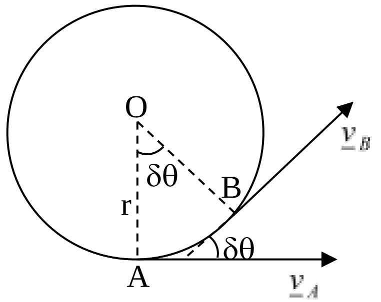
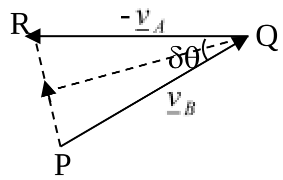
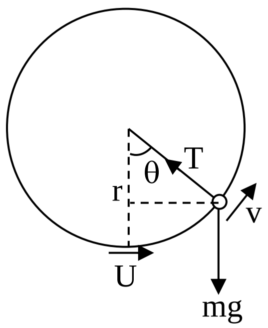
P1 S6 EXAM AUGUST 2017 MARKING GUIDE

Qn	Answer	Mks
1	(a)(i) Angular velocity - the rate at which the line joining the particle to the centre of the circle sweeps an angle about the centre	1
	Or it is the rate of change of angular displacement for a particle moving is a circle. Centripetal acceleration- rate of change of angular displacement for a particle moving in a circle.	1
	(ii)  	
	Suppose that during time δt a particle moves from A to B so that its velocity vector changes from $\underline{v}_A$ to $\underline{v}_B$. Then the change in velocity is $\underline{v}_B - \underline{v}_A$, which is the vector $\underline{PR}$ in the diagram on the right. If δt is small, the angle AOB, i.e. $\delta\theta$, which is equal to PQR is also small, so that the angle RPQ tends to a rightangle. This means that the change in velocity, $\underline{PR}$, is towards O, the centre of the circle.	1
	Thus, the acceleration is towards the centre of the circle.	½
	Acceleration, $a = \frac{\text{Change in velocity}}{\text{Time}} = \frac{PR}{\delta t}$	
	But PR $= 2v \sin\frac{1}{2}\delta\theta$	
	Since $\delta\theta$ is small, $\sin\frac{1}{2}\delta\theta = \frac{1}{2}\delta\theta$	½
	i.e. PR $= 2v.\frac{1}{2}\delta\theta = v\delta\theta$	
	Thus $a = \frac{v\delta\theta}{\delta t}$	
	In the limit, as $\delta t \to 0$, $a = \frac{vd\theta}{dt} = v\omega$	
	But $v = r\omega$	
	$\therefore$ $\mathbf{a = \frac{v^2}{r}}$ or $\mathbf{a = r\omega^2}$	1
	Thus, if a particle of mass m moves in a circle at a uniform speed v, the centripetal force on it is $ma = m\frac{v^2}{r}$ or $mr\omega^2$	1
	(b) 	1
	Let T be the tension in the string when it makes an angle θ to the vertical.	

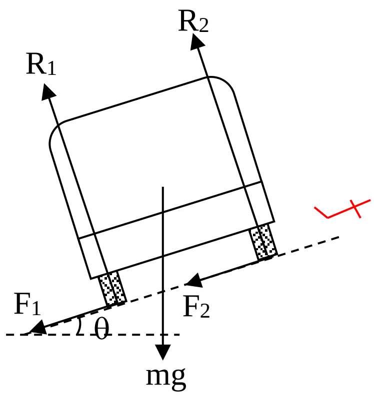
$T = \frac{mv^2}{r} + mg\cos\theta$ 1

Now when $\theta = 0$, $T = \frac{mv^2}{r} + mg$, hence maximum tension occurs at a point directly below the centre of the circle. 1

When $\theta = 90^0$, $T = \frac{mv^2}{r}$

When $\theta = 180^0$, $T = \frac{mv^2}{r} - mg$, hence minimum tension occurs at a point directly above the centre of the circle. 1

(c)



Let F1, F2 be the frictional forces and R1 , R2 the normal reactions.

Then $F_1 + F_2 = \mu(R_1 + R_2)$

$\therefore\ (R_1 + R_2)\cos\theta = \mu(R_1 + R_2)\sin\theta + mg \ldots (1)$

$\frac{mv^2}{r} = (R_1 + R_2)\sin\theta + \mu(R_1 + R_2)\cos\theta \ \ldots (2)$ 1

From (1): $R_1 + R_2 = \frac{mg}{\cos\theta - \mu\sin\theta} \ \ldots\ldots (3)$

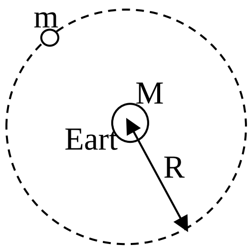
From (2): $R_1 + R_2 = \frac{mv^2}{r(\sin\theta + \mu\cos\theta)} \ \ldots\ldots (4)$ 1

From (3) and (4): $\frac{v^2}{r(\sin\theta + \mu\cos\theta)} = \frac{g}{\cos\theta - \mu\sin\theta}$

$\therefore\ v = \sqrt{\frac{gr(\sin\theta + \mu\cos\theta)}{\cos\theta - \mu\sin\theta}} = \sqrt{\frac{9.81 \times 60(\sin 24^0 + 0.25\cos 24^0)}{\cos 24^0 - 0.25\sin 24^0}} = 21.46\ ms^{-1}$ 1

1

(d)(i)



Suppose a satellite of mass m moves with speed v in a circle of radius R round the earth of mass M.

Gravitational attraction $= \frac{GMm}{R^2}$

But this the centripetal force keeping the satellite in orbit.

Thus $\frac{GMm}{R^2} = mR\omega^2$ 1

$R = \sqrt[3]{\frac{gR_e^2T^2}{4\pi^2}} = \sqrt[3]{\frac{9.81 \times (6.4 \times 10^6)^2 \times (1.9 \times 10^8)^2}{4\pi^2}} = 7.162 \times 10^9\ m$ 1

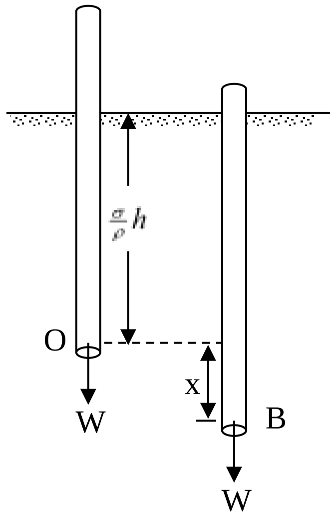
Height, $h = 7.162 \times 10^9 - 6.4 \times 10^6 = 7.156 \times 10^9\ m$ 1

(ii) Total energy of the satellite $= \frac{GMm}{2R} + -\frac{GMm}{2R} = -\frac{GMm}{2R}$

$= -\frac{120 \times 9.81 \times (6.4 \times 10^6)^2}{2 \times 7.162 \times 10^9} = -3.366 \times 10^6\ J$ 1

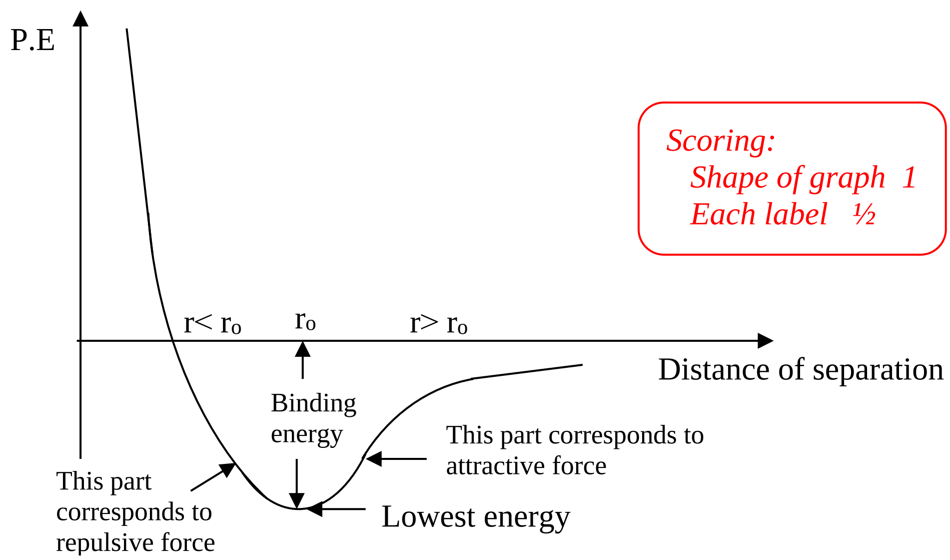
2

Total =20

2. (a)	(i) When a body is wholly or partially immersed in a fluid it experiences an upthrust which is equal to the weight of the fluid displaced.	1
	(ii) $\frac{mg - 2.06}{mg - 2.45} = 1.8$ $\therefore$ $mg - 2.06 = 1.8mg - (1.8 \times 2.45)$ $\therefore$ $mg(1.8 - 1) = (1.8 \times 2.45) - 2.06$ $\therefore$ $m = \frac{4.41 - 2.06}{0.8 \times 9.81} = \mathbf{0.299\ kg}$	1 1 1
(b)	(i) A particle is said to execute simple harmonic motion if it moves such that its acceleration along its path is always directed towards a fixed point in that path, and is proportional to its displacement from the fixed point.	1
	(ii) A damped oscillation is one whose amplitude decreases with time due to dissipation of energy A forced oscillation is one that receives periodic impulses from an external agent	1 1
(c)	(i)  When freely floating, the height submerged is $\frac{\sigma}{\rho}$h Weight of the cylinder, W = weight of the liquid displaced = hAσg During motion, suppose at a certain instant the lower end is at a distance x below the equilibrium, O. Then, the upthrust, $U = (\frac{\sigma}{\rho}h + x)A\rho g$ Let a = acceleration (positive away from O) Then, using ma = W – U, where m = hAσ $ma = hA\sigma g - hA\sigma g - xA\rho g$ $\therefore$ $hA\sigma a = -xA\rho g$ $\therefore$ $a = -\frac{\rho g}{\sigma h}x$ The negative sign means that the acceleration is towards O, and since it is proportional to the displacement x from O, the cylinder executes simple harmonic motion.	 1 1 1 1 1

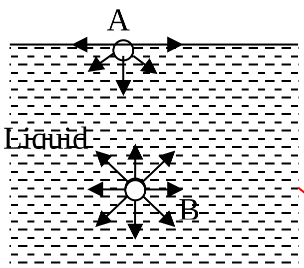
	(ii) Now $\frac{\rho g}{\sigma h} = \omega^2 = \frac{4\pi^2}{T^2}$ $\therefore \quad T = 2\pi\sqrt{\frac{\sigma h}{\rho g}}$	1 1
(d)	(i) $\omega^2 = \frac{k}{m} = \frac{4\pi^2}{T^2}$ $\therefore \quad T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{0.1}{24.5}}$ $= \textbf{0.408 s}$	½ ½ 1
	(ii) Since it starts from maximum displacement, the equation of motion is $y = a\cos\omega t$ Now $\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{24.5}{0.1}} = 15.65 \text{ rad s}^{-1}$ $\therefore \quad \omega t = 15.65 \times 0.4 \text{ radians} = 15.65 \times 0.4 = \frac{180^o}{\pi}\times 15.65\times 0.4 = 358.67^o$ $\therefore \quad y = 0.05\cos 358.67^o$ $= 0.04999\ \textbf{m}$	1 1 ½ ½ 1

Total = 20

3. (a)	(i) Intermolecular forces are forces of attraction or repulsion which act between neighbouring particles such as molecules. These forces arise from the potential energy of the molecules, and the thermal energy of the molecules which is kinetic energy of the molecules and it depends on the temperature of the substance	3
	(ii)  *Scoring:* *Shape of graph 1* *Each label ½*	2

(b) (i) surface tension is the work done in increasing the surface area by 1 m^2 under isothermal conditions. 1

(ii)



Liquid molecules attract each other. ½

In bulk, a molecule B is attracted in all directions by other molecules, and the resultant attractive force is zero. ½ ½

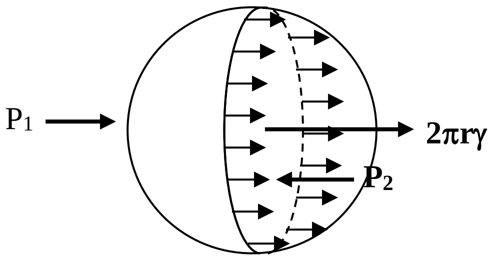
A molecule A at the liquid surface has greater molecular separation than equilibrium separation. ½

The molecule A at the surface experiences greater attraction from its neighbours and this puts molecule at the surface in tension. ½ ½

This is the phenomenon termed surface tension.

(iii) Let P_1 and P_2 be the external and internal pressures

An air bubble has one surface in contact with the liquid. So the surface tension force $F_\gamma = \pi r\gamma$



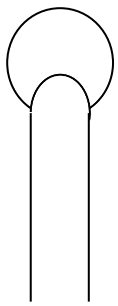
For the soap bubble in equilibrium

Force due to pressure P_1 + force due to surface tension = force due to pressure P_2

Thus, $2\pi r\gamma + \pi r^2 P_1 = \pi r^2 P_2$

$\therefore \quad \mathbf{P_2 - P_1 = \frac{2\gamma}{r}}$ 4

(c) r = 0.5 cm = 0.005 m



$\gamma_{soap} = 3.0 \times 10^{-2}\ N\ m^{-1}$

$\gamma_{water} = 7.0 \times 10^{-2}\ N\ m^{-1}$

Assuming zero angle of contact 1

$$h\rho g - \frac{2\gamma_{water}}{r} = \frac{4\gamma_{soap}}{r}$$ 1

$$\therefore \quad h = \frac{1}{1000 \times 9.81}\left(\frac{4 \times 3.0 \times 10^{-2}}{0.005} + \frac{2 \times 7.0 \times 10^{-2}}{0.005}\right)$$ 2

$$= \mathbf{3.06 \times 10^{-2}\ m}$$ 1

(d) Drops take on shapes for which the sum of the surface energy and gravitational potential energy is minimum 1

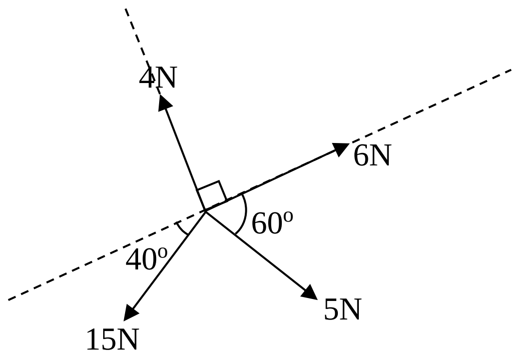
For large drops, the effect of gravity is greater than that of the surface tension. 1

Thus they flatten to reduce the gravitational potential.

Total = 20

4. (a) (i) …a single force having exactly the same effect as the number forces it represents

(ii)



Along the 6N force: $F_x = 6 + 5\cos 60^\circ - 15\cos 40^\circ$ 1

$= 6 + 2.5 - 11.5 = -3$ N ½

Perpendicular to the 6N force: $F_y = 4 - 5\sin 60^\circ - 15\sin 40^\circ$ 1

$= 4 - 4.33 - 9.64 = -9.97$ N ½

Resultant force, $F = \sqrt{F_x^2 + F_y^2}$

$= \sqrt{3^2 + 9.97^2} = 10.4$ N 1

Now, acceleration, $a = \frac{F}{m} = \frac{10.4}{2} = 5.2$ m s^{-2} 1

Using $s = ut + ½at^2$, we have

$s = 0 + ½ \times 5.2 \times 3^2$

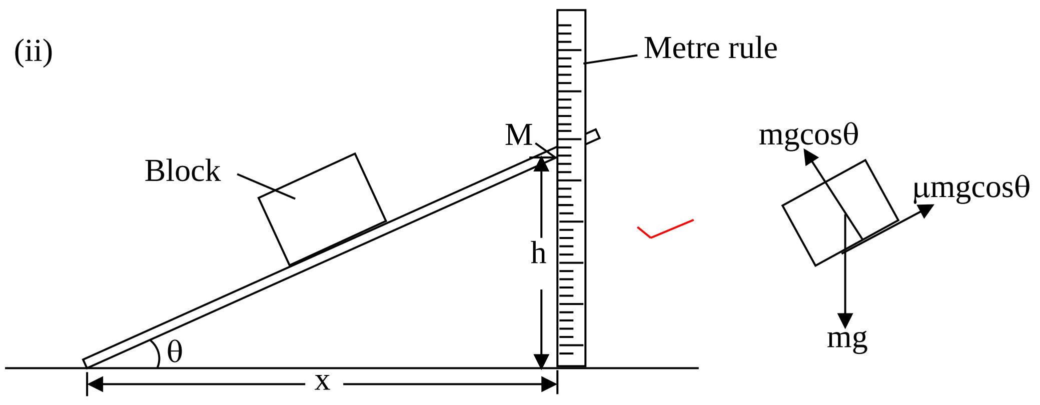
$= \mathbf{23.4\ m}$ 1

(b) (i)

Solid friction	Fluid friction
- Independent of area of contact - Independent of relative velocity of the layers in contact	- Depends on area of layers considered - Depends on the relative velocity of the layers involved

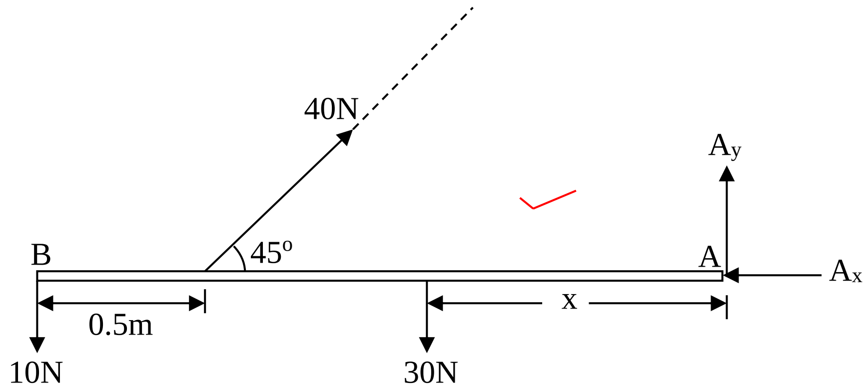
2

(ii)

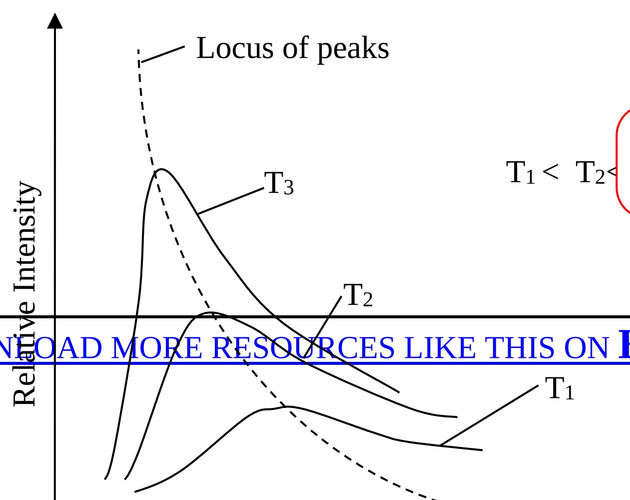


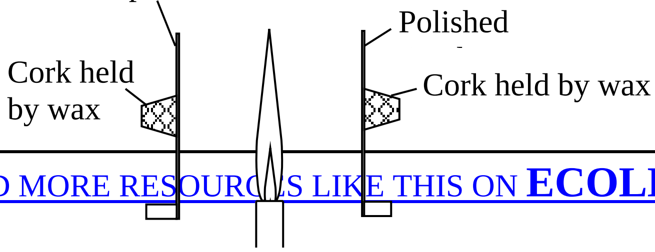
1

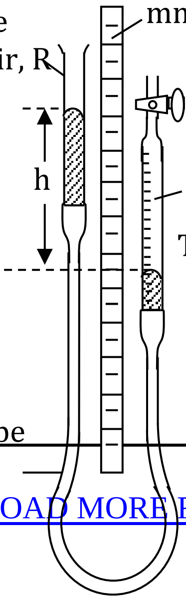
- A mark, M, is made at a suitable location on the board ½
- Then the block is placed on the board and the board is gently tilted until the block is just beginning to slide down ½

	- Then the height, h, of the mark, M, above the bench is measured	½
	- The horizontal distance, x, of M from the line of contact of the board and the bench is also measured (where x is perpendicular to the line of contact).	½
	The diagram on the right shows the forces on the block at the start of slipping, in which μ is the coefficient of friction	
	So, $\mu mg\cos\theta = mg\sin\theta$	½
	∴ $\mu = \tan\theta = \frac{h}{x}$	½
(c)	(i) 	1
	Let x = distance of centre of gravity from end A Taking moments about end A, we have $30x + 10 \times 2 = 40 \times 1.5\sin45^o$	1
	∴ $x = \frac{40 \times 1.5\sin45^o - 20}{30}$ $=$ **0.748 m from end A**	1
	(ii) $A_x = 40\cos45^o = 28.28$ N	1
	$A_y + 40\sin45^o = 10 + 30$ ∴ $A_y = 40 - 28.28 = 11.72$ N	1
	∴ reaction at A $= \sqrt{A_x^2 + A_y^2} = \sqrt{28.28^2 + 11.72^2} =$ **30.6 N**	1
	at an angle α to the horizontal, where $\alpha = \tan^{-1}\left(\frac{11.72}{28.28}\right) =$ **22.5°**	1

Total = 20

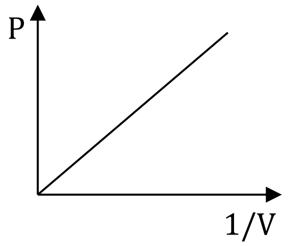
5. (a)	(i)  $T_1 < T_2 <$ *Shape → 1* *Relative positions → 1*	2

	(ii) At first the ball is invisible It becomes dull red, then bright red and finally less red, tending to white. This is because as the temperature rises, the intensity of the shorter wavelengths increases more rapidly. So the peak intensity shifts from the red end of the spectrum into the visible spectrum, which is a narrow band.	½ 1 1 ½
	(iii) The cavities approximate to black bodies. So the radiation from the cavities is of higher intensity than that from the rest of the areas.	1 1
(b)	(i) *Wien's displacement law:* The wavelength of the highest intensity is inversely proportional to the absolute temperature of the body. *Stefan,s law*: The total power radiated by a black body per m^2 is directly proportional to the fourth power of the body's absolute temperature	 1 1
	(ii) According to Wien's displacement law $\lambda_m T = 2.9 \times 10^{-3}$ mK $\therefore \quad T = \frac{2.9\times10^{-3}}{1.5\times10^{-6}}$ $= \mathbf{1933\ K}$	 ½ ½ 1
	(iii) 	

		1
	- Two sheets of tin plate, one polished and the other dull black, are set up vertically a short distance apart. - On the back side of each is fixed a cork by means of wax. - A bunsen burner is placed midway between the plates. - As the burner continues burning, eventually the wax on the back of the dull black plate melts and the cork falls while that on the polished plate remains. *Conclusion:* The dull black plate must have absorbed heat faster than the polished one. So dull black surfaces are better absorbers than polished ones.	1 ½ ½ ½ ½
(c)	(i) Let r = radius of the star = 7.0×10^8 m R = distance between the star and the planet = 1.4×10^{11} m Then at a distance R the total area catching the radiation from the star is $4\pi R^2$ So power radiated by the star = power received over an area $4\pi R^2$ $\therefore \sigma A T^4 = 4\pi R^2 \times 1.4 \times 10^3$ $\therefore \sigma . 4\pi r^2 . T^4 = 4\pi R^2 \times 1.4 \times 10^3$ $\therefore \quad T^4 = \left(\frac{R}{r}\right)^2 \times \frac{1.4\times10^3}{\sigma}$ $= \left(\frac{1.4\times10^{11}}{7\times10^8}\right)^2 \times \frac{1.4\times10^3}{5.7\times10^{-8}} = 9.824 \times 10^{14}$ $\therefore \quad T = \sqrt[4]{982.4} \times 10^3$ $=$ **5599 K**	1 1 1 1
	(ii) - The star radiates as a black body - No radiant energy lost in the space around.	½ ½
	Total = 20	
6.	(a) (i) When a gas is heated at constant pressure, it expands and therefore some of the heat which is supplied to the gas is used to do external work and the rest is used to increase the internal energy of the gas WHEREAS when a gas is heated at constant volume all the heat is used to increase the internal energy of the gas. (ii) *Verification of Boyle's Law*  The apparatus consists of a graduated tube, T, connected by rubber tubing to a reservoir, R. Dry air is trapped in the graduated tube over mercury as shown. If H is the atmospheric pressure in mm of mercury, then the pressure acting on the air in T is P = H + h. The pressure is varied by altering the position of the reservoir, each time noting the height h and the volume V of the air in T. A graph of P against 1/V is plotted. It is a straight line through the origin. Hence $P \propto 1/V$.	1 1 1 1 1 1

Thus, the results may be summarised as

PV = C (a constant) 1



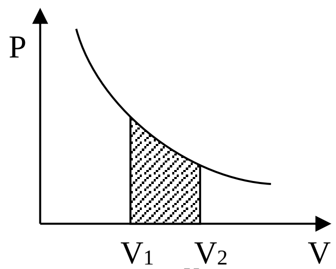
(b) (i) Conditions for an Isothermal Process:

- Thin-walled, highly conducting vessel surrounded by a constant temperature bath.
- The process must occur very slowly to allow transference of heat to maintain a constant temperature at every instant. 1

(ii) Suppose a gas expands by, δV, at a pressure P. The work done,

$\delta W = P.\delta V$ 1

The total work done in expanding from V_1 to V_2 is



$$W = \int dW = \int_{V_1}^{V_2} PdV$$

Which is the shaded area on the P-V curve shown.

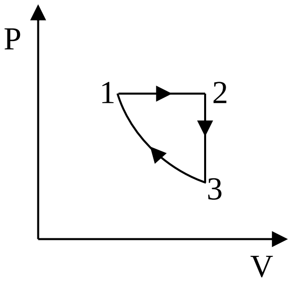
For n moles of gas

$$P = \frac{nRT}{V}$$

Hence $W = \int_{V_1}^{V_2} PdV = \int_{V_1}^{V_2} nRTdV = nRT\log_e\left(\frac{V_2}{V_1}\right)$

The heat required, $Q = W = nRT\log_e\left(\frac{V_2}{V_1}\right)$

(c)



Work done, $W = W_{12} + W_{23} + W_{31}$

$$= P_1(V_2 - V_1) + 0 + P_1V_1 \ln\left(\frac{V_1}{V_3}\right)$$

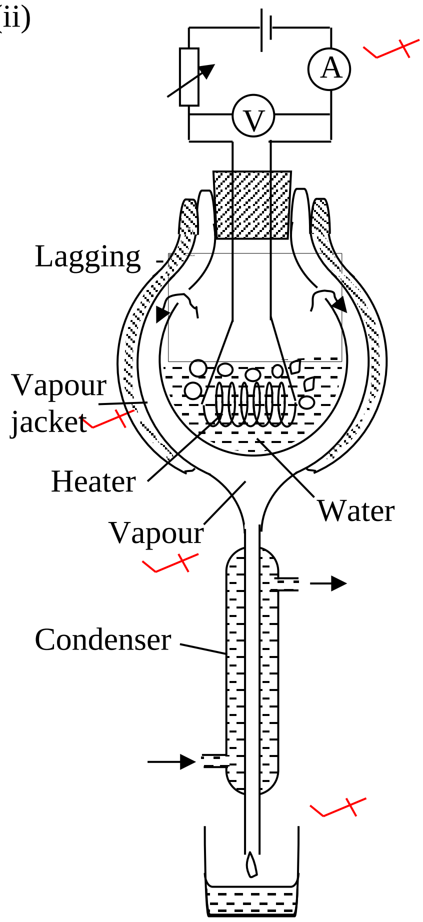
$$= P_1V_1 + P_1V_1 \ln\left(\frac{1}{2}\right)$$

$= 1.5 \times 10^5 \times 2 \times 10^{-3}(1 - 0.693) = 92.1$ J

(d) Let P = pressure of the gas

V = volume each gas

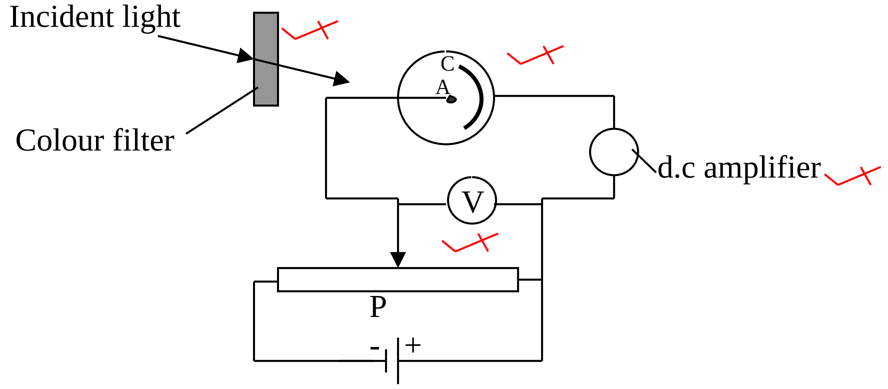
and n_1, n_2, n_3 be the respective numbers of molecules of gases 1, 2 and 3 in identical containers.

	Then PV $=\frac{1}{3}n_1m_1\overline{c_1^2} = \frac{1}{3}n_2m_2\overline{c_2^2} = \frac{1}{3}n_3m_3\overline{c_3^2}$ Since the gases are at the same temperature, $m_1\overline{c_1^2} = m_2\overline{c_2^2} = m_3\overline{c_3^2}$ Therefore $n_1 = n_2 = n_3$	
7. (a)	(i) …the quantity of heat required to convert 1 kg mass of a substance from liquid to vapour at constant temperature.	1
	(ii)  The apparatus is set up as shown in the diagram. The setup is switched on and given time to attain steady conditions, with the liquid at its boiling point. Under these conditions, the heat supplied by the heater is used in evaporating the liquid and offsetting the losses. - The condensed liquid is then collected in a weighed beaker over a measured time interval. Let m_1 = mass of liquid collected per second V_1 = p.d across the heater coil I_1 = current through the coil h = heat lost per second L = specific latent heat of vaporisation of the liquid Then $I_1V_1 = m_1L + h$ ……………(1) - The experiment is repeated at new values I_2 and V_2 of current and p.d respectively. Let m_2 = new mass of liquid collected per second. Then $I_2V_2 = m_2L + h$ ……………(2) From (1) and (2) $L = \frac{I_1V_1 - I_2V_2}{m_1 - m_2}$	½ 1 1 1 ½ ½ 1 ½ 1
(c)	(i) … the quantity of heat required to raise the temperature of 1 kg of a substance by 1 K.	1
	(ii) Let m = mass of liquid evaporated M = original mass of liquid P = electrical power C = heat capacity of flask Then Pt = (Mc + C)(78 -28) + mL ∴ mL = Pt – (Mc + C)(78 – 28) = (500 x 10 x 60) – (2 x 2500 + 840) x 50 = $3.0 \times 10^5 - 2.92 \times 10^5 = 8 \times 10^3$ ∴ $m = \frac{8\times10^3}{8.54\times10^3}$ = **0.937 kg**	2 1 1 1 1

	It is assumed that all the electrical energy is used to heat and evaporate the liquid.	
(d)	(i) …the temperature at which the saturated vapour pressure of a liquid is equal to the external pressure acting on the liquid.	1
	(ii) When the external pressure is increased, the liquid molecules will need a higher kinetic energy in order to develop the vapour pressure that will equal to the external. So the liquid boils at a higher temperature	2
	Total = 20	

8.(a)	(i) It is used to establish the electronic charge. Or to show that charge is quantised. (ii) A constant temperature bath is used to: - Eliminate convectional currents - Eliminate the variations of viscosity of air due to temperature change.	1 2
(b)	(i) Work function – minimum energy required for an electron to be ejected from a metal surface. (ii) Stopping potential – is the value of the negative potential difference which just stops the electrons with maximum kinetic energy from reaching the anode from the cathode.	

(c) **(i) Laboratory Experiment to verify Einstein's photoelectric**



½

½

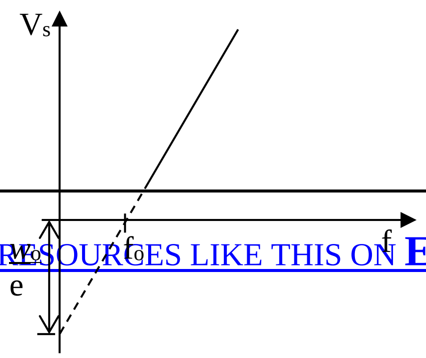
½

½

The circuit is connected as shown in which P is a potential divider. The incident light is passed through a colour filter to select a desired frequency f. The frequency of the filter is noted. The p.d V, applied to the anode A, is increased negatively until the current, measured by the d.c amplifier just becomes zero. Then the reading, V_s, of the voltmeter is noted. It is the stopping potential for the frequency used. ½ ½

The procedure is repeated using different colour filters, each time noting the corresponding stopping potentials V_s. ½

A graph of V_s against f is plotted. It is a straight line with a negative intercept on the V_s axis. ½ ½



		The slope, s of the graph is obtained. Then Planck's constant is calculated from $h = slope \times e$, where e is the electronic charge. (ii) $f = 8.8 \times 10^{14}\ Hz,\ W_0 = 2.5eV = 2.5 \times 1.6\times10^{-19} = 4\times10^{-19}\ J$ By Einstein's equation, $\frac{1}{2}mv^2 = hf - W_0$ $\frac{1}{2}mv^2 = 6.6\times10^{-34}\times8.8\times10^{14} - 4\times10^{-19} = 1.808\times10^{-19}$ $v^2 = \frac{2\times1.808\times10^{-19}}{9.11\times10^{-31}} = 3.96926\times10^{11}$ $v = 6.30 \times 10^5\ ms^{-1}$	½ ½ 4
	(d)	Given: D = 4.0 x10^{-2} m, d = 4.0 x 10^{-2} m, V = 12V, v = 1.0 x 10^6 ms^{-1}, The horizontal velocity remains the same = v The time taken between the plates is $t = \frac{D}{v}$ and the vertical acceleration, $a_y = \frac{Ve}{dm}$ Let v_y = the vertical velocity Then, using v = u + at, where u = 0, we have $v_y = \frac{VeD}{dmv}$ Now, $\tan\theta = \frac{v_y}{v} = \frac{VeD}{dmv^2}$ $= \frac{12\times1.6\times10^{-19}\times4.0\times10^{-2}}{4.0\times10^{-2}\times9.11\times10^{-31}1.0\times10^{12}} = 2.11$ $\therefore \theta = \mathbf{64.6^o}$	½ ½ ½ ½ 1 1 1
		Total = 20	
9.(a)	(i)	- Electrons are thermionically emitted from the cathode heated by a low voltage supply. - The electrons are accelerated to high speeds by E.H.T. applied between the anode and the cathode - On hitting the target metal, electrons in deeper energy levels are displaced. - On falling back X-ray radiation is emitted.	1 1 1 1
	(ii)	see table below	2

X-rays	Positive rays
Carry no charge	Carry a positive charge
Not deflected by electric field	Deflected by electric field
Travel at the speed of light	Do not travel at speed of light

(iii)
X-rays are produced when energetic electrons hit matter and the energy of the X-rays depends on the energy of the bombarding electrons, whereas 1
Photoelectric effect is emission of electrons when electromagnetic radiation of high enough frequency strikes a metal surface. The energy emitted depends on the frequency of the incident radiation 1

(b)
$V = 1.5 \times 10^5 V$; $c = 2.5 \times 10^2\ J\ kg^{-1}K^{-1}$; $m = 0.25\ kg$; $\frac{\Delta\theta}{t} = 8\ k\ s^{-1}$

(i) 99% of electric energy supplied = heat gained by metal target material 1

$$\frac{99}{100} neV = mc\left(\frac{\Delta\theta}{t}\right)$$ 1

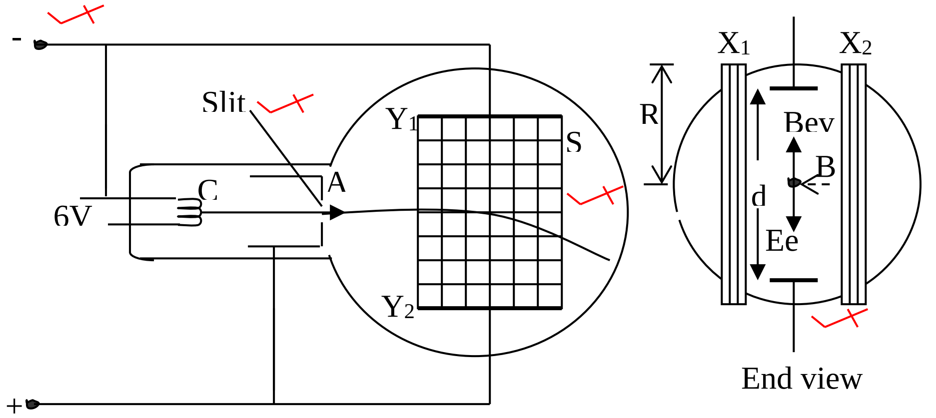
$$\therefore \quad n = \frac{0.25 \times 2.5 \times 10^2 \times 8}{1.6 \times 10^{-19} \times 1.5 \times 10^5 \times 0.99} = \mathbf{2.10 \times 10^{16}} \text{ electrons per second}$$ 2

(ii) $eV = hf = h\frac{c}{\lambda}$ 1

$$\therefore \lambda = \frac{hc}{eV} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{1.6 \times 10^{-19} \times 1.5 \times 10^5} = \mathbf{8.25 \times 10^{-12}\ m}$$ 1

(c)
(i) …the ratio of charge of an electron to its mass 1

(ii)



X_1, X_2 = Helmholtz coils ½ ½ ½ ½

- A vacuum-type cathode-ray tube, connected as shown, is used, with the accelerating p.d, V, also applied between the parallel deflecting plates Y_1Y_2 which support a vertical fluorescent screen S set at an angle.
- A fine flat electron beam, emerging through the slit, produces a fine trace on S as shown. ½
- The current I in the Helmholtz coils, arranged as shown, is switched on and adjusted so that the trace suffers no deflection. ½

Under these conditions:

{The electric force produced by plates Y_1Y_2 on an electron} = {Magnetic force produced by the current in the Helmholtz coils} ½

Let d = distance between plates Y_1
v = velocity of electrons on e
B = magnetic field density

Then $\frac{Ve}{d} = Bev$ ……………………………… (1) ½

and $\frac{1}{2}mv^2 = eV$,where m = mass of electron ……….(2) ½

Eliminating v from (1) & (2) $e/m = \frac{V}{2B^2d^2}$ ½

The flux density B for the Helmholtz coils is given by $B = \frac{0.72\mu_o NI}{R}$

where N = no. of turns in one coil.
Also, accept the J. Thomson's method for determination of specific charge.

Total = 20

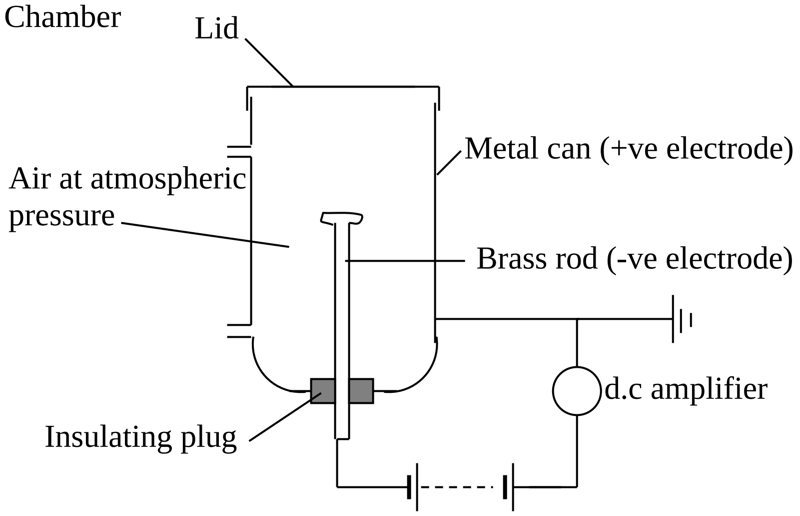
10. (a) (i)

RADIOACTIVITY	NUCLEAR FISSION
Spontaneous disintegration of the nucleus	An induced disintegration of the nucleus by bombardment with neutrons.
Daughter nuclei are not of comparable masses	Daughter nuclei are of comparable masses

1
1

(ii) – Neutrons have no charge and therefore they are not repelled by the nucleus. 1
- The neutron-proton ratio increases hence making the nucleus unstable. 1

(b) Ionisation Chamber



½
½
1
½

It consists of a metal can containing a co-axial brass electrode. The can forms one electrode and the brass rod the other. 1

When a radioactive particle passes, it ionizes the air as it does so. The positive ions move to the central rod while the electrons move to the can, causing a current to flow in the external circuit. The ionization current depends on the p.d across the chamber and the rate at which ionization is produced. 1 ½

		½ ½
(c)	(i) Let N = number of radioactive atoms present r = distance of G-M from the source then, since $\frac{dN}{dt} = -\lambda N$ γ-radiation reaching the G-M per unit area per s is $\frac{\lambda N}{4\pi r^2}$ $\therefore$ γ-radiation per s incident on the window of area A is $\frac{\lambda N}{4\pi r^2}A$ = count rate $\therefore \quad N = \frac{4\times 11\pi r^2}{\lambda A} = \frac{44\pi\times 10^2\times 100\times 24\times 3600}{0.693\times 7}$ $= \mathbf{2.46 \times 10^{10}}$	1 2 1 1
	(ii) 1 radioactive atom is present in 10^{12} atoms of the sample. So the number of atoms in the sample = N x 10^{12} = 2.46 x 10^{22} atoms These give a mass of 1.2 g $\therefore$ Mass number $= \frac{6.02\times 10^{23}\times 1.2}{2.46\times 10^{22}}$ $= \mathbf{29.4\ g}$	½ 1 ½
(d)	Mass of Pb and α-particle = 205.929 + 4.002 = 209.931 u Since the total mass of nuclei is less than that of the parent nucleus, the nucleus will undergo disintegration.	1 2
	Total = 20	