G.C.E. (Advanced Level) Examination - April 2006

PHYSICS - I

Provisional Scheme of Marking

2006 - Answers

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

G.C.E. (Advanced Level) Examination - April 2006

PHYSICS - II

Provisional Scheme of Marking

A - PART

(01) (a) (i) $T = 2\pi\sqrt{l/g}$ 01

(ii) $T^2 = \frac{4\pi^2 l}{g}$ 01

(iii) Bob has the highest (maximum) speed at B
OR Time measurement is sharp at B 01

(b) (i) $\frac{0.1}{2.0} \times 100 = 5\%$ 01

(ii) $\frac{0.1}{50.2} \times 100$

0.2 %

(c) (i) $T^2 \frac{4\pi^2}{g}(L + r)$ OR $T^2 = \frac{4\pi^2}{g} L + \frac{4\pi^2}{g} r$

(ii) L^2 = Versus L graph

Gradient $\frac{4\pi^2}{g}$ OR $\frac{g}{4\pi^2}$ 01

$\frac{4\pi^2}{g} = 4$

$g = 9.6\ ms^{-2}$

(iii) identification of the intercept 01
T^2 versus L graph

Intercept $= \frac{4\pi^2 r}{g}$

$= 0.04$

$r = 0.01m$ (1.0 cm)

(d) woodern bob
woodern bob has lesser inertia (rotational inertia/ moment of inertia)
(OR Metal bob has a higher inetia (rotational inertia / moment of inertia)
OR
Intial stored energy is high for Metal (law for wood)
OR
woodern bob has less mass (less energy) and high frctional energy loss. 01

02. (a) To maintain the same cooling conditions.
OR
To keep the exposed surface area of the calorimeter the same in both cases. 01

(b) (i) L_1 01
(ii) To minimize the exposed inside surface area of the calorimeter OR
To achive the temperature of the calorimeter uniform every where OR
To make the heat capacity of liqud/ water larger than that of the calorimeter OR
To minimize the heat loss by the inner surface area of the colorimeter. 01

(c) Stirring the water (liquid) well. 01

(d) (i) $(112 + 0.2 \times 4 \times 10^3) \times \frac{(55-45)}{4 \times 60}$ (with correct unit)

$= 38w$

OR $(112 + 0.2 \times 4 \times 10^3)\ \frac{(55-45)}{4}$
2280 J / m in

(ii) $(112 + 0.172 \times s)\ \frac{(55-45)}{2 \times 60} = 38$

OR $(112 + 0.172 \times 5)\ \frac{(55-45)}{2} = 2280$

OR $(112 + 0.1725)\ \frac{(55-45)}{2} = (112 + 0.2 \times 4 \times 103)\ \frac{(55-45)}{4}$

$S = 2 \times 10^3\ Jkg^{-1}K^{-1}$ 01

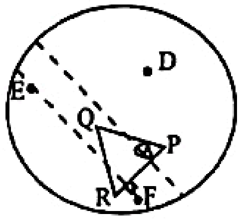
(e) There will be a appreciable temperature differnce between the outer surface of the container and the water / liquid inside the container OR
Glass is a bad thermal conductor OR
Temperture of the surface of the container will not be uniform.

03. (a) (1) telescope 01
(2) prism table

(b) Inverted (↓) 01

(c) eyepiece 01

(d)

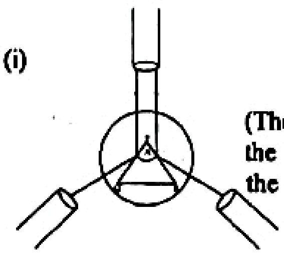


(PQ OR PR is perpendicular at to the dotted lines)

(e) (i) Prism table is not leveled
(ii) Slit is not vertical
(iii) The slit is too broad

any two 02
any one 01

(f) (i)



(The drawing of corect location of the prism and the two positions of the telescope) 01

(ii) Prism angle A $= \frac{(197^\circ 6' - 72^\circ 52')}{2}$

$A = 62^\circ 7'$ 01

(g) Not correct
It is not possible to locate the position of the sodium wavelength / spectral line from the yellow band of the continuoces spectrum (or band) of white light 01

(h) $n = \dfrac{\sin\left(\frac{A+D}{2}\right)}{\sin (A/2)}$ 01

04. (a) $B = \dfrac{\mu_0 I}{2\pi h}$ 01

(b) $F = Bib$
$F = \dfrac{\mu_0 Ibi}{2\pi h}$ } 01

(c) A arrow (⟵) indicated in the diagram 01
Force on CD in downward (↓). The creates a clock wise moment. To blance the system, an equal and opposite moment must be applied by moving the rider to left. 01

(d) $I = \dfrac{2\pi\Delta \times mgh}{\mu_0 bai}$ 01

(e) $I = \sqrt{\dfrac{2\pi\Delta \times mgh}{\mu_0 ba}}$ 01

(f) (i) In series with CD and PQ 01
(ii) For different readings of the ammeter, blance the system, calculate I and plot a graph of ammeter reading Vs Calculated I 01

(g)

Para meter	By inreasing the magnitude	By decreasing the magnitude
h		✓
m		✓
a	✓	
b	✓	

(Decrease h and m Increase a and b) all correct 02, any two correct 01

PART - B

01.(i) Dimensions of ρV^2 $= ML^{-3} [LT^{-1}]^2$
$= ML^{-1} T^{-2}$

Dimensions of Pressure $= \dfrac{MLT^{-2}}{L^2}$
$= ML^{-1} T^{-2}$

ρV^2 has the Dimensions of Pressure

(ii) (a) The velocity of air relative to the plane is V to the right $\vec{V}$ 01

[OR $V_{AP} = V_{AG} + V_{GP} = O - V = -V$] 01

(b) $A_1 V = A_2 V'$ [OR $A_1 V = \dfrac{A_1 V^1}{1.2}$]
$V^1 = 1.2\ V$

(c) Let P_1 and P_2 be the pressure underneath the wing and above the wing respestively.

$P_1 + \frac{1}{2}\rho V^2 = P_2 + \frac{1}{2}\rho V'^2$ = OR $P_1 + \frac{1}{2}\rho V^2 = P_2 + \frac{1}{2}\rho (1.2V)^2$ 01

But $P_1 - P_2 = \dfrac{mg}{A} = \dfrac{2.64 \times 10^5 \times 10}{250}$ 01

$\frac{1}{2} \times 1.2 \times (1.2^2 V^2 - V^2) = \dfrac{2.64 \times 10^5}{25}$

$V^2 = \dfrac{2.64 \times 10^5}{0.44 \times 0.6 \times 25} = \dfrac{10^6}{25}$

$V = 200 ms^{-1}$ 01
$(224 - 225\ ms^{-1})$

(d) Applying F = ma to the plane
$6 \times 10^6 - 7.2 \times 10^5 = 2.64 \times 10^5\ a$ 01

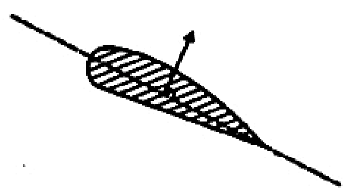
$a = \dfrac{52.8 \times 10^5}{2.64 \times 10^5}$

$a = 20\ ms^{-2}$

Applying $V^2 = u^2 + 2as$ to the plane
$200 \times 200 = 2 \times 20S$ 01
$S = 1000m\ (1km)$ 01
(1258 - 1259m)

[Applying $Fs = \frac{1}{2} mv^2$
$(6 \times 10^6 - 7.2 \times 10^5)\ S = \frac{1}{2} \times 2.64 \times 10^5 \times (200)^2$] 02
$S = 1000m$ 01
(1258 - 1259m)

(iii) (a)



01

(b) New lifting force $= \frac{1}{2} \times 1.2 \times (250^2 - 200^2) \times 250$ 01

New vertical lifting force $= \frac{1}{2} \times 1.2\ (250^2 - 200^2) \times 250\ \cos 10°$
$= 3.32 \times 10^6 - 2.64 \times 10^6$ 01
$= 0.68 \times 10^6 N\ (0.7 \times 10^6 N)$

(c) At higher altitudes the density of air is less OR ρ is less OR air is thinner 01

02. (i) (a) B 01
Zero (o) 01
(b) 680 KH_z 01

(ii) (a) $F' = \dfrac{(u - v)}{u} F_0$

(b) $F'' = \dfrac{u}{u + v} F^1$

$F'' = \dfrac{u}{u + v} \dfrac{(u - v)}{u} F_0$

$F'' = \dfrac{u - v}{u + v} F_0$

(c) beat frequency $= F_0 - F''$ 01

$= F_0 - \frac{u-v}{u+v} F_0$

$= F_0 \left(\frac{u+v-u+v}{u+v} \right)$

$= \frac{2F_0 v}{u+v}$

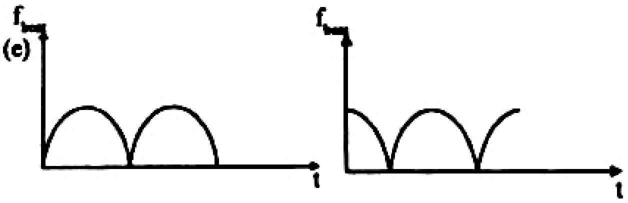
$= \frac{2F_0 v}{u}$ (v<<u)

(d) A 01

$600 = \frac{2 \times 680 \times 10^3 v}{340}$ OR $600 = \frac{2 \times 680 \times 10^3 \times v}{340 + v}$

$V = 0.15\ ms^{-1}\ (15 cms^{-1})$

(e)



(iii) (a) time period $T = 0.05 \times 2 = 0.1s$

Frequecy of ripples $f = \frac{1}{T} = \frac{1}{0.1}$

$= 10Hz$ 01

(b) $V = f\lambda$

$f\lambda = \sqrt{\frac{2\pi T}{\lambda \rho}} \Rightarrow T = \frac{f^2 \lambda^3 \rho}{2\pi}$

$T = \frac{10^2 \times (12 \times 10^{-3})^3 \times 13600}{2 \times 3}$

$= 0.393\ (0.4)\ Nm^{-1}$ 01
(0.39 - 0.40)

03. (i) incrase of effective surface area OR exchange of air takes places more efficiently. 01

(ii) (a) Tolal surface area $= 4 \times 3 \times (0.1)^2 \times 1.5 \times 10^8\ [4\pi r^2 \times n]$
$= 1.8 \times 10^7\ mm^2\ [18m^2]$ 01

(b) let R be the corresponding radius

$4\pi R^2 = 12 \times 1.5 \times 10^6$

$12R^2 = 12 \times 1.5 \times 10^6$

$R = 1.22 \times 10^3\ mm\ (1.22m)$ 01

(iii) (a) $\Delta p_1 = \frac{2 \times 5 \times 10^{-2}}{0.05 \times 10^{-3}}$ 01

$\Delta p_1 = 2.0 \times 10^3\ Pa$ 01

Simi larly $\Delta p_2 = \frac{2 \times 5 \times 10^{-2}}{0.1 \times 10^{-3}}$

$\Delta p_2 = 1.0 \times 10^3\ pa$ 01

(b) Therefore $\Delta p_1 - \Delta p_2 = 1.0 \times 10^3 \times 7.5 \times 10^{-3}$
$\Delta p_1 - \Delta p_2 = 7.5\ mmHg$ 01

The maximum Pressure difference that could be achieved by moving the diaphragm is 1mmHg. (Indentitifying maximum as 1mmHg) 01

Since 7.5 > 1 alveolus cannot be fully inflated

(c) with the surfactant $\Delta p_1 - \Delta p_2 = \frac{7.5}{1.5}$
$= 0.5\ mmHg$ 01

Now it is possible to inflate the alveolus by moving the diaphragm.

(iv) (a) The distrbution of the surfacfant is more dense in the small alveolus than that of the large alveolus OR the number of surfactant molecules is more in the small alveolus than thatofthe large alveolus. 01

(b) Pressure should be equal inside both alreolius.

$\frac{2T_r}{r} = \frac{2T_R}{R}$ OR $\frac{T_r}{r} = \frac{T_R}{R}$

$\frac{T_r}{T_R} = {}^r/_R$ 01

(c) (i) Dimensions of K $= MLT^{-2} L^{-1} L^2$
$= ML^2 T^{-2}$ 01

(ii) $T_R = 5 \times 10^{-2} - K / R^2$

(d) $T_r - 5 \times 10^{-2} = K / r^2$ (A)
$T_R - 5 \times 10^{-2} = K / R^2$ (B)

$\frac{(A)}{(B)}$ $\frac{T_r - 5 \times 10^{-2}}{T_R - 5 \times 10^{-2}} = \frac{R^2}{r^2}$

$R^2 T_R - r^2 T_r = 5 \times 10^{-2} (R^2 - r^2)$ (C) 01

But $T_R = {}^R/_r T_r$

(C) $\Rightarrow T_r(\frac{R^3}{r} - r^2) = 5 \times 10^{-2} (R^2 - r^2)$

$T_r(1/0.5 - 0.5^2) = 5 \times 10^{-2} (1 - 0.5^2)$

$T_r = \frac{5 \times 10^{-2} \times 0.75}{1.75}$

$T_r = 2.1 \times 10^{-2}\ Nm^{-1}$ 01
(2.1 - 2.2)

$T_R = 4.2 \times 10^{-2}\ Nm^{-1}$ 01
(4.2 - 4.4)

04. (i) gravitfational force F_G between two objects When they are separated by a distance r

$= \frac{Gm^2}{r^2}$ 01

Similary the electric force $= \frac{q^2}{4\pi\varepsilon_0 r^2}$ 01

For Zero work done $\frac{Gm^2}{r^2} = \frac{q^2}{4\pi\varepsilon_0 r^2}$ 01

$\left[m = \frac{q}{2\sqrt{\pi\varepsilon_0 G}} \right]$

(a) $\frac{Gm^2}{r^2} > \frac{q^2}{4\pi\varepsilon_0 r^2}$, work will be done by the second object
[when $m > \frac{q}{2\sqrt{\pi\varepsilon_0 G}}$

(b) $\frac{Gm^2}{r^2} < \frac{q^2}{4\pi\varepsilon_0 r^2}$, work will be done by the second object
[i.e. when $m > \frac{q}{2\sqrt{\pi\varepsilon_0 G}}$

(ii) Consider the situation in which the second object is at a distance r from the first object

Gravitational potential energy of the 2nd object $= \frac{-Gm^2}{r}$

Electrical Potential energy of the 2 nd objeet $= \frac{q^2}{4\pi\varepsilon_0 r}$ 01

Total work done when briging a seeand object

$$= \frac{-Gm^2}{r^2} + \frac{q^2}{4\pi\varepsilon_0 r}$$ 01

(iii)(i) a (01)

(iv) Resultant force towards first mass $= \frac{Gm^2}{r^2} - \frac{q^2}{4\pi\varepsilon_0 r^2}$

Second object will execute a rotaional motion around the first object if

$$\frac{Gm^2}{r^2} - \frac{q^2}{4\pi\varepsilon_0 r^2} = \frac{mV_0^2}{r}$$ 01

(v) Let the charge to be placed on each object at R be Q. Total energy of the second object it is at R is

given by 01

$$\frac{1}{2}mv^2 - \frac{GmM}{R} + \frac{Q^2}{4\pi\varepsilon_0 R}$$

Total energy at $R/2$ is given by

$$\frac{Q^2}{2\pi\varepsilon_0 R} - \frac{2GmM}{R}$$ 01

$$\therefore \frac{1}{2}mv^2 - \frac{GmM}{R} + \frac{Q^2}{4\pi\varepsilon_0 R} = \frac{Q^2}{2\pi\varepsilon_0 R} - \frac{2GmM}{R}$$ 01

$$Q = 2\sqrt{2\varepsilon_0 R\left(\frac{1}{2}mv^2 + \frac{GmM}{R}\right)}$$ 01

05. (A) (i) $R = \rho\ell/A$ 01

$$R = \frac{10^{-6} \times 0.45}{10^{-8}}$$

$= 45\,\Omega$ 01

(ii) (a) $220 = i(10 + 45 + 45)$

$i = 2.2A$ 01

Power disspation by heating elements $= 2 \times 2.2^2 \times 45$
$= 435.6W$ 01

(b) Power disspation by motor $= 2.2^2 \times 10$
$= 48.4W$ 01

(c) $220 = i(10 + 45)$
$i = 4A$
Power disspation by heating elements $= 4^2 \times 45$
$= 720w$ 01

(d) Power disspation by motor $= 4^2 \times 10$
$= 160w$ 01

Alternative method
$W = V^2/R$

(a) $\frac{\left(\frac{220}{100} \times 90\right)^2}{90} = 435.6\,W$ (c) $\frac{\left(\frac{220}{55} \times 45\right)^2}{10} = 720\,W$

(b) $\frac{\left(\frac{220}{100} \times 10\right)^2}{10} = 48.4\,W$ (d) $\frac{\left(\frac{220}{55} \times 10\right)^2}{10} = 160\,W$

(If the student has assumed 220v as the peak voltage and used $\frac{220}{\sqrt{2}}$V as the r.m.s value award full marks)

(iii) (a) Kinetic energy / mechanical energy heat / sound.
for any two 01

(b) The current at switch posstion B is greater Therefore, the air speed is greater.

Therfore the temperature of air must be lower at switch position B 02

(iv) (a) $R_t = R_0(1 + \alpha t)$

$R_{200} = R_0(1 + 0.002 \times 200)$ —— ①

$45 = R_0(1 + 0.002 \times 25)$ —— ②

① / ② $\frac{R_{200}}{45} = \frac{(1 + 0.4)}{(1 + 0.05)}$

$R_{200} = 60\,\Omega$ 01

(59.8 - 60.0)

(b) $i_{max} = \frac{220}{70}$ A

New power dissipation $Q = \left(\frac{22}{7}\right)^2 \times 60 = 592.6W$

Decrease $= 720 - 592.6 = 127.4$ W
Power dissipation will decrease by 127.4 W 01
(127.3 - 127.4)

(v) Fan speed will decrease 01

whlen Q is out of airflow its temperature will Increase. This will increase the resistance of Q reduce the current and decrease the fan speed. 01

05. (B) (i) $V_0 = A(V_1 - V_2)$ 01

(ii) $(V_1 - V_2)$ min $= \frac{Vsat}{A}$

$= 5/10^5$

$= 50\,\mu V$ (OR 5×10^{-5} v) 01

(iii) (a) $V_2 = \left(\frac{5}{R_1 + R_2}\right)R_2$ OR $3 = \left(\frac{5 \times 10^3}{10^3 + R_1}\right)$

$R_1 = \frac{2}{3} \times 10^3$

$= 667\,\Omega$ (666 - 668) 01

(b) At 6.00 p.m
$R_3 = 1600\,\Omega$

$V_1 = \left(\frac{5}{R_3 + R_4}\right)R_3$ OR $V_1 = \left(\frac{5}{1600+1200}\right)1600$

$V_1 = \frac{80}{28}$

$V_1 = 2.86$ V

This value is less then 3V OR
$(V_1 - V_2)$ is negative (and its magnitude is > 50μ V) 01

$\therefore V_0 = -5V$

At 6. 30 p.m

$R_2 = 2000\ \Omega$

$V_1 = \left(\frac{5}{1200 + 2000}\right)2000$

$= \frac{100}{32}$

$= 3.1\ V$ 01

This value is qreater than 3v OR

$(V_1 - V_2)$ is positive (and $>50\mu$ V) 01

$V_0 = +5V$

(iv) (a) $V_{AB} = I_B R + V_{BE}$ OR

$5 = 100 \times 10^{-6} R + 0.7$ 01

$R = \frac{4.3}{100 \times 10^{-6}}$

$= 43\ K\Omega\ (43000\ \Omega)$

(b) Collector current Ic

$Ic = \frac{12 - 0}{600}$ or $Ic = \frac{12 - 0.1}{600}$

$= 20\ mA$ or $Ic = 19.8\ mA$ 01

06. (A)

(i) (a) $V_\theta = V_0(1 + 3\alpha\theta)$ or

$V_{100\ glass} = 1\ (1+3 \times 3 \times 10^{-6} \times 100)$ 01

$= 1.0009 \times 10^{-6}\ m^3$ 01

$= (1.0009\ cm^3)$

(b) $V_{100\ Hg} = 1\ (1 + 20 \times 10^{-5} \times 100)$ 01

$= 1.02\ cm^3$

increase in volume of mercury $= 1.02 - 1.0$

$= 0.02\ cm^3$ 01

$(2.0 \times 10^{-8}\ m^3)$

OR

incrase Volume $= 1 \times 20 \times 10^{-5} \times 100$ 01

$= 0.02 cm^3$

$(2.0 \times 10^{-8} cm^3)$ 01

(c) Rise of mercury volume in the capilary tube

$= 1.02 - 1.0009 = 0.019 cm^3$ 01

$(1.9 \times 10^{-8} m^3)$

[OR mercury volume $= 1 \times (20 - 0.9) \times 10^{-5} \times 100$

$= 0.019 cm^3\ (1.9 \times 10^{-8} m^3)$ 01]

(d) Cross - sectional Area of the Capilay tube $= \frac{\text{rise of mercury volume}}{\text{length}}$

$= \frac{0.019}{25}$

$= 0.00076\ cm^2$

$= (7.6 \times 10^{-8}\ m^2)$

(ii) Rise of mercury volume at 300°C

$= 3 \times 0.019 = 0.057\ cm^3$ 01

Volume of the cavity $= 0.057 - 0.019$

$= 0.038\ cm^3$

(OR $3.8 \times 10^{-8}\ m^3$)

[OR can argue that Volume of the cavity]

$= 2 \times 0.019 cm^3$ 01

$= 0.038 cm^3$ 01

$(3.8 \times 10^{-8} m^3)$

OR V_{300} glass $= 1\ (1 + 3 \times 3 \times 10^{-6} \times 300)$

V_{300}Hg $= 1\ (1 + 20 \times 10^{-5} \times 300)$

These rise in mercury volume $= 1.06 - 1.0027$

$= 0.057 cm^3$

Volume of the cavity $= 0.057 - 0.019$ 01

$= 0.038 cm^3$ 01

$(3.8 \times 10^{-8} m^3)$

(iii) Correct temperture $= \left[\frac{[99.8 - (-0.3)] \times 40}{100}\right] - (03)$

$= 40.04 - 0.3$

$= 39.74^\circ C$ 01

(iv) Uniform expansion

opaque

large expansivity

Do not wet glass / large angle of contact

Higher boiling point

lower vapour parssure

High therma conductivity — any three correct 02

any two 01

06. (B)

(i) (a) Sum of the masses $= (341.917595 + 6.644625) \times 10^{-27}$ Kg

$= 348.562220 \times 10^{-27}$ Kg 01

(b) loss of mass (Δm)

$= 10^{-27}(348.571554 - 348.562220)$

$= 0.009334 \times 10^{-27}$Kg 01

(c) Eergy Created (E) $= (0.009334 \times 10^{-27}) \times (3 \times 10^8)^2$

$= 8.4 \times 10^{-13}$ J 01

(d) magnitude = P & direction -x (OR - P) 01

(e) $K = \frac{A_4}{A_4 + A_c} E$

$= \left[\frac{206}{206 + 4}\right] \times (8.4 \times 10^{-13})$ 01

$= 8.2 \times 10^{-13}$ J 01

(8.2 -8.3)

OR $K = \frac{Ad}{Ad + A\alpha} E$

$= \left[\frac{341.917595}{(341.917595 + 6.644625)}\right] \times (8.4 \times 10^{-13})$ 01

$= 8.2 \times 10^{-13} J$ 01

(ii) (a) $N = \frac{6.0 \times 10^{23}}{210}$

$= 2.86 \times 10^{21}$ (2.8 - 2.9) 01

(b) $A = n\lambda$

$= (2.86 \times 10^{21})(5.6 \times 10^{-8})$

$= 1.6 \times 10^{14}$ Bq 02

(1.5 - 1.7) (1 mark for the correct unit)

(c) Rate of emisson of α - Particle $= 1.6 \times 10^{14}$ (particals s^{-1})

(d) Rate of release of energy $= (1.6 \times 10^{14}) \times (8.4 \times 10^{-13})$

$= 134.4$ W

(123W - 143W)

(e) (i) Half life $(T\tfrac{1}{2})$ $= \frac{0.7}{5.6 \times 10^{-8}} = (1.16 \times 10^{-5})$ S

$= 145$ days 01

(ii) No of half lifes in 2 years $= \frac{2 \times 365}{145}$ 01

$= 4.9 \approx 5$

Fractional dercrease in 2 years $= 1 - \frac{1}{2^5}\left(1 - \frac{1}{2^{5.034}}\right)$

$= 1 - \frac{1}{32}$ OR

$= \frac{31}{32}$ OR

OR (0.96 - 0.97)

01