Unit 2: Application of Core Principles of Chemistry

Section A

Question Number	Question	
1	Which of the following best describes the molecular shape of carbon dioxide, CO_2? A Linear B Trigonal planar C Triangular D V-shaped	
	Correct Answer	Mark
	A	**1**

Question Number	Question	
2	Which of the following species is polar? A NH_3 B BF_3 C SO_3 D CO_3^{2-}	
	Correct Answer	Mark
	A	**1**

Question Number	Question	
3	Polar liquids are affected by electric fields. For which of the following liquids would a jet of the liquid be affected by an electric field? A hexane B cyclohexane C cyclohexene D cyclohexanol	
	Correct Answer	Mark
	D	**1**

Question Number	Question	
4	What are the intermolecular forces in methanal, HCHO? A London forces only B hydrogen bonds and London forces C permanent dipole – permanent dipole only D permanent dipole – permanent dipole and London forces	
	Correct Answer	Mark
	D	**1**

Question Number	Question	
5	Which of the following substances is likely to be insoluble in water? A methanol, CH_3OH B ethanol, CH_3CH_2OH C fluoromethane, CH_3F D hydrogen fluoride, HF	
	Correct Answer	Mark
	C	**1**

Question Number	Question	
6	The following liquids have a similar number of electrons per molecule. Suggest which is likely to have the highest boiling point? A $CH_3CH_2CH_2CH_2CH_3$ B $(CH_3)_3COH$ C $CH_3CH_2CH(OH)CH_3$ D $CH_3CH_2CH_2CH_2OH$	
	Correct Answer	Mark
	D	**1**

Question Number	Question	
7	Which concentrated acid should be used to dissolve a carbonate of a Group 2 metal to carry out a flame test? A ethanoic acid B hydrochloric acid C nitric acid D sulfuric acid	
	Answer	Mark
	B	**1**

Question Number	Question	
8	What colour does a barium salt give in a flame test? A colourless B green C red D yellow-red	
	Correct Answer	Mark
	B	**1**

Question Number	Question	
9	Separate flame tests are carried out with lithium, sodium, potassium, magnesium, calcium and strontium salts. How many of these metal ions would colour the flame red? A 1 B 2 C 3 D 4	
	Correct Answer	Mark
	C	**1**

Question Number	Question	
10	A Group 2 element reacts vigorously with water to produce a soluble hydroxide, which forms a white precipitate when neutralised by sulfuric acid and forms a carbonate which is very stable to heat. The element could be A magnesium B calcium C strontium D barium	
	Correct Answer	Mark
	D	**1**

Question Number	Question	
11	The Group 2 metals, considered in order of increasing atomic number, show a decrease in A first ionisation energy B nuclear charge C chemical reactivity D ionic radius	
	Correct Answer	Mark
	A	**1**

Question Number	Question	
12	When a Group 1 metal nitrate is heated, brown fumes are observed. The metal could be A lithium B sodium C rubidium D caesium	
	Correct Answer	Mark
	A	**1**

Question Number	Question	
13	Methyl orange is red in acidic solutions and yellow in alkaline solutions. What is the colour of the indicator at the end point of a titration of aqueous sodium hydroxide solution with hydrochloric acid? A red B pink C orange D yellow	
	Correct Answer	Mark
	C	**1**

Question Number	Question	
14	The volume, in cm^3, of 0.25 mol dm^{-3} hydrochloric acid required to neutralise 100 cm^3 of 0.125 mol dm^{-3} barium hydroxide solution, $Ba(OH)_2(aq)$, is A 25 B 50 C100 D 200	
	Correct Answer	Mark
	C	**1**

Question Number	Question	
15	What is the oxidation number of SULFUR in sodium tetrathionate, $Na_2S_4O_6$? A -½ B +1½ C +2½ D + 5	
	Correct Answer	Mark
	C	**1**

Question Number	Question	
16	Which of the following statements is FALSE? A iodine is more electronegative than bromine. B fluorine is more electronegative than chlorine. C metallic elements tend to react by loss of electrons. D chlorine is more electronegative than sulfur.	
	Correct Answer	Mark
	A	**1**

Question Number	Question	
17	A commercial production of iodine involves the reduction of a solution of iodate(V) ions, IO_3^-, with a theoretical quantity of hydrogen sulfite ions, HSO_3^-. The equation for the reaction may be written $xIO_3^- + yHSO_3^- \longrightarrow zSO_4^{2-} + I_2 + 3H^+ + H_2O$ What are the balancing numbers x, y and z? A 5,2,2 B 2,5,2 C 2,5,5 D 5,5,2	
	Correct Answer	Mark
	C	**1**

Question Number	Question	
18	An organic compound is found to react with sodium metal and to react with acidified sodium dichromate(VI), but not to decolourise bromine water, nor to neutralise sodium carbonate solution. The liquid could be A ethanol B ethane C ethanoic acid D ethene	
	Correct Answer	Mark
	A	**1**

Question Number	Question	
19	Which of the following is not a greenhouse gas? A CH_4 B CO_2 C H_2O D N_2	
	Correct Answer	Mark
	D	**1**

Question Number	Question	
20	Which of the following fuels has the smallest carbon footprint? A petrol made from crude oil B hydrogen made from methane C ethanol made from sugar D coal	
	Correct Answer	Mark
	C	**1**

Question Number	Question	
21	Which of the following would not lead to a greater sustainability in an industrial process? A using a catalyst that improves atom economy B running the reaction at a higher temperature C using biofuels to run the process D recycling waste products	
	Correct Answer	Mark
	B	**1**

Question Number	Question	
22 (a)	The reason that 50% sulfuric acid was used rather than concentrated sulfuric acid is because concentrated sulfuric acid A would oxidise some of the bromide ions to bromine B would cause the reaction to go too fast. C would react with the bromide ions to produce hydrogen bromide. D is too hazardous a chemical.	
	Correct Answer	Mark
	A	**1**

Question Number	Question	
22 (b)	The reaction mixture was distilled. The impure distillate did NOT contain A butan-1-ol B 1-bromobutane C sodium bromide D hydrogen bromide	
	Correct Answer	Mark
	C	**1**

Question Number	Question	
22 (c)	The impure 1-bromobutane was washed with concentrated hydrochloric acid and shaken in a tap funnel with a base to remove acidic impurities. Which of the following would remove acidic impurities without reacting with the 1-bromobutane. A calcium hydroxide solution B sodium hydroxide solution C calcium chloride solution D sodium hydrogencarbonate solution	
	Correct Answer	Mark
	D	**1**

Question Number	Question	
22 (d)	The 1-bromobutane was washed with water, dried and distilled. Which of the following is the correct procedure? A heat the liquid to 118 ^{o}C and collect the substance given off B heat the liquid to 100 ^{o}C and collect the substance given off C boil the liquid and collect the fraction that boils off between 116 and 120 ^{o}C D boil the liquid and collect the fraction that boils off between 98 and 102 ^{o}C	
	Correct Answer	Mark
	D	**1**

Question Number	Question	
23	Which of the following changes in conditions would increase the equilibrium yield of ethanoic acid? A increase pressure B decrease pressure C increase temperature D add a catalyst	
	Correct Answer	Mark
	A	**1**

Question Number	Question	
24 (a)	propanone from propanal and propan-1-ol A B C D	
	Correct Answer	Mark
	D	**1**

Question Number	Question	
24 (b)	propanal from propanone and propan-1-ol A B C D	
	Correct Answer	Mark
	C	**1**

Question Number	Question	
24 (c)	propan-1-ol from propanal and propanone A B C D	
	Correct Answer	Mark
	A	**1**

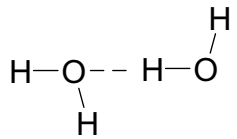
Section B

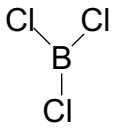
Question Number	Question		
25 (a)	Draw the structural formulae of the two isomers with molecular formula C_3H_8O which are alcohols. Give the names of these alcohols.		
	Acceptable Answers	Reject	Mark
	$CH_3CH_2CH_2OH$ (1) Propan-1-ol (1) $CH_3CH(OH)CH_3$ (1) Propan-2-ol (1)		**4**

Question Number	Question		
25 (b) (i)	Give the name and structural formula of the carboxylic acid formed when the primary alcohol C_3H_8O is fully oxidised.		
	Acceptable Answers	Reject	Mark
	Propanoic acid (1) $CH_3CH_2CO_2H$ (1)		**2**

Question Number	Question		
25 (b) (ii)	**State the reagents used for this oxidation.**		
	Acceptable Answers	Reject	Mark
	Either sodium dichromate ((VI)) or potassium manganate(VII) (1) Sulfuric acid (1) dependent on 1st mark Ignore concentrated/dilute		**2**

Question Number	Question		
26 (a) (i)	Name the type of bonding that exists between water molecules.		
	Acceptable Answers	Reject	Mark
	Hydrogen/H bonding (1)		**1**

Question Number	Question		
26 (a) (ii)	Draw a diagram to show this bonding. Use displayed formulae of two water molecules. Clearly mark and label the bond angle BETWEEN the water molecules.		
	Acceptable Answers	Reject	Mark
	 (1) Either Bond angle 180° around the hydrogen bonded H atom, i.e. O---H—O	O---H-O if not in a straight line	**2**

Question Number	Question		
26 (b) (i)	Draw the boron trichloride molecule, BCl_3, making its shape clear. Mark the bond angle on your diagram.		
	Acceptable Answers	Reject	Mark
	trigonal planar diagram (1)  *IGNORE name* 120 ° marked on diagram (1) – *stand alone*		**2**

Question Number	Question		
26 b (ii) QWC (i) & (iii)	Explain why boron trichloride has this shape.		
	Acceptable Answers	Reject	Mark
	There are 3 bond pairs (of electrons) around the B atom (1) And no lone pairs (1) They repel to a position of minimum repulsion/maximum separation (1)	maximum repulsion	**3**

Question Number	Question		
26 (b) (iii)	Explain why a B-Cl bond is polar.		
	Acceptable Answers	Reject	Mark
	B and Cl have different electronegativities / Cl more electronegative than B *OR different electronegativities explained*		**1**

Question Number	Question		
26 (b) (iv)	Explain why a BCl_3 molecule is non-polar.		
	Acceptable Answers	Reject	Mark
	Dipoles (or vectors) cancel/symmetrical molecule/ centres of positive and negative charges coincide (1) *IGNORE* polarity cancels	Charges cancel	1

Question Number	Question		
26 (b) (v)	Name the strongest intermolecular force between boron trichloride molecules.		
	Acceptable Answers	Reject	Mark
	London forces / instantaneous dipole-Induced dipole/dispersion /v der Waals *Temporary or instantaneous can be used instead of induced* (1)	"dipole" forces/ permanent dipole/ dipole-dipole vdw	**1**

Question Number	Question		
27 (a) (i)	Why was ethanol added to each test-tube?		
	Acceptable Answers	Reject	Mark
	Make halogenoalkanes miscible with silver nitrate/$AgNO_3$ solution OR to dissolve halogenoalkanes/acts as solvent (1)		**1**

Question Number	Question		
27 (a) (ii)	The mechanism of this reaction is similar to that of the reaction between halogenoalkanes and aqueous hydroxide ions. What feature of a water molecule enables it to act as a nucleophile in this reaction? Suggest the mechanism for the reaction between water and 1-iodobutane. (You may represent 1-iodobutane as RCH_2I).		
	Acceptable Answers	Reject	Mark
	Feature of water molecule: The oxygen atom has a lone pair of electrons (1) Either an S_N2 mechanism Arrow from O of water towards C atom (1) and arrow from C-I σ bond to I atom (1) transition state with no charge (1) Ignore final loss of H^+ and formation of I^- Or an S_N1 mechanism Arrow from C-I σ bond to I (1) intermediate with + charge and I^- ion (1) arrow from O of water to C+ of intermediate (1) Ignore final loss of H^+		**4**

Question Number	Question		
27 (a) (iii)	What is the colour of the precipitate in the third test-tube? A cream B white C yellow D grey		
	Correct Answer	Reject	Mark
	C		**1**

Question Number	Question		
27 (a) (iv)	Name the precipitate which forms slowly in the FIRST test-tube.		
	Acceptable Answers	Reject	Mark
	Silver((I)) chloride (1) Ignore capitals		**1**

Question Number	Question		
27 (a) (v)	Ammonia solution is added to the precipitate in the FIRST test-tube. Describe what you would observe.		
	Acceptable Answers	Reject	Mark
	Precipitate dissolves/disappears/clears (1)	Precipitate changes colour	**1**

Question Number	Question		
27 (a) (vi) QWC (i-iii)	Suggest, why the rates of hydrolysis of the three halogenoalkanes are different, in terms of bonding and kinetics.		
	Acceptable Answers	Reject	Mark
	Must be given in a logical sequence C-I bond is weakest (and break more easily) (1) Because the iodine atom is the largest / greatest bond length (1) So lowest activation energy (1) Or reverse argument: e.g. C-Cl bond strongest	Cl is more electronegative than I OR Cl forms a carbocation more readily than C-I	**3**

Question Number	Question		
27 (b) QWC (i) & (iii)	One method of the manufacture of alcohols is to react steam with an alkene. For example. $C_2H_4(g) + H_2O(g) \longrightarrow C_2H_5OH(l)$ Suggest TWO reasons why this method is preferred to the hydrolysis of halogenoalkanes.		
	Acceptable Answers	Reject	Mark
	Any two from three: 100 % atom economy (1) higher cost of halogenoalkanes/halogenoalkanes are made from alcohols (1) alkenes readily available from oil (1)		**2**

Question Number	Question		
27 (c) (i)	State the hazard when the heating is stopped.		
	Acceptable Answers	Reject	Mark
	suck back (1)		**1**

Question Number	Question		
27 (c) (ii)	How would you minimise the risk associated with this hazard?		
	Acceptable Answers	Reject	Mark
	remove delivery tube from water/add Bunsen valve (1)		**1**

Section C

Question Number	Question		
28 (a) (i)	The record of measurements reveals faults both in procedure and the recording of measurements. State ONE fault in each of these.		
	Acceptable Answers	Reject	Mark
	Procedure: Only one titration carried out/ no check on accuracy of titration OR 1000 cm^3 volume to large to fit in titration flask (1) Recording: Did not record burette readings to 0.05 cm^3 / 1 decimal place / sufficient precision / recording only one significant figure in a titration reading (1)		**2**

Question Number	Question		
28 (a) (ii)	Calculate the number of moles of sodium thiosulfate used in the titration.		
	Acceptable Answers	Reject	Mark
	4.65×10^{-5} / 4.7×10^{-5} / 0.0000465 / 0.000047 (mol)		**1**

Question Number	Question		
28 (a) (iii)	Use your answer to (ii) to calculate the number of moles of iodine reacted.		
	Acceptable Answers	Reject	Mark
	2.3×10^{-5} / 0.000023 OR candidates answer to (ii) divided by 2		**1**

Question Number	Question		
28 (a) (iv)	Deduce the concentration of chlorine, in mol dm^{-3}, in the swimming pool water.		
	Acceptable Answers	Reject	Mark
	2.3×10^{-5} / 0.000023 mol dm^{-3} OR candidates answer to (iii)		**1**

Question Number	Question		
28 (b) (i) QWC (i) & (iii)	State and explain the type of reaction that occurs when chlorine attacks a metal, using the example of iron.		
	Acceptable Answers	Reject	Mark
	Redox as chlorine removes/gains electrons from the metal (and is reduced) (1) And metal gives/loses electrons to the chlorine (and is oxidised) (1) Redox is essential in order to score both marks The gain / loss of electrons can be awarded from two ionic half equations.		**2**

Question Number	Question		
28 (b) (ii)	Suggest ONE other reason why the use of chlorine is undesirable in swimming pools.		
	Acceptable Answers	Reject	Mark
	Chlorine is (highly) toxic/poisonous/irritant OR chlorine has an unpleasant smell (1)		**1**

Question Number	Question		
28 (b) (iii)	Give the formula for calcium chlorate(I).		
	Acceptable Answers	Reject	Mark
	$Ca(ClO)_2$ (1)		**1**

Question Number	Question		
28 (b) (iv) QWC (ii)	Chlorine dioxide, ClO_2, undergoes a disproportionation reaction when it reacts with water. $4ClO_2 + 2H_2O \rightarrow HClO + 3HClO_3$ Explain, in terms of oxidation numbers, why this is a disproportionation reaction.		
	Acceptable Answers	Reject	Mark
	Cl is oxidised from +4 (in ClO_2) to +5 (in $HClO_3$) (1) and is reduced (from +4) to +1 (in HClO) (1)		**2**

Question Number	Question		
28 (c) QWC (i-iii)	Discuss and explain the science community's advice that CFCs should no longer be used in aerosols, foams and refrigerants. Support your answer with one or more equations.		
	Acceptable Answers	Reject	Mark
QWC	Any of the five points below as long as they are logically connected and use correct scientific terminology plus 1 mark for an equation to a maximum of 6 marks. • CFCs are greenhouse gases • because their dipole moment changes when they vibrate • and so contribute to global warming • depletion of the ozone layer • causes less ozone to absorb UV radiation (from the sun) /increase in UV reaching the earth's surface • causes skin cancer / mutations • CFCs (decompose photolytically to) produce free radical chlorine atoms/ Cl radicals • Recognition that one Cl radical can cause the destruction of many thousands of ozone molecules / or mention of chain reaction Equations $Cl^{\bullet} + O_3 \rightarrow ClO^{\bullet} + O_2$ $ClO^{\bullet} + O^{\bullet} \rightarrow Cl^{\bullet} + O_2$ Either equation or other relevant equation (1)		**6**