# Trends in the Periodic Tables

## Question 1

(*a*) Define *electronegativity*. (6)

Why is there an increase in electronegativity value moving from gallium to germanium in the periodic table? (6)

Mendeleev predicted the properties of the elements gallium and germanium years before either of them was discovered. Explain the basis for his predictions. (6)

Write the molecular formula for the simplest compound formed between germanium(IV) and hydrogen.

Would you expect this compound to be water soluble? Justify your answer. (7)

## Question 2

(*h*) In the periodic table, identify an element

(*i*) in the same period as magnesium but with larger atoms,

(*ii*) in the same group as magnesium but with smaller atoms.

## Question 3

(*b*) Define *first ionisation energy*. (6)

Explain why the first ionisation energy value of silicon is

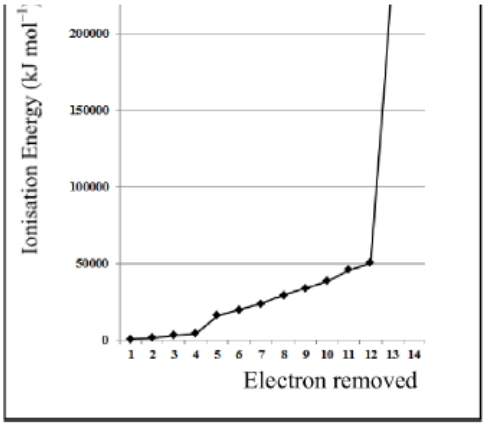
(*i*) greater than that of aluminium,

(*ii*) less than that of carbon. (9)

(*c*) The successive ionisation energies of silicon are shown in the graph on the right.

Explain how the graph provides evidence for energy levels in the silicon atom. (6)

What other experimental evidence do we have for the existence of energy levels in atoms? (3)

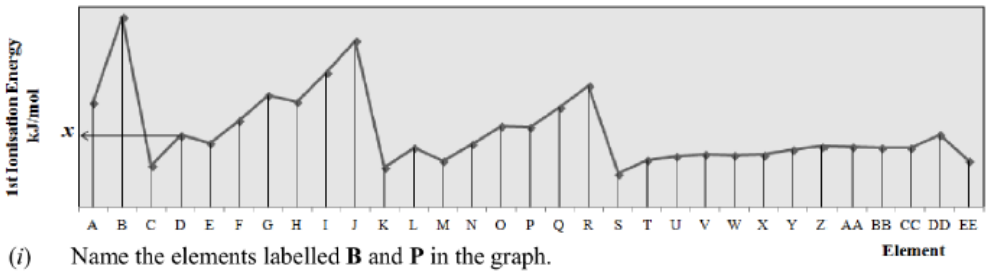


## Question 4

**11.** Answer any **two** of the parts (*a*), (*b*) and (*c*). (2 × 25)

(*a*) Define *first ionisation energy*. (7)

The graph shows the first ionisation energy values, displayed in order of increasing atomic number, for the first 31 elements of the periodic table. Refer to the table of first ionisation energy values on page 80 of the *formulae and tables booklet*.




(*i*) Name the elements labelled **B** and **P** in the graph.

What is the numerical value of ***x***? (9)

(*ii*) What is the principal reason for the large decrease in first ionisation energy between the elements labelled **R** and **S**? (3)

(*iii*) Explain why the first ionisation energy value of the element labelled **H** is lower than that of the element labelled **G**. (6)

## Question 5

(*b*) Define *atomic radius* (*covalent radius*).

State and explain the trend in atomic radii (covalent radii) across the second period of the periodic table of the elements. (12)

(*c*) Give **one** reason why electronegativity values exhibit a general increase across the second period of the periodic table. (3)

(*d*) Consider the following hydrides of some of the elements from the second and third periods of the periodic table: **$H_2O$** **$NH_3$** **$PH_3$** **HCl**

(*i*) State how the bonding in **$PH_3$** differs from the bonding in the other three hydrides.

What is the reason for this difference in bonding?

(*ii*) From these four hydrides, identify the hydride or hydrides in which hydrogen bonding occurs between the molecules.

Give **one** property that is affected by the presence of intermolecular hydrogen bonding in the hydride or hydrides you have identified.

(*iii*) State the shape of the **$PH_3$** molecule and explain using electron-pair repulsion theory how this shape arises. (21)

(*e*) Boron trichloride (**$BCl_3$**) is a colourless gas. Would you expect (*i*) the **B–Cl** bonds, (*ii*) the **$BCl_3$** molecules, to be polar or non-polar? Justify your answers. (9)

## Question 6

(*b*) *The minimum energy required to completely remove the most loosely bound electron from a mole of gaseous atoms in their ground state* defines an important property of every element.

(*i*) Identify the energy quantity defined above. State the unit used to measure this quantity. (7)

(*ii*) Using **X** to represent an element, express the definition above in the form of a balanced chemical equation. (6)

(*iii*) Would it take more or less energy to remove the most loosely bound electron from an atom if that electron were not in its ground state? Explain. (6)

(*iv*) An element has a low first ionisation energy value and a low electronegativity value. What does this information tell you about how reactive the element is likely to be, and what is likely to happen to the atoms of the element when they react? (6)