Eunoia Junior College
8873 H1 Chemistry
2018 Paper 1 Worked Solutions

1

Species	No. of electrons	No. of protons
$^{1}_{1}H$	1	1
$^{1}_{1}H^{-}$	2	1
$^{1}_{1}H^{+}$	0	1
$^{2}_{1}H$	1	1
$^{2}_{1}H^{-}$	2	1
$^{2}_{1}H^{+}$	0	1

All the particles have the same number of protons as isotopes only differ in the number of neutrons.

The smallest particle will be the one with the most number of electrons. Hence, the order must be cation < atom < anion.

⇒ **C**

2 The four electrons of highest energy for an atom of one of the Group 14 elements are the valence electrons.

Hence, the electronic configuration will be in the form $ns^2\ np^2$.

⇒ **B**

3 If shielding increases as electrons are removed, successive ionisation energies should decrease, not increase.

From the data illustrated, successive ionisation energies increase. This means that less energy is required to remove the electrons in the outer shells (which are removed earlier) as compared to those in the inner shells (which are removed later).

⇒ **C**

4 The structure of C_2H_2 is H—C≡C—H

Hence, there are 3 σ bonds (2 single bonds and 1 in the triple bond) and 2 π bonds (in the triple bond).

⇒ **D**

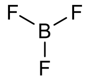
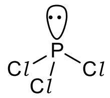
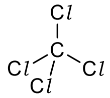
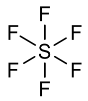
5 **1** ✓ The electron-deficient A*l* atom accepts a pair of electrons from a chlorine atom to form the dimer.

2 ✓ The shape around the aluminium atom changes from trigonal planar to tetrahedral – bond angles decreased from 120º to 109.5º.

3 × The shape around the aluminium atom changes from trigonal planar to tetrahedral

⇒ **B**

6

Species		Shape	Polarity
BF_3		Trigonal planar	Non-polar
PCl_3		Trigonal pyramidal	Polar (due to lone pair)
CCl_4		Tetrahedral	Non-polar
SF_6		Octahedral	Non-polar

⇒ **B**

7 HBr has a higher boiling point than HC*l*.

HBr has more electrons than HC*l*, and hence a larger and more polarisable electron cloud. This leads to stronger instantaneous dipole-induced dipole forces between HBr.

Note: HC*l* is a more polar molecule as compared to HBr. Hence, permanent dipole-permanent dipole forces between HC*l* should be stronger i.e. option D is wrong.

⇒ **C**

8 1.00 g of X = 0.009434 mol of X

Amount of Y formed = 0.009434 mol

Mass of Y formed = **<u>1.57 g</u>**

⇒ **D**

9 A buffer comprises a mixture of a weak acid/base and its conjugate base/acid.

Option D involves the addition of an excess of CH_3CO_2H, which is a weak acid. This will produce a mixture of $CH_3CO_2^{-}Na^{+}$ and CH_3CO_2H, which forms a buffer.

⇒ **D**

10 In the same period, anions will have larger radii as compared to cations as anions have one more filled quantum shell.

Anionic radii decrease across a period. Hence, Sb^{3-} will have the largest radius.

⇒ **C**

11 Option A is false as the H_3PO_4 formed from the reaction of PCl_5 with water will not form a white precipitate with NaOH(aq).

⇒ **A**

12 **1** × Bond energy decreases down the group as the size of the halogen atom increases. With a larger halogen atom, the orbital overlap between hydrogen and the halogen atoms is less effective, leading to a weaker H−X bond.

2 ✓ Electronegativity decreases down the group.

3 × Oxidising power of halogens decreases down the group, so astatine will not be a strong enough oxidising agent to oxidise chloride.

⇒ **D**

13 Total number of C atoms = 12

Total number of H atoms = 20

Total number of N atoms = 4

Total number of O atoms = 7

Molecular formula of the molecule is $C_{12}H_{20}N_4O_7$, and the empirical formula is also $C_{12}H_{20}N_4O_7$.

⇒ **D**

14 Molecular formula of methanol is CH_3OH.

1 ✓ Number of methanol molecules in 32.0 g of methanol
$= 32.0 \div 32.0 \times 6.02 \times 10^{23}$

2 ✓ Number of oxygen atoms in 32.0 g of methanol
= Number of methanol molecules in 32.0 g of methanol
$= 32.0 \div 32.0 \times 6.02 \times 10^{23}$

3 × Number of hydrogen atoms in 32.0 g of methanol
= 4 × Number of methanol molecules in 32.0 g of methanol
$= 4 \times 32.0 \div 32.0 \times 6.02 \times 10^{23}$

⇒ **B**

15

	V	C	H	O
Mass per 100g /g	19.21	45.30	5.29	30.20
Amt/ mol	$\frac{19.21}{50.9}$ = 0.377	$\frac{45.30}{12.0}$ = 3.76	$\frac{5.29}{1.0}$ = 5.29	$\frac{30.20}{16.0}$ = 1.89
Ratio	1	10	14	5

Empirical formula of complex is $VC_{10}H_{14}O_5$, and molecular formula of complex is also $VC_{10}H_{14}O_5$.

Hence, 1 + 2x = 5 ⇒ x = **<u>2</u>**

⇒ **A**

16 Addition of a catalyst will decrease the activation energy, but will not change the shape of the Boltzmann distribution curve.

Increasing the temperature will lead to a larger proportion of particles have higher energy levels. Hence, peak of the Boltzmann distribution curve will shift to the right.

The total area under the curve represents the total number of particles in the system, hence it must remain constant. Due to this, the peak will be lower than before.

⇒ **B**

17 $Zn \rightarrow Zn^{2+} + 2e^{-}$

$Zn : e^{-} : As = 6 : 12 : 2 \times 1$
$= 3 : 6 : 1$

Since 1 mol of As gains 6 mol of electrons, the oxidation number of As decreases by 6.

New oxidation number of As
= −3(−2) ÷ 2 −6 = **<u>−3</u>**

⇒ **A**

18 $Fe^{2}+ \rightarrow Fe^{3+} + 3e^- $ --(1)

$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$ --(2)

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ –(3)

To get the overall equation, take (1)×5 + (2)×5 + (3)×3

Overall equation:

$3MnO_4^- + 24H^+ + 5Fe^{2+} + 5C_2O_4^{2-}$
$\rightarrow 5Fe^{3+} + 10CO_2 + 3Mn^{2+} + 12H_2O$

Hence, 1 mol of MnO_4^- will oxidise 5 ÷ 3 = **<u>1.67 mol</u>** of FeC_2O_4

⇒ **C**

19 The energy diagram shows an endothermic reaction.

Option A shows bond formation, which is exothermic.

Option B shows combustion of carbon, which is exothermic.

Option C shows the lattice energy of LiH (formation of ionic bonds), which is exothermic.

Option D shows the reverse of the lattice energy of LiOH (breaking of ionic bonds), which is endothermic.

⇒ **D**

20 Initial concentration of melphalan
= 100 ÷ 4.0 = 25.0 mg dm^{-3}

6 hours = 6 × 60 ÷ 90 = 4 half-lives

Therefore, concentration of melphalan six hours later = 25.0 ÷ 2^4 = **<u>1.56 mg dm^{-3}</u>**

⇒ **A**

21 Zn is the limiting reagent as it is completely reacted with the acid. Hence, total volume of hydrogen gas evolved should be the same.

Initial rate of reaction should be the same as the concentration of the acid used is the same.

The maximum temperature change will decrease as the same amount of heat is produced, but the total volume of solution used is doubled.

⇒ **A**

22 Since dissociation of water is endothermic, when temperature increases, the position of equilibrium shifts right to form more products, leading to an increase in $[H^+]$ as well as K_w.

⇒ **D**

23 **1** ✓ Since the forward reaction is exothermic, when temperature is decreased, the position of equilibrium will shift to the right to increase the temperature, producing more NO.

2 ✓ When pressure is reduced, the position of equilibrium will shift to the right to increase the number of gaseous particles in the system, producing more NO.

3 × Increasing the surface area of the catalyst will not change the position of equilibrium.

⇒ **B**

24

$$K_c = \frac{[C_2H_5OH(breath)]}{[C_2H_5OH(blood)]}$$

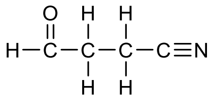
$$4.3 \times 10^{-4} = \frac{[C_2H_5OH(breath)]}{75 \text{ mg per 100 cm}^3}$$

$$[C_2H_5OH(breath)] = \mathbf{3.23 \times 10^{-2}} \text{ mg per 100 cm}^3$$

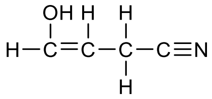
⇒ **B**

25 Since the compound contains a nitrile, it cannot be an amide.

Possible structures of the compound which satisfy the molecular formula C_4H_4NO include:

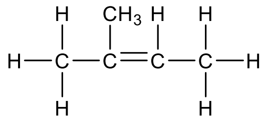
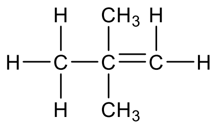
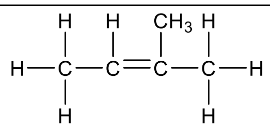
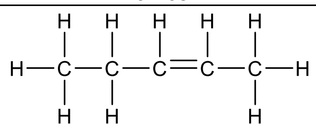


and



⇒ **B**

26

A	 Correct structure
B	 Not possible as there is a carbon atom with five bonds
C	 Same structure as A, but name is wrong. Numbering of carbon atoms should start from the end that will lead to the lowest number
D	 Same structure as $CH_3CH_2CH{=}CHCH_3$

⇒ **A**

27 Since the compound contains four primary alcohol groups, all four of them will be oxidised to form carboxylic acids.

For the oxidation of each primary alcohol group, there will be a decrease of two hydrogen atoms, and increase of one oxygen atom.

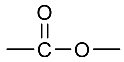
Hence, the molecular formula of compound X is $C_5H_{(12-4\times2)}O_{(4+4)}$, which is $C_5H_4O_8$.

⇒ **A**

28 Addition of bromine on an alkene will lead to two bromo groups to be on adjacent carbon atoms.

⇒ **B**

29 **1** ✓ An intramolecular condensation reaction occurs to form the compound in question.

2 ✓ The compound is as ester as it has the  group.

3 ✓ The ester group of the compound will be hydrolysed in the presence of warm, aqueous alkali.

⇒ **A**

30 Poly(ethene) is non-polar and saturated, hence the bonding between it and a polymer of methyl cyanoacrylate is instantaneous dipole-induced dipole interactions.

⇒ **C**

<u>Answer Key</u>

Qn	Ans
1	C
2	C
3	C
4	D
5	B
6	B
7	C
8	D
9	D
10	C

Qn	Ans
11	A
12	D
13	D
14	B
15	A
16	B
17	A
18	C
19	D
20	A

Qn	Ans
21	A
22	D
23	B
24	B
25	B
26	A
27	A
28	B
29	A
30	C