Eunoia Junior College
8873 H1 Chemistry
2020 Paper 1 Suggested Solution

1 Isotopes have the same number of protons, but different number of neutrons $\Rightarrow$ **A** or **C**

Since the two particles have different charges, the *difference* between the number of protons and electrons must be different.

$\Rightarrow$ **C**

2 Examine the number of *p*, *n* and *e*

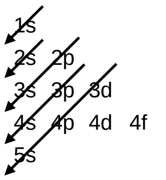
	$^{58}_{28}Ni^{3+}$	$^{60}_{28}Ni^{2+}$	$^{62}_{28}Ni^{2+}$	$^{64}_{28}Ni^{3+}$
p	28	28	28	28
n	30	32	34	36
e	25	26	26	25
m	9.712×10^{26}	1.005×10^{25}	1.038×10^{25}	1.072×10^{25}

$\Rightarrow$ **C**

3 **A ✗:** The 3*d* subshell can hold a maximum of 10 electrons. The shell with principal quantum number 3 can hold a maximum of 2 (3s) + 6 (3p) + 10 (3d) = 18 electrons.

B ✗: According to Aufbau principle, electrons fill atomic orbitals of the *lowest* available energy levels before occupying higher levels.

C ✗: The order of filling the orbitals is



1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s … …

D ✓: In atoms of transition elements, the electronic configuration is [Ar] $3d^n\ 4s^2$ or [Ar] $3d^5\ 4s^1$ (Cr), with n = 1–9

$\Rightarrow$ **B**

4 Within the same principal quantum shell *n*, the energy of the orbitals is in the order:

*n*s < *n*p < *n*d < *n*f

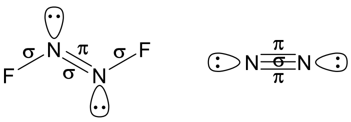
and there are 1 s orbital, 3 p orbitals, 5 d orbitals and 7 f orbitals in each principal quantum shell.

$\Rightarrow$ **A**

5 Gaseous HC*l* has a simple molecular structure with a polar covalent bond between H and the electronegative atom C*l*, *i.e.* uneven sharing of a pair of electrons between the two nuclei, with a resultant partial plus charge on the H and a partial minus charge on the C*l*.

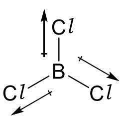
$\Rightarrow$ **C**

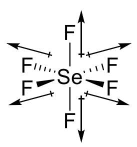
6



$\Rightarrow$ **C**

7





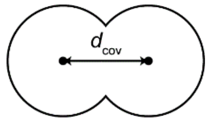
trigonal planar
B–C*l* bonds are polar
bond dipoles cancel
$\Rightarrow$ **non-polar**

octahedral
Se–F bonds are polar
bond dipoles cancel
$\Rightarrow$ **non-polar**

$\Rightarrow$ **A**

8 By definition, bond energy is the energy needed to *break* one mole of the gaseous bond.

Covalent bond length:



$\Rightarrow$ **A**

9 Arrhenius acid produces H^+(aq), while Arrhenius base produces OH^-(aq).

$\Rightarrow$ **D**

10 For an indicator to show the end-point of a titration, the working pH range of the indicator *must lie within* the region of rapid pH change during the titration.

$\Rightarrow$ **A**

11 Blood contains the H_2CO_3/HCO_3^- buffer. To maintain the pH of blood, the conjugate base HCO_3^- must remove H_3O^+ from the lactic acid produced during exercise:

$$HCO_3^- + H_3O^+ \rightarrow H_2CO_3 + H_2O$$

$\Rightarrow$ **C**

12 **A ✗:** Since both I and Xe does not conduct electricity and have rather low boiling points, both I and Xe exists as simple molecules.

B ✗: Te is only a semi-conductor (like Si), so it is a metalloid with a giant covalent structure.

C ✓: Period 3 only contains 3 metallic elements, Na, Mg and A*l*, while there are at least 5 metallic elements (high electrical conductivity and high boiling point) in Period 5.

D ✗: Rubidium in Group 1 is a metal despite having a melting point below 1000 K.

$\Rightarrow$ **C**

13 1 ✗: Electronegativity of the halogen decreases down the group, all are more electronegative than H. Hence the difference in electronegativity decreases down the group.

2 ✗: Down the group, the atomic (covalent) radius increases, hence the bond length is longer, with the bonding pair of electrons getting further from the halogen nucleus going down the group.

3 ✓: Down the group, as H–X bond length increases, the H–X bond strength decreases, leading to a decrease in thermal stability down the group.

$\Rightarrow$ **D**

14 **A ✓:** More electrons $\Rightarrow$ stronger id-id $\Rightarrow$ higher boiling point $\Rightarrow$ less volatile

B ✗: Volatility is related to strength of intermolecular forces of attraction and not the X–X bond strength.

C ✗: More electrons $\Rightarrow$ stronger id-id $\Rightarrow$ higher boiling point $\Rightarrow$ less volatile

D ✗: Volatility is related to strength of intermolecular forces of attraction and not the X–X bond strength.

$\Rightarrow$ **A**

15 Atomic radius decreases across the period due to increase in ENC (nuclear charge increases while shielding is ~constant) $\Rightarrow$ Since E is larger $\Rightarrow$ E is in Group 15

Going from Group 15 ($ns^2\ np^3$) to Group 16 ($ns^2\ np^4$), there is a drop in first I.E. since there is inter-electronic repulsion between the pair *n*p electrons in Group 16 $\Rightarrow$ E should have a higher first I.E.

$\Rightarrow$ **B**

16 **A ✗:** $n_{Cl_2} = \dfrac{71.0}{35.5\times2} = 1.0$ mol

$\Rightarrow 6.02\times10^{23}$ Cl_2 molecules

B ✗: 1 mol of $Mg(NO_3)_2$ contains 3 mol of ions = 3 × 6.02 × 10^{23} = 1.81 × 10^{24} ions

C ✓: At s.t.p., V_m = 22.7 dm mol^{-1}

$n_{O_2} = \dfrac{22.7}{22.7} = 1.0$ mol

1 mol of O_2 contains 2 mol of O atoms = 2 × 6.02 × 10^{23} = 1.20 × 10^{23} O atoms

D ✗: $n_{Be^{2+}} = \dfrac{4.50}{9.0} = 0.50$ mol

Each Be^{2+} contains 4–2 = 2 electrons.

0.50 mol of Be^{2+} contains 0.50 × 2 × 6.02 × 10^{23} = 6.02 × 10^{23} electrons

$\Rightarrow$ **C**

17 $C_xH_y + \left(x+\dfrac{y}{4}\right)O_2 \rightarrow xCO_2 + \dfrac{y}{2}H_2O$

$n_{O_2} = \dfrac{0.720}{24.0} = 0.030$ mol

$n_{H_2O} = \dfrac{0.36}{1.0\times2+16.0} = 0.020$ mol

$n_Z : n_{O_2} : n_{H_2O} = 0.0050 : 0.030 : 0.020$

$1 : x+\dfrac{y}{4} : \dfrac{y}{2} = 1 : 6 : 4$

$\Rightarrow$ *y* = 8 and *x* = 4

$\Rightarrow$ **C**

18 **A ✓:** Energy needed to overcome the stronger intermolecular forces of attraction in the liquid.

B ✗: Energy is released when stronger intermolecular forces of attraction is formed in the solid.

C ✗: Enthalpy change of neutralisation. Energy is released when a O–H is formed between H^+ and ^-OH.

D ✗: Opposite of bond dissociation. Energy is released when 2 O–H bonds are formed between the H and O atoms.

$\Rightarrow$ **A**

19 lattice energy $\propto -\left|\dfrac{q^+q^-}{r_+ + r_-}\right|$

$q_{Mg^{2+}} = 2q_{Na^+}$ and $r_{Mg^{2+}} < r_{Na^+}$ $\Rightarrow$ lattice energy of MgX_2 is more negative than that of NaX

$r_{Br^-} > r_{Cl^-}$ $\Rightarrow$ lattice energy of $MgCl_2$ is more negative than that of $MgBr_2$

$\Rightarrow$ **B**

20 unit of $k = \dfrac{\text{mol dm}^{-3}\ \text{s}^{-1}}{(\text{mol dm}^{-3})^n}$, where n is the overall order of reaction

$\Rightarrow$ **D**

21 Given $\text{rate} = k[\text{X}]^0[\text{Y}]^1[\text{Z}]^2 = k[\text{Y}][\text{Z}]^2$

$$k = \frac{\text{rate}}{[\text{Y}][\text{Z}]^2} = \frac{4.68\times10^{-4}}{(0.0500)(0.0400^2)}$$
$$= 5.85$$

$\Rightarrow$ **B**

22 Since the decomposition of N_2O_5 involves only N_2O_5 molecules, and is first order w.r.t. N_2O_5, the half-life of the decomposition must be a constant $\left(=\dfrac{\ln 2}{k}\right)$ at the same temperature.

$\Rightarrow$ **B**

23 The presence of a catalyst does not affect the shape of the Boltzmann distribution, hence E_{mp} will not change.

However, presence of a catalyst lowers E_a, hence increasing the frequency of effective collisions between the molecules.

$\Rightarrow$ **D**

24 The K_c of a reaction is only affect by changes in temperature (provided $\Delta H \neq 0$)

$\Rightarrow$ **A**

25 Considering the equilibrium:

	Cl_2	+	2NO	$\rightleftharpoons$	2NOCl
initial amt	1		2		0
change amt					
eqm amt	x				

The change in amt of Cl_2 is $-(1-x)$.

By the stoichiometry of the reaction, changes in the amt of NO and NOCl are

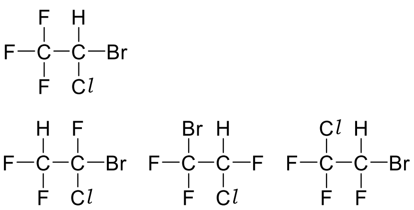
	Cl_2	+	2NO	$\rightleftharpoons$	2NOCl
initial amt	1		2		0
change amt	$-(1-x)$		$-2(1-x)$		$+2(1-x)$
eqm amt	x				

Hence the eqm amts are:

	Cl_2	+	2NO	$\rightleftharpoons$	2NOCl
initial amt	1		2		0
change amt	$-(1-x)$		$-2(1-x)$		$+2(1-x)$
eqm amt	x		$2x$		$2-2x$

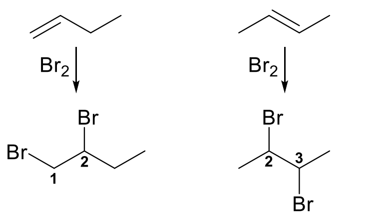
$\Rightarrow$ **C**

26 The possible constitutional isomers are:



$\Rightarrow$ **B**

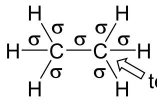
27 The two straight-chain C_4H_8 are

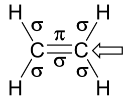


1,2-dibromobutane   2,3-dibromobutane

$\Rightarrow$ **B**

28

ethane 

ethene 

$\Rightarrow$ **D**

29 Due to the presence of –OH and –CO_2H groups in polymer 2 and 3, which can form hydrogen bonds with water, they are likely to be water soluble.

$\Rightarrow$ **C**

30 1 ✓: Surface area is important as catalytic converters relies on heterogeneous catalysis where the reactant molecules are adsorbed and react on the surface of the catalyst.

2 ✓: The ability of gecko to climb a wall depends on sum of instantaneous dipole-induced dipole attractions between the millions of microscopic hairs on the feet of the gecko and the wall. The hairs increases the surface area allowing more extensive id-id attractions to form.

3 ✗: The high tensile strength of graphene is due to the strong C–C bond within the graphene sheet and is not related to the surface area.

$\Rightarrow$ **B**

<u>**Answer Key**</u>

Qn	Ans	Qn	Ans	Qn	Ans
1	C	**11**	C	**21**	B
2	C	**12**	C	**22**	B
3	B	**13**	D	**23**	D
4	A	**14**	A	**24**	A
5	C	**15**	B	**25**	C
6	C	**16**	C	**26**	B
7	A	**17**	C	**27**	B
8	A	**18**	A	**28**	D
9	D	**19**	B	**29**	C
10	A	**20**	D	**30**	B