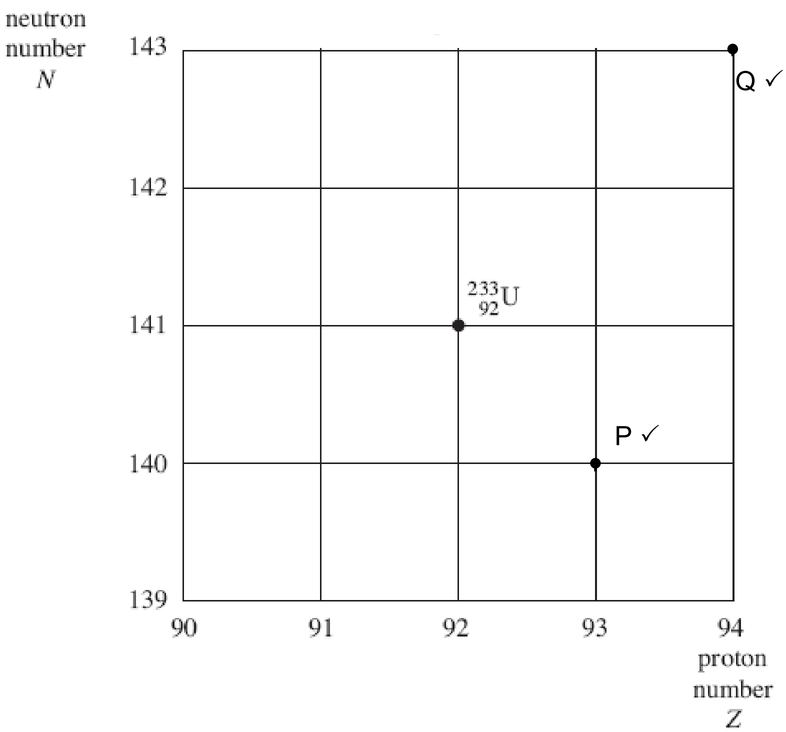
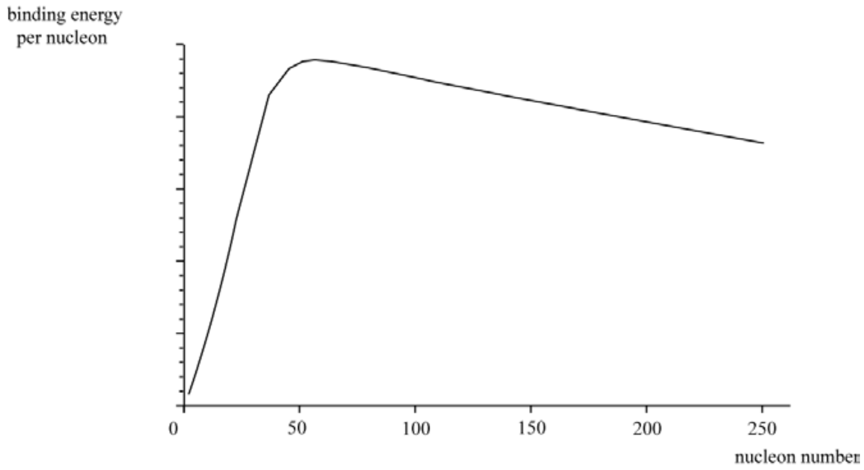
GCE Physics, Specification A, PHYA5/1, Nuclear and Thermal Physics

Question 1		
a	$^{233}_{91}\mathrm{Pa}$ ✓ anti (electron) neutrino ✓	**2**
b		**2**
c i	$x = 4$ ✓	**1**
c ii	mass defect = [(232.98915 + 1.00867) – (90.90368 + 138.87810 + 4 × 1.00867)] u ✓ = 0.18136 u ✓ energy released (= 0.18136 × 931) = 169 (MeV) ✓	**3**
	Total	**8**

Question 2		
a	$^{27}_{13}\mathrm{Al} + \alpha \rightarrow {}^{30}_{15}\mathrm{P} + {}^{(1)}_{(0)}\mathrm{n}$ ✓	**1**
b	kinetic energy lost by the α particle approaching the nucleus is equal to the potential energy gain ✓ $2.18 \times 10^{-12} = \frac{1}{4\pi \times 8.85 \times 10^{-12}} \times \frac{13 \times 1.6 \times 10^{-19} \times 2 \times 1.6 \times 10^{-19}}{r}$ ✓ $r = 2.75 \times 10^{-15}$ (m) ✓	**3**
	Total	**4**

Question 3		
a	 peak 8.7 (accept 8.0 – 9.2) ✓ in MeV ✓ (or peak 1.4×10^{-12} accept $1.3 – 1.5 \times 10^{-12}$ ✓ in J ✓) at nucleon number 50 – 60 ✓ accept 50 – 75 sharp rise from origin and moderate fall not below 2/3 of peak height ✓	**4**
b	energy is released/made available when binding energy **per nucleon** is increased ✓ in fission a (large) nucleus splits and in fusion (small) nuclei join ✓ the most stable nuclei are at a peak ✓ fusion occurs to the left of peak and fission to the right ✓	**max 3**
	Total	**7**

Question 4		
a	(use of $\Delta Q = mc\Delta T$) $30 \times 98 = 0.100 \times c \times 14$ ✓ $c = 2100$ (J kg^{-1} K^{-1}) ✓	**2**
b	(use of $\Delta Q = ml + mc\Delta T$) $500 \times 98 = 0.100 \times 3.3 \times 10^5$ ✓ + $0.100 \times 4200 \times \Delta T$ ✓ (ΔT = 38°C) T = 38°C ✓	**3**
c	the temperature would be higher ✓ as the ice/water spends more time below 25°C **or** heat travels in the direction from hot to cold **or** ice/water first gains heat then loses heat any **one** line ✓	**2**
	Total	**7**

Question 5		
a	graph passes through given point 2.2×10^{-3} m^3 at 0°C straight line with positive gradient ✓ (straight) line to aim or pass through –273°C at zero volume ✓	**2**
b	(use of $n = P\,V/R\,T$) $1.00 \times 10^5 \times 2.20 \times 10^{-3}/8.31 \times 273$ ✓ n = 0.0970 (moles) ✓	**2**
c	(use of mean kinetic energy = 3/2 K T) $= 3/2 \times 1.38 \times 10^{-23} \times 323$ ✓ 6.69×10^{-21} (J) ✓ 3 sfs ✓	**3**
d	total internal energy = $6.69 \times 10^{-21} \times 0.0970 \times 6.02 \times 10^{23}$ = 390 (J) ✓	**1**
e	**The candidate's writing should be legible and the spelling, punctuation and grammar should be sufficiently accurate for the meaning to be clear.** The candidate's answer will be assessed holistically. The answer will be assigned to one of three levels according to the following criteria. **High Level (Good to excellent): 5 or 6 marks** The information conveyed by the answer is clearly organised, logical and coherent, using appropriate specialist vocabulary correctly. The form and style of writing is appropriate to answer the question. The candidate provides a comprehensive and coherent sequence of ideas linking the motion of molecules to the pressure they exert on a container. At least three of the first four points listed below must be given in a logical order. The description should also show awareness of how a balance is maintained between the increase in speed and shortening of the time interval between collisions with the wall to maintain a constant pressure. To be in this band, reference must be made to force being the rate of change of momentum or how, in detail, the volume compensates for the increase in temperature. **Intermediate Level (Modest to adequate): 3 or 4 marks** The information conveyed by the answer may be less well organised and not fully coherent. There is less use of specialist vocabulary, or specialist vocabulary may be used incorrectly. The form and style of writing is less appropriate. The candidate provides a comprehensive list of ideas linking the motion of molecules to the pressure they exert on a container. At least three of the first four points listed below are given. The candidate also knows than the mean square speed of molecules is proportional to temperature. Using this knowledge, an attempt is made to explain how the pressure is constant.	**max 6**

	Low Level (Poor to limited): 1 or 2 marks The information conveyed by the answer is poorly organised and may not be relevant or coherent. There is little correct use of specialist vocabulary. The form and style of writing may be only partly appropriate. The candidate attempts the question and refers to at least two of the points listed below. **Incorrect, inappropriate of no response: 0 marks** No answer or answer refers to unrelated, incorrect or inappropriate physics. **Statements expected in a competent answer should include some of the following marking points.** molecules are in rapid random motion/many molecules are involved molecules change their momentum or accelerate on collision with the walls reference to Newton's 2nd law either $F = ma$ or F = rate of change of momentum reference to Newton's 3rd law between molecule and wall relate pressure to force $P = F/A$ mean square speed of molecules is proportional to temperature as temperature increases so does change of momentum or change in velocity compensated for by longer time between collisions as the temperature increases as the volume increases the surface area increases which reduces the pressure	
	Total	**14**