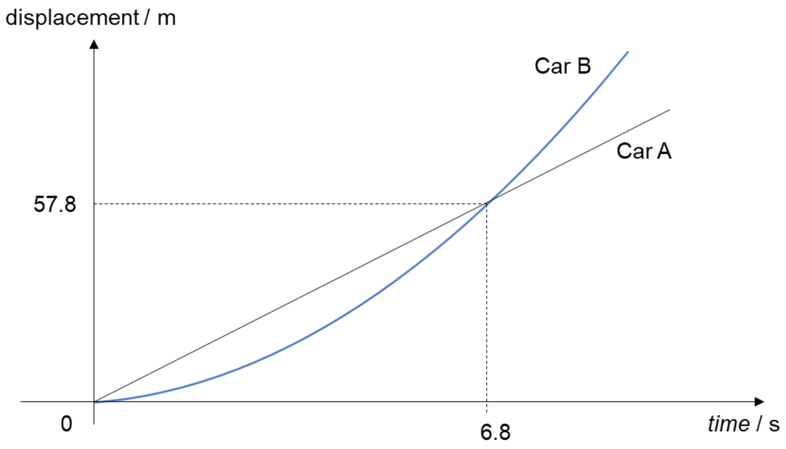
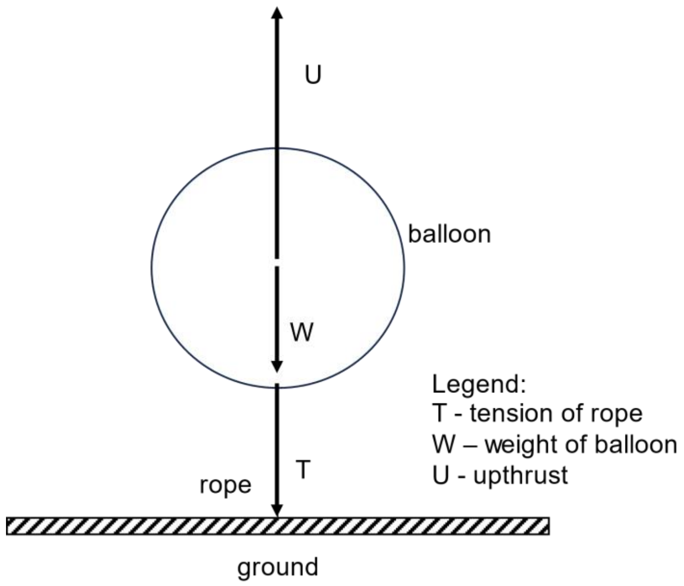
Qn	Suggested MS
1(a)	$s = ut + \frac{1}{2}gt^2$ Since u = 0, $s = \frac{1}{2}gt^2$ $g = \frac{2s}{t^2}$ $g = \frac{2(5.88)}{(1.1)^2}$
	$g = 9.72$ m s^{-1}
(b)	t should be recorded for every 100cm of h e.g. 100cm, 200cm till 600cm. Plot the graph for h against t^2 and get a best fit line. Obtain g = 2 × gradient.
	The best fit line reduces/removes the systematic error that might be present if the vertical intercept is non-zero. This results in a more accurate value of g.
(c)	Loss in GPE $= mgh = (0.010)(9.72)(5.88) = 0.571\text{J}$
(d)	$U = m(\frac{2h}{t^2})h$ $U = \frac{2mh^2}{t^2}$ Hence $\frac{\Delta U}{U} = \frac{\Delta m}{m} + 2\frac{\Delta h}{h} + 2\frac{\Delta t}{t}$
	$\frac{\Delta U}{0.571} = \frac{1}{10} + 2(\frac{1}{588}) + 2(\frac{0.1}{1.1})$ $\Delta U = 0.163\text{J}$
	$U \pm \Delta U = (0.6 \pm 0.2)\text{J}$

2)(a) (i)	$s_A = vt - (1)$ $s_B = ut + \frac{1}{2}at^2 = 0.5(2.5)(t^2)$ $s_A = s_B$ $8.5(t) = \frac{2.5}{2}(t^2)$ $t = 6.8\ s$
	$s_B = 0.5(2.5)(6.8)^2 = 57.8m$
(ii)	
(b) (i)	Vertical component $v_y^2 = u_y^2 + 2gs_y$ $v_y = \sqrt{2gs_y} = \sqrt{2(9.81)(6.5)} = 11.3\ ms^{-1}$
	$\tan\theta = \frac{11.3}{11.5}$ $\theta = 44.5°$
(ii)	Final horizontal velocity is the smaller
	The other component of the velocity is correct θ will therefore be larger

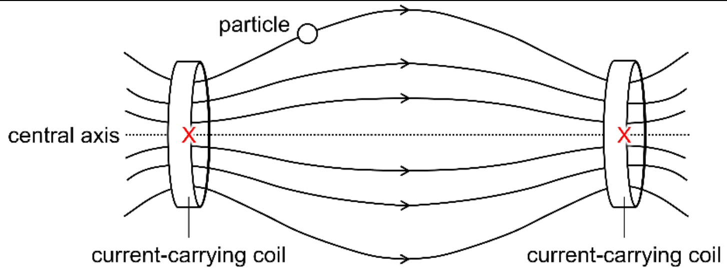
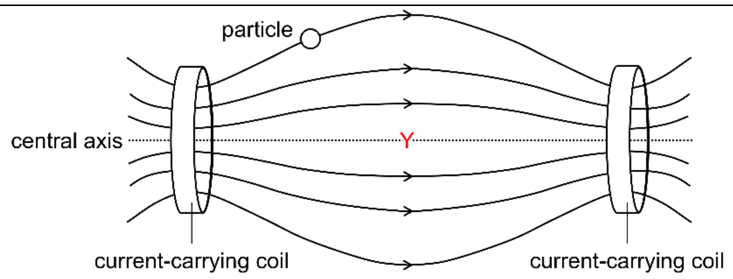
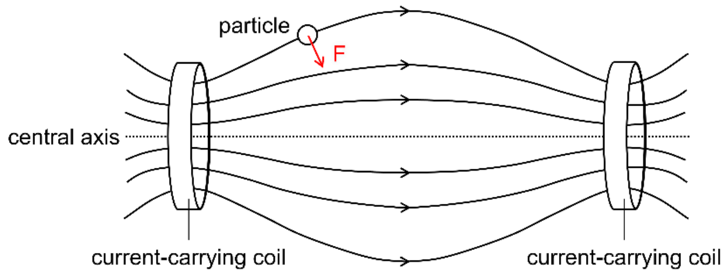
3(a)(i)	It is the resultant vertical upward force exerted by the fluid on an object as the pressure at the bottom surface is greater than that at the top. Upthrust is equal in magnitude and opposite in direction to the weight of the fluid displaced by a submerged or floating object.
3(b)(i)	 B1 – correct direction with labeling B1 – correct length of U, W and T and point of action
(ii)	$U = \rho V g$ $= (1.3)(\frac{4}{3}\pi(\frac{1.5}{2})^3)(9.81) = 22.54N$
	$U = T + mg$ $T = U - mg$ $= 22.54 - (0.3)(9.81) = 19.6N$
(b)(ii)	Net force upwards as upthrust is more than weight
	As altitude increases, air pressure/density decreases, causing upthrust to decrease
	Upthrust will decrease till its magnitude is equal to weight.

4(a)	e.m.f. is the amount of non-electrical energy converted into electrical energy per unit charge passing through the terminals of the cell (source).
	p.d. is the amount of electrical energy converted to other forms of energy per unit charge passing from one point to the other.
(b)(i)	Draw best fit line. Emf = 9.0 V
(b)(ii)	Read off two points along best fit line. (0,9.0) and (1.800, 5.4)
	V = E – Ir 5.4= 9.0 – 1.8(r) r = 2.0 Ω
(b)(iii)	Add a switch in correct location.
	When the switch is used, it will result in an open circuit between the resistors and the cell. Since no current flows through the cell, the terminal potential difference is the same as the emf.
(c)	p.d. across 2R = $(\frac{25+25}{3(25)+15})\times E$
	Since galvanometer reads zero, p.d. across 2R = p.d. across R_C $(\frac{25+25}{3(25)+15})\times E=(\frac{R_c}{R_c+15})\times E$
	R_C = 18.8 Ω

5(a)	
(b)(i)	PSYV
(b)(ii)	Electrons experience a magnetic force.
	The accumulation of the electrons causes a potential difference to be set up.
(iii)	$F_e = F_B$
	$e\dfrac{V_H}{d} = evB$ $V_H = 0.020 \times 56 \times 0.28$ $= 0.31\text{ V}$
(b)(iv)	Deflection would be opposite, so positive charges will accumulate on opposite face as before.
	Hence, polarity of the hall voltage will not change.

6(a)	Apply Charles' law $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $V_2 = \frac{T_2 V_1}{T_1} = \frac{(273.15 + 58)(52.1)}{(273.15 + 41)}$
	$V_2 = 54.9 \text{ cm}^3$
(b)	The real gas does not behave like an ideal gas.
(c)	Pressure: Piston is free to move in and out
	Amount of gas: cap stops gas leaving or entering the syringe and the piston seals the gas
(d)	Increase in *T* causes the molecules to move with higher kinetic energy
	The particle will exert a larger force on the wall as the (rate of) change in momentum when the particle collide with the wall will be larger.
	To ensure pressure stays the same, V must increase so that the frequency of the collisions must decrease

7)a)	Rate of decay
b)i)	$N = \frac{1}{222} \times 6.02 \times 10^{23}$ $N = 2.71 \times 10^{21}$
ii)	$\lambda = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{3.8 \times 24 \times 60 \times 60} = 2.11 \times 10^{-6}$
	$A = \lambda N = (2.11 \times 10^{-6})(2.71 \times 10^{21}) = 5.73 \times 10^{15}$
iii)	$A = A_o e^{-\lambda t}$ $0.01 = e^{-\lambda t}$
	$t = -\frac{\ln(0.01)}{\frac{\ln 2}{3.8 \times 24 \times 60 \times 60}}$ $= 2.18 \times 10^{6} s$
iv)	$\Delta m = (222.017576 - 218.008966 - 4.002602)$ $= 0.006008u$
	$E = \Delta mc^2$ $= 0.006008(1.66 \times 10^{-27})(3 \times 10^{8})^2 = 8.98 \times 10^{-13 J}$
	$E = N\Delta mc^2$ $= \frac{(2.71 \times 10^{21})8.98 \times 10^{-13}}{1.6 \times 10^{-19}} = 1.52 \times 10^{28} eV = 1.52 \times 10^{22} MeV$
v)	As the area of the GM tube cannot fully enclose the sample and therefore it can only capture a fraction of the total activity

8(a)	$E = 28.368 - 2.230 - 8.499$ $= 17.64$
	$E \approx 17.6$ MeV
(b)	The 'Coulomb barrier' is the electric potential energy due to the electrostatic repulsion between the positively charged nuclei that must be overcome for nuclear fusion to occur.
(c)(i)1.	
(i)2.	
(i)3.	
(c)(ii)	The nucleus will not have a component of velocity that is perpendicular to the magnetic field. Hence, there will be no magnetic force acting on the nucleus.
(d)(i)	Changing the current through the central solenoid changes the magnetic field produced by the central solenoid.
	This changes the magnetic flux linkage in the plasma. By Faraday's law, an e.m.f. is induced in the plasma.
	This causes the charged particles in the plasma to flow around the torus producing plasma current.
(d)(ii)	the resistivity of the plasma is $1.8 \times 10^{-9}\ \Omega$ m
	$R = \dfrac{\rho l}{A}$ $= \dfrac{\rho(2\pi R)}{\pi a^2}$ $= \dfrac{(1.8 \times 10^{-9})(2\pi)(6.2)}{\pi(2.0)^2}$ $= 5.58 \times 10^{-9}$
	$R \approx 5.6 \times 10^{-9}\ \Omega$

(d)(iii)	$P = I^2R$ $= \left(15\times10^{6}\right)^{2}\left(5.6\times10^{-9}\right)$ $= 1.26\times10^{6}$ $\approx 1.3\times10^{6}\,\text{W}$
(e)	Magnetic force provides for the centripetal force.
	$Bqv = mr\omega^2$ $= m(r\omega)\omega$ $= mv\omega$ $\omega = \dfrac{Bq}{m}$ $= \dfrac{(5.3)\left(1.60\times10^{-19}\right)}{2\times1.66\times10^{-27}}$ $= 2.554\times10^{8}$ rad s^{-1}
	$2\pi f = 2.554\times10^{8}$ $f = \dfrac{2.554\times10^{8}}{2\pi}$ $= 40.65\times10^{6}$ Hz ≈ 41 MHz
(f)	Neutral beams are unaffected by the magnetic fields hence they are able to propagate in a straight line before entering the into plasma.

(g)	volume of the torus $V = 2\pi^2 R a^2$ $= 2\pi^2 (6.2)(2^2)$ $= 489.53 \text{ m}^3$
	$S = kn^2 E$ $= (3.57 \times 10^{-23})(10^{20})^2 (17.6 \times 10^6 \times 1.60 \times 10^{-19})$ $= 1.0053 \times 10^6 \text{ W m}^{-3}$
	$Q = \dfrac{SV}{P_{\text{CRH}} + P_{\text{NBI}}}$ $= \dfrac{(1.0053)(489.53)}{20 + 33}$ $= 9.29$ ≈ 9.3