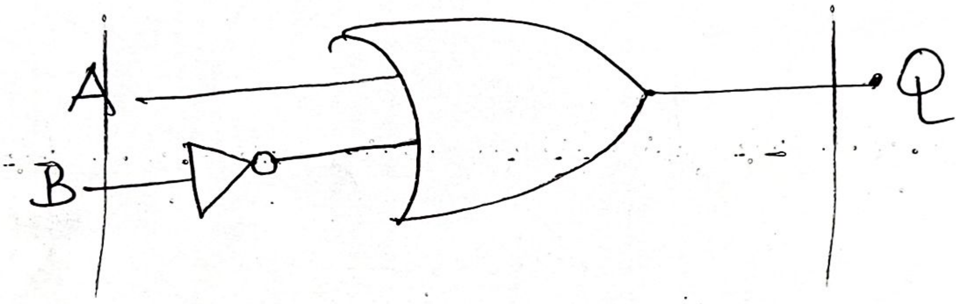
$= \bar{B} + AB$ - - - - $0\frac{1}{2}$ mrk.

$= (\bar{B}+A)\cdot(\bar{B}+B)$

$= \bar{B}+A\cdot 1$ - - - - $0\frac{1}{2}$ mrk

$Q = \bar{B}+A$ - - - - $0\frac{1}{2}$ mrk

Logic circuit required,



(01 mrk)