

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.

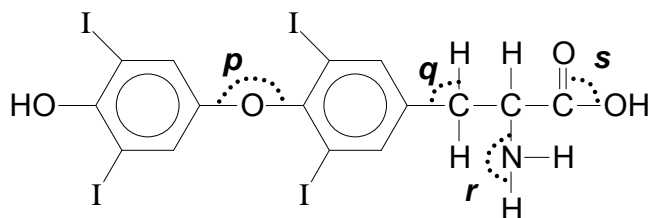
Determine the concentration of sulfur dioxide, in mol dm^{-3} , in the wine.

- 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**?

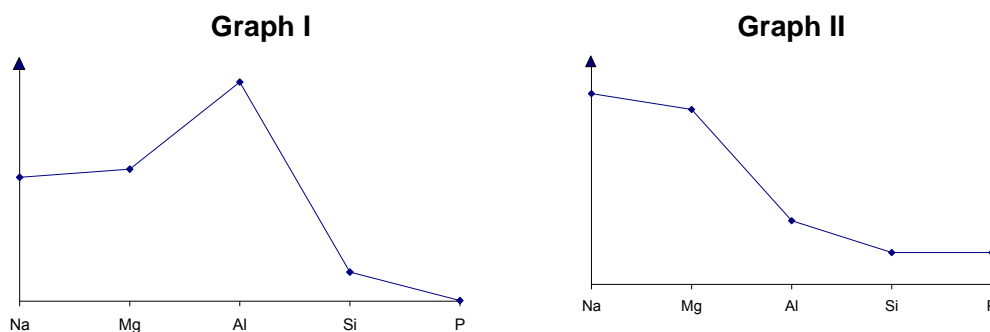
	p	q	r	s
A	180°	90°	180°	90°
B	105°	109.5°	107°	120°
C	180°	90°	120°	180°
D	105°	90°	107°	180°

- 6 In butanoic acid, $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ (*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.



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.

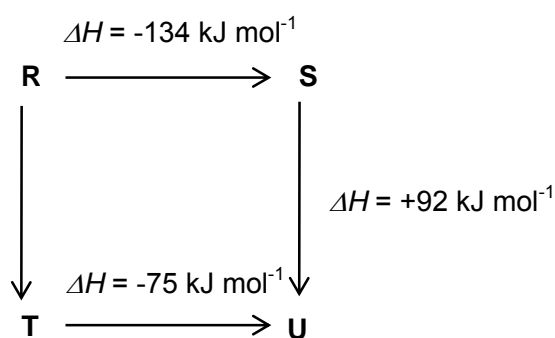
What is the likely structure of **G**?

- 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.



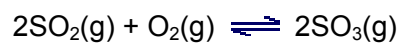
Which of the following statements is false?

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

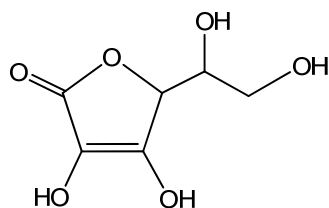
- 12 In the manufacturing of sulfuric acid, one of the important steps involves the oxidation of sulfur dioxide to produce sulfur trioxide.



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?

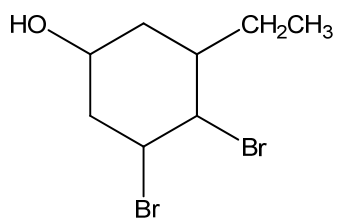
- A 8
- B 64
- C 80
- D 640
- 13 Equal volumes of HCl (aq) of pH 4 and H_2SO_4 (aq) of pH 2 were mixed. What is the pH of the resulting mixture?
- A 2.0
- B 2.3
- C 2.5
- D 3.0
- 14 What is the total number of sigma bonds in a molecule of vitamin C as shown below?



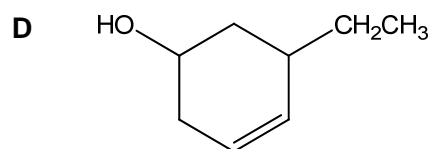
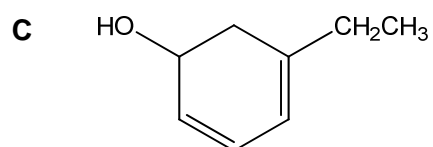
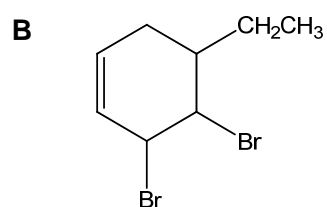
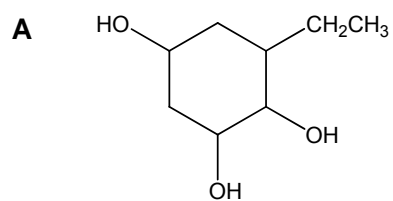
- A 16
- B 18
- C 20
- D 22

- 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 $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_3$ and $\text{C}_6\text{H}_5\text{CH}_3$
B CH_3OH and $\text{CH}_2(\text{OH})\text{CH}_2\text{OH}$
C $\text{CH}_3\text{CH}_2\text{CHO}$ and $(\text{CH}_3)_2\text{CHOH}$
D $\text{CH}_3\text{CH}_2\text{OH}$ and $\text{CH}_3\text{CH}=\text{CHCH}_3$

- 18 The following compound was heated with ethanolic potassium hydroxide.



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



- 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	$\text{CH}_2=\text{CHCOCH}_3$
B	CH_3COCH_3	$(\text{CH}_3)_2\text{C}(\text{OH})\text{COCH}_3$
C	$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$	$\text{CH}_3\text{COCH}_2\text{CH}_3$
D	$\text{CH}_2=\text{CHCHO}$	$\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CHO}$

- 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?

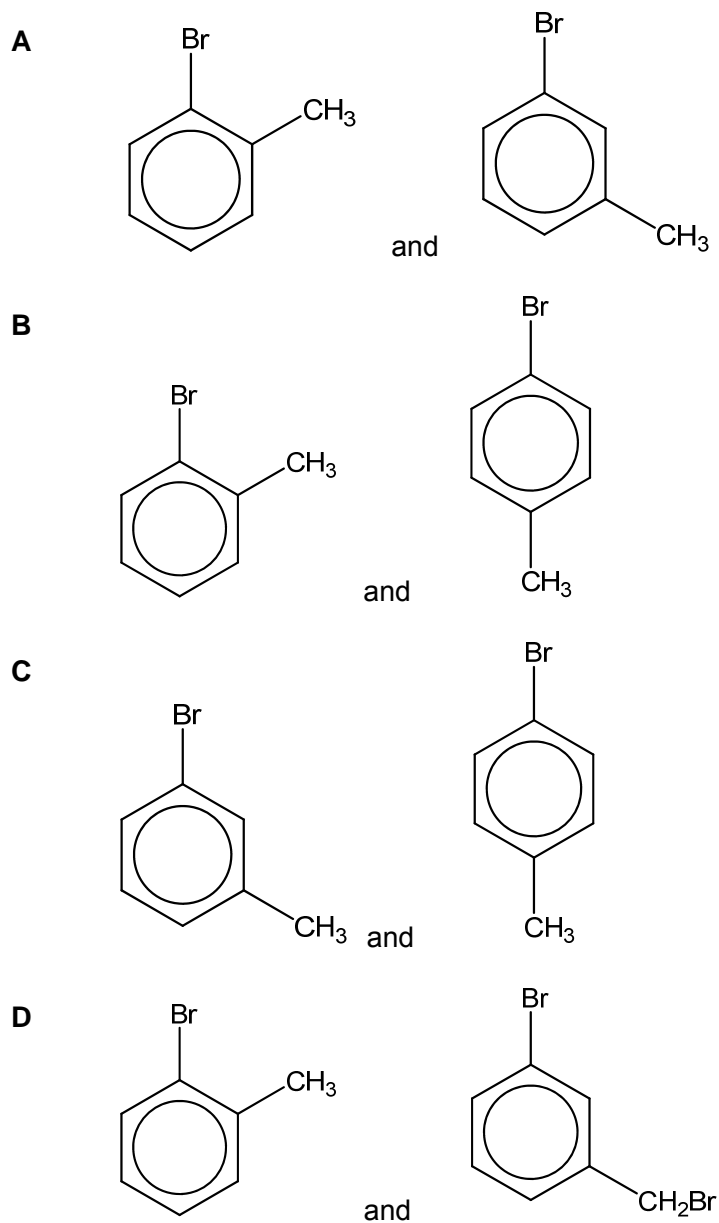
- A** $\text{CH}_3\text{COOCH}(\text{CH}_3)_2$
B $\text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_3$
C $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3$
D $\text{CH}_3\text{CH}_2\text{COOCH}(\text{CH}_3)_2$

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

- A** $\text{CH}_3\text{CH}_2\text{OH} > \text{CH}_3\text{CO}_2\text{H} > \text{CH}_2\text{FCO}_2\text{H}$
B $\text{BrCH}_2\text{CO}_2\text{H} > \text{ClCH}_2\text{CO}_2\text{H} > \text{CH}_3\text{CO}_2\text{H}$
C $\text{CH}_3\text{CH}_2\text{CO}_2\text{H} > \text{CH}_3\text{CO}_2\text{H} > \text{HCOOH}$
D $\text{CH}_3\text{CCl}_2\text{CO}_2\text{H} > \text{ClCH}_2\text{CHClCO}_2\text{H} > \text{Cl}_2\text{CHCH}_2\text{CO}_2\text{H}$

- 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?



- 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.

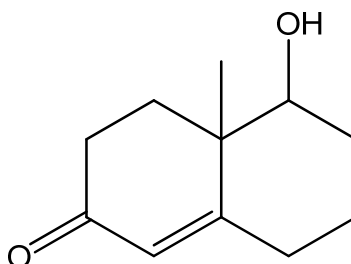
28 In which of the following reactions does NH_3 act as a Bronsted-Lowry base?

- 1 $2\text{NH}_3 \rightarrow \text{NH}_2^- + \text{NH}_4^+$
- 2 $\text{HSO}_4^- + \text{NH}_3 \rightarrow \text{SO}_4^{2-} + \text{NH}_4^+$
- 3 $\text{Ag}^+ + 2\text{NH}_3 \rightarrow [\text{Ag}(\text{NH}_3)_2]^+$

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

- 1 $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$
- 2 $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$
- 3 $\text{H}_2\text{O}(\text{l}) + \text{CH}_3\text{CO}_2\text{C}_2\text{H}_5(\text{l}) \rightleftharpoons \text{C}_2\text{H}_5\text{OH}(\text{l}) + \text{CH}_3\text{CO}_2\text{H}(\text{l})$

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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