## Section A

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

**1** 0.18 g of a dibasic acid (Mr = 90) is reacted with 0.10 mol $dm^{-3}$ sodium hydroxide solution. What is the volume of the alkali needed for complete reaction?

**A** 30 $cm^3$ **B** 40 $cm^3$ **C** 50 $cm^3$ **D** 60 $cm^3$

**2** A gaseous organic compound, X, was burnt in an excess of oxygen. A 0.224 $dm^3$ sample of X, measured at s.t.p., produced 2.2 g of carbon dioxide. How many carbon atoms are there in one molecule of X?

**A** 2 **B** 3 **C** 4 **D** 5

**3** If the relative atomic mass of an element which consists of two isotopes $^{10}M$ and $^{11}M$ is 10.8, what is the percentage of $^{11}M$ atoms in the isotopic mixture?

**A** 20 **B** 50 **C** 80 **D** 92

**4** Ions of two isotopes of chlorine are $^{35}Cl^-$ and $^{37}Cl^-$.
Which one of the following statements is correct?

**A** The $^{37}Cl^-$ has more protons than $^{35}Cl^-$.

**B** The $^{37}Cl^-$ has more neutrons than $^{35}Cl^-$.

**C** The $^{37}Cl^-$ has more electrons than $^{35}Cl^-$.

**D** The electron arrangement of both these ions is $1s^2 2s^2 2p^6 3s^2 3p^5$

**5** For whch of the following is the lattice energy likely to have the greatest numerical value (i.e. greatest magnitude, disregarding the sign)?

**A** lithium fluoride **C** potassium iodide
**B** rubidium chloride **D** sodium chloride

**6** From which of the following reactions can the bond energy of the C—Cl bond be determined by using **only** the standard enthalpy change of the reaction?

**A** $CCl_4(g) \rightarrow C(g) + 4Cl(g)$

**B** $CCl_4(g) \rightarrow CCl_2(g) + Cl_2(g)$

**C** $CCl_4(g) \rightarrow C(s) + 2Cl_2(g)$

**D** $CCl_4(s) \rightarrow CCl_4(g)$

**7** Which one of the statements about the properties associated with ionic and covalent substances is correct?

**A** All covalent compounds have low melting points compared to ionic compounds.

**B** Any covalent compound that contain both hydrogen and oxygen in its molecule can form intermolecular hydrogen bonds.

**C** A covalent compound cannot be an electrolyte.

**D** Ionic compounds differ from metals in that ionic compounds do not conduct electricity in the solid state.

**8** Which of the following statements best explains why the boiling point of ethanal is higher than that of propane?

**A** The C=O bond in ethanal is stronger than the bonds present in propane molecules.

**B** The dipole-dipole interaction between ethanal molecules is stronger than the Van der Waals forces between propane molecules.

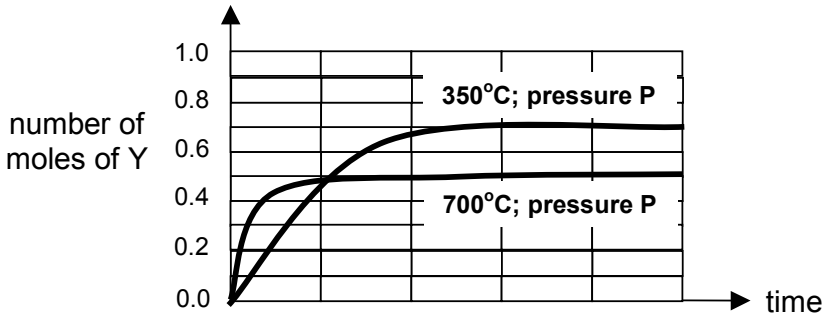
**C** The relative molecular mass of ethanal is higher than that of propane.

**D** The ethanal molecule has a larger surface area than that of propane.

**9** V and W can react together to reach equilibrium in the reaction below.

$$V(g) + W(g) \rightleftharpoons X(g) + Y(g)$$

In an experiment, an 1.0 mole each of V and W were reacted at constant pressure P and temperature 350$^{O}$C. The amount of Y present in the mixture at intervals of time was recorded. The experiment was repeated at the same pressure P, but at a temperature of 700$^{o}$C. The results for both experiments are shown below.




Which one of the following information cannot be deduced from the graph?

**A** The value of $K_c$ decreases with an increase in temperature.

**B** The rate at which equilibrium is achieved is faster at higher temperatures.

**C** The enthalpy change for the forward reaction is negative.

**D** The activation energy of the forward reaction is high.

**10** An equilibrium can be represented by the following equation.

$$A(aq) + B(aq) \rightleftharpoons P(aq) + Q(aq)$$

In a certain mixture, the equilibrium concentration of B is 5 mol $dm^{-3}$ .
What will be the new equilibrium concentration of B if 2 mol of pure B is dissolved in the mixture?

**A** 5 mol $dm^{-3}$

**B** 7 mol $dm^{-3}$

**C** betweeen 5 mol $dm^{-3}$ and 7 mol $dm^{-3}$

**D** between 3 mol $dm^{-3}$ and 5 mol $dm^{-3}$

**11** What is the pH of the solution formed by mixing equal volumes of two separate portions of aqueous sodium hydroxide of pH 11 and 13?

**A** 11.3 **B** 12.0 **C** 12.5 **D** 12.7

**12** What is a satisfactory indicator for the titration of 0.1 mol $dm^{-3}$ ethanoic acid with 0.1 mol $dm^{-3}$ aqueous potassium hydroxide?

**A** methyl orange (pH range 3 – 4)

**B** bromothymol blue (pH rang 6 – 8)

**C** phenolpthalein (pH range 8 – 10)

**D** There is no satisfactory indicator.

**13** The acid-catalysed iodination of propanone may be investigated by reacting dilute aqueous iodine with solutions containing known concentrations of propanone and acid. The rate can be followed by using a colorimeter to measure the colour intensity of iodine present.

$$CH_3COCH_3 + I_2 \xrightarrow{H^+} CH_3COCH_2I + HI$$

Why is a large excess of propanone used?

**A** to keep the propanone concentration effectively constant

**B** to prevent the iodine form precipitating out of solution

**C** to buffer the acid concentration

**D** to keep the rate of reaction constant

**14** Benzene is nitrated by a mixture of concentrated nitric acid and concentrated sulphuric acid. When the reaction was carried out in an organic solvent the results shown below were obtained.

| Expt No. | $[C_6H_6]$ / mol $dm^{-3}$ | $[HNO_3]$ / mol $dm^{-3}$ | initial rate x $10^4$ / mol $dm^{-3}$ $s^{-1}$ |
|---|---|---|---|
| 1 | 0.30 | 0.30 | 1.64 |
| 2 | 0.30 | 0.60 | 3.28 |
| 3 | 0.60 | 0.90 | 4.92 |

What is the rate equation for the reaction?

**A** rate = $k[C_6H_6]$

**B** rate = $k[HNO_3]$

**C** rate = $k[C_6H_6]\,[HNO_3]$

**D** rate = $k[C_6H_6]^2\,[HNO_3]$

**15** In which of the following substances does chlorine exhibit its highest oxidation state?

**A** $PCl_5$ **B** $NaClO_3$ **C** $ClO_3F$ **D** $Cl_2O$

**16** Sodium thiosulphate is used in the textile industry to remove an excess of chlorine from bleaching processes by reducing it to chloride ions.

$$S_2O_3^{2-} + 4Cl_2 + 5H_2O \rightarrow 2HSO_4^- + 8H^+ + 8Cl^-$$

In this reaction, how many moles of electrons are supplied per mole of thiosulphate?

**A** 2 **B** 4 **C** 6 **D** 8

**17** Beryllium resembles aluminium in its chemical properties.
Which property of beryllium compounds is **unlikely** to be correct?

**A** Beryllium oxide can undergo reaction with aqueous sodium hydroxide.

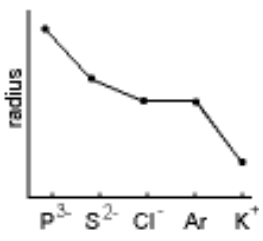
**B** Beryllium chloride can form the dimer $Be_2Cl_4$.

**C** Beryllium chloride is an ionic compound.

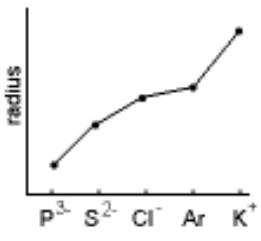
**D** Beryllium chloride dissolves in water to give an acidic.solution.

**18** Which graph best shows the variation of radii of the species indicated?

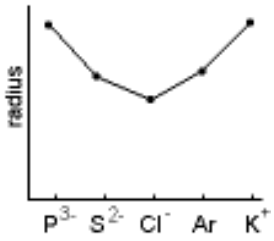
**A**



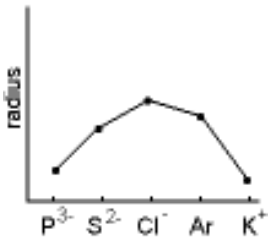

**B**




**C**




**D**



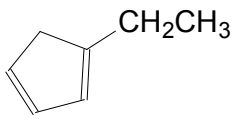
**19** The elements xenon (Xe), caesium (Cs) and barium (Ba) are consecutive elements in the Periodic Table.
What is the order of their first ionisation energies?

| | least endothermic ⟶ | | most endothermic |
|---|---|---|---|
| **A** | Xe | Ba | Cs |
| **B** | Ba | Xe | Cs |
| **C** | Xe | Cs | Ba |
| **D** | Cs | Ba | Xe |

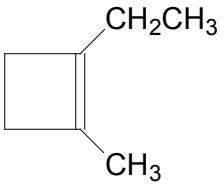
**20** A hydrocarbon, on heating with an excess of hot concentrated acidified $KMnO_4(aq)$, produces $HO_2CCH_2CH_2COCH_2CH_3$ as one of the products.

What could the hydrocarbon be?

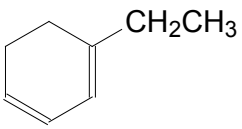
**A**



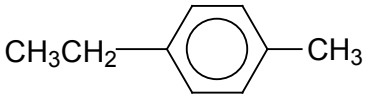

**B**



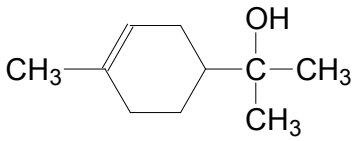

**C**




**D**




**21** The compound terpeneol is commonly found in thinner.




What deduction about terpeneol can be made from this structure?

**A** It undergoes oxidation with warm acidified potassium dichromate(VI).

**B** It undergoes dehydration reaction with concentrated $H_2SO_4$ .

**C** 1 mole of terpeneol reacts with 2 moles of bromine in $CCl_4$.

**D** It forms a salt with aqueous sodium hydroxide.

**22** The Russian composer Borodin discovered a reaction in which two ethanal molecules combine to form a compound commonly known as aldol (reaction **I**). Aldol forms another compound on reacting with reagent **Q**.

**I** $2CH_3CHO \rightarrow CH_3CH(OH)CH_2CHO$

**II** $CH_3CH(OH)CH_2CHO \rightarrow CH_3COCH_2CO_2H$

Which of the following best describes reactions **I**, **II** and reagent **Q**?

| | **I** | **II** | **Q** |
|---|---|---|---|
| **A** | substitution | oxidation | acidified $KMnO_4$ |
| **B** | substitution | reduction | $LiAlH_4$ |
| **C** | addition | hydrolysis | dilute $H_2SO_4$ |
| **D** | addition | oxidation | acidified $KMnO_4$ |

**23** The same carboxylic acid is obtained either by the hydrolysis of a nitrile **R** or by the oxidation of an alcohol **S**.
Which of the following pairs could be **R** and **S**?

| | **R** | **S** |
|---|---|---|
| **A** | $(CH_3)_3CCN$ | $(CH_3)_3COH$ |
| **B** | $CH_3CH_2CN$ | $CH_3CH_2OH$ |
| **C** | $(CH_3)_2CHCN$ | $(CH_3)_2CHCH_2OH$ |
| **D** | $CH_3CH_2CH(CH_3)CN$ | $CH_3CH_2CH_2CH(OH)CH_3$ |

**24** Dichlorodifluoromethane, $CCl_2F_2$, is widely used in aerosol propellants and as a refrigerant.
Which statement helps to explain why dichlorodifluoromethane is chemically inert?

**A** The carbon-fluorine bond energy is large

**B** The carbon-fluorine bond has a low polarity.

**C** Fluorine is highly electronegative.

**D** Van der Waals' forces between fluorine atoms are weak.

**25** In a reaction with sodium, 1 mol of a compound **X** gives 1 mol of $H_2(g)$.
Which compound might **X** be?

**A** $CH_3CO_2CH_2CO_2H$

**B** $(CH_3)_3COH$

**C** $CH_3CH(OH)CO_2H$

**D** $CH_3CHClCH_2CO_2H$

## 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 these statements is or 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** Which of the following reagents can be used to distinguish between propanal and propene?

**1** acidified potassium dichromate(VII)
**2** 2,4-dinitrophenylhydrazine
**3** hydrogen bromide

**27** The successive ionization energies, in kJ $mol^{-1}$, of an element **X** is given below.
**X** 225 489 711 991 1577 1886 3586 4665
Which of the following statements about element X can be deduced?

**1** It is found in Group VI.
**2** It has 2 unpaired electrons in the outermost p orbital.
**3** It is likely to form a positive ion with a +2 charge.

**28** In which sequences are the molecules quoted in order of increasing bond angle within the molecule?

| | | | |
|---|---|---|---|
| **1** | $SF_6$ | $SO_3$ | $CO_2$ |
| **2** | $NH_3$ | $H_2O$ | $CH_4$ |
| **3** | $SO_2$ | $BeCl_2$ | $BF_3$ |

**29** Which of the following in aqueous solution do **not** considerably change in pH when relatively small volumes of strong acid or strong alkali are added?

**1** a mixture of sodium sulphate and sodium chloride
**2** a mixture of sodium ethanoate and ethanoic acid
**3** a mixture of sodium carbonate and sodium hydrogencarbonate

**30** The rate constant of a reaction is usually

**1** different for the forward and backward reactions in an endothermic process.
**2** increased in the presence of a catalyst.
**3** lowered when temperature decreases