<table>
<tr><th>Qn</th><th>Suggested Guide</th><th></th></tr>
<tr><td>1</td><td></td><td></td></tr>
<tr><td>(a)</td><td><u>Product of force</u> and <u>displacement moved in the direction of the force</u>.</td><td></td></tr>
<tr><td>1 (b)</td><td>
<table>
<tr><th>Situation</th><th>On what object is the work done?</th><th>Application of conservation of energy</th></tr>
<tr><td>Steam engine</td><td>Work is done on the Piston of the engine.</td><td>Internal energy of steam is converted to to KE of piston (to drive engine).</td></tr>
<tr><td>Photocell / Light Dependent Resistor (LDR)</td><td>Work is done on the Electrons on metal surface</td><td>Photon energy to EPE of electrons (to jump energy gap from VB to CB) (and KE of electrons).</td></tr>
<tr><td>Battery</td><td>Word is done on the Motor in chainsaw.</td><td>Electrical energy of charges to rotational KE of motor to KE of chainsaw and subsequently heat due to work done against friction(and sound) on drilling of wood.</td></tr>
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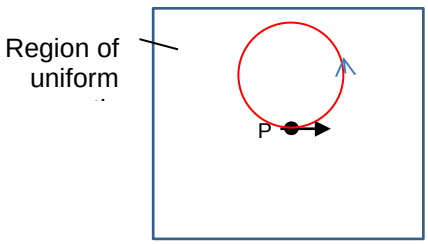
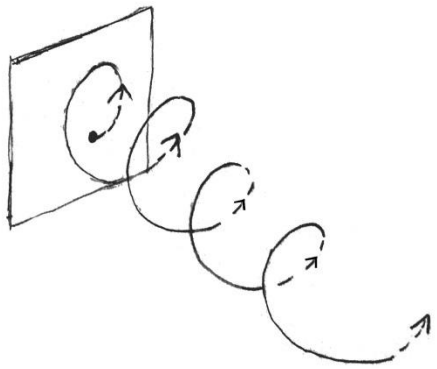
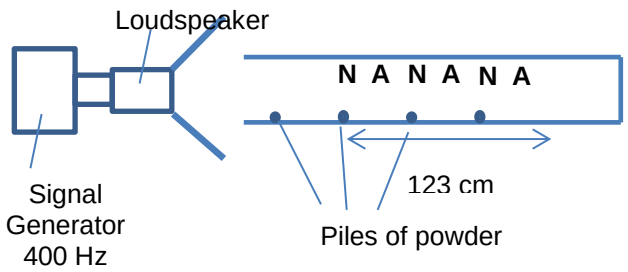
Qn	Suggested Guide	
2(a)(i)	$\frac{1}{2}m < c^2 >= \frac{3}{2}kT$ $\sqrt{< c^2 >} = \sqrt{\frac{3(1.38x10^{-23})(296)}{(5.3x10^{-26})}}$	
	= 481 m s^{-1}	
(ii)	According to Kinetic Theory, the **mean KE is the same** since at the **same temperature**. However as **mass is different** they have different rms speed.	
(b)	Reference made to **distribution of speeds**. (*ie idea on molecules having speed above and below rms speeds*)	
	For hydrogen the **probability** of molecules having speed greater than escaped speed is higher than oxygen *as rms speed is higher.*	
(c)	When molecule collide with the wall, the wall exerts a force on the molecule causing the molecule to experience a **change in momentum,** hence it rebounds.	
	By N3L, it exerts a force of the same magnitude back on the wall.	
	As there are **many molecules** moving about **randomly**, colliding with the wall, an **average constant force** and hence **pressure** is exerted on the wall.	

Qn		Suggested Guide	
3	(a)(i)		
	(ii) 1.	F_B = Bqv = 1.5 x 10^{-3} x 1.6 x 10^{-19} x 1.8 x 10^{7}	
		= 4.32 x 10^{-15} N (Shown)	
	2.	Magnetic force provides centripetal force for circular motion	
		$F_B = F_c$ $4.32\times10^{-15} = \frac{mv^2}{r}$ $r = \frac{9.11\times10^{-31}\times(1.8\times10^{7})^2}{4.32\times10^{-15}}$	
		$r = 0.068\ m$	
	(b)		
		The helical path has progressively larger pitch *(since F_E acts out of the plane of the paper* ⇨ *Electrons accelerates out)*	

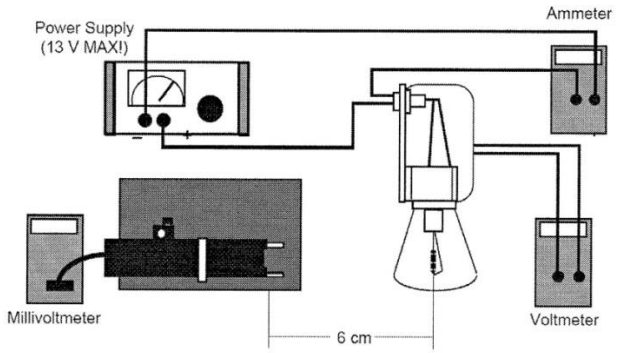
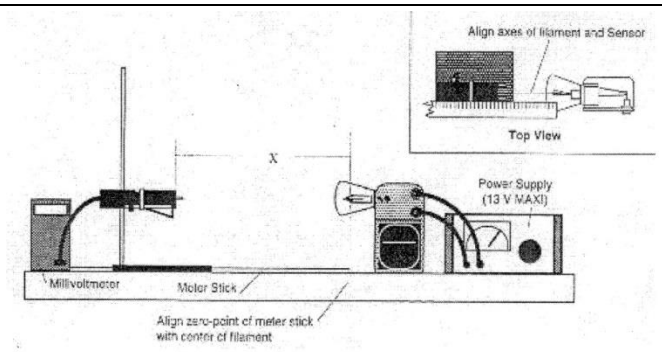
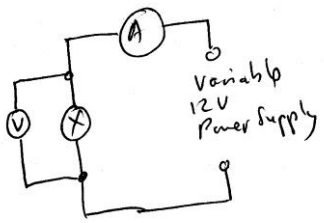
Qn	Suggested Guide	
4		
(a)(i)	Interference is observation in the **variation of the intensity** of the resultant wave when two of more waves meet due to the resultant displacement being given by the vector sum of the displacement of the individual wave.	
(b) (i)		
(b)(ii)	When the sound wave that are produced by the source is **reflected** at the glass boundary with a **phase difference of** π. The incident and reflected wave **overlaps** and as they have the **speed** and **frequency**, resulting in the formation of nodes and antinodes of a **standing wave** if the length of the tube is given by odd multiples of $\lambda/4$. The **piles of power gather at the nodes** as at the nodes no oscillation occurs.	
(b)(iii)	Wavelength of stationary wave =123 X 2/3 = 82 cm Hence speed of wave = 400 Hz X 0.82 m = 328 = 330 m	

Qn	Suggested Guide	
5(a)	Stimulated emission is triggered by an external photon whereas spontaneous emission happens on its own accord.	
(b)	In stimulated emission, a photon of energy equal to the energy difference between the metastable state and lower excited state will trigger the transition of the atom to the lower energy state.	
	This results in **2 emitted photons that have the same frequency and hence coherent.** In addition, the photons emitted are **in phase,** have the **same polarization and** are moving in the **same direction**	
	These photons further stimulate more photons that are in phase, creating a coherent beam of laser light of high intensity.	
(c)	Population inversion that is, there being more **excited atoms in the higher energy state than a lower one** is one of the conditions required	
	This ensures that **the probability that an incident photon will stimulated emission exceeds the probability that the photon will be absorbed** *as Incident photons can cause either stimulated absorption or stimulated emission.* (*If there is no population inversion, incoming photons will be more likely absorbed to cause excitation rather than to result in stimulated emission as upper energy level is unoccupied. It is required so that the stimulated emission dominates spontaneous emission in the excited atoms*.)	
(d)	**The 4 level system ensures there is always population inversion between E_3 and E_2 as E_2 undergoes rapid spontaneous emission to E_1** **This reduces the loss of photons by stimulated absorption between the upper (E_3) and lower (E_2) laser level.** (*Note Level 4 is practically empty due to fast spontaneous emission, hence any appreciable population accumulating in level 3, the upper laser level, will form a population inversion with respect to level 2. That is, as long as population in level 3 > 0, then a population inversion is achieved between E_3 and E_2.* Since only a few atoms must be excited into the upper laser level to form a population inversion, a four-level laser is much more efficient than a three-level one, and most practical lasers are of this type.)	
6(a)(i)	Count rate flunctuates / curve not smooth	
(ii)	The new graph should give the same half-life.	

(b)(i)	Alpha particle is **stopped in air**, hence cannot be detected.	
(ii)1.	As thickness of Al sheets increases, the count rate **decreases rapidly** as beta particles are stopped by mm of Al.	
(ii)2.	The count rate became a **constant** for thickness beyond 3 mm. This indicates presence of gamma particles as they are not stopped by mm of Al.	
(c)(i)	Total disintegrations $= 4\pi(7)^2[\frac{5.4x10^4/60}{3}]$ $= 184725.6\ s^{-1}$	
	$=18.5 \times 10^4\ s^{-1}$	
(ii)	$A = \lambda N$ $184725.6 = 4.80 \times 10^{-11}\ N$	
	Hence $N = 3.85 \times 10^{15}$	

Qn	Suggested Guide	
7(a)(i) 1	Electrostatic force provides the centripetal force	
	$F_E = F_C$ $\frac{e^2}{4\pi\varepsilon_o r^2} = \frac{mv^2}{r}$	
	$\frac{me^2}{4\pi\varepsilon_o r} = m^2v^2$	
	$p = \sqrt{\frac{me^2}{4\pi\varepsilon_o r}}$	
2	= 1.99 x 10^{-24} kg m s^{-1}	
(ii)	If momentum of electron in radial direction is fixed, then its uncertainty is zero. Using $\Delta\times\Delta p \geq \frac{h}{4\pi}$, $\Delta\times$ would be infinite. However the above model has a fixed radius.	
(b)(i)	$\Delta E = E_1 - E_2$ $= \frac{-(13.60)(Z-1)^2}{1^2} - \frac{-(13.60)(Z-1)^2}{2^2}$	
	$= -(10.2)(Z-1)^2\ eV$	
(ii)	$f = \frac{E_2 - E_1}{h}$ $= \frac{(10.2\times1.6\times10^{-19})(Z-1)^2}{(6.63\times10^{-34})}$	
	$= (2.46\times10^{15})(Z-1)^2$	
(c)(i)	7.72	
(ii)1.	Plot point at coordinates (28, 7.72) to half smallest square	
2.	Points evenly scattered on both sides of line	
(iii)	Knowing *A* = gradient Correct value of *A* (= 0.286 x 10^4)	
	-AB = vertical intercept = -0.281 x 10^4	
	Correct value of *B* (= 0.98)	
(d)	Calculate $\sqrt{\frac{1}{\lambda_\times}}$	
	To get the impurity as Zinc.	

Q8 – Suggested Mark Scheme and Proposed answers

Q8	*www.physics.nus.edu.sg/~L1000/PC1142/**StefansLaw**.pdf*; *personal.tcu.edu/zerda/manual/**lab**22.htm* (adapted)		
	(Annotate all marks awarded with the corresponding alphabet)		
	Basic procedure (2 marks)		
	Radiation from lamp directed to radiation sensor	B1	
	Vary Power/voltage supplied to lamp, find power radiated	B1	(max B2)
	Diagram (2 marks)		
			
OR	 		
	Sensor connect to DMM (voltmeter) / data logger /–Mentioned radiation meter gives direct reading	**D1**	
	Electrical circuit for lamp given (allow use of ohmmeter to measure resistance.)	D1	(max D2)

	Measurements (2 marks)		
	Determination the resistance R and temperature T of the filament 1. For each voltage setting, using the corresponding values of I and V from the ammeter and voltmeter respectively, calculate the corresponding resistance R_T of the filament using $R_T = \frac{V}{I}$ Or mention use of ohmmeter to give readings for each value of PS. 2. Calculate the ratio of $\frac{R_T}{R_{ref}}$; the corresponding temperature T can be determined from the graph of $\frac{R_T}{R_{ref}}$ against T.	M1	
	Determination of Power Radiated from Bulb For each T, record readings of Power radiated from the voltmeter which is a measure of the power radiated.	M1	**Max 2**
	Analysis (1 mark)		
	Assuming that the power *P* radiated by the filament is proportional to T^n (or $(\frac{R_T}{R_{ref}})^n$)where *n* is a constant, plot a graph of log P against log T (or log $(\frac{R_T}{R_{ref}})$)to investigate how *P* depends on *T*. The gradient will give *n if a straight line graph is obtained.* *(Accept any other suitable analysis including)* *(Do not accept if student only mentioned plotting of graph without equation involved)*	A1	**(Max A1)**
	Control of variables (1 marks)		
	Radiation sensor should be kept at a fixed distance from the filament.	C1	
	Radiation sensor should be set at the same height as the filament.	C1	
	Alignment of filament with respect to sensor window that is angle of inclination of filament to the vertical should be kept fixed	C1	**(Max C1)**
	Further details (3 marks)		
	mV range used to measuring o/p from sensor	F1	
	For each voltage setting of the power supply, be brisk when recording the data points and the sensor readings as lamp will begin to heat up the sensor.	F1	
	In between readings cover shield the sensor with aluminized foam-core board, with aluminized side facing the bulb.	F1	
	Remove all other objects in the vicinity of the radiation sensor to ensure that its output is not influenced by extraneous radiation sources.	F1	**(Max F3)**
	Satety (1 mark)		
	Bulb used in this experiment will cause burns if you touch it; do not move the bulb while it is on, but if necessary move it by the base only.	S1	
	Place bulb on good footing as it is light and could tip over easily.	S1	
	Do not exceed voltages of 12 V or currents of 3 A on the bulb filament.	S1	
	When maximum power voltage is reached gradually turn down the voltage to 0 V and turn off the supply.	S1	**(Max S1)**