Pearson Edexcel

Mark Scheme (Results)

October 2024

Pearson Edexcel International Advanced Level In Physics (WPH15) Paper 01 Thermodynamics, Radiation, Oscillations and Cosmology

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Mark scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. **It is not a set of model answers.**

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the MS has specified specific words that must be present. Such words will be indicated by underlining e.g. '<u>resonance</u>'

1.2 Bold lower case will be used for emphasis e.g. '**and**' when two pieces of information are needed for 1 mark.

1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".

1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.

2.2 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in epen.

2.4 Occasionally, it may be decided not to insist on a unit e.g the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.

2.5 The mark scheme will indicate if no unit error is to be applied by placing brackets around the unit.

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not prevent a mark being awarded if the answer given rounds to the answer in the MS.

3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.

3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.

3.4 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

3.5 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

4. Calculations

4.1 **use of** the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.2 If a 'show that' question is worth 2 marks, then both marks will be available for a reverse working. If the question is worth 3 marks then only 2 marks will be available.

4.3 The mark scheme will show a correctly worked answer for illustration only.

5. Quality of Written Expression

5.1 Questions that asses the ability to show a coherent and logically structured answer are marked with an asterisk.

5.2 Marks are awarded for indicative content and for how the answer is structured.

5.3 Linkage between ideas, and fully-sustained reasoning is expected.

Question Number	Answer	Mark
1	**A is the only correct answer** B is not the correct answer, as alpha radiation is the least penetrating C is not the correct answer, as beta radiation is only moderately ionising D is not the correct answer, as gamma radiation is the most penetrating	**1**
2	**A is the only correct answer**, as ductile materials deform plastically	**1**
3	**D is the only correct answer** A is not the correct answer as, intensity depends upon luminosity and distance B is not the correct answer as, no information about mass can be deduced C is not the correct answer as, no information about radius can be deduced	**1**
4	**D is the only correct answer**, as $a \propto -x$	**1**
5	**C is the only correct answer**, as $\Delta E_{\text{grav}} = m\Delta V$ and ΔE_{grav} must be negative	**1**
6	**B is the only correct answer**, as $T = 2\pi\sqrt{\frac{m}{k}}$ and $f = \frac{1}{T}$	**1**
7	**B is the only correct answer** A is not the correct answer, as for this condition the universe would expand forever C is not the correct answer, as density not mass determines the fate of the universe D is not the correct answer, as density not mass determines the fate of the universe	**1**
8	**B is the only correct answer** A is not the correct answer, as this is a red giant star C is not the correct answer, as this is a red giant star D is not the correct answer, as this is white dwarf star	**1**
9	**D is the only correct answer**, as force is exactly out of phase with the displacement	**1**
10	**B is the only correct answer**, as force is proportional to the gradient of the velocity-time graph	**1**

Question Number	Answer		Mark
11	Use of $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$	(1)	
	Internal energy = 7300 J	(1)	2
	[Do not credit a calculation of *NkT*, as the internal energy is not equal to *pV*]. <u>Example of calculation</u> Mean kinetic energy per molecule = $\frac{3}{2}kT$ So internal energy = $N \times \frac{3}{2}kT$ Internal energy $= 1.20 \times 10^{24} \times \frac{3}{2} \times 1.38 \times 10^{-23}\ \mathrm{J\ K^{-1}} \times 293\ \mathrm{K}$ Internal energy = 7280 J		
	Total for question 11		**2**

Question Number	Answer	Mark
12	Use of $\Delta E = mc\Delta\theta$ **(1)** Use of $\Delta E = mL$ **(1)** Equates energy changes **(1)** (energy from copper = energy to increase temperature of tin + energy to melt tin) $\theta = 1390$ K **(1)** <u>Example of calculation</u> Energy transferred from copper $= 10.5\text{ kg} \times 572\text{ J kg}^{-1}\text{ K}^{-1} \times (1520\text{ K} - \theta)$ $\therefore$ Energy transferred from copper $= 9.13 \times 10^6\text{ J} - 6.00 \times 10^3\text{ J K}^{-1}\,\theta$ Energy transferred to tin = $2.7\text{ kg} \times 214\text{ J kg}^{-1}\text{ K}^{-1} \times (\theta - 295\text{ K}) + 2.7\text{ kg} \times 5.92 \times 10^4\text{ J kg}^{-1}$ Energy transferred to tin $= 578\,\theta - 1.70 \times 10^5\text{ J} + 1.60 \times 10^5\text{ J}$ $\therefore$ Energy transferred to tin $= 1.00 \times 10^4\text{ J} + 578\text{ J K}^{-1}\,\theta$ Energy transferred from copper equals energy transferred to tin $\therefore 9.13 \times 10^6\text{ J} - 6.00 \times 10^3\text{ J K}^{-1}\,\theta = 1.00 \times 10^4\text{ J} + 578\,\theta$ $\therefore 9.12 \times 10^6\text{ J} = 6.58 \times 10^3\text{J K}^{-1}\,\theta$ $\therefore \theta = \dfrac{9.12 \times 10^6\text{ J}}{6.58 \times 10^3\text{ J K}^{-1}} = 1386\text{ K}$	4
	Total for question 12	**4**

Question Number	Answer	Mark
13	$T = 2\pi\sqrt{\frac{L}{g}}$ applied to obtain an expression for ω or v **(1)** [Allow MP1 if the expression for T is given for both pendulums] $\omega = \frac{2\pi}{T}$ substituted **(1)** $v = \omega A \sin \omega t$ used with $\sin \omega t = 1$ [allow r for A] **(1)** $E_k = \frac{1}{2}mv^2$ applied with $v = \omega A$ **(1)** $(E_k)_{L/2} = 2(E_k)_L$ so student's suggestion is incorrect **Or** KE of shorter pendulum is twice KE of longer pendulum so student's suggestion is incorrect **(1)** [Valid methods may involve derived expressions for E_k, e.g. $E_k = \frac{1}{2} m A^2 \frac{g}{l}$] [Valid methods may involve the use of ratios]	5
	Total for question 13	**5**

Question Number	Answer		Mark
14	Calculates volume of bubble **Or** uses V proportional to d^3 Pressure at bottom of lake = atmospheric pressure + pressure due to depth of water Conversion of temperature to kelvin Use of $pV = NkT$ [Allow $\frac{pV}{T}$ = a constant] Diameter = 2.1×10^{-3} m <u>Example of calculation</u> $V_b = \frac{4}{3}\pi\left(\frac{1.5 \times 10^{-3}\text{m}}{2}\right)^3 = 1.77 \times 10^{-9}\ \text{m}^3$ $p_b = 1.02 \times 10^5\ \text{Pa} + 1.56 \times 10^5\ \text{Pa} = 2.58 \times 10^5\ \text{Pa}$ $\frac{1.02 \times 10^5\ \text{Pa} \times V_t}{2.58 \times 10^5\ \text{Pa}\ \times 1.77 \times 10^{-9}\ \text{m}^3} = \frac{(18 + 273)\ \text{K}}{(6.0 + 273)\ \text{K}}$ $\therefore V_t = \frac{1.04 \times 4.57 \times 10^{-4}\ \text{Pa m}^3}{1.02 \times 10^5\ \text{Pa}} = 4.67 \times 10^{-9}\ \text{m}^3$ $r = \sqrt[3]{\frac{3 \times 4.67 \times 10^{-9}\ \text{m}^3}{4\pi}} = 1.04 \times 10^{-3}\ \text{m}$ $\therefore$ Diameter $= 2 \times 1.04\ \times 10^{-3}\text{m} = 2.08 \times 10^{-3}\ \text{m}$	**(1)** **(1)** **(1)** **(1)** **(1)**	5
	Total for question 14		**5**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>15(a)</td><td>Substitutes values into $A = 4\pi r^2$

Use of $L = \sigma A T^4$

$L = 9.69 \times 10^{27}$ (W)

<u>Example of calculation</u>
$L = 5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4} \times 4\pi \times (1.18 \times 10^{9} \text{m})^2 \times (9940\ \text{K})^4$
$\therefore L = 9.685 \times 10^{27}$ W</td><td>(1)

(1)

(1)</td><td>3</td></tr>
<tr><td>15(b)</td><td>EITHER

Use of $I = \frac{L}{4\pi d^2}$

Ratio of intensities calculated

$\frac{I_S}{I_C} = 3.0$ (ecf for L from (a))

Sirius appears to be 3 times not twice as bright, so the claim is not accurate.
Or Ratio of intensities equals $3 \neq 2$, so the claim is not accurate.
[Allow a conclusion consistent with a comparison of calculated values for MP4]

<u>Example of calculation</u>
$I_S = \frac{(9.69 \times 10^{27}\ \text{W})}{4\pi \times (8.15 \times 10^{16}\ \text{m})^2} = 1.16 \times 10^{-7}\ \text{W m}^{-2}$

$I_C = \frac{(4.12 \times 10^{30}\ \text{W})}{4\pi \times (2.93 \times 10^{18}\ \text{m})^2} = 3.82 \times 10^{-8}\ \text{W m}^{-2}$

$\frac{I_S}{I_C} = \frac{1.16 \times 10^{-7}\ \text{W m}^{-2}}{3.82 \times 10^{-8}\ \text{W m}^{-2}} = 3.04$

OR

Use of $I = \frac{L}{4\pi d^2}$

2× $I_{Canopus}$ calculated

(2× $I_{Canopus}$) compared with I_{Sirius} (ecf for L from (a))
[e.g. $7.64 \times 10^{-8}\ \text{W m}^{-2} \neq 11.6 \times 10^{-8}\ \text{W m}^{-2}$]

Intensity of Sirius is not twice the intensity of Canopus , so the claim is not accurate
[Allow a conclusion consistent with a comparison of calculated values for MP4]</td><td>(1)

(1)

(1)

(1)

(1)

(1)

(1)

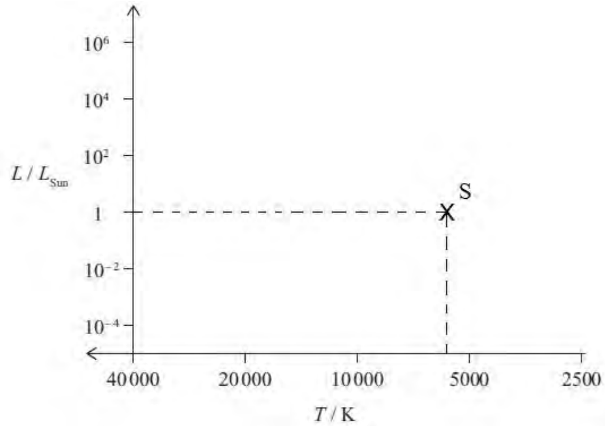
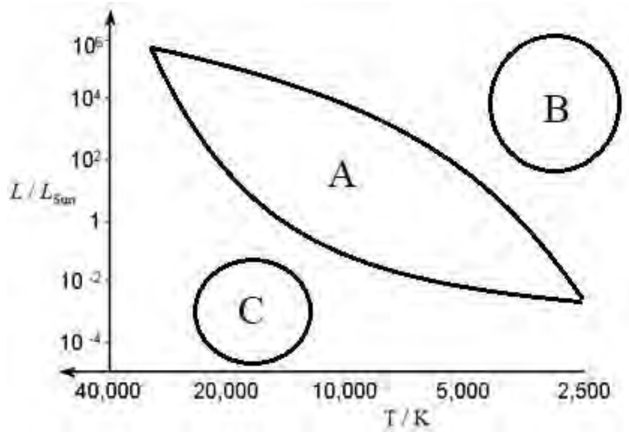
(1)</td><td>4</td></tr>
<tr><td></td><td>Total for question 15</td><td></td><td>7</td></tr>
</table>

Question Number	Answer		Mark
16	Add ice to water (in a beaker to bring temperature down to 0°C) Use thermometer (to measure temperature) [Allow 'sensor used to measure temperature' **or** 'temperature sensor'] Measure corresponding resistance on ohmmeter [Must be the idea that the reading is taken for a particular temperature] States method of heating (water) (e.g. (Bunsen) burner, electrical/immersion heater) [Allow water bath] Plot resistance against temperature [Allow symbols here e.g. a graph of R against θ] Stir the water (to ensure a uniform temperature) **Or** record temperature/resistance approx.. every 10°C [+/- 5°C] **Or** Place the thermometer near to the thermistor (to ensure that the thermistor is at the temperature measured by the thermometer) **Or** Stop heating and wait before taking readings **Or** Read thermometer at eye level	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**
	Total for question 16		**6**

Question Number	Answer		Mark
17(a)(i)	Arcturus/source/star is moving away (from observer) [Allow ‘receding’ for ‘moving away’] So there is a Doppler effect/shift **and** the wavelength (received) is greater [Acccept ‘red shift’ for ‘Doppler shift’]	(1) (1)	2
17(a)(ii)	Wavelengths of the two absorption peaks read from graph Use of $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ [must have λ_{Sun} in denominator] $v = 5.1 \times 10^4$ m s^{-1} [3.4×10^4 m s^{-1} → 6.8×10^4 m s^{-1}] [Do not accept values outside of this range that only round to the limits] Example of calculation $\Delta\lambda = (884.0 - 883.85) \times 10^{-9}$ m $= 1.5 \times 10^{-10}$ m $v = \frac{1.5 \times 10^{-10} \text{ m}}{883.85 \times 10^{-9} \text{ m}} \times 3.0 \times 10^8 \text{ m s}^{-1} = 5.09 \times 10^4 \text{ m s}^{-1}$	(1) (1) (1)	3
17(b)	Red shift of light from (distant) galaxy is determined/measured **Or** Change in wavelength ($\Delta\lambda$) of light from (distant) galaxy is determined/measured Velocity/speed (of distant galaxy) is calculated (using Doppler shift equation) $v = H_0 d$, is used to calculate/determine distance to distant galaxy [Allow reference to Hubble’s law rather than the equation]	(1) (1) (1)	3
	Total for question 17		**8**

Question Number	Answer		Mark
18(a)	Gravitational force equated to centripetal force Use of $\omega = \frac{2\pi}{T}$ **Or** Use of $v = \frac{2\pi r}{T}$ Conversion between seconds and days Ganymede would have made one complete orbit around Jupiter in 7.2 days, so 8 days would have been long enough **Or** Yes, because 7.2 days < 8 days [Must see correct value for orbital time for MP4 to be awarded. Allow orbital time in seconds if 8 days has been converted to 6.91×10^5 s.] <u>Example of derivation</u> $m\omega^2 r = \frac{GMm}{r^2}$ $\omega = \sqrt{\frac{6.67 \times 10^{-11}\text{ N m}^2\text{ kg}^{-2} \times 1.90 \times 10^{27}\text{ kg}}{(1.07 \times 10^9\text{ m})^3}} = 1.02 \times 10^{-5}\text{ rad s}^{-1}$ $T = \frac{2\pi\text{ rad}}{1.02 \times 10^{-5}\text{ rad s}^{-1}} = 6.18 \times 10^5\text{ s}$ $T = \frac{6.18 \times 10^5\text{ s}}{8.64 \times 10^4\text{ s day}^{-1}} = 7.15\text{ day}$	(1) (1) (1) (1)	4
18(b)(i)	Use of $g = \frac{Gm}{r^2}$ $g = 1.42\ (\text{N kg}^{-1})$ <u>Example of calculation</u> $g = \frac{6.67 \times 10^{-11}\text{ N m}^2\text{ kg}^{-2} \times 1.48 \times 10^{23}\text{ kg}}{(2.64 \times 10^6\text{ m})^2} = 1.416\text{ N kg}^{-1}$	(1) (1)	2
18(b)(ii)	Reference to $\frac{GM}{r^r}$ with $r_{\text{Ganymede}} = 1.5 \times r_{\text{Moon}}$ **Or** Reference to $\frac{GM}{r^r}$ with $r_{Moon} = \frac{2}{3} \times r_{\text{Ganymede}}$ So $M_{\text{M}} = \frac{M_{\text{G}}}{2.25}$ [Accept $M_{\text{M}} = \frac{4}{9} \times M_{\text{G}}$, $M_{\text{M}} = 0.44 \times M_{\text{G}}$, $M_{\text{M}} = 44\%$ of M_{G}] **Or** $M_{\text{Moon}} = 6.58 \times 10^{22}$ kg [$M_{\text{Moon}} < \frac{1}{2} \times M_{\text{Ganymede}}$ can gain MP2 if MP1 has been awarded]	(1) (1)	2
	Total for question 18		**8**

Question Number	Answer		Mark
19(a)(i)	Use of $F = mg$ Use of $\Delta F = k\Delta x$ $k = 45.3$ (N m^{-1}) [If g = 10 N kg^{-1} is used, then max 2 marks] Example of calculation $k = \frac{0.55 \text{ kg} \times 9.81 \text{ N kg}^{-1}}{11.9 \times 10^{-2} \text{ m}} = 45.3 \text{ N m}^{-1}$	**(1)** **(1)** **(1)**	**3**
19(a)(ii)	Use of $\Delta F = k\Delta x$ Use of $T = 2\pi\sqrt{\frac{m}{k}}$ Use of $f = \frac{1}{T}$ $f = 2.1$ Hz (ecf value of k from (a)(i)) Example of calculation $m = \frac{45.3 \text{ N m}^{-1} \times 5.8 \times 10^{-2} \text{ m}}{9.81 \text{ N kg}^{-1}} = 0.268 \text{ kg}$ $T = 2\pi\sqrt{\frac{0.268 \text{ kg}}{45.3 \text{ N m}^{-1}}} = 0.483 \text{ s}$ $f = \frac{1}{0.483 \text{ s}} = 2.07 \text{ Hz}$	**(1)** **(1)** **(1)** **(1)**	**4**
19(b)	The driving/forcing frequency (of the animal) equals the natural frequency (of the spring balance) **Or** The bag/spring/balance/scale(s) is forced to oscillate at its natural frequency [Accept 'driven at its natural frequency'; accept 'close to its natural frequency'] There is a large transfer of energy (to the bag) **Or** There is maximum energy transfer (to the bag) **Or** Resonance occurs [Accept 'maximum efficiency of energy transfer']	**(1)** **(1)**	**2**
	Total for question 19		**9**

Question Number	Answer		Mark
20(a)(i)	Use of $c = f\lambda$	(1)	
	Use of $\lambda_{max}T = 2.898 \times 10^{-3}$ m K	(1)	
	$T = 5900$ (K)	(1)	3
	<u>Example of calculation</u> $\lambda = \dfrac{3.00 \times 10^{8}\ \text{m s}^{-1}}{6.10 \times 10^{14}\ \text{Hz}} = 4.92 \times 10^{-7}\ \text{m}$ $T = \dfrac{2.898 \times 10^{-3}\ \text{m K}}{4.92 \times 10^{-7}\ \text{m}} = 5890\ \text{K}$		
20(a)(ii)	Cross where $T \approx 6000$ K and $L = 1$	(1)	1
	[The position of the Sun should match with a relative luminosity of about 1 on the vertical axis. The temperature should be in the first half of the 5000 to 10,000 interval (near the 5000 end).]		
	<u>Example of diagram</u>  		
20(a)(iii)	A: diagonal area extending from top left to bottom right of diagram	(1)	
	B: area top right of diagram	(1)	
	C: area bottom left of diagram	(1)	3
	[If areas are not marked A, B, C but labelled ‘main sequence (stars)’, ‘red giant (stars)’ and ‘white dwarf (stars)’, marks can be awarded., but do not allow variations.]		
	<u>Example of diagram</u>  		

***20(b)**	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.	

IC points	IC mark	Max linkage mark	Max final mark
6	4	2	6
5	3	2	5
4	3	1	4
3	2	1	3
2	2	0	2
1	1	0	1
0	0	0	0

The following table shows how the marks should be awarded for structure and lines of reasoning.

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Indicative content

IC1 There must be a (very) high temperature (in the core)

IC2 To give nuclei/protons large/enough kinetic energy [accept K.E. or E_k]

IC3 So that nuclei/protons get close enough to fuse

IC4 There is an electrostatic repulsion between nuclei/protons

IC5 There must be a (very) high density

IC6 To give a high/sufficient collision rate to maintain fusion

[IC3: accept reference to close enough for strong force to act
IC4 allow "there is repulsion due to positively charged nuclei"
IC5 allow "a (very) high pressure"
IC6 allow To give a high/sufficient collision rate to maintain high temperature]

6

	Total for question 20	**13**

Question Number	Answer	Mark
21(a)(i)	Top line correct **(1)** Bottom line correct **(1)** <u>Example of equation</u> $^{241}_{92}U \rightarrow ^{241}_{93}Np + ^{0}_{-1}\beta^{-}$	2
21(a)(ii)	Conversion between u and kg **(1)** Identification of values for Z **and** (A−Z) **(1)** Mass defect calculated **(1)** [Calculation must be an attempt to include mass of all nucleons] Use of $\Delta E = c^2 \Delta m$ **(1)** Binding Energy = 3.4×10^{-10} (J) (dependent upon MP2) **(1)** <u>Example of calculation</u> Mass of $^{241}_{92}U = 241.06033 \times 1.66 \times 10^{-27}$ kg $= 4.0016 \times 10^{-25}$ kg Mass defect $= (92 \times 1.67 \times 10^{-27}$ kg$) + (149 \times 1.68 \times 10^{-27}$ kg$)$ $- 4.0016 \times 10^{-25}$ kg Mass defect $= 3.8 \times 10^{-27}$ kg $\Delta E = c^2 \Delta m = (3.00 \times 10^8 \text{ m s}^{-1})^2 \times 3.8 \times 10^{-27} \text{ kg} = 3.42 \times 10^{-10}$ J	5
21(a)(iii)	Conversion between J and eV **(1)** B. E./nucleon = 8.9 MeV (ecf from (a)(ii)) **(1)** [‘Show that’ value gives 7.8 MeV] <u>Example of calculation</u> $\text{B. E.} = \frac{3.42 \times 10^{-10} \text{ J}}{1.6 \times 10^{-19} \text{ J eV}^{-1}} = 2.14 \times 10^9 \text{ eV}$ $\text{B. E./nucleon} = \frac{2140 \text{ MeV}}{241} = 8.88 \text{ MeV}$	2

Question Number	Answer	Mark	
21(b)	Use of $\lambda = \frac{\ln 2}{t_{1/2}}$ Use of $N = N_0 e^{-\lambda t}$ Ratio of $N_{241} : N_{242}$ calculated $\frac{N_{241}}{N_{242}} = 2$ so the deduction is correct (dependent upon MP3) [Ratio may vary a little depending upon number of sig figs retained. E.g. if 2 sf values are used, ratio may be 2.1; there is no sig fig penalty] <u>Example of calculation</u> $\lambda_{241} = \frac{\ln 2}{40} = 0.0173\ \text{min}^{-1}$ $\lambda_{242} = \frac{\ln 2}{17} = 0.0408\ \text{min}^{-1}$ $N_{241} = N_0 e^{-0.0173 \times 30} = 0.595\ N_0$ $N_{242} = N_0 e^{-0.0408 \times 30} = 0.294\ N_0$ $\frac{N_{241}}{N_{242}} = \frac{0.595}{0.294} = 2.02$	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 21		**13**