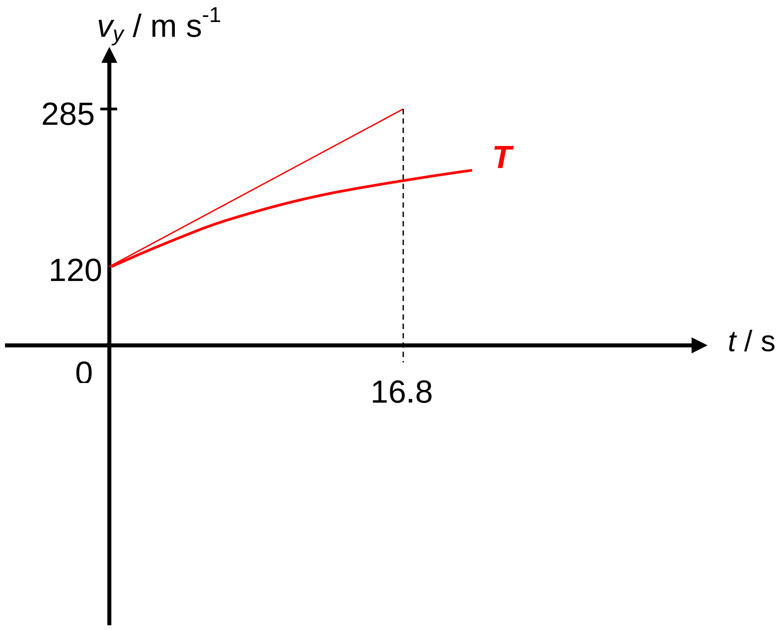
HWA CHONG INSTITUION

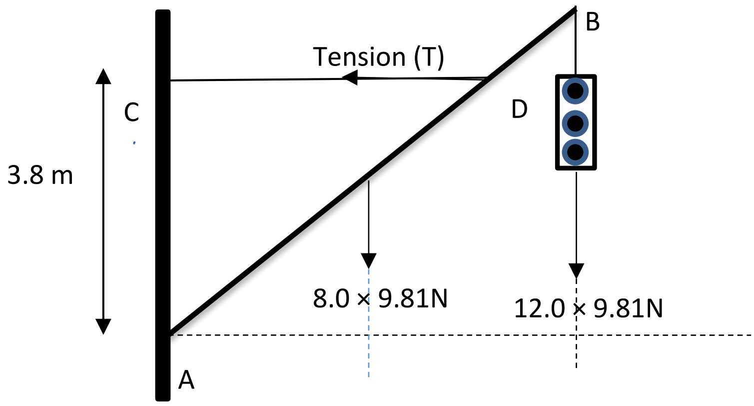
2015 JC 2 Prelim

H! Physics Paper 1 Answers

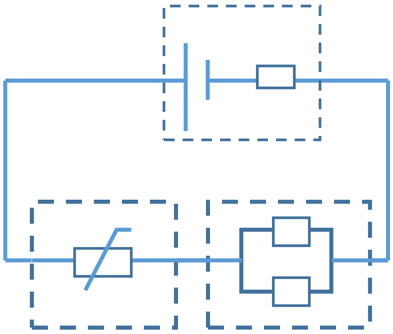
Q1	D	Q2	B	Q3	D	Q4	D	Q5	A
Q6	B	Q7	C	Q8	B	Q9	C	Q10	B
Q11	B	Q12	D	Q13	C	Q14	C	Q15	C
Q16	B	Q17	D	Q18	A	Q19	C	Q20	D
Q21	A	Q22	D	Q23	A	Q24	B	Q25	A
Q26	C	Q27	D	Q28	A	Q29	B	Q30	A

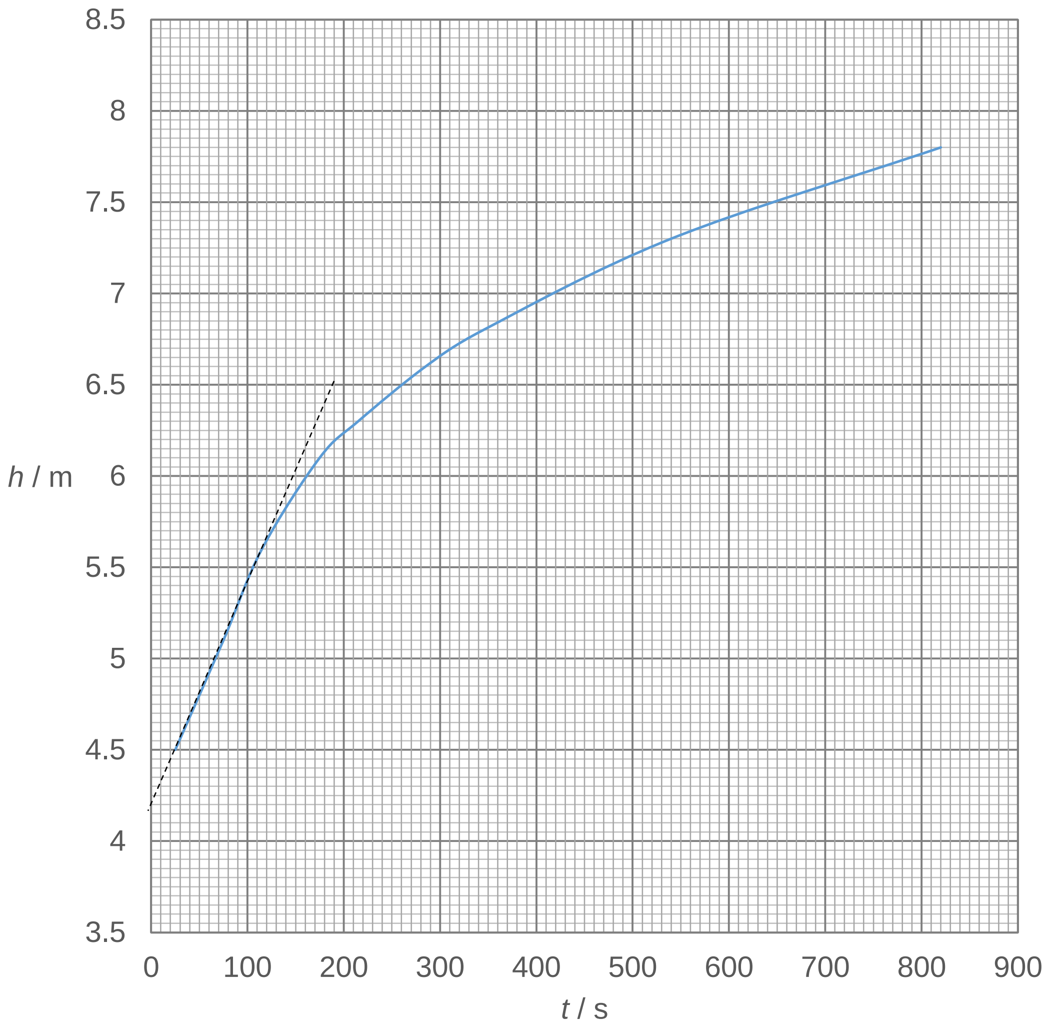
H1 Paper 2 Suggested Solutions

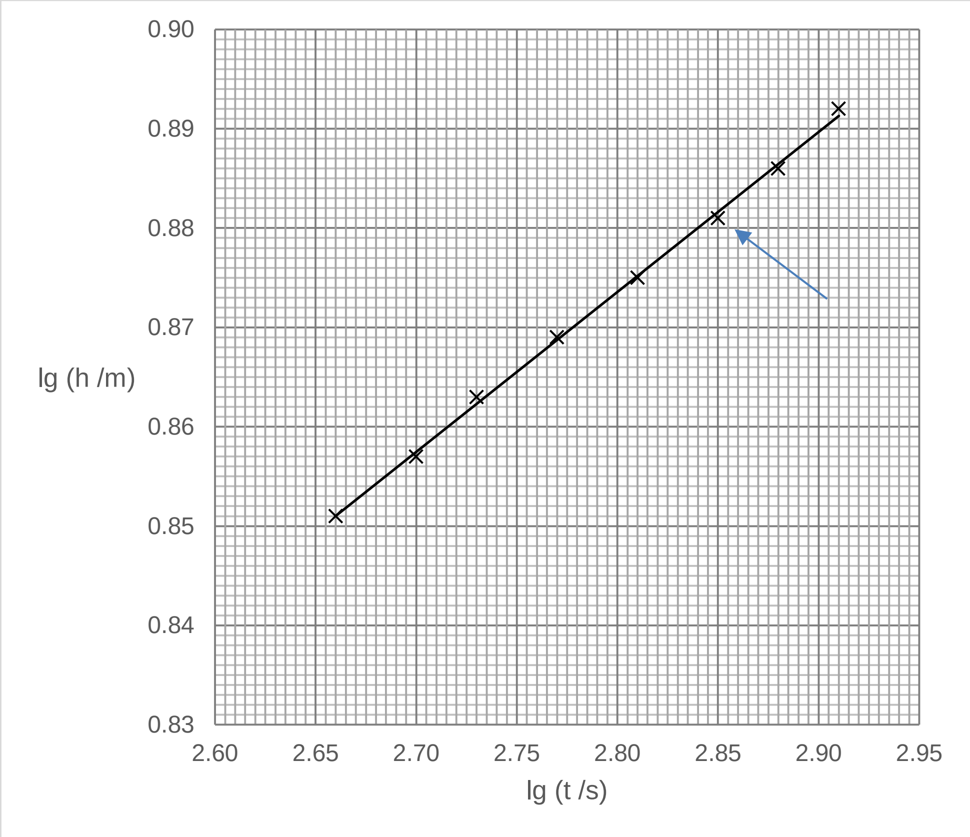
1		**(a)**	Parabola, with the line being tangent to the velocity at t = 0.	[1]
		(b)	Taking downward as positive, $s_y = u_y t + \frac{1}{2} a_y t^2$ $3400 = 240\sin(30^\circ)t + \frac{1}{2}(9.81)t^2$ t = 16.8 s	[1] [1]
		(c)	Taking downward as positive $v_x = u_x t = 240\cos(30^\circ) = 207.8$ $v_y = u_y + a_y t$ $v_y = 240\sin(30^\circ) + 9.81(16.8) = 284.8$ $v = \sqrt{v_x^{\ 2} + v_y^{\ 2}}$ $= 353$ m s^{-1}	[1] [1]
		(d)	 **Fig. 1.2**	
			Straight line with positive gradient. Values for start and end velocities and time of flight indicated (ecf applies).	[1]
		(e)	Correct shape; graph starting at the same point as that without air resistance. Area under the graph must be the approximately the same as that without air resistance	[1] [1]

2	**(a)**	The moment of a force about a point O is the product of the force and the perpendicular distance from O to the line of action of the force.		[1]
	(b)	**(i)**  Taking moments about A and since the sum of the clockwise moments must equal the sum of the anticlockwise moments yields $8.0 \times 9.81 \times 7.5/2 \times \cos 37^0 + 12 \times 9.81 \times 7.5 \times \cos 37^0 = T \times 3.8$ Hence $T = 2.5 \times 10^2$ N (to 2 s.f.)		[1] [1] [1]
		(ii)	Since net horizontal force must be zero, $F_H = 2.5 \times 10^2$ N Since net vertical force must be zero, $F_V = 8.0 \times 9.81 + 12.0 \times 9.81 = 2.0 \times 10^2$ N $F = \sqrt{F_H^2 + F_V^2} = 3.2 \times 10^2$ N $\tan\theta = F_V / F_H$ $\theta = 39°$, anticlockwise above horizontal.	[1] [1] [1]

3	**(a)**	Total momentum of a system is constant provided no net external force acts on it		[2]
	(b)	**(i)**	$120(25.2)+400(-14.5)=120v_A+400v_B$ $-2776=120v_A+400v_B$	[1]
		(ii)	$v_B-v_A=u_A-u_B=25.2-(-14.5)$ $v_B-v_A=39.7$	[1]
		(iii)	$v_A=-35.9$ m s^{-1} $v_B=3.82$ m s^{-1}	[1] [1]
			Direction of travel of **A**: towards the left Direction of travel of **B**: towards the right	[1]

4	**(a)**		[2]
	(b)	Resistance of A $= \frac{\rho l}{A} = \frac{(1.6)(0.02)}{2.0\times10^{-3}} = 16\ \Omega$ Resistance of B $= \frac{\rho l}{A} = \frac{(1.1)(0.02)}{1.0\times10^{-3}} = 22\ \Omega$ For parallel connection, effective resistance == $\left(\frac{1}{16}+\frac{1}{22}\right)^{-1} = 9.3\Omega$	[2]
	(c)	Reading from the graph, at 28°C, *I* = 0.20 A And resistance $R = \frac{V}{I} = \frac{2.0}{0.2} = 10\ \Omega$	[2]
	(d)	Either When temperature increases, resistance of thermistor decreases. Total resistance of circuit decreases, thus current in circuit increases. As $V = \varepsilon - Ir$, terminal potential difference across battery decreases. Or When temperature increases, resistance of thermistor decreases. Total resistance of circuit decreases compared to the internal resistance of the battery hence terminal potential difference will decrease.	[2]

5	**(a)**		
	(i)	Extrapolate line to find intercept on y-axis; h_0 = 4.20 (± 0.05) m	[1]
	(ii)	Gradient of the dotted line = $\dfrac{6.5-4.2}{190-0}$ = 0.0121 (± 0.001) volume per second = cross-sectional area × $\dfrac{\Delta h}{\Delta t}$ = 1.8 x 0.121 = 0.022 $m^3\ s^{-1}$)	[1] [1]
	(iii)	Total volume = 820 x 0.02 = 16.4 m^3	[1]
	(b) (i)	*700* | 7.60 | *2.85* | *0.881*	[1]

	(ii)	 Correct point plotted, best fit line drawn.	[1]
	(iii) 1.	Gradient $= \dfrac{0.880 - 0.856}{2.84 - 2.69}$ $= 0.160\ (\pm\ 0.001)$	[1] [1]
	2.	Sub (2.84,0.880), n = 0.160 into lg $h = n$ lg t + lg k 0.880 = 0.160(2.84) + lg k lg k = 0.4256 k = 2.66 (± 0.1) From $h = kt^n$, unit on LHS = m = unit on RHS Thus, unit of k = m $s^{-0.160}$	 [1] [1]

6 (a) Wavelength: Distance between 2 consecutive points on the wave of the same phase [1]

Frequency: Number of oscillations per unit time made by a point on the wave [1]

Speed: Distance travelled per unit time by a wavefront [1]

(b) Based on the definitions of (a), derive the equation for the speed of a progressive wave in terms of its wavelength and frequency.

From the definition of speed, for the wave to travel a distance of one wavelength λ, the time taken by the waveform is one period, T. [1]

Speed of wave = distance moved / time taken

= λ / T

= f λ (since f = 1 / T) [1]

(c) (i) If amplitude, A is inversely proportional to the distance r from the source, then the product Ar should be a constant. [1]

r	A	Ar
0.8	2.5	2
2	1	2
4	0.5	2
10	0.2	2

Based on at least 3 different points, the product Ar is constant. [2]

(ii) Intensity, $I \propto A^2$ OR $I \propto \left(\frac{1}{r}\right)^2$

$$\frac{I_2}{7.0} = \left(\frac{0.4}{1.0}\right)^2 \quad \text{OR} \quad \frac{I_2}{7.0} = \left(\frac{2.0}{5.0}\right)^2$$ [1]

$I_2 = 1.12$ W m^{-2} [1]

(iii) $I \propto A^2$

$$\frac{3.5}{7.0} = \left(\frac{A}{1.0}\right)^2$$

$A = 0.71\text{mm}$ (Sketch the line to be 0.71 of the original amplitude) [1]

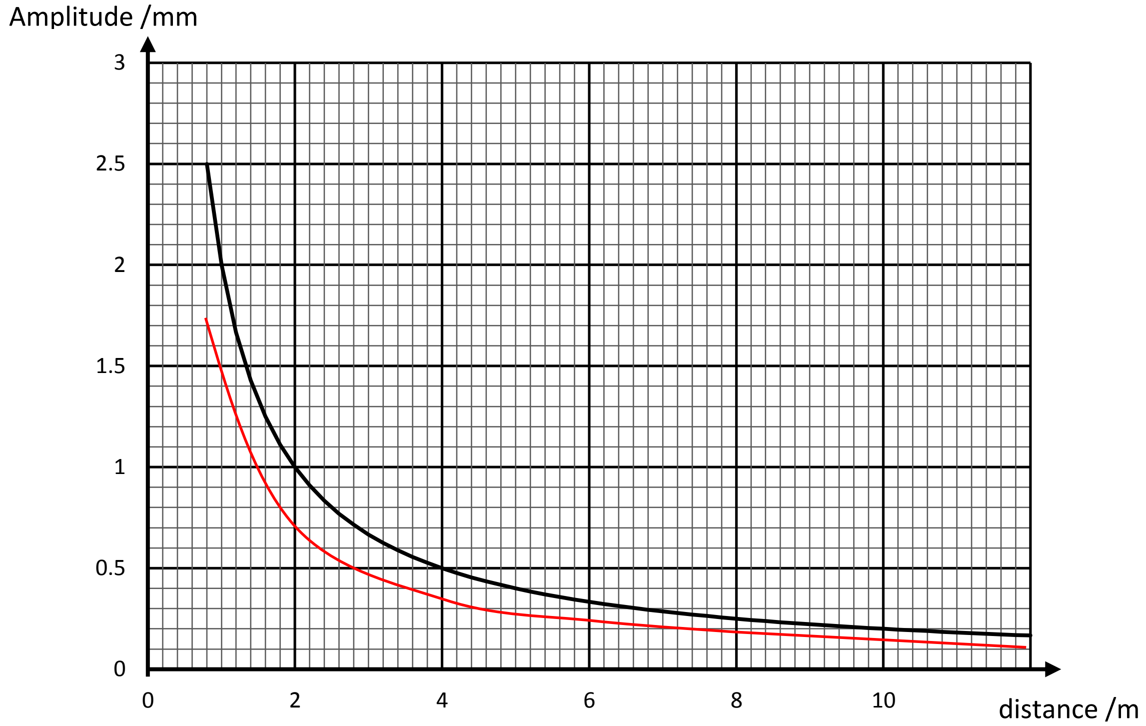
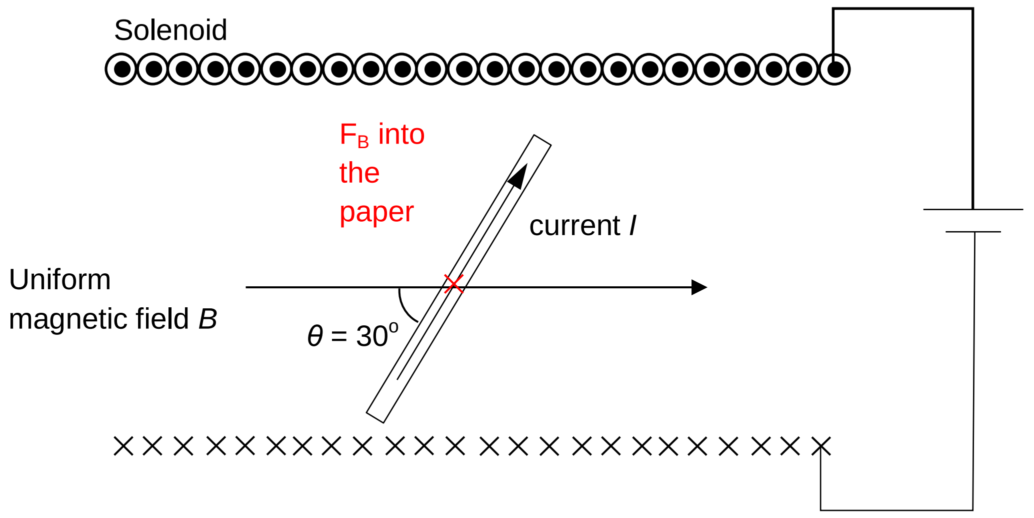


Fig. 6.1

(d)	**(i)**		Sound waves produced by the loudspeaker is reflected by the water. The reflected wave has the same frequency and amplitude as the incident wave. The two waves traveling in opposite direction superpose. A stationary wave is formed at certain frequencies such that a node of vibration is located just above the water and an antinode of vibration is located at the top of the tube near the loudspeaker.	[1] [1] [1]
	(ii)	**1.**	$\frac{\lambda}{2} = 590 - 370 = 220$ mm $\lambda = (0.220)2 = 0.44$ m	[1] [1]
		2.	$v = f\lambda = 750(0.44)$ $v = 330$ m s^{-1}	[1] [1]
	(iii)		The microphone responds to pressure variation. The air just above the water level is a displacement node. Where there is a displacement node, the pressure variation is maximum (pressure antinode)	 [1] [1]

7	**(a)**	**(i)**	The **force per unit length per unit current** acting on a current-carrying conductor **placed perpendicular to a magnetic field**.	[1]
		(ii)	The magnetic flux density that causes a force per unit length of 1 newton per unit metre on a conductor carrying 1 ampere of current placed perpendicular to the magnetic field.	[1]
		(iii)	For magnetic levitation of trains. For medical imaging (magnetic resonance imaging).	[1]
	(b)	**(i)**	EITHER: Solenoid or Helmholtz coils [1] connected to battery [1]	[2]
		(ii)	Direction of F_B into the paper.	[1]
			 Fig. 7.1	
		(iii)	$F = BIL = (5.7 \times 10^{-2})(10.2)(1.0)$ $F = 0.29$ N	[1] [1]
	(c)	**(i)**	Concentric lines increasing spacing further from the wire. Anticlockwise	[1] [1]

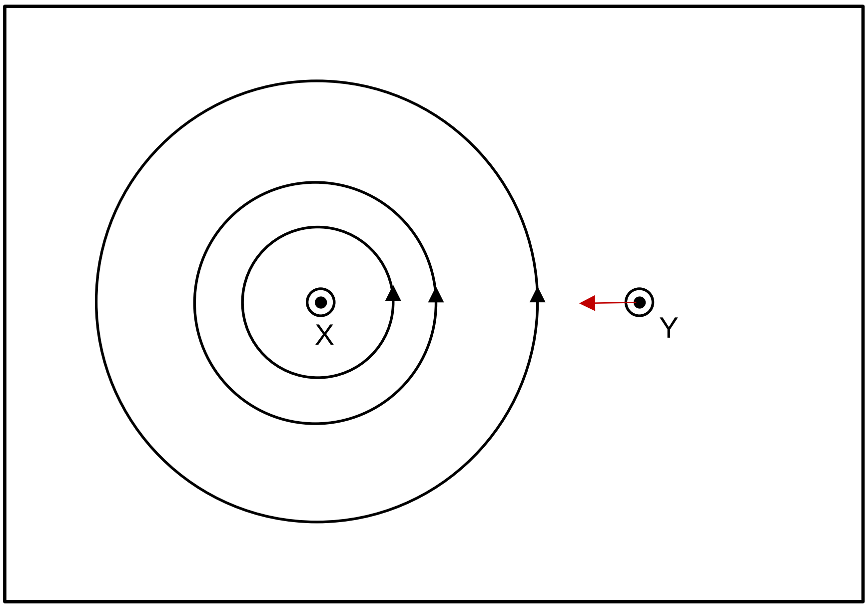
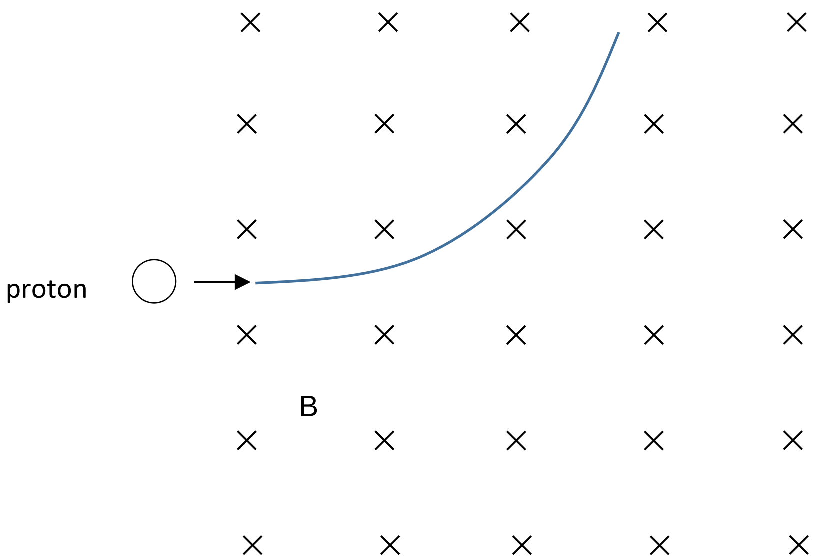
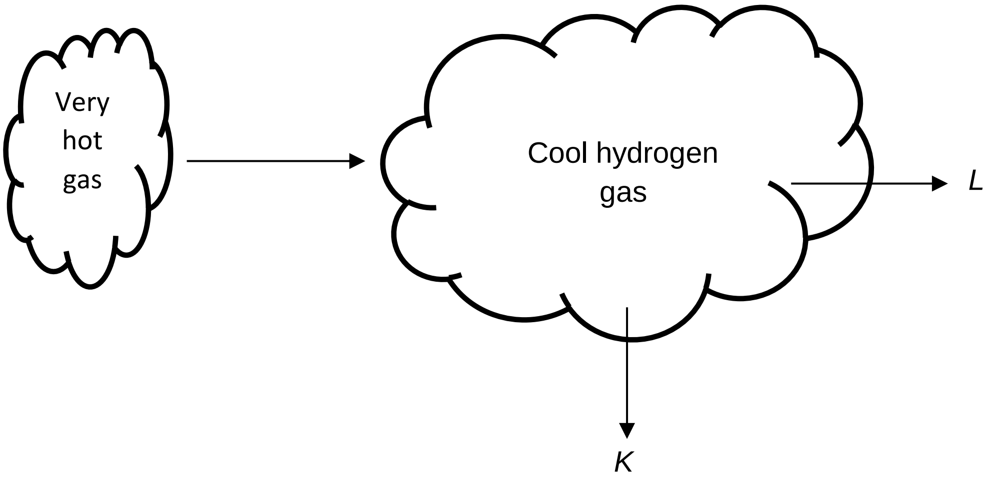


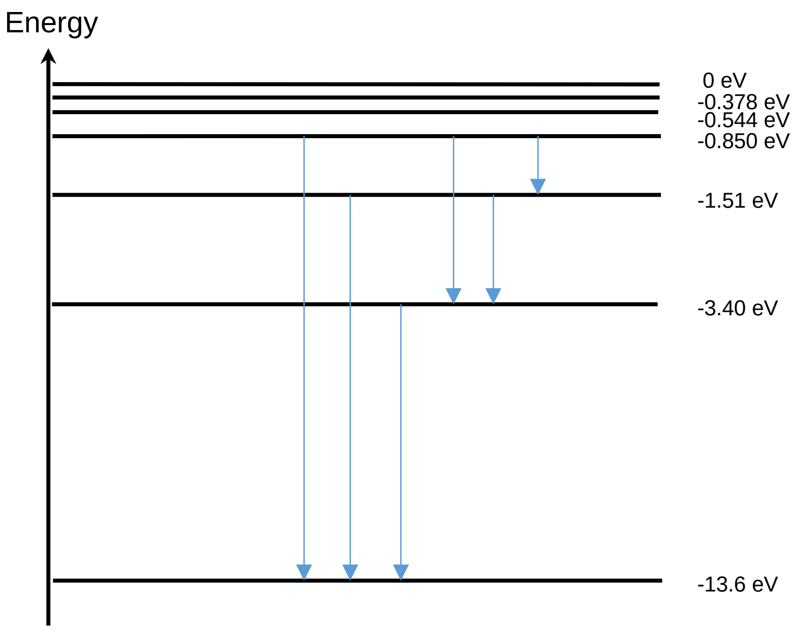
Fig. 7.3

		(ii)	Magnetic force towards X	[1]
		(iii)	**1.** $F = B_X I_Y L = \frac{\mu_0 I_X}{2\pi r} I_Y L = \frac{(4\pi \times 10^{-7})3.0}{2\pi(0.040)} 6.0L$	[1]
			$\frac{F}{L} = 9.0 \times 10^{-5}\ \text{N m}^{-1}$	[1]
			2. $\frac{F}{L} = 9.0 \times 10^{-5}\ \text{N m}^{-1}$	[1]
			Explanation: By Newton's 3rd law, the force acting on X by Y is the same magnitude as force acting by X on Y but in opposite direction.	[1]
	(d)			



		(i)	Curves upwards	[1]
		(ii)	By **Fleming's Left Hand rule**, a magnetic force acts on the proton **perpendicular to its velocity and the magnetic field**. The proton is deflected upwards.	[1] [1]
		(iii)	The electron will be deflected downwards since it has opposite charge of the proton (negative charge). Since its mass is much smaller than the proton, the electron will be deflected into a smaller circular path.	[1] [1]

8	(a)	Cool hydrogen gas is illuminated with electromagnetic radiation from a very hot gas as shown in Fig. 8.1		
		 Fig. 8.1		
8	(a)	(i)	Emission line spectrum is seen in the direction K. When a photon from the hot gas with the same energy as the difference in energy levels of the hydrogen atom, it excites the hydrogen atom from ground state to a higher energy level. The excited hydrogen atom then spontaneously de-excite and emit a photon in random directions. The emitted photon has only discrete energies and hence wavelengths, corresponding to the difference in energy levels of the atom.	[1] [1] [1]
		(ii)	Absorption line spectrum is seen in the direction L. The radiation from the hot gas has a continuous spectrum. Photon from the hot gas with the same energy as the difference in energy levels of the hydrogen atom will be absorbed by the hydrogen atoms. When a photon from the hot gas is absorbed by the hydrogen, it is re-emitted in random directions and no longer travels towards *L*. The radiation in the direction L is missing these photons.	[1] [1] [1]
	(b)	(i)	The electron is attracted to the nucleus which is positively charged. Hence, positive work must be done on the atom to separate the electron from the nucleus. The energy level correspond to the total energy of the electron and the nucleus. Since the total energy of the ionized atom (free electron at infinite distance from the nucleus) is defined to be zero, then the total energy of the electron and the nucleus in the bound state must be less than zero, hence negative.	[1] [1]

		(ii)	1.	 Fig. 8.2 -13.6+12.75 = -0.850eV 6 de-excitations shown.	[1]
			2.	Since E = hf = hc/λ, the shortest wavelength corresponds to the most energetic photon. $hf = E_{higher} - E_{lower} = 12.75\text{eV}$ $\frac{hc}{\lambda} = 12.75\text{eV}$ $\frac{6.63\times10^{-34}(3\times10^{8})}{\lambda} = 12.75(1.6\times10^{-19})$ $\lambda = 9.75 \times 10^{-8}$ m Ultraviolet	[1] [1] [1]
	(c)	(i)	Each photon transfers all its energy to a single electron in an instant. The electromagnetic radiation contains photons each with energy 12.75eV which is greater than the minimum work required to be done to eject the electron from B, which is 5.34 eV.		[1] [1]
		(ii)	$hf = KE_{max} + \phi$		
			$12.75\,\text{eV} = KE_{max} + 5.34\,\text{eV}$ $KE_{max} = 7.41\,\text{eV} = 1.19\times10^{-18}$ J		[1] [1]
		(iii)	A variable voltage supply is connected in parallel with the photoelectric tube as shown in Fig. 8.4.		

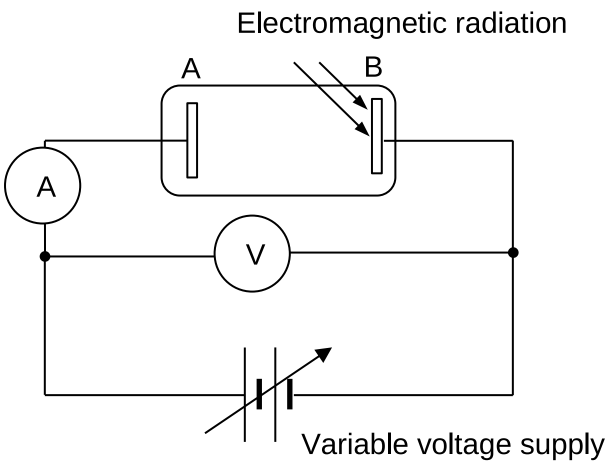


Figure 8.4

			1.	$KE_{max} = eV_s = 1.19 \times 10^{-18}$ J = 7.41 eV $V_s = 7.41\,V$	[1] [1]
			2.	V_s indicated on V axis Correct shape	[1] [1]

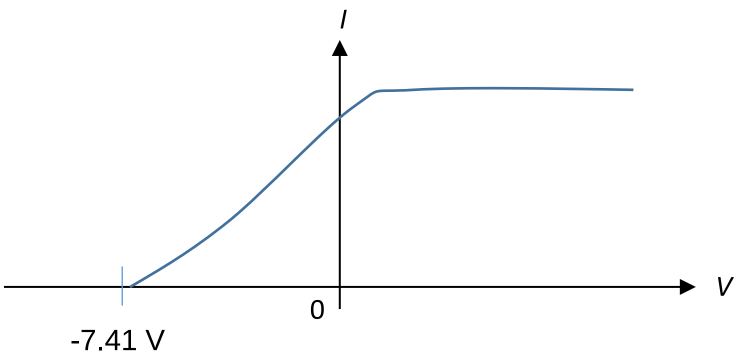


Figure 8.5