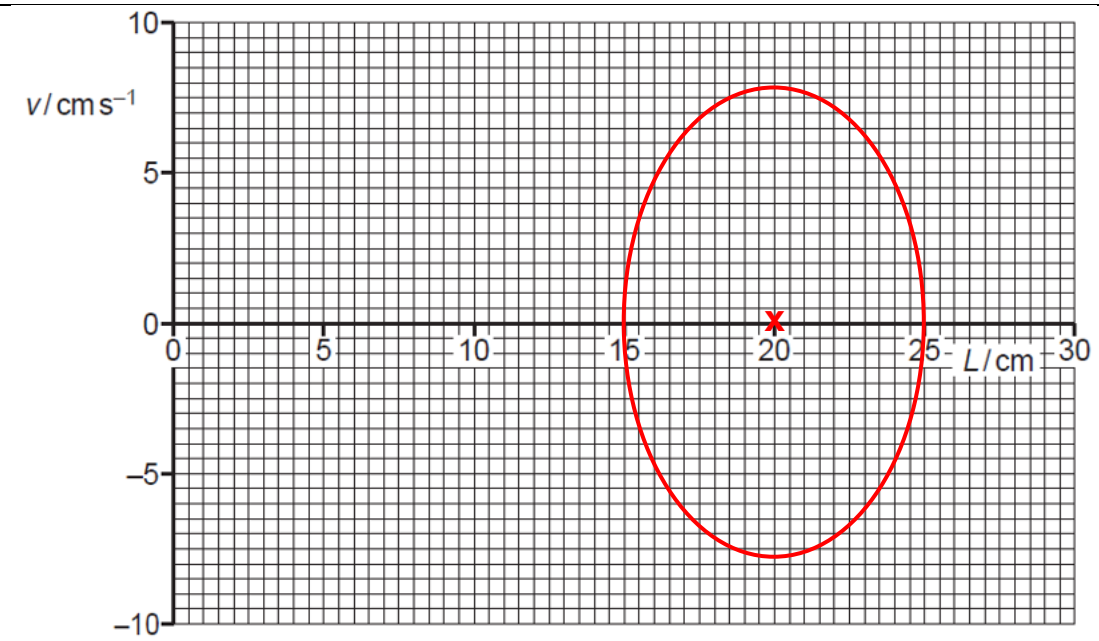
Anderson Serangoon Junior College 2025 H2 Physics P2 Prelim Mark Scheme

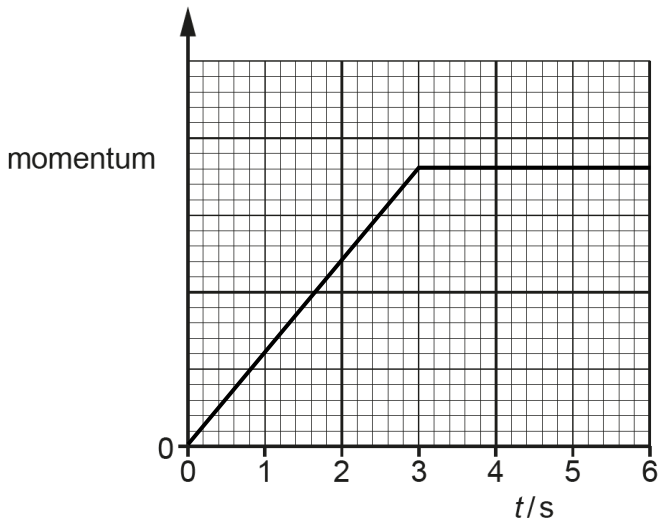
Paper 2 (60 marks) **E – Easy, A – Average, D – Difficult**

ECF	Error carried forward	**SF**	Significant figures error	**M0**	No A marks awarded
AE	Arithmetic error	**BOD**	Benefit of doubt	**^**	More is needed in answer
POT	Power of ten error	**CON**	Contradictory response	**XP**	Wrong physics
TE	Transcription error	**IR**	Irrelevant (part) response		

1ai	$g = (4\pi^2 \times 1.50) / (2.48^2)$ $= 9.63$ m s^{-2} *Examiner's comments:* Most answers were correct. A small number of students incorrectly left the answer in 1 or 2 s.f. though the least s.f. of data in the question is 3.	**E**	A1
1aii	percentage uncertainty = 2 + (3 × 2), OR fraction uncertainty = 0.02 + (0.03 × 2) actual uncertainty = 0.08 × 9.63 = 0.8 m s^{-2} *Examiner's comments:* Many answers showed lack of understanding/familiarity of use of percentage uncertainty.	**A**	C1 A1
1bi	$\omega = 2\pi / T$ $= 2\pi / 4.0$ $= 1.57$ rad s^{-1} $v_0 = \omega x_0$ $= 1.57 \times 5.0$ $= 7.9$ cm s^{-1} (2 s.f.) *Examiner's comments:* Period and amplitude have to be read to half the smallest square. Some answers were obtained through the gradient approach, but since the tangent was not accurately drawn, their answers did not fall within the acceptable range. Hence, in this case the calculation approach is preferred.	**A**	B1 B1
1bii	• initial pull was to the right/initial motion is toward the left • distance from X to trolley at equilibrium is 20 cm • initial motion undamped, then motion becomes (lightly) damped at/from 12 s • maximum speed at 1 s, 3 s, etc. / stationary at 2 s, 4 s, etc. *Any two points, 1 mark each* *Examiner's comments:* Since this question refers to the given graph, quantities must be quoted where relevant (e.g. time when damping begins), except if the quantities had been determined in part (b)(i), as per instruction of the question. The key word "exponentially" is often missing when describing decrease in amplitude (e.g. amplitude decreases exponentially".	**A**	B2

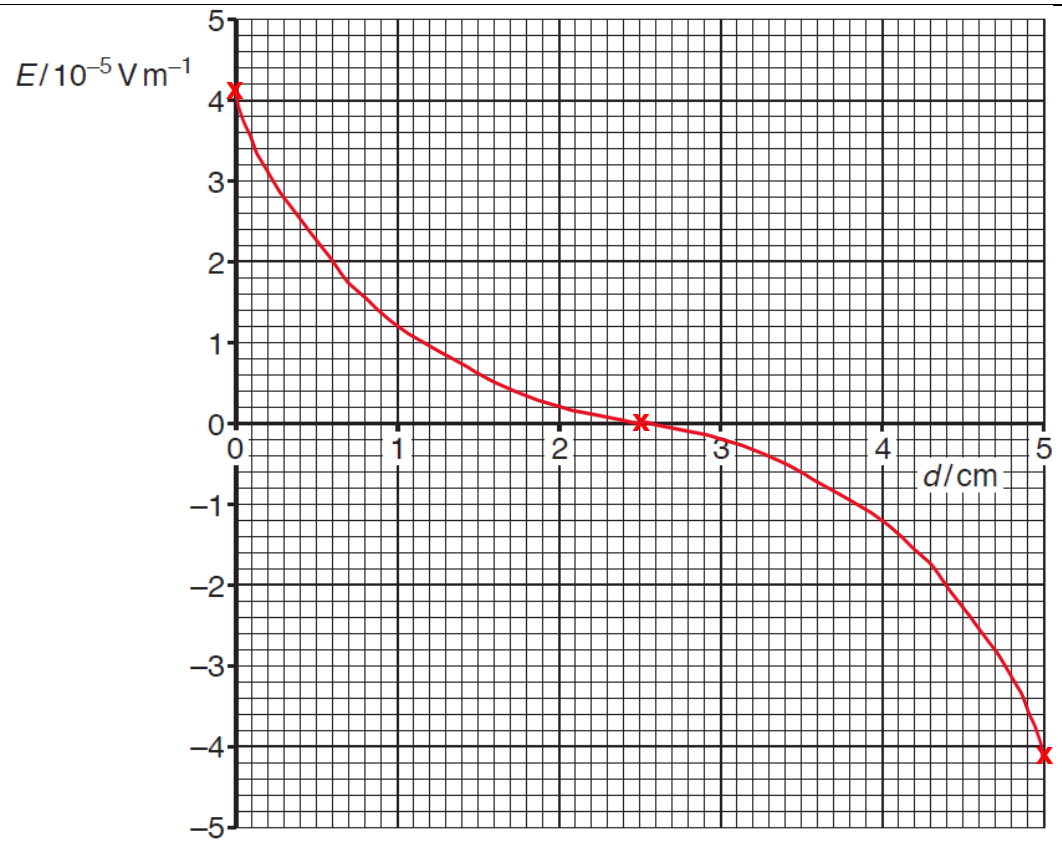
1biii	 sketch: minimum *L* shown as 15 cm and maximum *L* shown as 25 cm minimum *v* shown as –7.9 cm s^{-1} and maximum *v* shown as +7.9 cm s^{-1} *Examiner's comments:* Many did not draw the ellipse shape properly, which resulted in mark deduction.	**D**	 B1 B1

2ai	change in momentum = (1.40 – 0.40 – 0.80 sin 30°) x 3.0 = 1.80 kg m s^{-1} *Examiner's comments:* Unable to determine the net force acting on the block for the specified time interval. Working for net force and the concept of Ft was not clearly demonstrated to meet the demand of a "Show" question. Many did not read graph to half smallest division. Need to indicate the smallest division even if the last digit is a "zero".	**A**	M2 A0
2aii	resultant force (on block) is zero (so) velocity is constant *Examiner's comments:* Those who were unable to determine the net force in earlier part often encountered difficulty in this part. Some concluded the velocity wrongly with the correct net force.	**D**	B1 B1
2aiii	0 to 3.0 s: upward sloping straight line from the origin. 3.0 to 6.0s: horizontal line at non-zero value of momentum with no 'step change' in momentum at 3.0 s	**A**	B1 B1

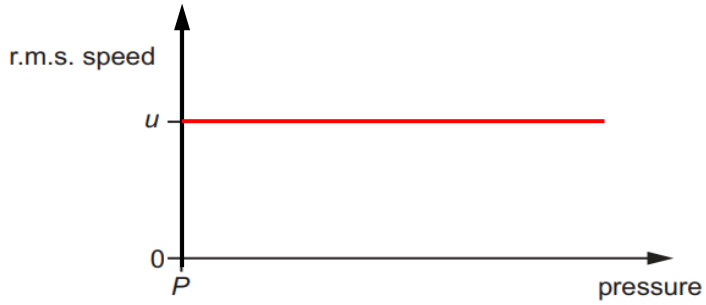
	 *Examiner's comments:* Many could obtain the correct answer for 0 to 3 s only. Common mistakes seen for 3 to 6 s included a step changed at 3 s and a non-linear line drawn.		
2bi	total initial momentum is not zero (in the absence of an external force,) the total momentum can never be zero, hence stopping at different times. **or** force on each nucleus is equal in magnitude (by N3L) with different mass, they have different magnitudes of deceleration and hence stopping at different times. *Examiner's comments:* Many students merely define COLM or stated "by COLM" without applying COM into the context of the question. Students need to state explicitly that the **total** initial momentum value is **non-zero** and to recognize that **total** final **cannot be zero**. By stating "total final momentum must be non-zero" merely regurgitated COLM and did not contextualize to the event when the nuclei stop at the same instant. Many students were not sensitive/clear with their choice of words used in explanations which could bring about different understanding, eg. "initial momentum is zero" is not the same as "total initial momentum is zero".	**D**	M1 A1 A0 (M1) (A1) (A0)
2bii	curve with positive final speed same change in momentum **or** total momentum remains constant **or** same force (N3L) since mass of P > mass of Q, **change** in velocity of Q > **change** in velocity of P **or** curve with positive final speed (Speed of approach = speed of separation) Speed of approach or speed of separation is positive value Hence, speed of Q > speed of P	**D**	B1 M1 A1 (B1) (M1) (A1)

	Examiner's comments: Many students merely stated COLM or RSS = RSA without applying them into the context of the question.		

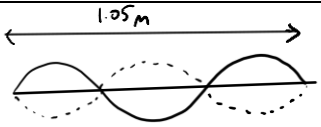
3ai	(tangent to) line gives direction of force on a (small test) mass	**E**	B1
3aii	(tangent to) line gives direction of force on a (small test) positive charge *Examiner's comments:* This recall-type question was generally not answered well.	**E**	B1
3b	similarity: lines are radial / greater separation of lines with increased distance from the sphere/ lines normal to the surface difference: gravitational lines directed towards sphere and electric lines directed away from sphere *Examiner's comments:* The answer must take into account relevance to the "positively charged sphere" context. Some answers showed that candidates lack of use of proper terms such as "radial", or incorrectly use the term "uniform".	**A**	B1 B1
3ci	$E = Q / 4\pi\varepsilon_0 r^2$ or $E = kQ / r^2$ with k defined / substituted in $4.1 \times 10^{-5} = [Q / (4\pi \times 8.85 \times 10^{-12} \times 0.025^2)] - [Q / (4\pi \times 8.85 \times 10^{-12} \times 0.075^2)]$ $Q = 3.2 \times 10^{-18}$ C *Examiner's comments:* This question was mostly answered well.	**A**	C1 C1 A1

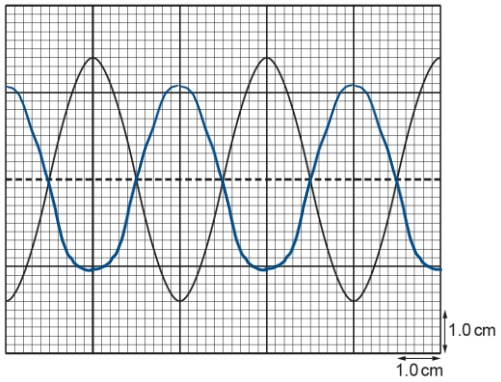
3cii	 smooth curve with gradient decreasing starting at (0, 4.1×10^{-5}) to d-axis at (2.5, 0) smooth curve with gradient increasing from (2.5, 0) ending at (5, -4.1×10^{-5}) *Examiner's comments:* The start and end of curve must be plotted to half the smallest square.	**A**	B1 B1
3ciii	acceleration decreases (to zero at mid-point) then acceleration increases in the opposite direction / increasing negative acceleration *Examiner's comments:* Many answers used as the verb "accelerated" which resulted in inaccurate descriptions. It is better to use the noun "acceleration" accompanied by its increase/decrease and its direction. (Note: deceleration is not always negative acceleration, as it depends on positive direction.)	**D**	B1 B1

4ai1 **4ai2**	total volume of molecules negligible compared to that of containing vessel molecules in random (and rapid) motion time of collision small compared with the time between collisions large number of (identical) molecules (any two of above, 1 mark each) *Examiner's Comments:* Many students did not read the question carefully and stated assumptions that are already implied in the question such as elastic collisions and no intermolecular forces between molecules.	**E**	B1 B1

	Students to take note that for assumption on comparing the volume of the molecules with the volume of the container, it must be the total volume of the molecules, not the volume of a molecule. Volume of the gas is also not accepted as the volume of gas is the same as the volume of the container.		
4aii	(random) kinetic energy increases with temperature no potential energy (so increase in temperature increases internal energy) *Examiner's Comments:* For this part, students need to be explicit in mentioning that there is no potential energy for idea gas to gain credit. Many students went on to give irrelevant or incorrect details about the movement of the molecules, pressure, volume of the gas when temperature increases. Students are to take note that the relationship between kinetic energy and temperature must be clear to gain credit.	**E**	B1 B1 A0
4aiii	Horizontal straight line passing through (P, u) The gas remains in thermal equilibrium with the surroundings, the temperature of the gas remains constant during compression. Since the r.m.s. speed depends on temperature, and temperature is constant, the r.m.s. speed of the oxygen molecules will also remain constant as the pressure increases.  *Examiner's Comments:* Many students were not able to gain credit. Many thought that the r.m.s speed will increase which is incorrect as the temperature remains constant.	**D**	B1
4b	gas expands so work done by gas (against atmosphere) no time for thermal energy Q to enter or leave the gas (Since $\Delta U = Q + W_{on\ gas}$ and hence ΔU is negative) U decreases *Examiner's Comments:* Many students were able to gain credit on recognizing work is done by the gas during expansion. Some were confused and wrongly described work done by gas increases instead of work done by gas is positive. The concept of positive or negative work done is not the same as work done increase or decreases. Many were not able to gain full credit as they were not able to deduce and explain that Q=0. A handful of students did not seem to know 1st law of thermodynamics.	**D**	M1 M1 A1

5a	1. Stationary does not advance while progressive wave advances in the direction of energy transfer of the wave. 2. For stationary wave, no energy is carried along the wave and the energy is stored as the kinetic and potential energy of the vibrating particles while energy is carried along in the direction of wave propagation for progressive wave.	**E**	B2

	3. For stationary wave, the amplitude of oscillations of the particles varies according to their positions, particles at the antinodes oscillate with maximum amplitude and particles at the nodes do not oscillate and have zero amplitude while for progressive wave, the amplitude of oscillations are the same for all particles in the wave regardless of position (assuming no energy loss), equal to the amplitude of the wave. 4. For stationary wave, all particles have the same phase within 2 adjacent nodes and particles in adjacent segments are π radians out of phase while for progressive wave, particles have different phases (0 to 2π) within a wavelength. Any 2 of the above. *Examiner's Comments:* • Some students went to describe the conditions to form stationary wave – NAQ. • Some students attributed the properties of transverse waves to stationary/progressive waves, and attributed the properties of longitudinal waves to the other. This is a misconception. Both stationary and progressive waves can be either transverse and longitudinal waves. • Poor phrasing from some students e.g. the particles have different phases for the entire wave in a progressive wave. This is only correct if the wave has exactly one wavelength.		
5bi	The incident sound wave travels towards the metal sheet and get reflected off the sheet. The incident and reflected waves travelling in opposite directions towards each another superpose, resulting in the formation of stationary wave *Examiner's comments:* The explanation of which waves formed the stationary wave was not always clear. E1: Used two waves instead of incident and reflected waves travelling in opposite directions or did not used 'superpose'; used wrong word (interfere, superimpose(everyday English)) or gave general answers about how standing waves are formed rather than relating to the situation described.	**A**	B1 B1
5bii	Microphone passes through 3 node-to-node separations Node-to-node separation is $\lambda/2$ $d = 1.5\,\lambda$ Any of the above line λ = 1.05 / 1.5 = 0.70 m  *Examiner's comments:* Some students misunderstood the question, and some unaware that the distance between successive nodes = $\lambda/2$.	**A**	 C1 A1
5ci	Intensity $\propto \frac{1}{\text{distance}^2} \propto$ amplitude^2 $A \propto \frac{1}{r}$ So $\frac{A_2}{A_1} = \frac{r_1}{r_2}$ $A_2 = \frac{1.05}{1.40} \times 2.8 = 2.1$ cm *Examiner's comments:* E1: many did not show their working, even though the question asked for it.	**A**	B1 A1

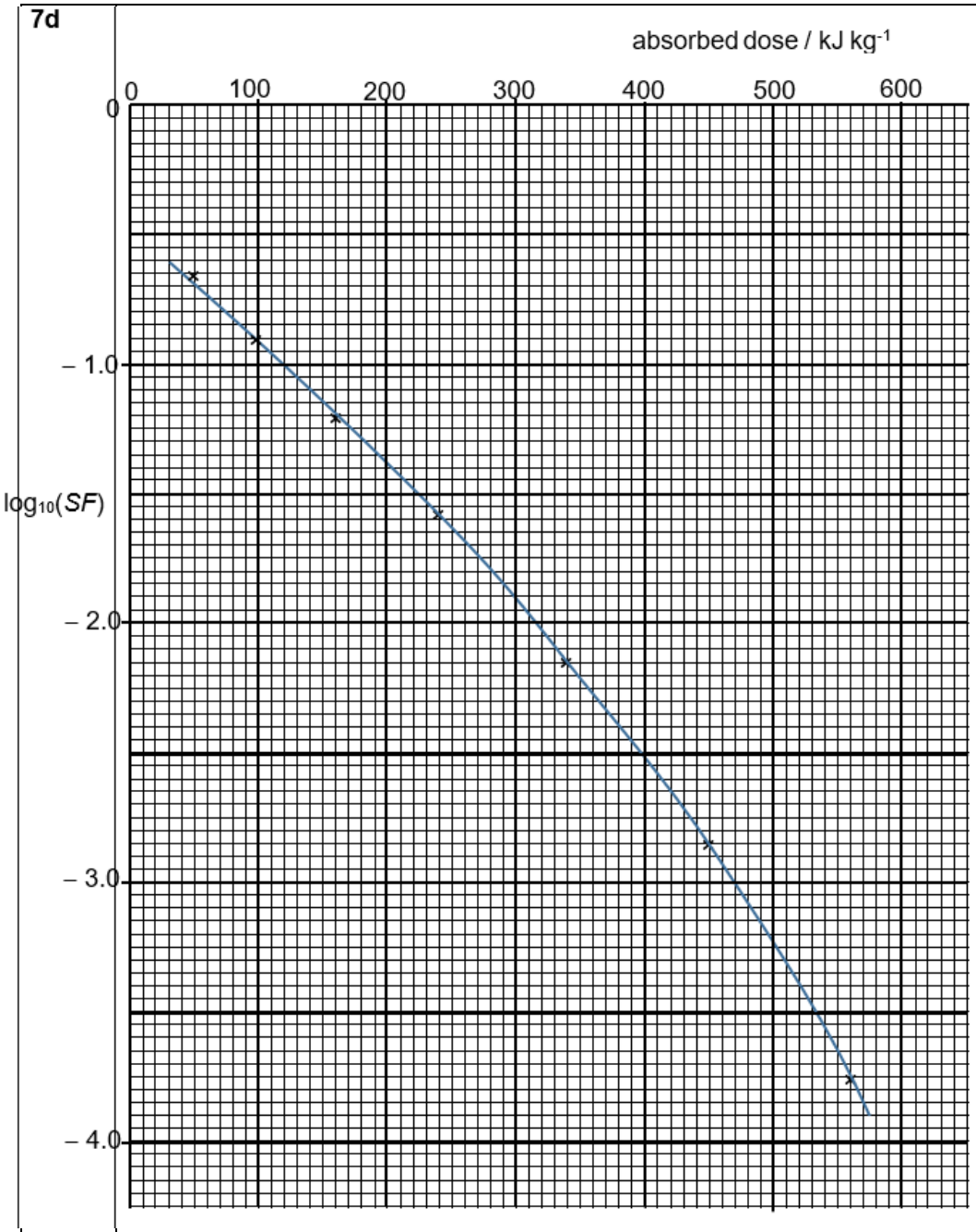
5cii	 period same as original, with amplitude 2.1 cm Phase difference of 180° from original *Examiner's comments:* E1: wrong amplitude given E2: wrong phase difference E3: phase difference does not match wavelength given in b(ii)	**D**	B1 B1

6ai	energy <u>required</u> to separate nucleons of nucleus **to infinity** <u>Examiner's Comments:</u> • One of the above definitions will suffice. • Note whether it is <u>released</u> or <u>required</u>, depending on the definition written. • Important to mention "constituent particles" or nucleons. • Note that the definition deals with nucleus, not atoms nor element.	**E**	A1
6aii	binding energy per nucleon is a maximum at around A = 56 products (of splitting a ^{56}Fe nucleus) must have a lower (total) binding energy (reaction would require) a net input of energy <u>Marking points:</u> 1st B1: Binding energy per nucleon is maximum for Fe 2nd B1: Compare BE or stability or mass between reactants and products 3rd B1: Indicate that energy input is needed <u>Examiner's Comments:</u> • Many added that "binding energy is equivalent mass defect" which is incorrect. Binding energy is the "<u>energy equivalent</u> of mass defect" or "mass defect × c^2". • This question was poorly done due to many incorrect understandings e.g. equal mass before and after reaction hence no net energy released.	**D**	B1 B1 B1
6bi	mass defect of uranium, Δm = 236.909 u – 235.044 u = 1.865 u given that energy equivalent to a mass of 1.00 u is 934 MeV, binding energy of uranium = 1.865 u × 934 = 1.742 MeV binding energy per nucleon of uranium = 1.742 / 235 = 7.412 MeV	**A**	C1 C1 A1

	Examiner's comments: Some students did not use the given relationship "1u is equivalent to 934 MeV" to simplify their calculations. Students wrongly used mass of nucleus as nucleon number. Not all substitutions were clearly shown in the workings.		
6bii	energy = {(1.219 + 0.859) – 1.865)} × 934 **or** energy = (95 × 8.443) + (139 × 8.189) – (235 × 7.412) = 199 MeV *Examiner's comments:* E1: Some students obtained negative energy but did not explain why omit the negative sign in final their answer. E2: did not multiply nucleon number to find BE of each nucleus. E3: made assumption on the mass of neutron.	**A**	C1 A1
6biii	number of reactions = $1.2 \times 10^{-7} \times 6.02 \times 10^{23}$ $= 7.22 \times 10^{16}$ energy release (for one reaction) = $199 \times 1.60 \times 10^{-13}$ (= 3.18×10^{-11} J) power = $(7.22 \times 10^{16} \times 3.18 \times 10^{-11}) / (25 \times 10^{-3})$ $= 9.2 \times 10^{7}$ W *Examiner's comments:* E1: did not find the number of molecules. E2: did not convert energy to joules.	**A**	C1 C1 A1

7ai	Electrical energy to sound energy OR Sound energy to electrical energy *Examiner's comments:* Kinetic energy refers to motion of crystal, not the emitted ultrasound energy in the medium. Be careful with terms: use 'electric potential energy' for a charge in a field and 'electrical energy' for energy supplied or stored by a device. For example: the battery supplies electrical energy; moving a charge through a potential difference changes its electric potential energy.	**E**	A1
7aii	Ultrasound is a wave in which the displacements of the particles in the wave are along the direction of transfer of energy of the wave and Light is a wave in which the directions of the oscillations of electric field and magnetic field are perpendicular to each other and at right angles to the direction of transfer of energy of the wave. Or ultrasound is longitudinal and light is transverse Or ultrasound needs medium for propagation but light can propagation in vacuum Or ultrasound cannot be polarised and light can be polarised.	**A**	B1

	Examiner's comments: E1: • comparison is incomplete. Examples of complete comparison are: 'ultrasound is mechanical wave and light is electromagnetic wave', 'ultrasound is longitudinal and light is transverse' • avoid negatives – state properties positively. E.g: ultrasound needs a **medium** for propagation but light can propagation in **vacuum.** • misconception: 'there are no particle displacements in Light' is wrong; should be ' the electric and magnetic fields oscillate perpendicular to the direction of propagation. • 'speed/frequency of light is larger than that of ultrasound' is vague; should be 'speed of light is many orders of magnitude greater than that of ultrasound'.		
7aiii	$v = f\lambda$ distance $d = v\,t$ $= (5.0 \times 10^{6})(3.1 \times 10^{-4}) \times \frac{(52.0 \times 10^{-6})}{2}$ = 0.040 (0.0403) m *Examiner's comments:* *This question was mostly answered well.*	**E**	C1 C1 A1
7b	Exposure time $= \frac{\text{absorbed dose}}{\text{dose - rate}} = \frac{240 \times 10^{3}}{200}$ = 1200 s *Examiner's comments:* Some students missed key information in the passage.	**A**	C1 A1
7ci	The range of *SF* values is too large to be accommodated on a graph paper for the various absorbed doses. *Examiner's comments:* Many students could not explain why the survival fraction is plotted on a logarithmic scale.	**D**	A1
7cii	more time for heat to conduct away Or more time for cell to repair damage *Examiner's comments:* Many students described what a lower dose rate is instead of explaining why it leads to higher cell survival.	**A**	B1
7ciii	<table><tr><th>absorbed dose / kJ kg^{-1}</th><th>$\log_{10}(SF)$</th></tr><tr><td>50</td><td>– 0.65</td></tr><tr><td>100</td><td>–0.90</td></tr><tr><td>160</td><td>–1.20</td></tr><tr><td>240</td><td>–1.58</td></tr><tr><td>340</td><td>–2.15</td></tr><tr><td>450</td><td>–2.85</td></tr><tr><td>560</td><td>–3.75 OR –3.78</td></tr></table> *Examiner's comments:* Some did not read to half the smallest division. Smallest division for $\log_{10}(SF)$-axis is 0.05.	**E**	A1

7d		**A**	
	Point plotted correctly (accuracy up to half of a small square) best fit curve/ straight line drawn (number of points on either side of curve differ by 1) *Examiner's comments:* E1: in each half of the line the number of points above and below differ by more than 1 (instead of same number or differ by 1). E2: number of points on either side of curve/straight line differ by more than 1(instead of same number or differ by 1).	**E**	B1 B1
7ei	There are dips in the curves at (about) 200 W kg^{-1} for the higher absorbed doses. *Examiner's comments:* Incorrect term — this is a dip (decrease), not a spike (increase).	**A**	A1

7eii	The curve is almost linear at low doses, and the gradient of the curve decreases at higher doses (the magnitude of the gradient of the curve increases at higher doses) *Examiner's comments:* Some students did not provide sufficient evidence to support their answers.	**D**	B1 B1
7f	diagnostic imaging: dose-rate: <1 W kg^{-1} Explanation: In order not to damage tissues, survival fraction needs to be high / close to 1. (for info, realistic values range from 10^{-4} to 10^{-2} W kg^{-1}) therapeutic ablation: dose-rate of 200 W kg^{-1} explanation: lower survival fraction *Examiner's comments:* Many students gave dose-rate of 35 W kg^{-1} for diagnostic imaging without realising that SF is still very high. When dose-rate of 35 W kg^{-1}, log SF is -0.48. $10^{(-0.48)}$ = 0.33, it means only 33% of cells surviving after exposure. In order not to damage tissues, survival fraction needs to be high / close to 1.	**A**	B1 (B1) B1 B1