Victoria Junior College
2016 JC2 H1 Chemistry Prelim Paper 1
Suggested Answers

No.	Ans	No.	Ans	No.	Ans
1	**D**	11	**C**	21	**D**
2	**B**	12	**C**	22	**A**
3	**A**	13	**C**	23	**D**
4	**D**	14	**C**	24	**D**
5	**B**	15	**A**	25	**B**
6	**C**	16	**B**	26	**A**
7	**D**	17	**C**	27	**A**
8	**C**	18	**B**	28	**B**
9	**C**	19	**B**	29	**D**
10	**A**	20	**A**	30	**B**

1 D

OF_2 is oxidised to F_2 where the oxidation number of F changes from –1 to 0.
OF_2 is reduced to SO_3 where the oxidation number of O changes from +2 to –2.
SO_2 is oxidised to SO_3 where the oxidation number of S changes from +4 to +6.

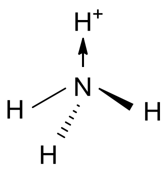
2 B

Mass of $CaCO_3$ in one chicken's egg shell
$= 50 \times \frac{5}{100} = 2.5$ g
No. of moles of $CaCO_3$ in one chicken's egg shell
= 2.5 ÷ 100.1 = 0.025 mol
No. of moles of ethanoic acid, CH_3CO_2H used
$= 2.0 \times 50 \times 10^{-3} = 0.10$ mol
$2CH_3CO_2H + CaCO_3 \rightarrow Ca^{2+}(CH_3CO_2^-)_2 + H_2O + CO_2$
No. of moles of $CaCO_3$ needed
= 0.10 ÷ 2 = 0.050 mol
No. of complete chicken's egg shells needed
= 0.050 ÷ 0.025 = 2

3 A

Equation:
$Al_4C_3 + 4NaOH + 4H_2O \rightarrow 4NaAlO_2 + 3CH_4$
Hydrocarbon is CH_4.

4 D



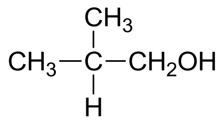
NH_4^+ is tetrahedral. The bond angles are 109º and the bonds are all of the same length.
NH_4^+ ions are formed when NH_3 behaves as a base, i.e. a proton acceptor.

On heating, $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$

5 B

$15\text{ g} \xrightarrow{t_{1/2}} 7.5\text{ g} \xrightarrow{t_{1/2}} 3.75\text{ g}$ (two half–lives)
Time taken = 2 × 8 = 16 days

6 C



$CH_3CH_2CH_2CH_2OH$

2-methylpropan-1-ol butan-1-ol

Option **A**: Both 2–methylpropan–1–ol and butan–1–ol can form intermolecular hydrogen bonds due to the presence of –OH in the molecules.
Option **B**: Both molecules have strong covalent bonds between their atoms.
Options **C** and **D**: 2–methylpropan–1–ol has weaker dispersion forces than butan–1–ol as 2–methylpropan–1–ol is more spherical and has less (not more) surface area for electron interaction than butan–1–ol.

7 D

In H_3^+,
p = 3, n = 0, e = 3 – 1 = 2 (one less e than p)

8 C

By Le Chatelier's Principle, when the volume of the reaction vessel decreases at constant temperature, the pressure of the system increases. The position of equilibrium will shift in a direction to decrease the pressure, i.e. shift to the side of the equilibrium with fewer moles of gaseous particles. Only option **C** has fewer moles of gaseous particles on the right.

Option	Moles of gaseous reactants	Moles of gaseous products
A	0	1
B	2	2
C	2	1
D	2	4

9 C

Option **A**: Fe catalyst increases the rate of reaction by lowering the activation energy of both the forward and backward reactions to the same extent.
Option **B**: Fe catalyst does not increase the value of equilibrium constant which is affected by temperature changes only.
Option **C**: Increasing the temperature increases the values of both k_1 and k_{-1}. The value of k_{-1} increases more than k_1 since position of equilibrium shifts left as temperature increases to favour the backward endothermic reaction.
Option **D**: Increasing the temperature favours the backward endothermic reaction to remove excess heat, leading to formation of more reactants and a decrease in the value of equilibrium constant.

10 A

No. of moles of HC*l* used
$= 0.15 \times 25 \times 10^{-3} = 0.00375$ mol
No. of moles of NaOH used
$= 0.10 \times 20 \times 10^{-3} = 0.00200$ mol (limiting reagent)
$NaOH + HCl \rightarrow NaCl + H_2O$
No. of moles of HC*l* left
$= 0.00375 - 0.00200 = 0.00175$ mol $= n_{H^+}$
$[H^+]$ in the final solution

= 0.00175 ÷ (45 × 10^{-3}) = 0.0389 mol dm^{-3}
pH = −lg(0.0389) = 1.4

11 C

Option **A**: As **X** is a weak acid, it is only partially ionised in solution.
Option **B**: As **X** is a stronger acid than **Y**, **X** should undergo ionisation to a larger extent than **Y**.
Option **C**: For the same concentration, since **X** ionises to a larger extent than **Y**, [H^+] is greater for **X**, giving it a lower pH.
Opton **D**: For the same no. of moles of **X** and **Y**, they require the same volume of NaOH(aq) for complete neutralisation.

12 C

Option **A**: Strength of dispersion forces increases when I_2(g) is changed to I_2(s) as the molecules are now closer together. This process is exothermic, i.e. it has a negative enthalpy change.
Option **B**: Formation of C*l*–C*l* covalent bond from C*l* gaseous atoms (reverse of bond energy) is exothermic, i.e. it has a negative enthalpy change.
Option **C**: This process represents the first ionisation energy of Ca which is endothermic, i.e. it has a positive enthalpy change.
Option **D**: This process represents the combustion of ethanol which is exothermic, i.e. it has a negative enthalpy change.

13 C

Standard enthalpy change of reaction of calcium and water, $\Delta H_r^\ominus$
$= \Sigma\Delta H_f^\ominus{}_{(product)} - \Sigma\Delta H_f^\ominus{}_{(reactant)}$
$= \Delta H_f^\ominus{}_{(Ca(OH)2)} - 2\Delta H_f^\ominus{}_{(water)}$ (since the enthalpy change of formation of Ca and H_2 are both zero)
Hence $\Delta H_f^\ominus{}_{(Ca(OH)2)} = \Delta H_r^\ominus + 2\Delta H_f^\ominus{}_{(water)}$

14 C

The rate of reaction is faster (steeper gradient) with H_2SO_4 due to a higher concentration of H^+ ions. Since H_2SO_4 is a dibasic acid, using the same volume and concentration of H_2SO_4 results in twice the no. of moles of H^+ present as compared to HC*l*. Since zinc is in excess, the volume of H_2 evolved at the end of the reaction will be twice (240 cm^3) that of the reaction with HC*l* (120 cm^3) since each molecule of H_2SO_4 releases two H^+ ions.

15 A

From the acid–base nature of the oxides, it can be deduced that **X** is in Group III, **Y** is in Group I or Group II, and **Z** is a non–metal. Since ionic radius of metal ion decreases across the period due to increasing nuclear charge, ion of **X** is smaller than ion of **Y**. Non–metal ion of the same period has a larger ionic radius than a metal ion as it gains electrons to form an additional shell of electrons. Hence, ion of **Z** has the largest ionic radius.

16 B

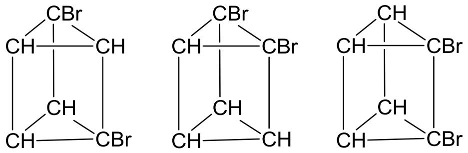
The white precipitate is the hydroxide of **M** which is soluble in both NaOH(aq) and H_2SO_4(aq). Hence **M** must be a Group III element with an amphoteric nature. **M** is therefore aluminium. A*l*C*l*$_3$(aq) is acidic due to high charge density of A*l*$^{3+}$.
$[Al(H_2O)_6]^{3+} + H_2O \rightleftharpoons [Al(H_2O)_5(OH)]^{2+} + H_3O^+$
$Al^{3+}(aq) + 3OH^-(aq) \rightarrow Al(OH)_3(s)$
$Al(OH)_3(s) + NaOH(aq) \rightarrow NaAl(OH)_4(aq)$
$2Al(OH)_3(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 6H_2O(l)$

17 C

Option **A**: Ionic radius of cation decreases across the period from Na^+ to Si^{4+} due to increasing effective nuclear charge as nuclear charge increases across the isoelectronic series (10 e^-). Ionic radius of anion decreases across the period from P^{3-} to C*l*$^-$ due to increasing effective nuclear charge as nuclear charge increases across the isoelectronic series (18 e^-). Ionic radius of anion is larger than that of cation due to an additional shell of electrons.
Option **B**: Group I and Group II chlorides have high melting points due to strong ionic bonds between oppositely charged ions which require a lot of energy to overcome. Group III to Group VI chlorides have low melting points due to weak intermolecular forces of attraction which require less energy to overcome.
Option **C**: Na_2O readily dissolves in water to form NaOH which is strongly alkaline with a very high pH 13. MgO reacts slightly with water to form $Mg(OH)_2$ of pH 10. Al_2O_3 and SiO_2 are insoluble in water giving pH 7. Non–metallic oxides form acids in water with low pH 2.
Option **D**: Generally, 1st IE increases across the period due to increasing effective nuclear charge. Exceptions: 1st IE of A*l* < 1st IE of Mg and 1st IE of S < 1st IE of P.

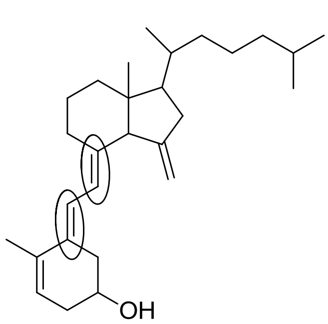
18 B

3 structural isomers are shown below.



19 B

G has two C=C bonds that can exhibit geometric isomerism. The C=C bond in the ring does not exhibit geometric isomerism due to ring strain. The terminal alkene does not exhibit geometric isomerism due to two identical H atoms on one carbon atom of the C=C bond.

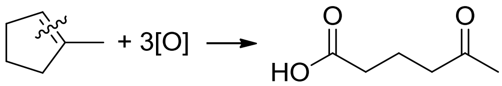


compound **G**

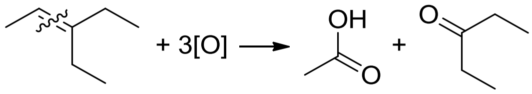
No. of geometric isomers = 2^2

20 A

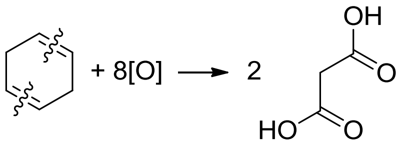
Option **A**: The methyl ketone, $RCOCH_3$ will give positive results for the 2,4–dinitrophenylhydrazine and the tri–iodoform tests.



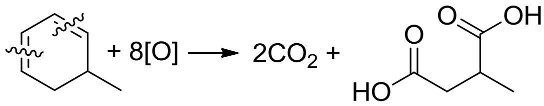
Option **B**: One of the products formed is a ketone which will give a positive result for the 2,4–dinitrophenylhydrazine test. However, none of the products has the $RCOCH_3$ structure to give a positive result for the tri–iodoform test.



Option **C**: The product formed does not give positive results for 2,4–dinitrophenylhydrazine and tri–iodoform tests.



Option **D**: The products formed do not give positive results for 2,4–dinitrophenylhydrazine and tri–iodoform tests.



21 D

Option **A**: Alcohol, aldehyde and ketone do not react with NaOH.

Option **B**: Benzaldehyde does not react with Fehling's solution. They only react with Tollens' reagent. Only aliphatic aldehydes react with Fehling's solution.

Option **C**: Aldehyde and ketone react with hydrogen cyanide in an addition reaction.

Option **D**: Aldehyde can be oxidised by hot acidified $K_2Cr_2O_7$ to a carboxylic acid while the two secondary alcohol groups are oxidised to ketones.

22 A

Size of atom: F < C*l* < Br < I

Strength of bond: C–F > C–C*l* > C–Br > C–I

The larger the size of the halogen atom, the longer and weaker the C–X bond (where X = F, C*l*, Br, I) which is more easily broken. Hence C–I bond is most easily broken and the I^- ions formed will react with Ag^+(aq) to form a yellow precipitate of AgI.

23 D

Options **A** and **B**: LiA*l*H_4 in dry ether is unable to reduce alkene.

Option **C**: Hot $KMnO_4$ with H_2SO_4(aq) will cause both $–CH_2OH$ and $–CH_2CH_2CH_3$ side chains on the benzene ring to be oxidised to $–CO_2H$ as both side chains have a benzylic hydrogen.

Option **D**: Both aldehyde and alkene functional groups will be reduced by H_2, Pt. Only the primary alcohol will be oxidised by hot $K_2Cr_2O_7$ with H_2SO_4(aq) to form $–CO_2H$.

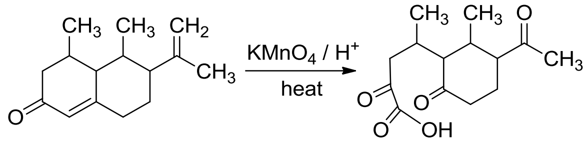
24 D

Option **A**: Nootkatone has no $CH_3CH(OH)–$ or $CH_3CO–$ structural unit to form a yellow ppt with alkaline I_2(aq).

Option **B**: Nootkatone has no aldehyde group to react with Tollens' reagent to give a Ag mirror.

Option **C**: Nootkatone does not contain C–X group to react with KCN(alc) to form a nitrile.

Option **D**: Nootkatone reacts with hot acidified $KMnO_4$ to form only one organic product.



25 B

Orange ppt. with 2,4–dinitrophenylhydrazine indicates presence of aldehyde and/or ketone.

1 mol of H_2 gas liberated with excess Na indicates presence of two –OH groups OR two $–CO_2H$ groups OR one –OH and one $–CO_2H$ groups.

Option **A**: Aldehyde present to form orange ppt. with 2,4–dinitrophenylhydrazine. But only one –OH group present to form 0.5 mol of H_2 when reacted with excess Na.

Option **B**: Ketone present to form orange ppt. with 2,4–dinitrophenylhydrazine. One –OH and one $–CO_2H$ groups present to form 1 mol of H_2 when reacted with excess Na.

Option **C**: No orange ppt. with 2,4–dinitrophenylhydrazine as aldehyde or ketone is absent. One –OH and one $–CO_2H$ groups present to form 1 mol of H_2 when reacted with excess Na.

Option **D**: Ketone present to form orange ppt. with 2,4–dinitrophenylhydrazine. But only one $–CO_2H$ group present to form 0.5 mol of H_2 when reacted with excess Na.

26 A (1, 2 and 3 are correct)

Option **1**: Correct

The reaction between a carbonyl compound and HCN involves the two reactant molecules combining to form the cyanohydrin product. Hence it is an addition reaction.

Option **2**: Correct

Comparing experiments 1 and 2, rate doubles when volume of CN^- doubles in experiment 2. Hence reaction is first order wrt CN^-.

Comparing experiments 1 and 4, rate doubles when volume of CH_3CH_2CHO doubles in experiment 4. Hence reaction is first order wrt CH_3CH_2CHO.

Comparing experiments 3 and 4, rate doubles when temperature and volume of HCN doubles in experiment 3. Given that rate doubles for every 10 °C rise in temperature, it can be deduced that reaction is zero order wrt HCN.

Hence, the rate equation is given by

rate = $k[CH_3CHO][CN^-]$

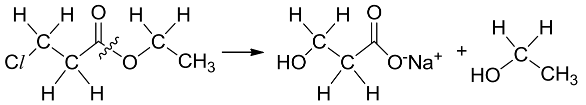
Option **3**: Correct

This is an overall second order reaction.

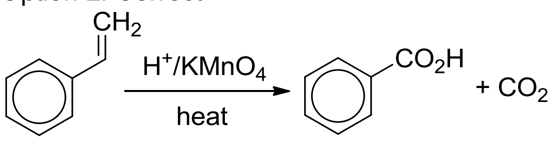
Units of k = (mol dm^{-3} s^{-1}) ÷ (mol dm^{-3})^2
= mol^{-1} dm^3 s^{-1}

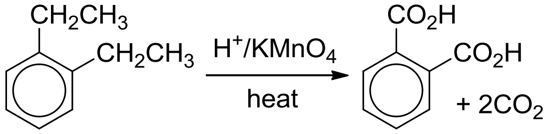
27 **A (1, 2 and 3 are correct)**
Option **1**: Correct
There are three bond pairs and zero lone pair around the C atom. Shape is trigonal planar around the C atom and hence angle x =120°.
Option **2**: Correct
The C=O bond is made up of one σ bond and one π bond while a single bond is made up of only one σ bond. Hence the molecule has only one π bond.
Option **3**: Correct
There are two lone pairs of electrons on each O atom and one lone pair of electrons on each N atom. Hence the molecule has only four lone pairs of electrons.

28 **B (1 and 2 only are correct)**
Option **1**: Correct
Al_2O_3 is an amphoteric oxide which can react with both KOH and HC*l* to form soluble compounds.
$Al_2O_3(s) + 2KOH(aq) + 3H_2O(l) \rightarrow 2K[Al(OH)_4](aq)$
$Al_2O_3(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2O(l)$
Option **2**: Correct
$SiCl_4$ undergoes hydrolysis in water as Si has energetically accessible vacant 3d orbitals to accept lone pairs of electrons from water to give an acidic solution.
$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$
Option **3**: Incorrect
S does not react with water.

29 **D (1 only is correct)**


The chloroalkane will undergo substitution when boiled with NaOH(aq) to form an alcohol. The ester will undergo base hydrolysis to form $RCO_2^-Na^+$ and an alcohol.

30 **B (1 and 2 only are correct)**
Effervescence is observed due to formation of CO_2(g).
Option **1**: Correct


Option **2**: Correct


Option **3**: Incorrect