STAV PUBLISHING

STAV Publishing 2009

CHEMISTRY

Unit 1

Trial Examination

SOLUTIONS BOOK

Published by STAV Publishing. STAV House, 5 Munro Street, Coburg VIC 3058 Australia.
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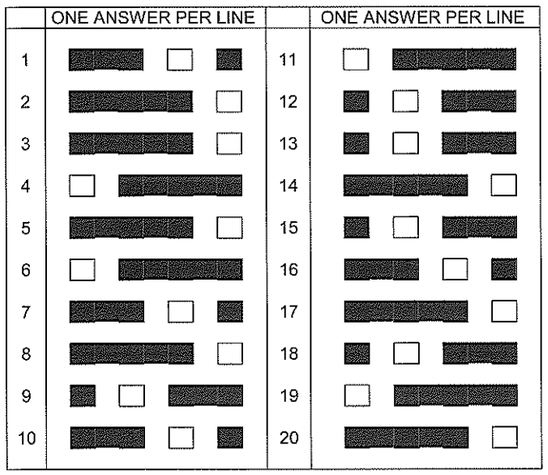
ABN 61 527 110 823

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.



Question 6 (8 marks)

Ca_3N_2 **(1 mark)**

Na_2S **(1 mark)**

$FeCl_3$ **(1 mark)**

1-propanol or propan-1-ol **(1 mark)** - must have 1 position designated for the mark

2-methylbutane **(1 mark)**

1-butene or but-1-ene **(1 mark)** - must have 1 position designated for the mark

$CH_3CH(CH_3)CH_2COOH$ **(1 mark)**

2-chlorobutane **(1 mark)**

Question 7 (5 marks)

a. An excited state means that one or more outer electrons are not in their lowest energy subshell. **(1 mark)**

b. $1s^2 2s^2 2p^6 3p^1$ or similar **(1 mark)**

c. The lines are produced as atoms absorb energy to have one or more electrons move to higher energy levels **(1 mark)**. On return to lower levels, energy corresponding to the energy difference between different levels is released **(1 mark)**. When this emitted light is passed through a spectroscope, discrete lines (wavelengths) are observed on a black background **(1 mark)**.

Question 8 (6 marks)

$n[Al_2(SO_4)_3] = m / M = 6.846 / 342.3 = 0.02000$ mol **(1 mark)**

5 ions per $Al_2(SO_4)_3$ cluster $\Rightarrow$ n(ions) = $5 \times 0.02000 = 0.1000$ mol **(1 mark)**

$N(ions) = 0.1000 \times 6.02 \times 10^{23} = 6.02 \times 10^{22} \Rightarrow N(atoms) = 1.204 \times 10^{23}$ **(1 mark)**

5 atoms per HNO_3 molecule $\Rightarrow$ $N(HNO_3) = 1.204 \times 10^{23} / 5 = 2.408 \times 10^{22}$ **(1 mark)**

$n(HNO_3) = 2.408 \times 10^{22} / 6.02 \times 10^{23} = 0.0400$ mol **(1 mark)**

$m(HNO_3) = m \times M = 0.0400 \times 63.0 = 2.52$ g **(1 mark)**

END OF SUGGESTED SOLUTIONS

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

$CHCl_3$ polar has polar bonds and the molecule lacks symmetry **(1 mark)**

SF_2 polar has polar bonds and the molecule lacks symmetry **(1 mark)**

Question 4 (9 marks)

a. $2K(s) + Cl_2(g) \rightarrow 2KCl(s)$ **(1 mark - ignore states here)**

b. K atoms (2,8,8,1) have **lost** an electron each to form potassium ions, K^+ (2,8,8)
(1 mark) ½ for each correct electron configuration

Cl atoms (2,8,7) have gained an electron to form Cl^- (2,8,8) ions.
(1 mark) ½ for each correct electron configuration

(The transfer of electrons from potassium atoms to chlorine atoms is due to the much greater electronegativity of the chlorine atoms)

c. Potassium chloride is an ionic compound **(1 mark)** composed of anions and cations held together in a network lattice structure in a 1:1 ratio **(1 mark)**. The attraction between these ions forms strong ionic bonding that requires considerable heat energy to overcome **(1 mark)**.
Chlorine consists of diatomic molecules **(1 mark)** 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)**. These weak forces of attraction are readily overcome making chlorine a gas at room conditions **(1 mark)**.

Question 5 (6 marks)

a. i. $0.90 \text{ mg/L} = 9.0 \times 10^{-4} \text{ g/L}$ **(1 mark)**

$n(F^-) = m/M = 9.0 \times 10^{-4} / 19.0 = 4.7 \times 10^{-5}$ mol **(1 mark)**

ii. $N(F^-) = n \times N_A = (4.7 \times 10^{-5} \times 6.02 \times 10^{23}) / 5 = 5.7 \times 10^{18}$ **(1 mark)**

b. $n(F^-) = n(NaF)$ **(1 mark)**

$m(NaF) = n \times M$ $M(NaF) = 23.0 + 19.0 = 42.0 \text{ g mol}^{-1}$ **(1 mark)**

$m(NaF) = 4.7 \times 10^{-5} \times 42.0 = 2.0 \times 10^{-3}$ g **(1 mark)**

SECTION A (Total 20 marks)

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

Comments for Section A answers

Question 1
Seaborg led a research group which discovered many of the transuranium elements. Seaborgium, $_{106}Sg$ was named in his honour relatively recently. Sb is antimony and has nothing to do with Seaborg. **Correct answer: C**

Question 2
^{56} Mn (atomic number 25) would have 31 neutrons
^{56} Ni (atomic number 28) would have 28 neutrons
^{57} Co (atomic number 27) would have 30 neutrons
^{58} Fe (atomic number 26) would have 32 neutrons and so has the most neutrons. **Correct answer: D**

Question 3
$_{12}Mg$ has electron configuration of $1s^2 2s^2 2p^6 3s^2$ but Mg^{2+} has lost two electrons and has electron configuration of $1s^2 2s^2 2p^6$. **Correct answer: D**

Question 4
$_{28}Ni$ has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$. It has just 2 electrons in its 4^{th} shell. **Correct answer: A**

Question 5
The ionic bond strength depends on both the size of ion and charge of ion. Mg^{2+} and O^{2-} are both small but the increased charge results in stronger attraction. **Correct answer: D**

Question 6
H_2S is similar to H_2O which is v-shaped or angular. **Correct answer: A**

Question 7
The hydrocarbon, C_2H_6, will be non-polar. **Correct answer: C**

Question 8
SiO_2 has a giant covalent structure with strong bonds that cannot be disrupted by water.
Correct answer: D

Question 9
Although the core charge is constant, the valence electron is further from the nucleus which makes it easier to remove – first ionisation energy decreases. **Correct answer: B**

Question 10
Potassium atoms are bigger than sodium atoms as they have more shells containing electrons.
The potassium ion has one less shell containing electrons than a potassium atom. **Correct answer: C**

Question 11
m(oxygen) = 2.65 – 2.12 = 0.53 g

n(Cu) : n(O) = 2.12/63.5 : 0.53/16.0 = 0.0331 : 0.0334 = 1.00 : 1.01 ie. 1: 1

Empirical formula is CuO. **Correct answer: A**

Question 12
$n(Na_3PO_4)$ = m/M = 1.64 / 164 = 0.0100 mol but there are three Na^+ ions per cluster

$n(Na^+)$ = 3 x 0.100 mol = 0.0300 mol. **Correct answer: B**

Question 13
$n(CH_4)$ = m/M = 2.0 / 16 = 0.125 mol; $N(CH_4)$ = n x N_A = 0.125 x 6.02 x 10^{23} = 7.525 x 10^{22}
but there are four H atoms per molecule.

N(H) = 4 x 7.525 x 10^{22} = 3.0 x 10^{23} **Correct answer: B**

Question 14
Butanoic acid is $CH_3CH_2CH_2COOH$; M = 88.0 $gmol^{-1}$

$m(CH_3CH_2CH_2COOH)$ = n x M = 0.150 x 88.0 = 13.2 g **Correct answer: D**

Question 15
Alkenes have at least one C/C double bond. **Correct answer: B** (NB. dienes have two C/C double bonds).
Answer D does not specify a C/C double bond.

Question 16
Butan-1-ol has the formula $CH_3CH_2CH_2CH_2OH$; There are ten H atoms per molecule.
Correct answer: C

Question 17
To form an addition polymer, the molecule must have at least one C/C double bond.
$CH_3CHCl\ CH_2Cl$ has only C/C single bonds. **Correct answer: D**

Question 18
C_5H_{12} has three structural isomers; pentane, 2-methylbutane, (2,2) dimethylpropane
Correct answer: B

Question 19
A carboxylic (alkanoic acid) must have a – COOH functional group. II is therefore not possible.
A sensible structure cannot be drawn for III. **Correct answer: A**

Question 20
The first three molecules are non-polar (CCl_4 is symmetrical and therefore has no overall dipole).
C_2Cl_6 would have the greatest dispersion forces between molecules as it has the highest electron count.
Correct answer: D

SECTION B

Question 1 (6 marks)

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

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

c. let **x** = fraction of Lithium-7 therefore (1-**x**) = fraction of Lithium-6 **(1 mark)**
6.015(1-**x**) + 7.016 (**x**) = 6.9 **(1 mark)** $\Rightarrow$ 1.001**x** = 0.885
$\Rightarrow$ x = 0.884 = 88.4 = 88% (2sf) **(1 mark)**

d. $^{7}_{3}Li$ **(1 mark)**

Question 2 (11 marks)

a. i. Y ii. T iii. E iv. Z v. A
vi. D vii. Y **(7 x 1 = 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. **(1 mark for the valence diagram, 1 mark for the shape)**

Molecule	Valence diagram	Shape
N_2	— N≡N —	**Linear**
$CHCl_3$	Cl, C, H, Cl, Cl	**tetrahedral**
SF_2	S, F, F	**Angular or v-shaped**