## Question 2: Long Answer — 10 points

**(a)** **(i)** For the correct answer: **1 point**

*14 protons and 14 neutrons*

**(ii)** For the correct answer: **1 point**

Accept one of the following:

- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$
- $[Ne]\ 3s^2\ 3p^2$

**Total for part (a)** **2 points**

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

*$SiH_4$ 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 $SiO_2$.*

**(c)** For the correct balanced equation (state symbols not required): **1 point**

$$\mathrm{SiH_4}(g) \rightarrow \mathrm{Si}(s) + 2\ \mathrm{H_2}(g)$$

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

*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.*

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

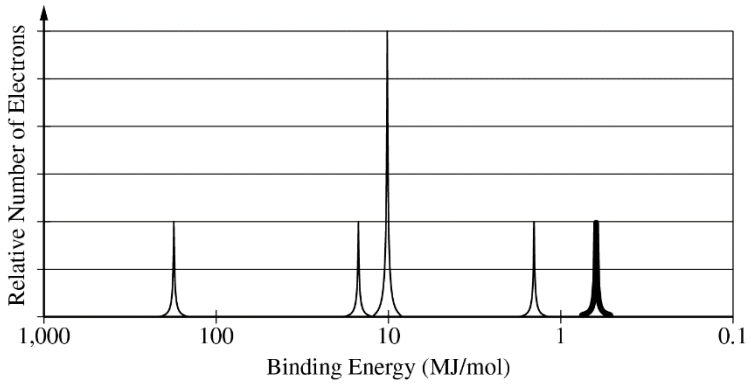
$$\Delta S^\circ_{rxn} = (18 + 2(131)) - 205 = +75\ \mathrm{J/(mol_{rxn} \cdot K)}$$

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

*High temperature is required for the reactant particles to have sufficient thermal energy to overcome the activation energy of the reaction.*

**(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**