Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 In a titration experiment, 30 cm^3 of 0.05 mol dm^{-3} phosphorous acid, H_3PO_3 was found to exactly neutralise 15 cm^3 of 0.20 mol dm^{-3} aqueous sodium hydroxide. Using this information, deduce the formula of the salt formed in the neutralisation process.

A NaH_2PO_3

* **B** Na_2HPO_3

C Na_3PO_3

D Na_3PO_4

2 Wines often contain a small amount of sulfur dioxide that is added as a preservative. The sulfur dioxide content of a wine is found by the following method:

A 50 cm^3 sample of white wine is reacted with 40.0 cm^3 of 0.01 mol dm^{-3} of excess aqueous iodine. The sulfur dioxide in the wine is oxidized to sulfate, SO_4^{2}, in the process. The unreacted iodine requires exactly 23.60 cm^3 of 0.02 mol dm^{-3} sodium thiosulfate for complete reaction.

Determine the concentration of sulfur dioxide, in mol dm^{-3}, in the wine.

A 1.64×10^{-3}

* **B** 3.28×10^{-3}

C 4.72×10^{-3}

D 9.44×10^{-3}

3 Which of the following is a possible configuration of a stable M^{3+} ion in the ground state?

A $1s^2 2s^2 2p^3$

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

* **C** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$

D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$

4 In which of the following does ionic bonding occur between the named atoms?

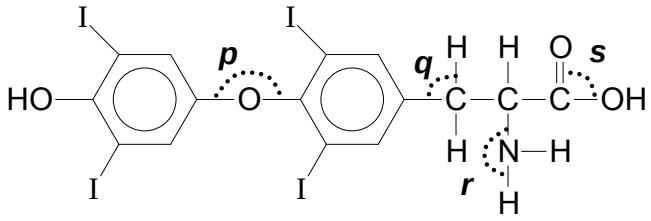
A aluminium and chlorine in aluminium chloride

* **B** hydrogen and sodium in sodium hydride

C boron and fluorine in boron fluoride

D silicon and chlorine in silicon tetrachloride

5 The thyroid gland concentrates iodine and uses it to produce thyroxine, which is a hormone that controls the metabolic rate.



Thyroxine

What are the values of the bond angles ***p***, ***q***, ***r*** and ***s***?

		p	***q***	***r***	***s***
	A	180°	90°	180°	90°
*	**B**	105°	109.5°	107°	120°
	C	180°	90°	120°	180°
	D	105°	90°	107°	180°

6 In butanoic acid, $CH_3CH_2CH_2COOH$ (*l*), there are covalent bonds, hydrogen bonds and Van der Waals' forces.

Which bonds or forces are broken when butanoic acid undergoes vapourisation?

A only hydrogen bonds

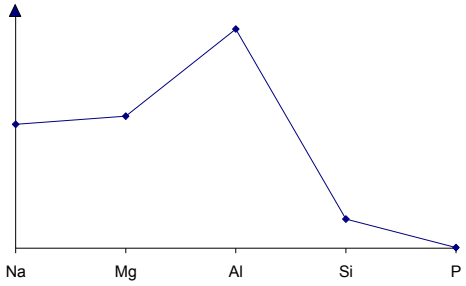
B covalent bonds and hydrogen bonds

C covalent bonds and Van der Waals' forces

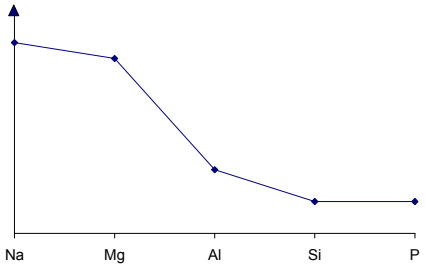
* **D** hydrogen bonds and Van der Waals' forces

7 The graphs below show the variation in two properties of the elements Na to P and their compounds.

Graph I



Graph II



Which properties are illustrated in Graphs I and II?

		Graph I	Graph II
*	**A**	electrical conductivity of the element	pH of the chloride when added to water
	B	electrical conductivity of the element	pH of the oxide when added to water
	C	melting point of the element	pH of the chloride when added to water
	D	melting point of the element	pH of the oxide when added to water

8 A solid **G** has the following physical properties.

- It is insoluble in hydrocarbon solvents.
- It melts at 1290°C.
- It conducts electricity in both aqueous and molten states.

What is the likely structure of **G**?

* **A** an ionic structure

B a simple molecular structure

C a simple atomic structure

D a giant molecular structure

9 For which process is the enthalpy change always negative?

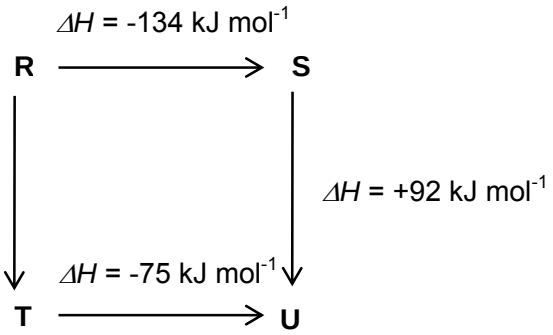
A Dissolving a compound in water

B Forming an ion from an atom

* **C** Burning an element in oxygen

D Synthesizing a compound from its elements

10 The diagram illustrates the energy changes of a set of reactions.



Which of the following statements is false?

A The enthalpy change for the transformation U to R is +42 kJ mol^{-1}.

* **B** The enthalpy change for the transformation R to T is -33 kJ mol^{-1}.

C The enthalpy change for the transformation T to S is exothermic.

D The conversion of T to U could be due to lattice energy.

11 The activation energy of a reaction is usually

* **A** different for the forward and backward reaction in an exothermic process.

B low for a reaction that takes place slowly.

C unaffected by the presence of a catalyst.

D higher when pressure is increased.

12 In the manufacturing of sulfuric acid, one of the important steps involves the oxidation of sulfur dioxide to produce sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

In a 10 litre reaction vessel at 723 K and 1 atm, an equilibrium mixture was found to contain 3 moles of SO_2, 1 mole of O_2 and 24 moles of SO_3.

What is the value of the equilibrium constant K_c for this reaction at 723 K?

A 8

B 64

C 80

* **D** 640

13 Equal volumes of HC*l* (aq) of pH 4 and H_2SO_4 (aq) of pH 2 were mixed. What is the pH of the resulting mixture?

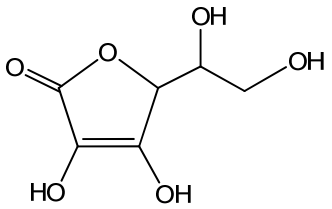
A 2.0

* **B** 2.3

C 2.5

D 3.0

14 What is the total number of sigma bonds in a molecule of vitamin C as shown below?



A 16

B 18

* **C** 20

D 22

15 In the free radical substitution of 3-methylpentane with chlorine, a mixture of mono-chlorinated compounds was obtained.

What is the suggested ratio of all the mono-chlorinated compounds formed?

A 3:3:2:1

B 4:3:2:1

C 5:5:3:1

* **D** 6:4:3:1

16 Which of the following chemical tests can distinguish between 1-bromobutane and 2-bromobutane?

* **A** Heating with excess KOH (aq), followed by adding aqueous iodine.

B Heating with limited NaOH (aq), followed by adding aqueous silver nitrate.

C Heating with KOH (aq), followed by refluxing with acidified aqueous potassium dichromate(VI).

D Heating with limited NaOH (aq), followed by adding concentrated sulfuric acid.

17 Which of the following pairs does not give the same product when treated with hot acidified $KMnO_4$?

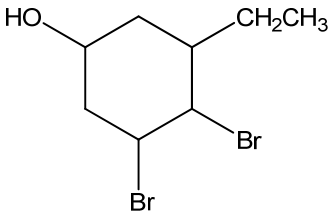
A $C_6H_5CH_2CH_3$ and $C_6H_5CH_3$

B CH_3OH and $CH_2(OH)CH_2OH$

* **C** CH_3CH_2CHO and $(CH_3)_2CHOH$

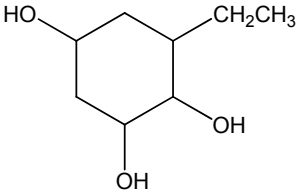
D CH_3CH_2OH and $CH_3CH{=}CHCH_3$

18 The following compound was heated with ethanolic potassium hydroxide.

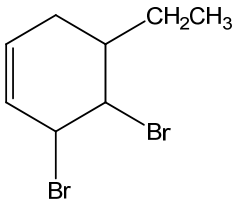


Which of the following represents the structure of the organic product?

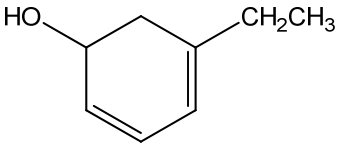
A



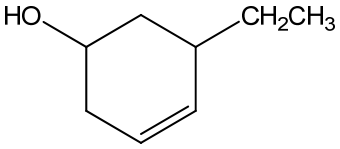
B



* **C**



D



19 Compounds **X** and **Y** both produce an orange precipitate with 2,4-dinitrophenylhydrazine.

However, only one of them decolourises hot potassium dichromate(VI) and gives a yellow precipitate with alkaline aqueous iodine.

Which of the following pairs could **X** and **Y** be?

		X	**Y**
*	**A**	CH_3CHO	$CH_2{=}CHCOCH_3$
	B	CH_3COCH_3	$(CH_3)_2C(OH)COCH_3$
	C	$CH_3CH(OH)CH_3$	$CH_3COCH_2CH_3$
	D	$CH_2{=}CHCHO$	$CH_3CH_2CH(OH)CHO$

20 Ethanenitrile was hydrolysed in acidic medium and the resulting product was made to react with propan-2-ol. What is the final product formed?

* **A** $CH_3COOCH(CH_3)_2$

B $CH_3COOCH_2CH_2CH_3$

C $CH_3CH_2COOCH_2CH_3$

D $CH_3CH_2COOCH(CH_3)_2$

21 Which of the following gives the compounds in order of decreasing K_a?

A $CH_3CH_2OH > CH_3CO_2H > CH_2FCO_2H$

B $BrCH_2CO_2H > ClCH_2CO_2H > CH_3CO_2H$

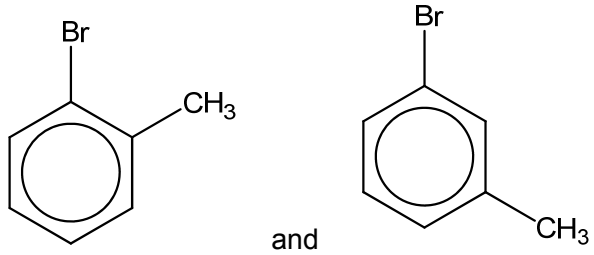
C $CH_3CH_2CO_2H > CH_3CO_2H > HCOOH$

* **D** $CH_3CCl_2CO_2H > ClCH_2CHClCO_2H > Cl_2CHCH_2CO_2H$

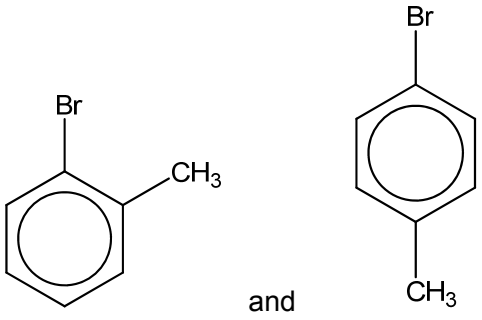
22 When bromobenzene is treated with chloromethane in the presence of a halogen carrier under suitable conditions, a mixture of two isomers is formed.

What are the structures of these two isomers?

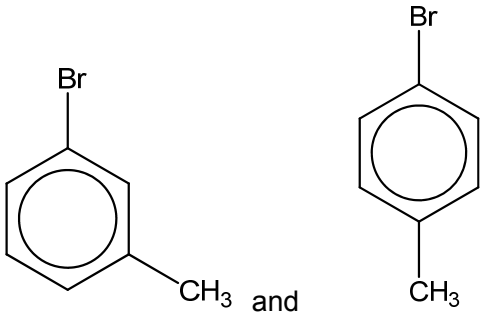
A



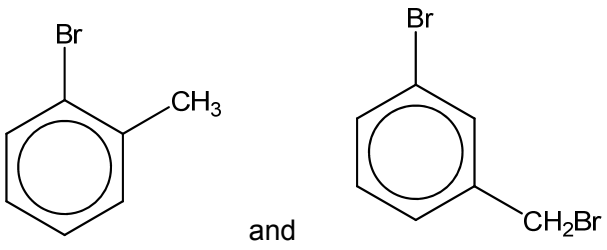
* **B**



C



D



23 Fruit juices and fizzy drinks such as lemonade are often sold in aluminium cans.

What is the most important reason why aluminium is a suitable metal?

A Aluminium can be recycled.

* **B** Aluminium is resistant to corrosion by acids.

C Aluminium is resistant to corrosion by water.

D Aluminium is the most abundant metal in the Earth's crust.

24 Consider the three oxides, Na_2O, SiO_2 and P_4O_{10}, which factor decreases when comparing Na_2O to SiO_2 **and** SiO_2 to P_4O_{10}?

A Covalent character

B Melting point

C Solubility in aqueous alkali

* **D** pH when mixed with water

25 The oxide of an element **Q** is insoluble in water and its chloride in aqueous solution reacts with a base.

To which Group of the Periodic table could element **Q** belong?

A Group III, Group IV or Group V

* **B** Group III or Group IV only

C Group III or Group V only

D Group IV or Group V only

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

26 The compound sodium borohydride, $NaBH_4$ is commonly used as a source of the hydride anion for synthetic purposes.

Which of the following types of bonding are found in the compound?

* **1** Ionic

* **2** Covalent

3 Hydrogen bonding

27 Elements **A, B, C, D** and **E** are consecutive elements in the same period and have atomic numbers < 10. The successive ionization energies, in kJ mol^{-1}, of an element **B** are given below:

1090 2400 4600 6200 37800

Which of the following statement(s) is/are true?

* **1** Chlorides of Element **A** are electron deficient.

* **2** Element **B** can conduct electricity in the solid state.

* **3** Element **E** exists in gaseous state at room temperature and pressure.

28 In which of the following reactions does NH_3 act as a Bronsted-Lowry base?

* **1** $2NH_3 \rightarrow NH_2^- + NH_4^+$

* **2** $HSO_4^- + NH_3 \rightarrow SO_4^{2-} + NH_4^+$

3 $Ag^+ + 2NH_3 \rightarrow [Ag(NH_3)_2]^+$

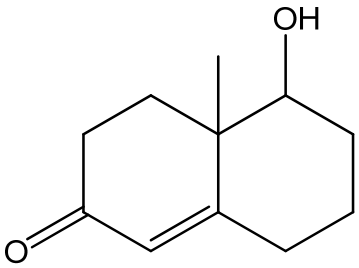
29 Which of the following closed systems have units of $mol^{-1}\ dm^3$ for the equilibrium constant K_c?

* **1** $2NO_2(g) \rightleftharpoons N_2O_4(g)$

2 $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

3 $H_2O(l) + CH_3CO_2C_2H_5(l) \rightleftharpoons C_2H_5OH(l) + CH_3CO_2H(l)$

30 Which of the following statement(s) is/are correct about compound **J** shown below?



Compound **J**

* **1** 1 mole of **J** reacts with 1 mole of phosphorus(V) chloride.

* **2** 1 mole of **J** reacts with 2 moles of diamminesilver(I) complex in alkaline solution.

* **3** 1 mole of **J** reacts with 2 moles of H_2 in presence of platinum catalyst.

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