

1. Explain why copper is considered a transition metal while scandium is not.

(Total 3 marks)

2. (i) Define the term *first ionization energy*.

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(2)

- (ii) Explain why the first ionization energy of magnesium is higher than that of sodium.

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(2)

(Total 4 marks)

3. Which statements about period 3 are correct?

- I. The electronegativity of the elements increases across period 3.
- II. The atomic radii of the elements decreases across period 3.
- III. The oxides of the elements change from acidic to basic across period 3.

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

(Total 1 mark)

4. Explain why the melting points of the elements decrease down group 1 and increase down group 7.

(Total 4 marks)

5. Consider the bonding and structure of the period 3 elements.

- (a) Explain the increase in the melting point from sodium to aluminium.

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(2)

- (b) Explain why sulfur, S₈, has a higher melting point than phosphorus, P₄.

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(2)

- (c) Explain why silicon has the highest melting point and argon has the lowest melting point.

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(2)

(Total 6 marks)

6. The periodic table shows the relationship between electron arrangement and the properties of elements and is a valuable tool for making predictions in chemistry.

(i) Identify the property used to arrange the elements in the periodic table.

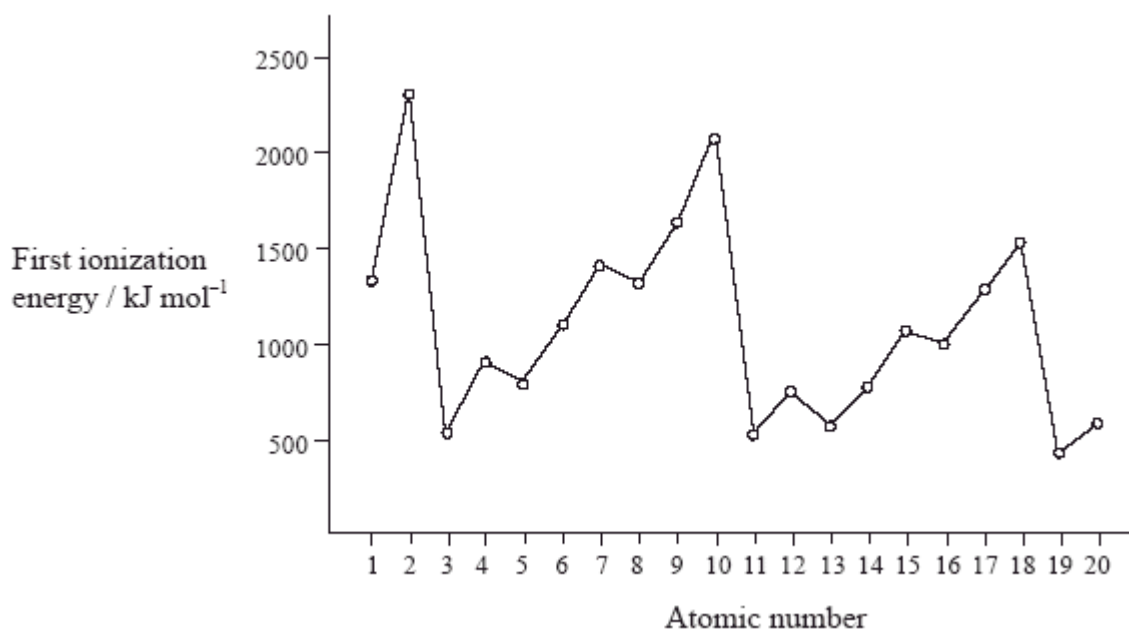
(1)

(ii) Outline **two** reasons why electronegativity increases across period 3 in the periodic table and **one** reason why noble gases are not assigned electronegativity values.

(3)

(Total 4 marks)

7. The graph of the first ionization energy plotted against atomic number for the first twenty elements shows periodicity.



(i) Define the term *first ionization energy* and state what is meant by the term *periodicity*.

(2)

(ii) State the electron arrangement of argon and explain why the noble gases, helium, neon and argon show the highest first ionization energies for their respective periods.

(3)

- (iii) A graph of atomic radius plotted against atomic number shows that the atomic radius decreases across a period. Explain why chlorine has a smaller atomic radius than sodium. (1)
- (iv) Explain why a sulfide ion, S^{2-} , is larger than a chloride ion, Cl^{-} . (1)
- (v) Explain why the melting points of the Group 1 metals ($Li \rightarrow Cs$) decrease down the group whereas the melting points of the Group 7 elements ($F \rightarrow I$) increase down the group. (3)
- (Total 10 marks)

8. Which combination of the characteristics of element X, a metal, and element Y, a non metal, is most likely to lead to ionic bonding?

	X	Y
A.	low ionization energy	high electronegativity value
B.	low ionization energy	low electronegativity value
C.	high ionization energy	high electronegativity value
D.	high ionization energy	low electronegativity value

(Total 1 mark)

9. Explain why silicon dioxide is a solid and carbon dioxide is a gas at room temperature.

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(Total 2 marks)

10. Describe the bonding within the carbon monoxide molecule.

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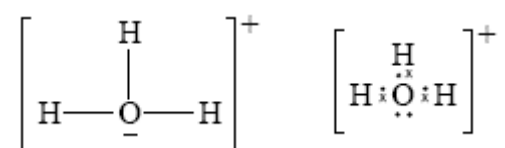
(Total 2 marks)

11. Which species does **not** contain delocalized electrons?

- A. $\text{CH}_3\text{CH}_2\text{O}^-$
- B. CH_3CO_2^-
- C. O_3
- D. NO_3^-

(Total 1 mark)

12. Lewis structures are represented in different ways in different parts of the world. Two ways of drawing the Lewis structure for H_3O^+ are shown below.



Which statement is correct about H_3O^+ ?

- A. The ion has a tetrahedral shape.
- B. The H–O–H bond angle is 120° .
- C. The H–O–H bond angle is 90° .
- D. The ion has a trigonal pyramidal shape.

(Total 1 mark)

13. Which combination of intermolecular forces, boiling point and enthalpy of vaporization is correct?

	Intermolecular forces	Boiling point	Enthalpy of vaporization
A.	strong	low	low
B.	strong	high	low
C.	weak	low	high
D.	weak	low	low

(Total 1 mark)

14. Which statement about the bonding between carbon atoms is correct?

- A. In C₆₀ fullerene each carbon atom is covalently bonded to three other carbon atoms.
- B. In C₆₀ fullerene each carbon atom is covalently bonded to four other carbon atoms.
- C. In graphite each carbon atom is covalently bonded to four other carbon atoms.
- D. In graphite each carbon atom forms a double covalent bond with three other carbon atoms.

(Total 1 mark)

15. Which intermolecular forces exist between molecules of carbon monoxide, CO?

- A. Hydrogen bonds and van der Waals' forces
- B. Dipole-dipole attractions and van der Waals' forces
- C. Van der Waals' forces only
- D. Dipole-dipole attractions only

(Total 1 mark)

16. Ethene, C_2H_4 , and hydrazine, N_2H_4 , are hydrides of adjacent elements in the periodic table.

- (a) (i) Draw Lewis (electron dot) structures for C_2H_4 and N_2H_4 showing all valence electrons.

(2)

- (ii) State and explain the $\text{H}-\text{C}-\text{H}$ bond angle in ethene and the $\text{H}-\text{N}-\text{H}$ bond angle in hydrazine.

(5)

- (b) The polarity of a molecule can be explained in terms of electronegativity.

- (i) Define the term electronegativity.

(2)

- (ii) Compare the relative polarities of the $\text{C}-\text{H}$ bond in ethene and the $\text{N}-\text{H}$ bond in hydrazine.

(1)

- (iii) Hydrazine is a polar molecule and ethene is non-polar. Explain why ethene is non-polar.

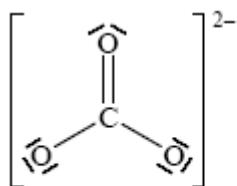
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- (c) The boiling point of hydrazine is much higher than that of ethene. Explain this difference in terms of the intermolecular forces in each compound.

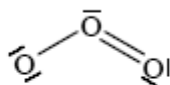
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(Total 13 marks)

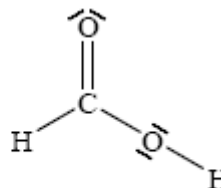
17. Which species have delocalized electrons?



I



II

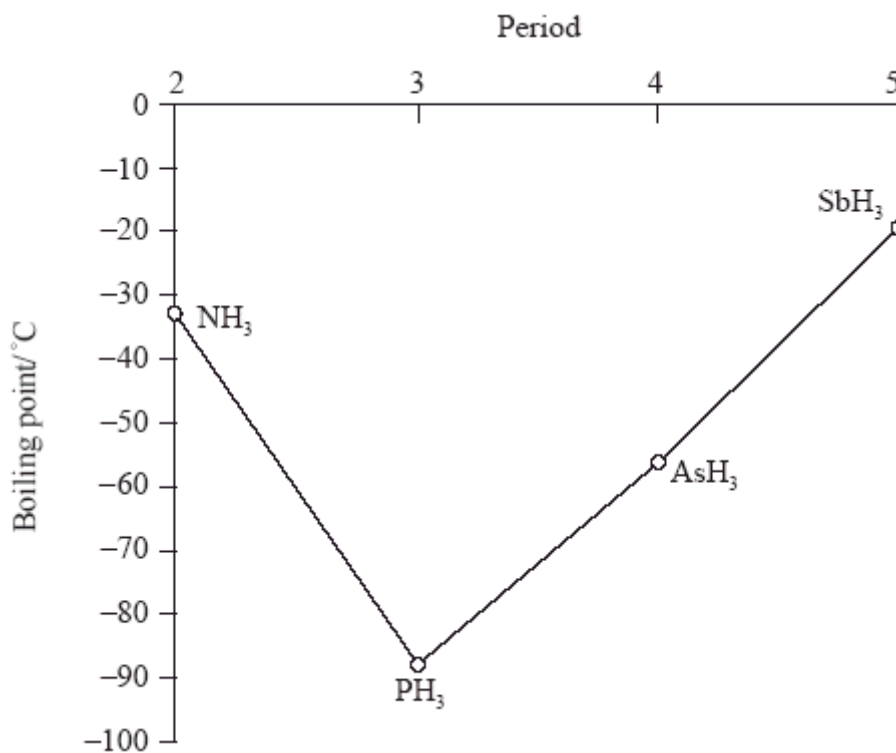


III

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

(Total 1 mark)

18. The graph below shows the boiling points of the hydrides of group 5. Discuss the variation in the boiling points.



(Total 4 marks)

19. (i) Outline the principles of the valence shell electron pair repulsion (VSEPR) theory. (3)
- (ii) Use the VSEPR theory to deduce the shape of H_3O^+ and C_2H_4 . For each species, draw the Lewis structure, name the shape, and state the value of the bond angle(s). (6)
- (iii) Predict and explain whether each species is polar. (2)
- (iv) Using Table 7 of the Data Booklet, predict and explain which of the bonds O-H, O-N or N-H would be most polar. (2)
- (Total 13 marks)