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CHEMISTRY

Unit 1

Trial Examination

SOLUTIONS BOOK

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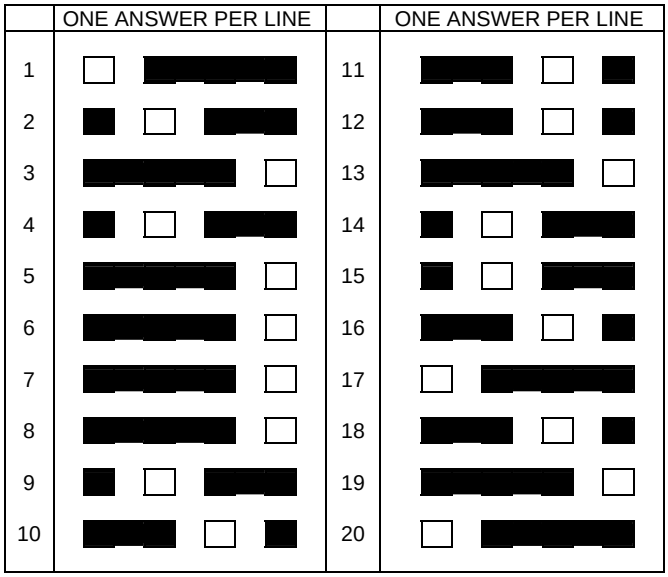
Use this page as an overlay for marking the multiple choice answer sheets. Simply photocopy the page onto an overhead projector sheet. The correct answers are open boxes below. Students should have shaded their answers. Therefore, any open box with shading inside it is correct and scores 1 mark.



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
SiO_2 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 PH_3. It must have one lone pair in the valence shell. This parallels the behavior of Nitrogen which also forms NH_3. 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
CH_3Cl has a one significantly polar bond (C–Cl) and is not symmetrical. **Answer D**

Question 9
The bolded C atom in CH_2= CH-**C**H_2-CH=CH_2 is the only tetrahedral C atom. **Answer B**

Question10
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 $CH_3CH_2CH_2CH_2OH$ and so has 10 H atoms. Alternatively butane is C_4H_{10} 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
$CH_3CHClCH_2Cl$ has no double C/C bonds and so cannot polymerise by addition. **Answer D**

Question 14
There are two isomers $CH_3CH_2CH_2CH_3$ and $CH_3CH(CH_3)CH_3$. **Answer B**

Question 15
ethanol, CH_3CH_2OH 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
$n(N_2$ molecules) = m/M = 7.0/28.0 = 0.25 mol n(N atoms) = 0.50 mol
n(C atoms) = m/M = 6.0 /12.0 = 0.50 mol
$n(S_8$ molecules) = m/M =8.0 /256.8 = 0.0312 n(S atoms) = 8 x 0.0312 = 0.250 mol
$n(O_2$ molecules) = m/M = 8.0/32.0 = 0.25 mol n(O atoms) = 0.50 mol
Answer C

Question 19
The law of conservation of mass would mean that the m(product) must be 25.40 + 6.53 = 31.93 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)	$CH_3CH_2CH_2COOH$	(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 × 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(Fe) = m / M = 14.9 / 55.9 = 0.267 mol (1 mark)

b. v = 4 x 3.14 x $(124 \times 10^{-10})^3$ / 3 = 7.98 x 10^{-24} cm^3 (1 mark)

c. 2.0 / 7.98 x 10^{-24} = 2.50 x 10^{23} atoms (1 mark)

d. Using ratio 2.50 x 10^{23} / 0.267 = x / 1.00 mol Hence x = 9.36 x 10^{23} (1 mark)

e. The calculated number is much larger (1 mark)

f. 9.36 x 10^{23} x 0.65 = 6.1 x 10^{23} (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 x 10^{23} and this compares favourably with the accepted value of 6.0 x 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 C_2H_2O (1 mark)

Question 6 (5 marks)

a. Mg(s) + 2 HCl(aq) → $MgCl_2$(aq) + H_2(g) (1 mark for equation and 1 mark for balance)

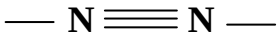
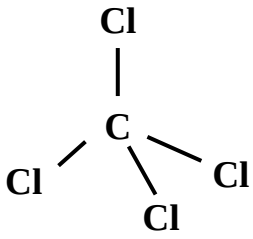
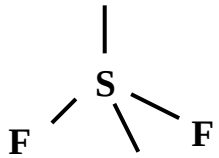
b. n(Mg) = ½ n(HCl) = 2.50 x 10^{-3} mol (1 mark)

c. m(Mg) = n x M = 2.50 x 10^{-3} x 24.3 = 0.0608 g (1 mark)

d. %Mg (m/m) = (0.0608 / 2.00) x 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		linear
CCl_4		tetrahedral
SF_2		Angular or v-shaped

b. N_2 non-polar as there is no electronegativity difference between the bonded atoms. (1 mark)

CCl_4 non-polar; although dipoles exist between the C and Cl atoms, the molecule is symmetrical and the bond dipoles sum to zero. (1 mark)

SF_2 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. $2K(s) + Cl_2(g) \rightarrow 2KCl(s)$ (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 1mark, two correct no marks)

ii. C_nH_{2n+2} (1 mark)

b. **i.** F (1 mark)

ii. n C_3H_6 $\rightarrow$ —$(C_3H_6)_n$— (1 mark)

iii. polypropene (1 mark)

END OF SUGGESTED SOLUTIONS