G.C.E. (Advanced Level) Examination - April 2003

PHYSICS - I

Provisional Scheme of Marking

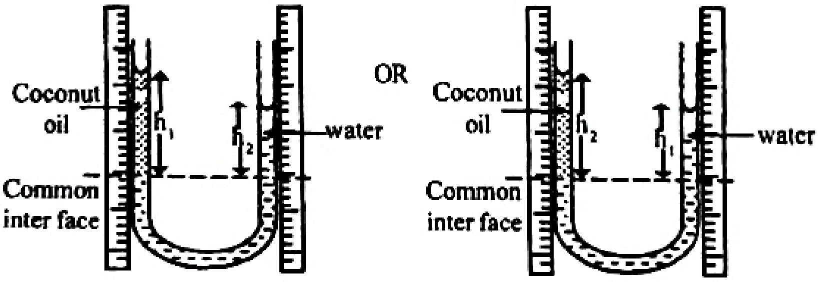
2003 - Answers

01	5	21	5	41	1
02	4	22	2	42	2
03	5	23	2	43	2
04	3	24	3	44	2
05	3	25	1	45	1
06	2	26	2	46	3
07	1	27	5	47	1
08	4	28	2	48	2
09	3	29	4	49	5
10	4	30	4	50	3
11	2	31	2	51	5
12	4	32	5	52	1
13	4	33	1	53	2
14	1	34	2	54	5
15	5	35	4	55	3
16	5	36	5	56	1
17	1	37	3	57	3
18	4	38	5	58	4
19	1	39	3	59	3
20	3	40	3	60	1

G.C.E. (Advanced Level) Examination - April 2003
PHYSICS - II
Provisional Scheme of Marking

A - PART

01. (a) (i)



(ii) Marking of h_1 (h_2) and h_2 (h_1) on the diagram above

(b) $d_1 = \frac{h_2 d_2}{h_1}$ or $d_1 = \frac{h_1 d_2}{h_2}$ 01

(c) (i) Procedure (2) or by adding coconut oil 01

(ii) liquid interface goes up the same height as water is added to the water column and therefore h_1 and h_2 values do not change/ h_1 and h_2 values remains the same / cannot obtain a set of readings for h_1 and h_2. 01

(iii) $d_1 = 870$ kgm^{-3} 01 [$d_1 = 0.87 \times 1000$kgm^{-3}]

(d) Water 01

Coconut oil will reside only in one arm of the tube OR if the students argue in the negative way as indicated below.

Coconut oil will be divided into both arms of the tube/ both arms will be occupied by coconut oil/ coconut oil will reside on top of water in both arms 01

(e) $0.1 = 2 \times \frac{1}{h}$

h = 20mm / 2cm / 0.02m 01

(f) The fraction or percentage error of the height of the balanced mercury column is high / The height of the balanced mercury column is small / The height of the mercury column cannot oil column will be exceedingly large/ Need large amount of coconut oil to do the experiment/ The length of the arm which occupies coconut oil should be exceedingly large. 01

02. (a) Add small pieces of ice to the water in the calorimeter one at a time and stir until dew is formed on the surface of the calorimeter or till the surface brightness disappears.

(b) (1) Temperature of water at which dew first begins to appear on the surface of the calori meter/ Temperture of water when the surface of the calorimeter begins to lose as brightnes. 01

(2) Temperature of water at which dew dissapears last on the surface of the calorimeter Temperature of water when the surface of the calorimeter regains its brightness. 01

(c) The required temperture in this experiment is the temperature of the calorimeter. Temperture of the calorimeter becomes equal to temperature of water. (or fo the temperature registered by the thermometer) only when the temperature is uniform throughout. 01

(d) $\frac{(23.2 + 23.6)}{2} = 23.4$ °C 01

(e) (i) Relative humidity $\frac{\text{SVP at dew point}}{\text{SVP at room temperature}} \times 100\%$ 01

(ii) Relative humidity $= \frac{25}{35} \times 100\,\%$

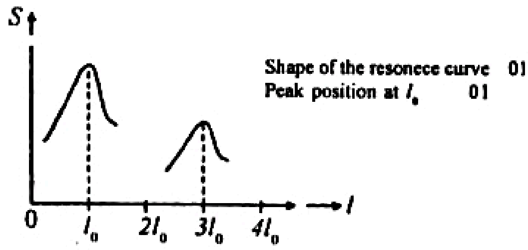
$= 71.4\,\%$ 01

(f) The water vapour concentration (or absolute humidity) of breath is higher than that of air. Therefore the dew point of breath is above room temperature. As breath cools down to room temperature on the metal surface. dew is formed and the brightness of the surface is being reduced. 01

03. (a) 420 Hz 01

(b) (i) Sound the tuning fork and place it close to the open end Move the pistion slowly of the right starting from the open end until a loud sound is heard. 01

(ii)



(iii) $3l_0$ 01

(iv) A curve drawn at $3l_0$ 01

(c) (i) A or 512 Hz tuning fork or the tuning fork the heighest frequency

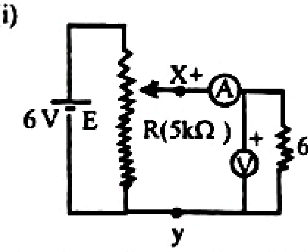
(ii) Room temperature or air temperature or temperature of the surroundings (or environment) 01

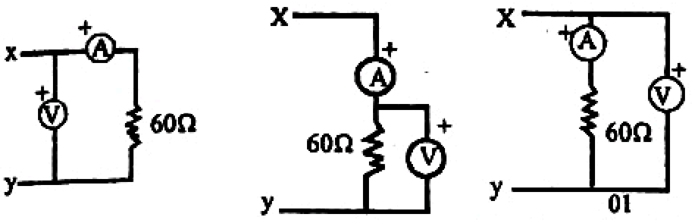
(d) $60 = 10 \log I/10^{-12}$ 01

$6 = \log (I/10^{-12})$

$I = 10^{-6}$ Wm^{-2} 01

04. (a) (i)





(Any one of the above circuits)

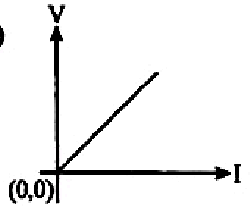
(ii) Marking the positive terminals if ammeter and voltmeter as in the above diagram. 01

(iii) Max . possible current thorugh ammeter (I) $\frac{6V}{60\ \Omega} = 0.1$ A

∴ Full scale deflection of the ammeter = 0.1 A or 100mA 01

(iv) Current can be read more accuratcly/ move precisely/ with less error / the ammeter operates with the maximum sensitivity. 01

(v)



01

(b) (i) change (or increase) of resistance of the filament due to the heat produced from the currect through the filament. 01

(ii) $R = {}^{v^2}\!/_{R}$

$R = {}^{v^2}\!/_{p} = \frac{(6.0)^2}{0.36}$

$R = 100\Omega$

(iii) Marking the operating point on the graph 01

(c) (i) 6V, 0.36W bulb or the first bulb 01

(ii) Consumes lesser power
Battery discharge is slower
Battery can last longer
Bulb is more efficient any one 01

PART - B

01.(i) Dimension of Mu — Dimensions of Force

$[Mu] = [MT^{-1}][LT^{-1}]$ — $[MLT^{-2}]$

$= [MLT^{-2}]$

(ii) (a) Applying $F = ma$

$3 \times 10^7 - 2 \times 10^6 \times 10 = 2 \times 10^6 a$

$a = 5\ ms^{-2}$ 01

(b) Applying $V = u + at$

$V = 5 \times 30$

$V = 150\ ms^{-1}$ 01

(iii) (a) $F = Mu$

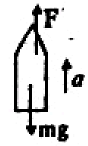
$3 \times 10^7 = 3 \times 10^3\ u$

$u = 10^4 ms^{-1}$ 01

(b) $V_{QE} = V_{QS} + V_{SE}$

$= \downarrow 10^4 + \uparrow 150$

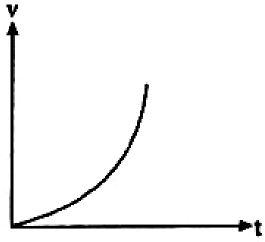
$V_{QE} = \downarrow 9850\ ms^{-1}$ 01



(iv) False, The shuttle expels the exhaust gas with a momentum and acquires a force it to pushes off against the exhaust gas or The downward force on the burning gas from the exhaust is equal to the upward force on the shottle 01
The shuttle expels the exbaust gas and it accelerates due to the low of conservation of the linear momentum.

(v) (a) Mass of the shuttle decreases as it burns fuel, and therefore its acceleration increases. 01

(b)



01

(vi) (a) Applying conservation of linear momentum.

$10^5 \times 4 \times 10^2 = 10^5/2 \times 8 \times 10^2 - 10^5/2 V_{QE}$

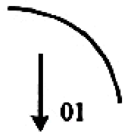
$V_{(QE)} = 0\ \overleftarrow{8 \times 10^2}$ 01

$V_{(QP)} = V_{QE} + V_{EP}$

$= 0 + \overleftarrow{8 \times 10^2}$

$V_{QP} =$ ms^{-1} 01

(b) P moves as a projectile or
Q falls down under gravity or
Q falls down vertically 01

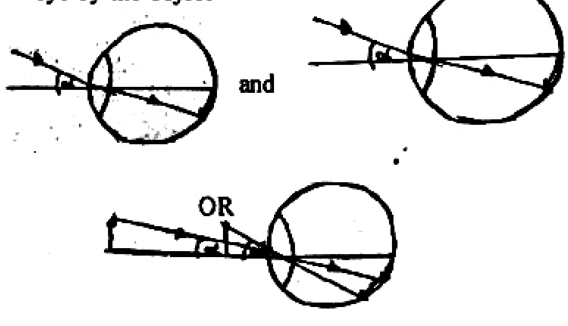


(c) $F = \frac{10^5}{2} \times \frac{(8-4) \times 10^2}{0.2}$ $\left[F = \frac{\Delta mv}{t}\right]$

$\left[F = \frac{10^5}{2} \times \frac{4 \times 10^2}{0.2} \text{ or } \frac{10^5}{2} \frac{(0-4)10^2}{0.2}\right]$

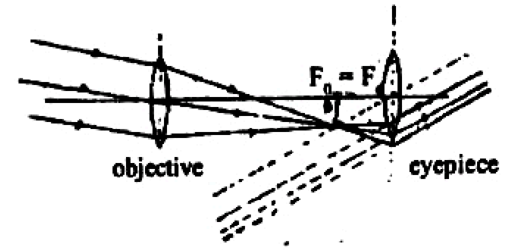
$F = 10^8$ N

02. $\alpha' =$ angle subtended at the eye by the final image 01
$\alpha =$ angle subtended at the unaided eye by the object



For any diagram 01

(i)



For the first image formed by the objective 01
For the image formed by the eye piece at infinity 01
For correct labeling of objective and eye piece 01

(ii) Angular magnification

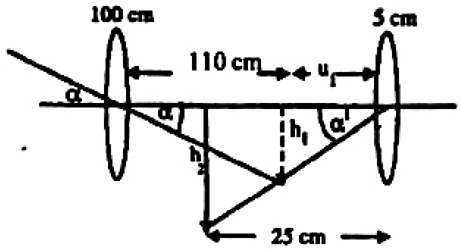
$$= \alpha^1/\alpha$$

$$= \frac{h/f_e}{h/f_0} \left(\text{or } f_0/f_e\right) \quad 01$$

$$= \frac{100}{5}$$

$$= 20 \quad 01$$

(iii)



h_1 - height of first image
h_2 - height to final image
u - distance to the first image from the eyepiece
α^1 - angle subtended by the final image

$0.25 \times 0.018 = h_1/100$ OR $\tan(0.25) = h_1/100$
$\alpha^1 \times 0.018 = h_2/25$ OR $\tan \alpha^1 = h_2/25$

But $\frac{h_2}{25} = \frac{h_1}{u}$ 01

Applying lens formula, For the eyepiece

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \quad 01$$

$$\frac{1}{25} - \frac{1}{u} = -\frac{1}{5} \quad 01$$

$$\frac{1}{u} = \frac{1}{25} + \frac{1}{5} = \frac{6}{25}$$

$$\frac{\alpha^1}{0.25} = \frac{100}{u} \quad \text{or} \quad \frac{\tan \alpha^1}{\tan(0.25)} = \frac{100}{u} \quad 01$$

$$= 100 \times \frac{6}{25}$$

$$\alpha^1 = 100 \times \frac{6}{25} \times 0.25$$

$$\alpha^1 = 6^\circ$$

01

[Alteranative method Angular magnification m] = α^1/α
For the eyepiece, applying the lens equation,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \quad 01$$

$$\frac{1}{25} - \frac{1}{u} = -\frac{1}{5}$$

$$\frac{1}{u} = \frac{1}{25} + \frac{1}{5}$$

$$\frac{1}{u} = \frac{6}{25}$$

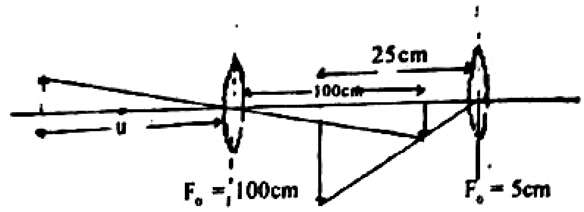
But $\frac{h_2}{h_1} = \frac{D}{u} = \frac{25}{25/6} = 6$ 01

$$m = 6 \times \frac{100}{25} = 24$$

$$\alpha^1/\alpha = \frac{\alpha^1}{0.25} = 24$$

$$\alpha^1 = 6^0$$

(iv)



distance to the first image from the objective = 100 + 10
= 110 cm 01

applying the lens formula for the objective

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{-1}{110} - \frac{1}{u} = \frac{-1}{100} \quad 01$$

$$u = 1100\text{cm} \quad 01$$

Distance to the objective from the objective (or u) = 1100cm 01

03. (i) M_E - Mass of earth
m - Mass of space lab
R_E = Radius of earth = 6400×10^3m
The gravitational attraction between the space lab and earth

$$= \frac{GM_E m}{\left[(6400+1700)\times 10^3\right]^2} \quad 01$$

Let the orbiting speed of the space lab be V
The centripetal force on the space lab $= \frac{mv^2}{\left[(6400 + 1700) \times 10^3\right]}$

$$\left(F = m v^2/r\right) \quad 01$$

∴ For the stability of the orbit

$$\frac{GM_E m}{\left[(6400+1700)\times 10^3\right]^2} = \frac{mV^2}{(6400+1700)\times 10^3} \quad 01$$

$$V^2 = \frac{GM_E}{(6400 + 1700) \times 10^3}$$

but $g = \frac{GM_E}{R_E^2}$ or $GM_E = gR_E^2$ 01

$$\therefore V^2 = \frac{GM_E}{(6400 + 1700) \times 10^3} = \frac{gR_E^2}{(6400 + 1700)\times 10^3}$$

$$V^2 = \frac{64^2 \times 10^{11}}{81 \times 10^2\ 10^3} \quad 01$$

$V = \frac{64}{9} \times 10^3\ ms^{-1}$ $V = 7.1\ (\pm 0.1) \times 10^3 ms^{-1}$ 01

(ii) When the space vehicle ($m = 10^4 kg$) is on the earth surface potential energy.

$$V_1 = -\frac{GM_E \times 10^4}{6400 \times 10^3} \qquad 01$$

$$= \frac{-GM_E \times 10^4}{64 \times 10^5}$$

The potential energy of the space vehicle when Just reaches the orbit

$$V_2 = \frac{-GM_E \times 10^4}{(6400 + 1700) \times 10^3} \qquad 01$$

$$= \frac{-GM_E \times 10^4}{81 \times 10^5}$$

Minimum energy required = $(V_2 - V_1)$ 01

$$= \frac{GM_E \times 10^4}{10^5}\left[\frac{6}{64} - \frac{1}{81}\right]$$

$$= \frac{gR_E^2 \times 10^4}{10^5} \times \frac{17}{64 \times 81} \qquad 01$$

$$= 1.3\,(\pm 0.1) \times 10^{11} J \qquad 01$$

Alternative method (consi daring potentials)
Gravitational potential at earth surface.

$$V_1 = \frac{-GM_E}{6400 \times 10^3} \qquad 01$$

$$V_2 = \frac{-GM_E}{81 \times 10^5}$$

Gravitational potential at the orbit

$$V_2 = \frac{-GM_E}{(6400 + 1700) \times 10^3} \qquad 01$$

$$V_2 = \frac{-GM_E}{81 \times 10^5}$$

Potential difference $= V_2 - V_1$ 01

$$= \frac{GM_E}{10^5}\left(\frac{1}{64} - \frac{1}{81}\right)$$

Minimum energy required $= (V_2 - V_1) \times 10^4$

$$= \frac{gR_E^2 \times 10^4}{10^5} \times \frac{17}{64 \times 81} \qquad 01$$

$$= 1.3\,(\pm 0.1) \times 10^{11}\ J \qquad 01$$

(iii) Additional kinetic energy that has to be provided to the space vehicle.

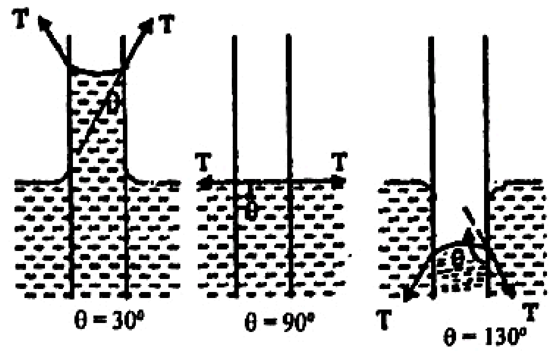
$$= \frac{1}{2} mv^2 \qquad 01$$

$$= \frac{1}{2} \times 10^4 \times \left(7.1 \times 10^3\right)^2 \qquad 01$$

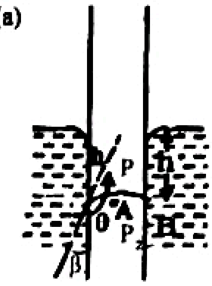
$$= 2.5\,(\pm 0.1) \times 10^{11} J \qquad 01$$

(iv) No
The total momentum of the system does not change due to the transfer of cargo. 01

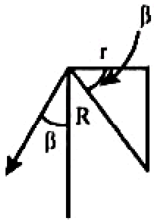
04. (i)



(ii) (a)



P_0 - Atmospheric pressure
P - Pressure Just below the surfece



$Cos\,\beta = r/R$ r - radius of the tube
R - radius of the meniscus

$\beta = 180 - \theta$

$\therefore\ \text{Cos}\,(180 - \theta) = r/R$

$$P_1 - P_0 = \frac{2T}{R} = \frac{2TCos\beta}{r} = \frac{2TCos(180-\theta)}{r} \qquad 01$$

$$P - P_0 = h\rho g \qquad 01$$

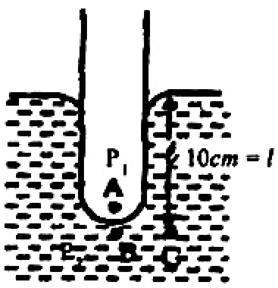
$$\therefore\ h\rho g = \frac{2TCos(180 - \theta)}{r}$$

$$h = \frac{2TCos\,(180 - \theta)}{\rho g r} \qquad 01$$

$$h = \frac{2 \times 0.465 \times 0.766}{13.6 \times 10^3 \times 10 \times 0.5 \times 10^{-3}} \qquad 01$$

$= 0.0105m$ (or 0.01 - 0.011m or 1.0 - 1.1cm) 01

(b)



P_1 - Pressure inside the tube
P_0 - Atmospheric pressure

For the identification of the radius of the meniscus (r)
= radius of the tube 01

The Pressure $P_2 = P_0 + l\rho g$

$P_2 = 1 \times 10^5 + 10 \times 10^{-2} \times 13.6 \times 10^3 \times 10$ 02

$= 1.136 \times 10^5 Pa$

$P_1 - P_2 = \frac{2T}{r}$

$= \frac{2 \times 0.465}{05 \times 10^{-3}}$ 01

$= 1.86 \times 10^3 Pa$

$P_1 = 1.136 \times 10^5 + 0.0186 \times 10^5$

$P_1 = 1.1546 \times 10^5$ Pa $\left(1.15 - 1.16 \times 10^5 \text{ Pa}\right)$ 01

(iii) The surface tension of oil is greater than that of water at high temperatures. Therefore oil forms bubbles 01
When temperature decrease the surface tension of oil decreases. rapidly compared to water and becomes comparable with that of water. If causes the oil to spread over the surface of soup. 01

05. (a) Real voltmeter has a finite resistance 01
Ideal voltmeter has infinite resistance.
(ideal voltmeter concept) 01
OR
Real voltmeter draws non - zero current 01
ideal voltmeter does not drow current (idel voltmeter concept) 01

(i) (a) 99V 01
(b) 50V (49.5 - 50V) 01

(ii) internal resistance of the voltmeter is the resistance across its terminals. Therefore when a voltmeter with finite internal resistance R_1 is connected across a resistor R_1 will appear in parallel with the resistor. 01

Voltmeter V_1 gives the true voltage across the combination
True voltages can be measured only by an ideal voltmeter connected across the combination. 01

(iii) Yes
under the balanced condition currents through paths XP and YQ are zero.
Terminals xy donot draw any current
OR
Current through the galvanometer is zero, and therefore the potentiometer does not drow current from the circuit. 02

(iv) $V_{AB} = 100 \times 0.5 \times 10^{-3}$ 01

$= 0.05V$

But $V_{AB} = k\ell_1$ 01

$\therefore K = \frac{0.05}{40} = \frac{5 \times 10^{-2}}{40}$

$V_{CD} = 250\ I_{CD}$

$\therefore I_{CD} = \frac{K\ell_2}{250} = \frac{5 \times 10^{-2}}{40} \times \frac{20}{250}$

$= \frac{10^{-1}}{1000}$

$= 10^{-4}$ A (0.1mA)

Then $I_{BF} = 0.5$ mA $- 0.1$ mA 01
$= 0.4$ mA $(4 \times 10^{-4}$A)

$\therefore V_{BF} = 0.4 \times 10^{-3} R_2$ 01

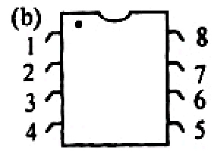
$V_{BF} = k\ell_3$

$= \frac{5 \times 10^{-2}}{40} \times 64$

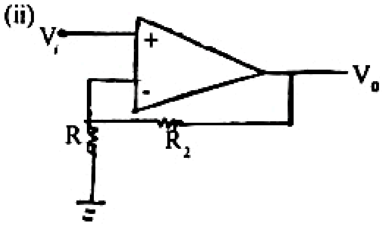
$\therefore R_2 = \frac{5 \times 10^{-2} \times 64}{40 \times 4 \times 10^{-4}} = \frac{5 \times 64 \times 10}{16}$

$= 200\Omega$ 01

05. (b) (i) (a) advantages
(1) Circuit is much smaller
(2) Circuit is well protected from dust, environment.
(3) Circuit is already assembled / no cost of assembling.
(4) less capacitive and inductive effects.
(5) Cost per component in IC is cheaper.
(6) Circuit is more reliable.
(7) identical components can be constructed using IC technology. Any two 02
Any one 01

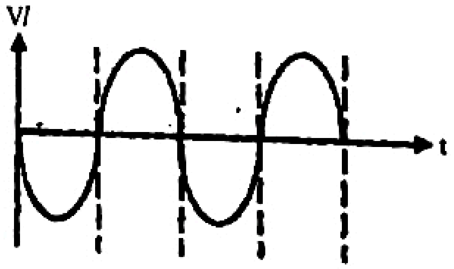
(b)


Correct labeling of all pins 01

(ii)


(a) It is a non iverting amplified 01

$V_0 = \left(\frac{R_1 + R_2}{R_1}\right) V_i$

(b)


01

(c) Voltage gain $\frac{V_0}{V_i} = \frac{R_1 + R_2}{R_1}$

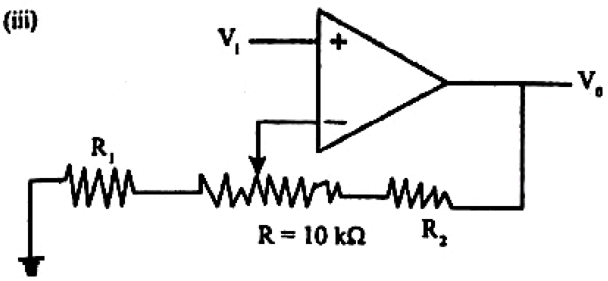
When $R_1 >>> R_2$ $\frac{V_0}{V_i} = \frac{R_1}{R_2} = 1$

OR

$\left[\frac{R_1 + R_2}{R_1} = 1 + \frac{R_2}{R_1}; \text{when } R_1 >>> R_2 ; \frac{R_2}{R_1} \to 0\right]$

$= 1$ (or no voltage) 01

(iii)



(a) For minimum voltage gain.

$$\frac{R_1 + 10 \times 10 \times 10^3 + R_2}{10 \times 10^3 + R_1} = 10 \quad (A) \qquad 01$$

For maximum Voltage gain

$$\frac{R_1 + R_2 + 10 \times 10^3}{R_1} = 100 \quad (B) \qquad 01$$

$$\frac{(A)}{(B)} \quad \frac{R_1}{10 + 10^3 + R_1} = \frac{1}{10}$$

$9R_1 = 10^4$

$R_1 = 1.11 \times 10^3 \Omega$ (or $1.11 k\Omega$) 01

(1.1 - 1.2)

From eq (A) $\frac{11.1 \times 10^3 + R_2}{11.1 \times 10^3} = 10$

$\therefore R_2 = 111.1 \times 10^3 - 11.1 \times 10^3$

$= 100 \times 10^3 \Omega \ (100 k\Omega)$

$(99 - 101)$ 01

(b) Range of input voltage that can be applied.

$\frac{+15}{10} \rightarrow \frac{-15}{10}$

$+1.5\text{ V} \rightarrow -1.5\text{V} \rightarrow$ or $+1.3\text{v} \rightarrow -1.3\text{V}$

(c) When R_1 is disconnected R_1 becomes infinite OR very large 01

Gain = 1 01

06. (a) (i) PV = nRT

$n = \frac{PV}{RT}$

$n = \frac{1 \times 10^5 \times (0.5)^2}{8.31 \times 300}$ 01

n = 5.014 moles or (5.0 - 5.1) moles 01

(ii) Total energy supplied $= VIt = \frac{V^2}{R} t$ 01

$= \frac{(230)^2 \times 60}{23}$

$= 69 \times 10^4$ J or 690KJ

(b) Energy absorbed by the walls $= 6.0 \times 200 \times 150$ 01
= 180000J or 180KJ

Energy absorbed by the beating element
$= 100 \times 800 = 80$KJ 01

Energy absorbed by walls and heating element = 260000J
= 260KJ

(c) Energy absorbed by the gas $= 20 \times 5.014 \times 150$ 01
= 15042 J or 15.04KJ
(15 - 15.1KJ) 01

(d) The Percentage energy lost $= \frac{(690 - 260 - 15)}{690} \times 100\%$

= 60.1% or (60 - 60.5%) 01

(iii) The rate of energy supplied $VI = V^2/R$

$= \frac{230^2}{23}$

= 2300J

The rate of energy lost $= Ae\sigma \left(T_1^4 - T_2^4\right)$

$= 6 \times 0.5 \times 0.5 \times 0.7 \times 5.67 \times 10^{-8} \left(T_1^4 - 300^4\right)$
01

At the steady state
The rate of energy supplied by the heating element
= the rate of energy lost to the surroundings.
OR
for equating the above two quantities 01
T_1 = 465 K (or 464 - 466k) 01
(or 191 - 193°C)

06. (b) (i) Bq or Becquerel 01

(ii) The rate of decay (A) of a given radioactive sample is directly proportional to the number of unstable. radioactive nuclei (N) in the sample. 01

(iii) Time taken to reduce the number of radioactive atoms (or unstable nuclei OR activity) of a given radioactive sample to one - half of its intitial value. 01

(iv) Because those nuclei OR atoms are unstable 01

(v) $^{14}_{7}N + n \rightarrow ^{14}_{6}C + P$ 01

$\left[or \ ^{14}_{7}N + n \rightarrow ^{14}_{6}C + ^{1}_{1}H \right]$

(vi) $^{14}_{6}C \rightarrow ^{14}_{7}N + \beta^- + \left(\bar{V}_c\right)$ 01

$\left(\beta^- \text{ or } ^{0}_{-}\beta \text{ or } \bar{e}\right)$

(vii) β^- particles are fast moving electrons and

β^+ particles are fast moving positrons 01

[or Particles similar to electrons but with a positive charge]
α particles are Helium nuclei OR He^{++} 01

(viii) When the rate of decay of $^{14}_{6}C$ is equal to the rate of product on of $^{14}_{6}C$.

The concentration of $^{14}_{6}C$ remains constant 01

(ix) Half - life of $^{14}_{6}C \left(T_{1/2}\right) = 1.8 \times 10^{11} s$

decay constant of $^{14}_{6}C\ (\lambda) = \frac{0.693}{1.8x10^{11}} S^{-1}$

$= 3.85 \times 10^{-12}\ S^{-1}$ 02

(3.8 - 3.9)

[OR Half life of $^{14}_{6}C\ \left(T_{1/2}\right) = 5730yrs$

decay constant of $^{14}_{6}C\ (\lambda) = \frac{0.693}{5730}\ yrs^{-1}$

$= 1.2 \times 10^{-4}\ yr^{-1}$]

(x) No of atoms in 1g of carbon in living plants

$= \left[5 \times 10^{22}\right] x \left(10^{-12}\right)$

$= 5 \times 10^{10}$

Activity of the sample (A) = $(3.85 \times 10^{12}) \times (5.0 \times 10^{10})$ Bq

= 0.1925Bq

Count accumulated in on hour = 0.1925 x 60 x 60

= 693 counts 01

(680 - 700)

(xi) Since a 1g of fossil produces 347 counts per-hour, the activity of the fossil piece is (approximately) half the activity of the living plant 01

As the time taken to reduce the activity by half equals to the half life the age of the fos sil = 5730 yr 01

$\left[347 \simeq \frac{693}{2}\right]$