

CHEMISTRY

Unit 1

Trial Examination

SOLUTIONS BOOK

Use this page as an overlay for marking the multiple choice answer sheets. Simply photocopy the page onto an overhead projector sheet. The correct answers are open boxes below. Students should have shaded their answers. Therefore, any open box with shading inside it is correct and scores 1 mark.

	ONE ANSWER PER LINE		ONE ANSWER PER LINE
1	☐ ☒ ☒ ☒	11	☒ ☒ ☐ ☒
2	☒ ☐ ☒ ☒	12	☒ ☒ ☐ ☒
3	☒ ☒ ☒ ☐	13	☒ ☒ ☒ ☐
4	☒ ☐ ☒ ☒	14	☒ ☐ ☒ ☒
5	☒ ☒ ☒ ☐	15	☒ ☐ ☒ ☒
6	☒ ☒ ☒ ☐	16	☒ ☒ ☐ ☒
7	☒ ☒ ☒ ☐	17	☐ ☒ ☒ ☒
8	☒ ☒ ☒ ☐	18	☒ ☒ ☐ ☒
9	☒ ☐ ☒ ☒	19	☒ ☒ ☒ ☐
10	☒ ☒ ☐ ☒	20	☐ ☒ ☒ ☒

SECTION A (1 mark for each correct response)

1.	A	2.	B	3.	D	4.	B	5.	D
6.	D	7.	D	8.	D	9.	B	10.	C
11.	C	12.	C	13.	D	14.	B	15.	B
16.	C	17.	A	18.	C	19.	D	20.	A

Brief comments on Answers in Section A**Question 1**

You need to look up the atomic numbers and subtract from the given mass numbers to find the number of neutrons. The iron isotope has 32 neutrons. **Answer A**

Question 2

Scandium (III) ion has only 18 electrons which occupy three shells in the ground state. **Answer B**

Question 3

SiO₂ is a covalent network lattice – and has all of these properties. **Answer D**

Question 4

Phosphorus has 5 valence electrons and needs to form 3 bonds to obtain an octet in PH₃. It must have one lone pair in the valence shell. This parallels the behavior of Nitrogen which also forms NH₃. It should be noted that Phosphorus is not bound to follow the octet rule as it is in Period 3. **Answer B**

Question 5

The neutron was the last of the major subatomic particles to be discovered around 1932 (20th century) by James ('Jimmy Neutron') Chadwick. Francis Aston was responsible for the development of a mass spectrometer in 1919. **Answer D**

Question 6

Ionic compounds have direction forces acting so they are not malleable. **Answer D**

Question 7

Only metallic substances conduct in both solid and liquid states. **Answer D**

Question 8

CH₃Cl has a one significantly polar bond (C–Cl) and is not symmetrical. **Answer D**

Question 9

The bolded C atom in CH₂=CH-**CH**₂-CH=CH₂ is the only tetrahedral C atom. **Answer B**

Question 10

The longest sequence of carbons is 3 giving a **prop** prefix and the hydroxyl functional group is on the middle carbon – therefore 2-propanol or propan-2-ol. 2-hydroxy propane is not correct in the IUPAC system. **Answer C**

Question 11

1-butanol is CH₃CH₂CH₂CH₂OH and so has 10 H atoms. Alternatively butane is C₄H₁₀ and has lost one H to be replaced by OH. So it still has 10 H atoms. **Answer C**

Question 12

Both ethanol and water exhibit covalent bonding within molecules but hydrogen bonds are possible between molecules of water and ethanol. **Answer C**

Question 13

$\text{CH}_3\text{CHClCH}_2\text{Cl}$ has no double C/C bonds and so cannot polymerise by addition. **Answer D**

Question 14

There are two isomers $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ and $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_3$. **Answer B**

Question 15

ethanol, $\text{CH}_3\text{CH}_2\text{OH}$ is present in alcoholic drinks. **Answer B**

Question 16

40% of 80 mL = 32 mL. **Answer C**

Question 17

Alkanoic acids must have at least two O atoms. **I** is a possible formula for an alkanoic acid. **III** has too many hydrogen atoms to draw an allowable structure.

Answer A

Question 18

$$n(\text{N}_2 \text{ molecules}) = m/M = 7.0/28.0 = 0.25 \text{ mol}$$

$$n(\text{N atoms}) = 0.50 \text{ mol}$$

$$n(\text{C atoms}) = m/M = 6.0/12.0 = 0.50 \text{ mol}$$

$$n(\text{S}_8 \text{ molecules}) = m/M = 8.0/256.8 = 0.0312$$

$$n(\text{S atoms}) = 8 \times 0.0312 = 0.250 \text{ mol}$$

$$n(\text{O}_2 \text{ molecules}) = m/M = 8.0/32.0 = 0.25 \text{ mol}$$

$$n(\text{O atoms}) = 0.50 \text{ mol}$$

Answer C

Question 19

The law of conservation of mass would mean that the $m(\text{product})$ must be $25.40 + 6.53 = 31.93 \text{ g}$

Answer D

Question 20

CH_4 has the lowest electron count and therefore the lowest dispersion forces and consequently the lowest boiling point.

Answer A

SECTION B**Question 1 (8 marks)**

Ca_3N_2	(1 mark)	1-butene or but-1-ene	(1 mark)
Na_2SO_4	(1 mark)	methanol	(1 mark)
copper(I) carbonate	(1 mark)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$	(1 mark)
aluminium nitrate	(1 mark)	2-chlorobutane	(1 mark)

Question 2 (11 marks)

- a. i. Y ii. D iii. E iv. G v. A
- vi. T (as TCl_3) vii. X (as XQ_4) (1 mark $\times$ 7 = 7 marks)
- b. i. AL (accept LiCl) (1 mark) ii. T_2Z_3 (accept Al_2O_3) (1 mark)
- c. i. $1s^2 2s^2 2p^2$ (1 mark) ii. $1s^2 2s^2 2p^6$ (1 mark)

Question 3 (9 marks)

- a. Iodine and hexane are composed of non-polar molecules (1 mark) while water is made up of polar molecules (1 mark). Non-polar molecular substances such as iodine dissolve better in non-polar solvents such as hexane because of similar strengths of the dispersion forces between molecules (1 mark).
- b. i. For Na_2S , any two of the following:
solid at room temperature, dissolves in water, high melting point,
conducts in molten and aqueous states. (max of 1 mark)
- For H_2S any two of the following:
gas at room temperature, low mp/bp, has a foul smell,
does not conduct electricity (max of 1 mark)
- ii. Na_2S consists of a network lattice of Na^+ cations and S^{2-} anions in a 2:1 ratio. (1 mark)
- The ionic bonding involves strong electrostatic attractions between ions and therefore accounting for the high mp. Heat and water can disrupt the ionic lattice to allow ions freedom to move. (1 mark)
- H_2S is a molecular substance. (1 mark)
- It has very weak dipole-dipole attractions between molecules together with dispersion forces. (1 mark)

Question 4 (9 marks)

- a. $n(\text{Fe}) = m / M = 14.9 / 55.9 = 0.267 \text{ mol}$ (1 mark)
- b. $v = 4 \times 3.14 \times (124 \times 10^{-10})^3 / 3 = 7.98 \times 10^{-24} \text{ cm}^3$ (1 mark)
- c. $2.0 / 7.98 \times 10^{-24} = 2.50 \times 10^{23} \text{ atoms}$ (1 mark)
- d. Using ratio $2.50 \times 10^{23} / 0.267 = x / 1.00 \text{ mol}$ Hence $x = 9.36 \times 10^{23}$ (1 mark)
- e. The calculated number is much larger (1 mark)
- f. $9.36 \times 10^{23} \times 0.65 = 6.1 \times 10^{23} \text{ (2sf)}$ (1 mark)
- g. The displaced volume of water (1 mark)
- h. The value calculated for another metal should be the same as Avogadro's number is a constant. (1 mark). A student may argue correctly that the number might be different because of a different type of packing (not 65%) of the atoms.
- i. The calculated value of Avogadro's number was found to be 6.1×10^{23} and this compares favourably with the accepted value of 6.0×10^{23} . (1 mark)

Question 5 (3 marks)

Assume 100g	C	H	O	
m	57.5	4.7	37.8	
n	$\frac{57.5}{12.0}$	$\frac{4.7}{1.0}$	$\frac{37.8}{16.0}$	(1 mark)
	4.79	4.7	2.36	
	$\frac{4.79}{2.36}$	$\frac{4.7}{2.36}$	$\frac{2.36}{2.36}$	(1 mark)
	2.03	1.99	1.00	

The empirical formula is $\text{C}_2\text{H}_2\text{O}$ (1 mark)

Question 6 (5 marks)

- a. $\text{Mg(s)} + 2 \text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$ (1 mark for equation and 1 mark for balance)
- b. $n(\text{Mg}) = \frac{1}{2} n(\text{HCl}) = 2.50 \times 10^{-3} \text{ mol}$ (1 mark)
- c. $m(\text{Mg}) = n \times M = 2.50 \times 10^{-3} \times 24.3 = 0.0608 \text{ g}$ (1 mark)
- d. $\% \text{Mg (m/m)} = (0.0608 / 2.00) \times 100 = 3.04 \%$ (1 mark)

Question 7 (9 marks)

a. (1 mark for each structural formula, 1 mark for each shape = 6 marks)

Molecule	Structural Formula	Shape
N ₂	$\text{— N} \equiv \text{N —}$	linear
CCl ₄	<pre> Cl Cl-C-Cl Cl </pre>	tetrahedral
SF ₂	<pre> S / \ F F </pre>	Angular or v-shaped

- b. N₂ non-polar as there is no electronegativity difference between the bonded atoms. (1 mark)
- CCl₄ non-polar; although dipoles exist between the C and Cl atoms, the molecule is symmetrical and the bond dipoles sum to zero. (1 mark)
- SF₂ highly polar; dipoles exist due to the significant electronegativity difference between the S and F atoms and the molecule is not symmetrical. (1 mark)

Question 8 (7 marks)

- a. $2\text{K(s)} + \text{Cl}_2\text{(g)} \rightarrow 2\text{KCl(s)}$ (1 mark for equation and 1 mark for balance)
- b. $1s^2 2s^2 2p^6 3s^2 3p^6$ (1 mark) (K atoms have lost an electron each to form potassium ions, K⁺)
 $1s^2 2s^2 2p^6 3s^2 3p^6$ (1 mark) (Cl atoms have gained an electron to form Cl⁻ ions)
- c. Potassium chloride is an ionic compound composed of anions and cations held together in a network lattice structure in a 1:1 ratio. The attraction between these ions forms strong ionic bonding that requires considerable heat energy to overcome. (1 mark)
- Chlorine consists of diatomic molecules with a single covalent bond between the chlorine atoms. The forces of attraction between these non-polar molecules are due to weak dispersion forces. (1 mark)
- d. $1s^2 2s^2 2p^6 3s^2 3p^6 5s^1$ is one example but there are many others (1 mark)

Question 9 (6 marks)

- a.**
- i.** Alkanes: A, D, G, J (All four correct 2 marks, three correct 1 mark, two correct no marks)
 - ii.** C_nH_{2n+2} (1 mark)
- b.**
- i.** F (1 mark)
 - ii.** $n C_3H_6 \rightarrow \text{---}(C_3H_6)_n\text{---}$ (1 mark)
 - iii.** polypropene (1 mark)

END OF SUGGESTED SOLUTIONS