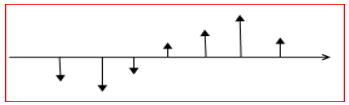
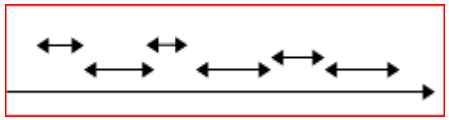
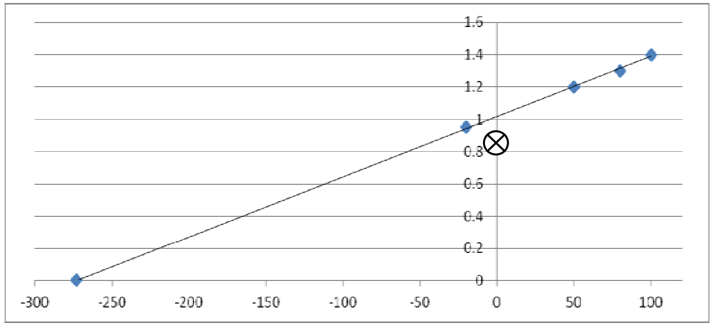
Question number		Answer	Notes	Marks
2 (a) (i)		B- 2 cm		1
(ii)		C- 8 cm		1
(b)		Idea that in a transverse wave the direction of vibration is perpendicular to the direction of the wave; (May be shown with labels on the diagram) Idea that longitudinal wave the direction of vibration is parallel to the direction of the wave; (May be shown with labels on the diagram) A named freehand sketch of either wave indicating the two directions; e.g.  transverse  Longitudinal	Allow (for vibration) oscillation / displacement / disturbance (for direction of wave) direction of travel / energy / transfer (for perpendicular) at right angles, is ⊥ to (for parallel) the same as, // the minimum labeliing is to name of the type of wave they have drawn. Allow sine waves with appropriate arrows Allow diagrams indicating compression and rarefaction e.g. in a spring Allow for 1 mark (but only if other mark is scored) a comparison of the directions of vibration of both waves without relating them to the direction of the wave e.g. transverse vibrates up and down but longitudinal vibrates back and forward	3
(c)		any two of		2

			MP1 can travel through vacuum OR needs no medium; MP2 speed (in a vacuum) OR speed = 3 X10^8 (m/s); MP3 obeys laws of reflection / refraction; MP4 obeys wave equation OR speed = frequency × wavelength; MP5 carries energy/ information; MP6 they are transverse	"speed in a vacuum" where seen, scores 2 marks (MP1 and MP2) Accept reflect, refract, diffract	
(d)	i		D - X-rays		1
	ii		A – absorbed by the bone		1
	iii		X-rays OR gamma rays idea of causing damage to cancer cells e.g. cells killed/mutated/ionised/destroys;	allow symbol γ do not allow UV Independent mark	2

<table>
<tr><td>3 (b) (i)</td><td></td><td>Plotting to nearest half-square (minus one for each plotting error, up to max 2 marks) ;;

line of best fit that intersects x-axis between -250 and -300;</td><td rowspan="2"><table><tr><th>Temperature in °C</th><th>Volume in litres</th></tr><tr><td>− 20</td><td>0.95</td></tr><tr><td>0</td><td>0.85</td></tr><tr><td>50</td><td>1.20</td></tr><tr><td>80</td><td>1.30</td></tr><tr><td>100</td><td>1.40</td></tr></table></td><td>3</td></tr>
<tr><td>(ii)</td><td></td><td>point (0, 0.85) circled or otherwise indicated;

 
</td><td>1</td></tr>
<tr><td>b(iii)</td><td></td><td>Reading from graph to nearest small square (±5 degrees);</td><td></td><td>1</td></tr>
</table>

(b)	(i)		any two of MP1 increase magnetic field(e.g. stronger magnets or magnets closer or magnets curved round coil); MP2 increase current OR voltage Or more cells; MP3 increase number of turns (on coil); MP4 a sensible alternative suggestion e.g. use two or more sets of coils at angles, lubricate axle;	 Allow “use thicker wire” Ignore “stronger battery” Allow idea of 3 phase supply, iron stator	2
	(ii)		Suggestion that clearly results in reversal of the current OR the cell connections OR the magnet’s field;		1
(c)			any two of MP1 Idea that force is increased (by stronger field); MP2 Idea of radial magnetic field (rather than a uniform one); MP3 Coil remains in the field for a longer time;	 Allow idea that iron is magnetised Allow idea that magnetic field acts “all the way around” Allow idea that force acts over a larger part of a cycle	2

Question number		Answer	Notes	Marks
12 (a)		A description to include any 5 of MP1 nucleus absorbs neutron OR nucleus hit by neutron; MP2 splits into (two) fragments/parts OR daughter atoms OR daughter nuclei; MP3 extra neutrons released; MP4 (kinetic) energy released; MP5 released neutrons hit further nuclei OR uranium nuclei; MP6 moderator slows down the neutrons/ makes it more likely for a neutron to be absorbed; MP7 control rods absorb extra neutrons; MP8 idea that control rods help prevent a "runaway" chain reaction;	Correct process using consistently incorrect particle instead of neutron (e.g. electron) = max 4 NB uranium, U-235 or nucleus must be mentioned Reject cells, molecules, more uranium Ignore heat allow atoms OR uranium atoms	5
(b)		kinetic/movement energy;		1
(c)		Idea that the shielding **absorbs** radiation / particles / energy;	Allow "stops radiation /particles from escaping" Ignore "radioactvity" escaping	1
			Total	**12**

Question number	Answer	Notes	Marks
13 (a) i	there is a voltage; And one of (because there is a) change of flux OR field (lines) are cut; (which is) an induced voltage / emf;	 Allow induced current	2
ii	greater deflection/voltage; Idea that rate of change of flux (linkage) is greater; eg more magnetic field lines cutting coil (per second)	 ignore speed of magnet	2
(b) i	Idea that deflection is smaller;		1
ii	Idea that deflection is greater;		1
iii	Idea that deflection is in opposite direction;		1
		Total	**7**