STAV PUBLISHING

STAV Publishing 2016

CHEMISTRY

Unit 1

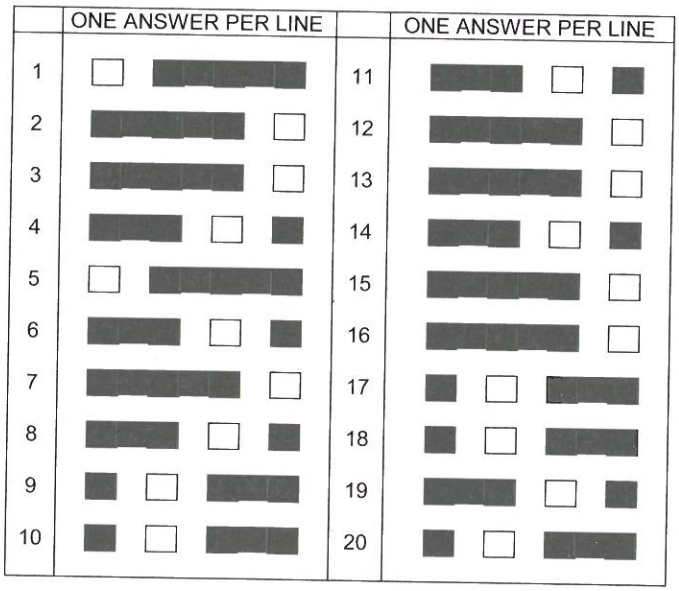
Trial Examination

SOLUTIONS BOOK

Published by STAV Publishing. STAV House, 5 Munro Street, Coburg VIC 3058 Australia.
Phone: 61 + 3 9385 3999 • Fax: 61 + 3 9386 6722 • Email: stav@stav.vic.edu.au Website: http://www.sciencevictoria.com.au/stavpublishing

ABN 61 527 110 823

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 (Total 20 marks)

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

Comments for Section A answers

Question 1
Number of neutrons = Mass Number –Atomic Number. Charge is irrelevant.
Cm has 244 - 96 = 148; Bk has 249 - 97 =152; Cf has 252 - 98 = 154; Es has 253 - 99 = 154
Correct answer: A

Question 2
Orbitals in different subshells have different shapes.
Bohr proposed 'shells', but not subshells.
The third shell has 9 orbitals.
Each orbital can indeed only hold a maximum of two electrons. **Correct answer: D**

Question 3
Shells in all atoms are further apart closer to the nucleus. **Correct answer: D**

Question 4
$_{24}Cr$ has the somewhat unusual electron configuration of $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$. Therefore it has five 3d electrons. **Correct answer: C**

Question 5
The s block is 2 elements wide with 7 shells = 14 elements
The p block is 6 elements wide with 6 shells = approx 36 elements
The d block is 10 elements wide with 4 shells = approx 40 elements
The f block is 14 elements wide with 2 shells = 28 elements **Correct answer: A**

Question 6
$_{26}Fe^{2+}$ has 24 electrons and has electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$ **Correct answer: C**

Question 7
The only non-metal in the group is sulfur. It forms pungent SO_2 gas. **Correct answer: D**

Question 8
The elements become **more** reactive as the attraction between the nucleus and valence electrons **decreases**. The 1st ionisation energy decreases as the outer electrons are further away from the nucleus. The atomic radius **increases**. **Correct answer: C**

Question 9
P, R, T, Q, S **Correct answer: B**

Question 10
The sample stays white after heating. **Correct answer: B**

Question 11
m(Sn) = 1.20 g m(O) = 0.32 g

n(Sn) = 1.20 / 118.7 = 0.0101 n(O) = 0.32 / 16.0 = 0.020

n(Sn) : n(O) = 0.0101 : 0.020 (divide each by 0.0101)

n(Sn) : n(O) = 1 : 1.98 i.e. SnO_2 **Correct answer: C**

Question 12
$CaCl_2$ and KCl are ionic. NH_3, SCl_2 and HCl are molecular and SiC is giant molecular.
Correct answer: D

Question 13
Group I elements are more reactive than Group II and reactivity increases down the group. Potassium is therefore the most reactive. **Correct answer: D**

Question 14
The hydrocarbon is non-polar. **Correct answer: C**

Question 15
$n(H_2) = m/M = 5.0 / 2.0 = 2.5$ mol; $n(H) = 2 \times n(H_2) = 2 \times 2.5 = 5.0$ mol **Correct answer: D**

Question 16
2.0 mol of NH_3 has $2 \times 6.02 \times 10^{23}$ molecules but each molecule contains four atoms. Total number of atoms = $2.0 \times 6.02 \times 10^{23} \times 4 = 4.8 \times 10^{24}$ **Correct answer: D**

Question 17
$n(CH_4) = m/M = 2.0 / 16.0 = 0.125$ mol

$N(CH_4)_{molecules} = n \times N_A = 0.125 \times 6.02 \times 10^{23} = 7.53 \times 10^{22}$

4 H atoms per molecule; $N(H)_{atoms} = 4 \times 7.53 \times 10^{22} = 3.01 \times 10^{23}$ **Correct answer: B**

Question 18
% H in $H_2O = 100 \times (2/18) = 11.1$

% H in $NH_3 = 100 \times (3/17) = 17.6$

% H in $PH_3 = 100 \times (3/34) = 8.8$

% H in $SiH_4 = 100 \times (4/32.1) = 12.5$ **Correct answer: B**

Question 19
All alkenes have one or more C/C double bonds. **Correct answer: C**

Question 20
Five structural isomers: hexane; 2-methylpentane and 3-methylpentane; 2,2-dimethylbutane, 2,3-dimethylbutane. **Correct answer: B**

SECTION B – Short answer questions

Question 1 (5 marks)

a. $1.5 \text{ mm} = 1.5 \times 10^{6} \text{ nm}$ **(1 mark)**

b. $97 \times 10^{-3} \text{ nm} = 97 \times 10^{-12} \text{ m} = 9.7 \times 10^{-11} \text{ m}$ **(1 mark)**

c. $\frac{V(\text{H nucleus}) = {}^{4}/_{3} \times \pi r^{3} = {}^{4}/_{3} \times 3.14 \times (1.4 \times 10^{-13})^{3}}{V(\text{H atom}) = {}^{4}/_{3} \times \pi r^{3} = {}^{4}/_{3} \times 3.14 \times (5.3 \times 10^{-9})^{3}}$ **(1 mark)** **(1 mark)**

Note: ${}^{4}/_{3} \times 3.14$ has been cancelled on the top and bottom lines above, giving:

$= \frac{(1.4 \times 10^{-13})^{3}}{(5.3 \times 10^{-9})^{3}} = 1.8 \times 10^{-14}$ **(1 mark)**

Question 2 (8 marks)

a. mass spectrometer **(1 mark)**

b. The relative refers to the reference isotope $^{12}C = 12$ exactly **(1 mark)**

c. let **x** = fraction of Rubidium-85 therefore $(1 - \mathbf{x})$ = fraction of Rubidium-87 **(1 mark)**
$84.95\,(x) + 86.94\,(1 - \mathbf{x}) = 85.5$ **(1 mark)** $\Rightarrow -1.99x = 1.44$
$x = 0.724$ $1 - x = 0.276 = 27.6\%$ **(1 mark)** 3 significant figures **(1 mark)**

d. $^{87}_{37}\text{Rb}$ **(1 mark)**

e. $72.4 / 27.6 = 2.62 : 1.00$ **(1 mark)**

Question 3 (4 marks)

a. Ionisation energy is the minimum energy required to remove an electron from an atom or ion (in the gaseous state). **(1 mark)**

b. $_{23}V$ has the subshell arrangement of $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$ **(1 mark)**

c. The five valence electrons i.e. $3d^3 4s^2$ are progressively slightly harder to remove **(1 mark)** and then there is a sizeable jump as electrons are then starting to be removed from the lower energy 3p subshell, showing two of the 3p electrons removed. **(1 mark)**

Question 4 (6 marks)

a. An atom or ion in which an electron is not in the ground state but is in a higher energy level. **(1 mark)**

b. $1s^2 2s^2 2p^6 3p^1$. There are many other possibilities. **(1 mark)**

c.

- Electron(s) are promoted to a higher energy level(s) (less stable) by heat or electricity **(1 mark)**
- Electron falls to a lower energy level **(1 mark)**
- A quantum of energy released in this movement. **(1 mark)**
- Each line in the spectrum represents this particular energy difference. **(1 mark)**

Question 5 (6 marks)

a. Assume 100 g.

m(K) = 24.7 g, m(Mn) = 34.7 g, m(O) = 40.5 g

n(K) : n(Mn) : n(O)

$\frac{24.7}{39.1}$: $\frac{34.7}{54.9}$: $\frac{40.5}{16.0}$ **(1 mark)**

0.632 : 0.632 : 2.53 **(1 mark)**

Divide each by 0.632

1.00 : 1.00 : 4.00 **(1 mark)**

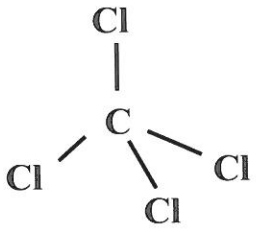
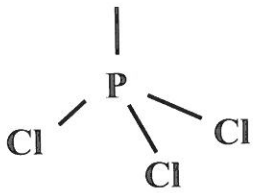
EF is $KMnO_4$

b. 39.1 + 54.9 + 4 x 16.0 = 158.0 g mol^{-1} **(1 mark)**

c. K^+ **(1 mark)** MnO_4^- **(1 mark)**

Question 6 (12 marks)

a. **(1 mark for the correct structural formula, 1 mark for the correct shape)**

Molecule	Structural formula (include lone pairs on central atoms)	Shape
CCl_4		**tetrahedral**
PCl_3		**pyramidal or trigonal pyramid**
OF_2		**angular or V-shaped**

b. CCl_4 non-polar **(1 mark)**. It has polar bonds (see electronegativity table in data sheet) but the sum of the dipoles equals zero due to the symmetrical nature of the molecule **(1 mark)**.

PCl_3 polar **(1 mark)**. It has polar bonds (see electronegativity table in data sheet) and the molecule lacks symmetry **(1 mark)**.

OF_2 polar **(1 mark)**. It has polar bonds (see electronegativity table in data sheet) and the molecule lacks symmetry **(1 mark)**.

Question 7 (8 marks)

a. NaCl is an ionic compound made up of Na^+ and Cl^- ions **(1 mark)**. The force of attraction between oppositely charged ions is relatively strong **(1 mark)** and results in quite a high melting and boiling temperatures. In the molten state, the ions have freedom to move and therefore conduct **(1 mark)**.

CCl_4 is molecular i.e. it is made up of molecules **(1 mark)**. The molecules are non-polar and are held together by relatively weak dispersion forces **(1 mark)**. In the molten state, the there are no ions and therefore conductivity is low **(1 mark)**.

b. Diagram should include power source **(1 mark)**, suitable globe or ammeter, inert electrodes and leads to complete circuit **(1 mark)**.
(As an alternative, a student may choose to use a commercial conductivity probe.)

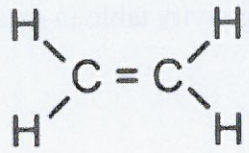
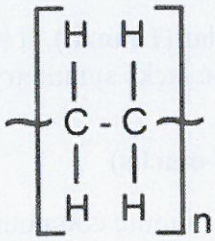
Question 8 (10 marks)

(1 mark for each correct response as indicated in bold in the table below)

Name of compound	Formula of compound
magnesium sulfate	**$MgSO_4$**
potassium nitride	**K_3N**
cobalt (II) chloride	**$CoCl_2$**
Iron(III) sulfate	$Fe_2(SO_4)_3$
1-butanol or butan-1-ol	$HOCH_2CH_2CH_2CH_3$
methylpropane	$CH_3CH(CH_3)CH_3$
but-1-ene	$CH_2CHCH_2CH_3$
hexanoic acid	semi-structural formula required **$CH_3CH_2CH_2CH_2CH_2COOH$**
2-chloropent-1-ene	$CH_3CH_2CH_2CClCH_2$
polypropene	$-[CH_2CH(CH_3)]_n-$

Question 9 (10 marks)

a.

Ethene	**Polyethene**
	
(1 mark)	**(1 mark)**

b. Although polyethene (polyethylene) has strong covalent bonds within molecules, it only has weak dispersion forces between the long molecules **(1 mark)**.
It does not require much energy to soften the solid so that it can be shaped **(1 mark)**.

c. The polymer used in power points has covalent bonds between polymer chains not relatively weak dispersion forces **(1 mark)**. It does not soften and will eventually char **(1 mark)**.

d. HDPE is mostly linear chain polymer molecules which can pack tightly together **(1 mark)**.
Used in plastic milk bottles, tablet containers **(1 mark)**. **(Check other uses)**
LDPE has chains with many branches. It melts at a lower temperature **(1 mark)**.
Used in plastic wraps, squeeze bottles **(1 mark)**. **(Check other uses)**

Question 10 (5 marks)

a. **i.** Graphene is a hexagonal formation of C atoms in a layer (one atom thick) **(1 mark)**.
ii. Graphite has similar hexagonal layers of C atoms **(1 mark)** with many layers held together by weak dispersion forces **(1 mark)**.

a. In Graphene, monolayers are strong, stiff and very light **(1 mark)**.
Currently, aerospace engineers are incorporating carbon fibre into the production of aircraft as it is also very strong and light.

In Graphite, the layers can be easily separated because of its weak dispersion forces and are able to slide past each other **(1 mark)** and this allows it to be used as the 'led' in pencils and as a dry lubricant.

END OF SUGGESTED SOLUTIONS