Neap

Trial Examination 2021

Suggested solutions

QCE Chemistry Units 1&2

Paper 1

SECTION 1 – MULTIPLE-CHOICE QUESTIONS

	A	B	C	D
1.	○	●	○	○
2.	○	○	○	●
3.	○	○	●	○
4.	●	○	○	○
5.	○	○	●	○
6.	○	○	●	○
7.	○	●	○	○
8.	○	○	○	●
9.	●	○	○	○
10.	○	○	○	●
11.	○	○	●	○
12.	○	●	○	○
13.	○	○	●	○
14.	○	●	○	○
15.	●	○	○	○

	A	B	C	D
16.	○	○	●	○
17.	●	○	○	○
18.	○	○	○	●
19.	●	○	○	○
20.	●	○	○	○
21.	●	○	○	○
22.	○	●	○	○
23.	○	○	●	○
24.	○	●	○	○
25.	○	○	○	●

QUESTION 1 B

B is correct. Dinitrogen pentoxide is a covalent compound, so the formula is derived from the prefixes in the name: di = 2 and pent = 5. Elements are listed in the same order as the name, thus N_2O_5. **A** is incorrect. The prefixes have been swapped. **C** and **D** are incorrect. The elements are in the wrong order.

QUESTION 2 D

D is correct. The pH is less than 7, so the substance is an acid. Low conductivity is due to a low concentration of ions, indicating only partial ionisation/dissociation (that is, a weak substance).

QUESTION 3 C

C is correct. Three H_2O molecules gives a total of three oxygen atoms in the products, thus three CuO molecules are required in the reactants. Three CuO molecules gives a total of three Cu atoms in the reactants, thus three Cu atoms are required in the products. **A** and **D** are incorrect. There are two nitrogen atoms in the products (N_2), thus two NH_3 molecules are required in the reactants. **B** is incorrect. Two NH_3 molecules gives a total of six hydrogen atoms in the reactants, thus three H_2O molecules are required in the products.

QUESTION 4 A

A is correct. Low vapour pressure indicates that few molecules are present as a gas and the strong intermolecular forces (IMFs) are holding most molecules in the liquid state. **B** is incorrect. Density is not a reliable indicator of IMFs. **C** and **D** are incorrect. Strong IMFs result in molecules that are tightly bound to each other. This in turn would result in high surface tension and a high melting point (more energy is needed to separate the molecules).

QUESTION 5 C

$$\text{Initial } [Cl^-] = c_1 \times \text{ions per formula unit} = 0.64 \times 3 = 1.92$$

$$\text{Final } [Cl^-] = \frac{c_1 V_1}{V_2} = \frac{1.92 \times 50}{50 + 150} = 0.48$$

QUESTION 6 C

C is correct. All non-zeros are significant. Zeros between non-zeros are significant, as are zeros after the decimal place (they show precision). As all the digits after the decimal place are significant, there are four significant figures. **A** is incorrect. Only the non-zeros have been counted and significant zeros after the decimal place have been omitted. **B** is incorrect. The final significant zero has not been counted. **D** is incorrect. Zeros before the decimal place are not significant (they are placeholders only).

QUESTION 7 B

B is correct. The container becomes cool because energy is being transferred from the surroundings (container) to the system (dissolving ammonium nitrate). Thus the reaction is endothermic. **A** is incorrect. Endothermic reactions do not release energy. **C** and **D** are incorrect. The reaction is not exothermic.

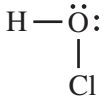
QUESTION 8 D

D is correct. The green powder was separated via a physical process based on different solubility, so it is a mixture. **A** is incorrect. An allotrope is a different physical form of an element (for example, graphite and diamond). There is no information about the chemical composition of the powder, so it cannot be classified as an allotrope. **B** and **C** are incorrect. If the powder was an element or compound, then all components would have the same physical properties, so all of it would have been in either the reside or filtrate.

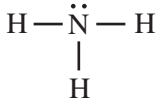
QUESTION 9 A

A is correct. Only HOCl contains two lone pairs (four non-bonding electrons) around the central O atom. **B** is incorrect. NH_3 has one lone pair (two electrons total) around the central N atom. **C** and **D** are incorrect. CS_2 and CH_2O do not contain any lone pairs on the central C atom.

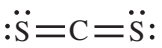
A



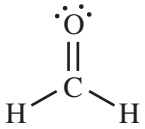
B



C



D



QUESTION 10 D

D is correct. In an endothermic reaction the reactants have lower energy than the products. **A** and **C** are incorrect. A catalyst lowers the activation energy, and these profiles show a higher activation energy with the catalyst. **B** is incorrect. The profile shows an exothermic reaction.

QUESTION 11 C

C is correct. The compound contains a metal and two non-metals, so it is ionic. Iron is a transition metal, so the name must include roman numerals to indicate the charge of the iron ions. The carbonate ion (CO_3) has a 2– charge, and three of them are 'balanced out' by two iron ions, thus the charge on an iron ion is 3+. **A** and **D** are incorrect. They do not follow ionic naming conventions: CO_3^{2-} is not carbon dioxide, nor cobalt. **B** is incorrect. The wrong charge is shown for the iron ion.

QUESTION 12 B

B is an incorrect conclusion and so is the required response. At 10°C, approximately 190 g of sucrose dissolves compared with 160 g of $AgNO_3$. However, $AgNO_3$ is ionic and will separate into Ag^+ and NO_3^-, doubling the amount of dissolved particles. The molar mass of $AgNO_3$ is also much lower than that of sucrose, meaning there are more moles of $AgNO_3$ in solution. **A** is a correct conclusion and so is not the required response. At room temperature (approximately 25°C), $NaNO_3$ is more soluble than KNO_3. **C** is a correct conclusion and so is not the required response. The solubility of NaCl at 50°C is approximately 35 g/100 g; 40 g is greater than this, so the solution is supersaturated. **D** is a correct conclusion and so is not the required response. The solubility of $CuSO_4.5H_2O$ at 30°C is approximately 25 g/100 g; 20 g is less than this, so the solution is unsaturated.

QUESTION 13 C

C is correct. Ice is less dense than water due to the increased space between molecules in the solid form. This is caused by the polar molecules adopting a specific pattern to correctly align positive and negative regions of the molecules. **A** is incorrect. The IMFs in water are unusually strong. **B** is incorrect. Hydrogen bonding is not overcome during freezing. **D** is incorrect. The molecules are further apart.

QUESTION 14 B

B is correct. Larger pieces of solid decrease the surface area and thus the rate of reaction, so it would take longer for the reaction to reach completion. **A** is incorrect. It shows a faster reaction. **C** and **D** are incorrect. The same amount of chemicals were used, so the mass loss would be the same.

QUESTION 15 A

$$\% \text{ nitrogen} = \frac{\text{mass nitrogen}}{\text{molar mass}} \times 100$$

A is correct. $\text{HCN} = \frac{14.01}{27.03} \times 100 = 52\%$

B is incorrect. $\text{CH}_4\text{N}_2\text{O} = \frac{28.02}{60.07} \times 100 = 47\%$

C is incorrect. $\text{NH}_4\text{NO}_3 = \frac{28.02}{80.06} \times 100 = 35\%$

D is incorrect. $\text{Al(NO}_2)_3 = \frac{42.03}{165.01} \times 100 = 25\%$

QUESTION 16 C

C is correct. H_2S is bent with polar bonds, NH_3 is trigonal pyramidal with polar bonds and HF has a polar bond. Thus all molecules are polar overall. **A** and **B** are incorrect. F_2 and N_2 are non-polar (no polar bonds). **D** is incorrect. CH_4 is non-polar (the bonds may be considered slightly polar but the even, tetrahedral arrangement 'cancels out' any net dipole).

QUESTION 17 A

A is correct. Accuracy refers to the 'correctness' of a value (that is, how close it is to the true or accepted value). Precision refers to the 'repeatability' of a value (that is, how similar it is to others). **B** is incorrect. The definitions are incorrectly placed in the columns. **C** and **D** are incorrect. The number of decimal places in a value is not a valid definition for either term (the number of digits in a reading is sometimes referred to as measurement precision, but this is not the same as precision).

QUESTION 18 D

D is correct. Sulfur has greater electronegativity so will 'take' electrons from potassium and form a negative ion (anion). **A** and **B** are incorrect. They use the electronegativity of phosphorus instead of potassium. **C** is incorrect. Potassium has the lower electronegativity and thus weaker ability to attract electrons, so it cannot form a negative ion (anion).

QUESTION 19 A

A is correct. Zinc is the only cation that forms an insoluble hydroxide and oxide, but a soluble chloride and iodide. **B** and **C** are incorrect. Lead(II) and copper(II) precipitate with hydroxide and oxide, but also with iodide. **D** is incorrect. Barium does not precipitate with any of the anions.

QUESTION 20 A

A is correct. $\text{Acid} + \text{metal} \rightarrow \text{salt} + \text{hydrogen}$. As zinc forms a 2+ ion, 2 nitrates (1–) are needed to balance it. **B** is incorrect. This shows an incorrect product. **C** and **D** are incorrect. These show the wrong formula for the salt and incorrect products.

QUESTION 21 A

A is correct. A catalyst lowers E_a but does not affect kinetic energy of particles. This diagram correctly shows a lower E_a with a catalyst. **B** is incorrect. It shows a higher E_a with the catalyst. **C** and **D** are incorrect. They show the catalyst changing the kinetic energy of the particles.

QUESTION 22 B

B is correct. Basic solutions contain an excess of OH^-, so $[OH^-]$ will be greater than 10^{-7} M.
A is incorrect. Acids contain $[H_3O^+] > 10^{-7}$ or $[OH^-] < 10^{-7}$. **C** is incorrect. A neutral solution contains equal concentrations of OH^- and H_3O^+ (10^{-7} at 25°C). **D** is incorrect. The term 'supersaturated' refers to amount of solute, not $[OH^-]$ or $[H_3O^+]$.

QUESTION 23 C

C is correct. Distillation will result in a methanol distillate. **A** and **D** are incorrect. The mixture is homogeneous, thus filtration and centrifugation will not work (there is no solid to separate).
B is incorrect. Evaporation will remove the methanol (as it has the lower boiling point) and leave the water.

QUESTION 24 B

B is correct. The concentration of reactants decreases during the reaction, thus reducing the frequency of collisions. **A** is incorrect. The reaction does not affect particle orientation. **C** is incorrect. The activation energy is constant during a reaction. **D** is incorrect. Temperature (not concentration) is a measure of kinetic energy.

QUESTION 25 D

D is correct. Activation energy is the measurement from the reactants to the activate complex ('top of the hill'); this is shown as 2 in the diagram. Enthalpy change is the difference between the reactants and the products; this is shown as 3 in the diagram.

SECTION 2

QUESTION 26 (5 marks)

bonding enthalpy of $C_2H_4 = 614 + (4 \times 414) = 2270$ *[1 mark]*

bonding enthalpy of $2O_2 = 2 \times 498 = 996$ *[1 mark]*

bonding enthalpy of $2H_2O = 4 \times 463 = 1852$ *[1 mark]*

$\Delta H = (C_2H_4 + 2O_2) - (2CO + 2H_2O)$; therefore, $-730 = (2270 + 996) - (2y + 1852)$ *[1 mark]*

Therefore $2y = 2144$, and so $C \equiv O = 1072 \text{ kJ mol}^{-1}$ *[1 mark]*

QUESTION 27 (5 marks)

a) Isotopes are atoms with the same number of protons but a different number of neutrons. *[1 mark]*

b) 3 (each peak/column represents an isotope) *[1 mark]*

c) abundance from graph: 294 = 10%, 296 = 60% and 297 = 30% *[1 mark]*

Substitute into formula:

$A_r = (294 \times 0.1) + (296 \times 0.6) + (297 \times 0.3)$ *[1 mark]*

$= 296 \text{ amu}$ *[1 mark]*

QUESTION 28 (5 marks)

a) $Mg + 2HCl \rightarrow H_2 + MgCl_2$ *[2 marks]*

1 mark for formula.
1 mark for balancing.

b) The energy absorbed to break the bonds in the reactants *[1 mark]*
is less than the energy released when the product bonds form. *[1 mark]*

Therefore energy is released into the surrounds/the reaction is exothermic. *[1 mark]*

QUESTION 29 (5 marks)

a) $^{20}_{10}G$ *[1 mark]*

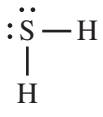
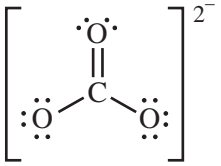
b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ *[1 mark]*

c) J *[1 mark]*

d) A and E *[1 mark]*

e) D and L *[1 mark]*

QUESTION 30 (6 marks)

	Hydrogen sulfide H_2S	**Carbonate ion CO_3^{2-}**
Lewis structure		
VSEPR shape	bent/V-shaped	trigonal planar

[6 marks]
1 mark for correct bonds and structure in each species (maximum 2 marks).
1 mark for all electrons shown in each species (maximum 2 marks).
1 mark for each correct VSEPR shape (maximum 2 marks).

QUESTION 31 (3 marks)

a) lead nitrate/chloride and any soluble iodide *[1 mark]*

b) $Pb^{2+}(aq) + 2I^{-}(aq) \rightarrow PbI_2(s)$ *[2 marks]*

1 mark for correct formula and balancing.
1 mark for correct state symbols.

QUESTION 32 (6 marks)

a) Assuming 100 g galactose, there is 40 g carbon, 6.7 g hydrogen and 55.3 g oxygen.
Find the number of moles of each, then simplify the ratio to get the empirical formula.

$$n(\mathrm{C}) = \frac{40}{12.01} = 3.33;\ n(\mathrm{H}) = \frac{6.7}{1.01} = 6.63;\ n(\mathrm{O}) = \frac{53.3}{16} = 3.3$$ *[1 mark]*

Simplify the above amounts by dividing each by 3.33. *[1 mark]*

Therefore the empirical formula is CH_2O. *[1 mark]*

b) Find the mass of the empirical formula and how many times this fits into the molar mass to determine the molecular formula.

m(empirical formula) = 30.03 *[1 mark]*

$$\frac{180}{30.03} = 6$$ *[1 mark]*

molecular formula = $C_6H_{12}O_6$ *[1 mark]*