ASSIGNMENT: ATOMIC STRUCTURE AND IONIZATION ENERGY

1. On the graph below, the first ionization energy of some elements is plotted against the atomic number of the elements.
   i. State two of the elements likely to be alkali metals.
   ii. State one of the elements likely to be an inert gas.
   iii. Which one of the elements would you expect to be in the same group of the Periodic Table as the element C?
   iv. State briefly how the first ionization energy of the elements varies with the rising atomic number.
   v. In which of the following ranges should the first ionization energy of the next element P, lie?
      a. 1400-1600 kJ mol^{-1}
      b. 1600-1800 kJ mol^{-1}
      c. 1800-2000 kJ mol^{-1}
      d. 2000-2200 kJ mol^{-1}
      e. 2200-2400 kJ mol^{-1}
2. Here are the first six ionization energies (in kJ mol^{-1}) of two elements X and Y:

$$X\,(g) \xrightarrow{1402} X^{+}(g) \xrightarrow{2855} X^{2+}(g) \xrightarrow{4522} X^{3+}(g) \xrightarrow{7452} X^{4+}(g) \xrightarrow{9462} X^{5+}(g) \xrightarrow{53170} X^{6+}(g)$$

$$Y\,(g) \xrightarrow{1315} Y^{+}(g) \xrightarrow{3387} Y^{2+}(g) \xrightarrow{5317} Y^{3+}(g) \xrightarrow{7452} Y^{4+}(g) \xrightarrow{11010} Y^{5+}(g) \xrightarrow{13320} Y^{6+}(g)$$

   i. The element Y has an atomic number greater by one than that of X. What would you expect the approximate seventh ionization energy of Y to be? State briefly the reasons for your answer.
   ii. The element Z has an atomic number less by one than that of X. the first four ionization energies (in kJ mol^{-1}) of Z are:

$$Z\,(g) \xrightarrow{1089} Z^{+}(g) \xrightarrow{2350} Z^{2+}(g) \xrightarrow{4650} Z^{3+}(g) \xrightarrow{6200} Z^{4+}(g)$$

What would you expect the approximate fifth ionization energy of Z to be? State briefly the reasons for your answer.

3. The electron energy levels of a certain element can be represented by:

$$1s^2 2s^2 2p^6 3s^2 3p^1$$

Sketch a graph showing a general form which you would expect for the first five ionization energies of the element.

4. The electron energy levels of a certain element can be represented by:

$$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^2$$

i. What is the atomic number of the element?
ii. In which group of the Periodic Table should the element be?
iii. What will be the charge on the ion of the element?

5. The following table shows the first three ionization energies (in kJ mol^{-1}) of elements in the same group of the Periodic Table:

Element	**1st I.E**	**2nd I.E**	**3rd I.E**
A	383	2437	not known
B	409	2667	3881
C	425	3065	4438
D	502	4568	6929
E	527	7314	11840

i. Which of these elements should have the largest atomic number? Give reasons for your answer.
ii. In which group of the Periodic table should the elements be placed? Give reasons for your answer.

For questions **6 to 9**, refer to the following table of ionization energies (kJ mol^{-1}) of five elements (the letters are not the symbols for the elements).

Element	**1st IE**	**2nd IE**	**3rd IE**	**4th IE**
A	520	7301	11817	not known
B	578	1817	2746	10813
C	1087	2354	4621	6425
D	496	4566	6917	9547
E	590	1146	4944	6469

6. Which of the elements, when it reacts, is most likely to form a 3+ ion?
7. Which one of the following pairs of elements are likely to be in the same group of the Periodic Table?

i. B and Eii. A and E iii. D and E iv. B and C v. C and E

8. Which of the elements would require the most energy to convert its atoms into ions carrying one positive charge?
9. Which of the elements would require the most energy to convert its atoms into ions carrying two positive charges?

10. Which of the following would require the most energy to convert them completely from the gaseous state into gaseous ions, each carrying one positive charge? Justify your answer.
i. Lithium atoms ii. Sodium atoms iii. Potassium atoms

11. Which of the following would require the least energy to convert them completely from the gaseous state into gaseous ions, each carrying one positive charge?
i. Li atoms ii. Be atoms iii. B atom iv. C atoms

12. Natural silicon consists of a mixture of three isotopes and its atomic number is 14.

Isotope	**Isotopic Mass**	**Percentage Abundance by Number of Atoms**
A	28.0	92.2
B	29.0	4.70
C	30.0	3.10

i. In each of the isotopes how many (a) neutrons and (b) protons are there in each atom?
ii. Calculate the atomic weight of natural silicon. Show how you arrive at your answer.
State, in the form of numbers and symbols, the energy levels of the electrons in the isotope B.