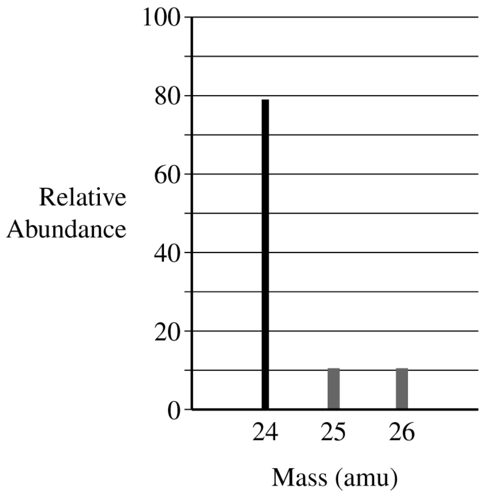
Question 1: Long Answer **10 points**

A (i) For the correct plotted lines: **Point 01**

The abundance for the two lines should be between 10 and 11.



(ii) For the correct answer: **Point 02**

Magnesium-26 has one more neutron than magnesium-25 does.

B (i) For a correct explanation: **Point 03**

The charge on the sodium ion is less than the charge on the magnesium ion. A smaller charge results in a weaker Coulombic attraction between Na^+ *and water.*

(ii) For a correct explanation: **Point 04**

The Na^+ *ion is larger than the* Mg^{2+} *ion, so the distance between the* Na^+ *and the oxygen on the water molecule will be greater. As distance increases, Coulombic attraction decreases.*

C For the correct calculated value: **Point 05**

$$\text{pOH} = -\log(2.80 \times 10^{-4}) = 3.553$$

$$\text{pH} = 14 - \text{pOH} = 14 - 3.553 = 10.447$$

D For the correct calculated value: **Point 06**

$$M_1V_1 = M_2V_2$$

$$M_2 = \frac{(1.85 \times 10^{-3}\,M)(0.03500\text{ L})}{(0.03500\text{ L} + 0.05000\text{ L})} = 7.62 \times 10^{-4}\ M$$

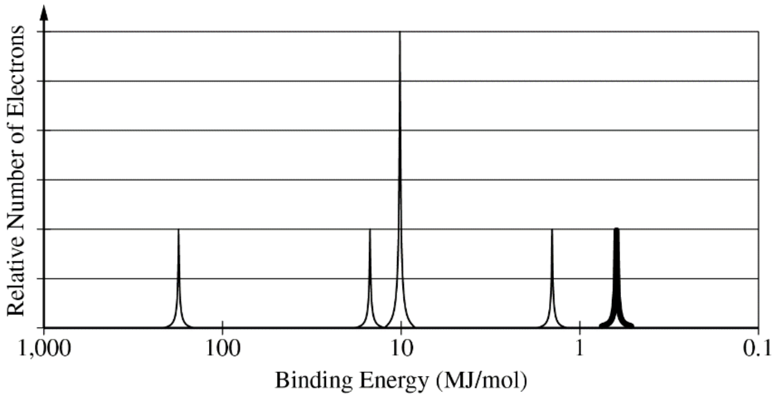
E	(i) For the correct expression: $K_{sp} = [Mg^{2+}][OH^-]^2$	**Point 07**
	(ii) For the correct calculated value, consistent with part D and part E (i): $Q = [Mg^{2+}][OH^-]^2 = (7.62 \times 10^{-4})(1.65 \times 10^{-4})^2 = 2.07 \times 10^{-11}$	**Point 08**
	(iii) For the correct prediction and justification, consistent with part E (ii). Examples of acceptable responses may include the following: • *$Q > K_{sp}$, so a precipitate will form.* • *The concentration of the ions in solution (represented by Q) is greater than that of a saturated solution, so a precipitate will form.*	**Point 09**
F	For the correct answer and justification: *Decrease. The* H^+ *from* $HNO_3(aq)$ *will react with* OH^-*, decreasing* $[OH^-]$ *and causing* $Q < K_{sp}$*. As a result, more* $Mg(OH)_2(s)$ *will dissolve until equilibrium is reestablished, resulting in less* $Mg(OH)_2(s)$.	**Point 10**

Question 2: Long Answer — 10 points

(a)	**(i)** For the correct answer: *14 protons and 14 neutrons*	**1 point**
	(ii) For the correct answer: Accept one of the following: • $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$ • $[Ne]\ 3s^2\ 3p^2$	**1 point**
	Total for part (a)	**2 points**
(b)	For a correct explanation: *SiH_4 is composed of molecules, for which the only intermolecular forces are London dispersion forces. SiO_2 is a network covalent compound with covalent bonds between silicon and oxygen atoms. London dispersion forces are much weaker than covalent bonds, so SiH_4 boils at a much lower temperature than SiO_2.*	**1 point**
(c)	For the correct balanced equation (state symbols not required): $\mathrm{SiH_4}(g) \rightarrow \mathrm{Si}(s) + 2\ \mathrm{H_2}(g)$	**1 point**
(d)	For a correct explanation: *The $H_2(g)$ molecules are more highly dispersed than the Si(s) atoms and, therefore, have a higher absolute molar entropy. Silicon is a solid; therefore, its atoms are in fixed positions, are less dispersed, and have a lower absolute molar entropy.*	**1 point**
(e)	For the correct calculated value: $\Delta S^\circ_{rxn} = (18 + 2(131)) - 205 = +75\ \mathrm{J/(mol_{\mathit{rxn}} \cdot K)}$	**1 point**
(f)	For a correct explanation: *High temperature is required for the reactant particles to have sufficient thermal energy to overcome the activation energy of the reaction.*	**1 point**

(g) For the correct peak height and location: **1 point**

The peak should be drawn to the right of the other peaks, and it should reach the second line above the horizontal axis.



(h) For a correct explanation: **1 point**

The valence electrons of a Ge atom occupy a higher shell (n=4) than those of a Si atom (n=3), so the average distance between the nucleus and the valence electrons is greater in Ge than in Si. This greater separation results in weaker Coulombic attractions between the Ge nucleus and its valence electrons, making them less tightly bound and, therefore, easier to remove compared to those in Si.

(i) For the correct calculated value: **1 point**

$$E = h\nu = h\left(\frac{c}{\lambda}\right) = 6.626\times10^{-34}\ \text{J}\cdot\text{s}\left(\frac{2.998\times10^{8}\ \text{m s}^{-1}}{4.00\times10^{-7}\ \text{m}}\right) = 4.97\times10^{-19}\ \text{J}$$

Total for question 2 10 points