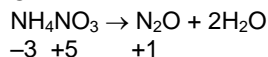


2014 JC2 H1 Chemistry Preliminary Examination  
Paper 1 Detailed Answers

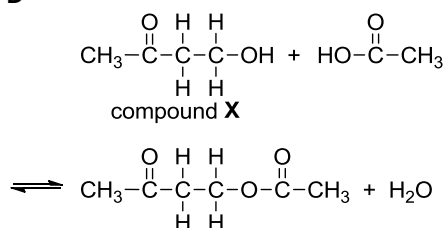
1	C	2	D	3	B	4	B	5	D
6	C	7	A	8	A	9	A	10	C
11	B	12	D	13	C	14	C	15	C
16	D	17	A	18	C	19	B	20	D
21	B	22	D	23	B	24	D	25	B
26	D	27	A	28	B	29	C	30	A

1 C



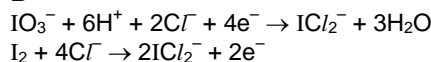
Changes in oxidation numbers of the two nitrogen atoms in  $\text{NH}_4\text{NO}_3$  are  $[+1 - (-3)] = +4$  and  $[+1 - (+5)] = -4$ .

2 D



Molecular formula of compound X is  $\text{C}_4\text{H}_8\text{O}_2$ .

3 B



Combining the two half-equations,  
 $\text{IO}_3^- + 2\text{I}_2 + 10\text{Cl}^- + 6\text{H}^+ \rightarrow 5\text{ICl}_2^- + 3\text{H}_2\text{O}$

Ratio of  $\text{IO}_3^-$  to  $\text{I}_2$  is 1:2.

4 B

Option	Valence shell electronic configuration of ion	No. of unpaired $\text{e}^-$
A	$\text{ns}^2\text{np}^2$	2
B	$\text{ns}^2\text{np}^5$	1
C	$\text{ns}^2\text{np}^3$	3
D	$\text{ns}^2\text{np}^2$	2

5 D

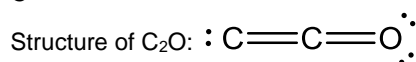
For A,  $\text{SnCl}_2$ :  $\sim 118^\circ$  (2 bp, 1 lp),  $\text{OCl}_2$ :  $105^\circ$  (2 bp, 2 lp)

For B, both are bent in shape. The electronegativity of O atom is greater than that of S atom. Hence the bond pair of electrons is closer to the nucleus of O atom resulting in stronger bp-bp repulsion in  $\text{H}_2\text{O}$  and a larger bond angle for  $\text{H}_2\text{O}$ .

For C, both are linear in shape.

For D, both are trigonal pyramidal in shape. The electronegativity of F atom is greater than that of Cl atom. Hence the bond pair of electrons is further away from the N atom resulting in weaker bp-bp repulsion in  $\text{NF}_3$  and a smaller bond angle for  $\text{NF}_3$ .

6 C



There are 3 lone pairs of electrons present in a molecule of  $\text{C}_2\text{O}$ .

7 A

For A, both sulfur ( $\text{S}_8$ ) and chlorine ( $\text{Cl}_2$ ) have covalent bonds between their atoms.

For B, chlorine has covalent bonds between the atoms while argon has weak dispersion forces between the atoms.

For C, magnesium has metallic bonding with electrostatic forces of attraction between the cations and sea of delocalised electrons while silicon has covalent bonds between the atoms.

For D, aluminium has metallic bonding with electrostatic forces of attraction between the cations and sea of delocalised electrons while phosphorous ( $\text{P}_4$ ) has covalent bonds between the atoms.

8 A

$\text{CH}_3\text{CH}_2\text{CO}_2\text{Na}$  exists as ions in solution and form strong ion-dipole interactions with water, making it the most soluble.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$  molecules form hydrogen bonds with water which are weaker than ion-dipole interactions but stronger than dipole-dipole interactions formed between  $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$  molecules and water.

9 A

	$\text{N}_2(\text{g})$	$3\text{H}_2(\text{g})$	$2\text{NH}_3(\text{g})$
Initial / $\text{mol dm}^{-3}$	2.00	6.00	2.40
Change / $\text{mol dm}^{-3}$	+0.32	3(+0.32)	2(-0.32)
Eqm / $\text{mol dm}^{-3}$	2.32	6.96	1.76

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} = \frac{(1.76)^2}{(2.32)(6.96)^3}$$

10 C

Lower pH means higher  $[\text{H}^+]$  in the solution.  $\text{HCO}_2\text{H}$  is a stronger acid and its molecules dissociate more fully than  $\text{HCO}_3^-$  ions to produce more  $\text{H}^+$  ions. Hence  $\text{HCO}_2\text{H}$  has a lower pH than a solution of sodium hydrogencarbonate of the same concentration.

For A,  $\text{HCO}_2\text{H}$  being the stronger acid will produce a weaker conjugate base as compared to weaker acid  $\text{HCO}_3^-$  producing a stronger conjugate base.

For B, both  $\text{HCO}_2\text{H}$  and  $\text{HCO}_3^-$  are monobasic acids and can only dissociate one  $\text{H}^+$  ion in aqueous solution.

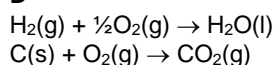
For D, the acid dissociation constant,  $K_a$ , of  $\text{HCO}_2\text{H}$  is greater than that of  $\text{HCO}_3^-$  as it is a stronger acid.

11 B

The enthalpy changes for ionisation energy (option A), reverse of lattice energy (option C) and bond energy (option D) are always endothermic.

For B, the enthalpy change of combustion ( $\Delta H_c$ ) is always exothermic.

12 D



Heat evolved for 1 g of hydrogen

$$= \frac{1}{2} \times 285 = 142.5 \text{ kJ}$$

Heat evolved for 1 g of carbon

$$= \frac{1}{12} \times 394 = 32.8 \text{ kJ}$$

Ratio of heat generated

$$= 142.5 \div 32.8 = 4.3$$

13 C

Heat evolved for A

$$= (200)(4.18)(12.7) \div 1000 = 10.6 \text{ kJ}$$

Enthalpy change per mole of A

$$= -10.6 \div 0.1 = -106 \text{ kJ mol}^{-1}$$

Enthalpy change per mole of strong dibasic acid

$$= 2(-57) = -114 \text{ kJ mol}^{-1}$$

Hence A is a weak dibasic acid.

14 C

No. of days	0	2	4	6	8
Amount of M	4	2	1	0.5	0.25
Amount of N	1		0.5		0.25

Equal amounts of M and N on the 8<sup>th</sup> day.

15 C

Rate  $\propto 1/\text{time}$

From experiments 1 and 2, when  $[\text{K}_2\text{S}_2\text{O}_8]$  is doubled, the time taken is halved, i.e. rate is doubled. Hence order of reaction wrt  $[\text{K}_2\text{S}_2\text{O}_8]$  is 1.

From experiments 1 and 3, when  $[\text{KI}]$  is tripled, the time taken is one-third the original time, i.e. rate is tripled. Hence order of reaction wrt  $[\text{KI}]$  is 1.

$$\text{Rate} = k[\text{K}_2\text{S}_2\text{O}_8][\text{KI}]$$

From experiments 1 and 4,

$$\frac{1/88}{1/35} = \frac{k(0.02)(Y)}{k(0.10)(0.20)}$$

$$Y = 0.40$$

16 D

Element J with the smallest atomic radius in the third period is Cl. Element K is P as only  $\text{Cl}_2$  and Ar have a lower melting point than  $\text{P}_4$ . Thus L is  $\text{PCl}_3$ .

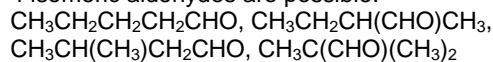
17 A

E is Al as oxide of E is amphoteric. F is either P or S as oxides of P and S can react with  $\text{NaOH}(\text{aq})$  at room temperature. G is Na as  $\text{Na}_2\text{O}$  reacts with water to give  $\text{NaOH}(\text{aq})$ , a strongly alkaline solution of pH 13.

Order of increasing proton number: G, E, F

18 C

4 isomeric aldehydes are possible:



19 B

Option	Products
A	$\text{CH}_3\text{CO}_2\text{H}$ $\text{CH}_3\text{COCH}_2\text{CH}_2\text{COCH}_3$ $\text{CH}_2(\text{CO}_2\text{H})_2$
B	$\text{CH}_3\text{COCH}_3$ $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CO}_2\text{H}$ $\text{CH}_2(\text{CO}_2\text{H})_2$
C	$\text{CH}_3\text{COCH}_3$ $\text{CH}_2(\text{CO}_2\text{H})\text{CH}_2\text{COCO}_2\text{H}$ $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
D	$\text{CH}_3\text{COCH}_3$ $\text{CH}_3\text{COCH}_2\text{COCH}_3$ $\text{CH}_2(\text{CO}_2\text{H})_2$

20 D

For A, the  $\pi$  electrons are only delocalised within the benzene ring and benzene is unable to conduct electricity.

For B, substitution in benzene has an equal probability of occurring at any of the six carbon atoms.

For C, benzene undergoes substitution reactions more readily than addition reactions so as to preserve its resonance stabilised ring structure.

For D, benzene exists as a resonance hybrid. Thus the carbon-carbon bond lengths in benzene are equal and intermediate in length (0.139 nm) between those of C-C bonds (0.154 nm) and C=C bonds (0.132 nm).

21 B

Due to the small atomic radius of F, there is effective overlap in the C-F bond resulting in large bond energy. The C-F bond is not easily broken and hence  $\text{CCl}_2\text{F}_2$  is chemically inert.

22 D

For A, due to ring strain, the C=C bond in the molecule does not exhibit geometric isomerism.

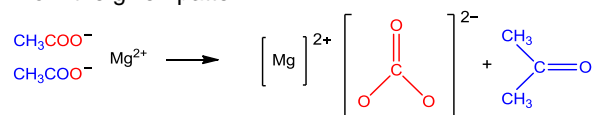
For B, alcohol does not react with  $\text{NaOH}(\text{aq})$ . The ester undergoes base hydrolysis with 1 mol of  $\text{NaOH}(\text{aq})$ .

For C, there is no aldehyde or ketone present to react with 2,4-DNPH.

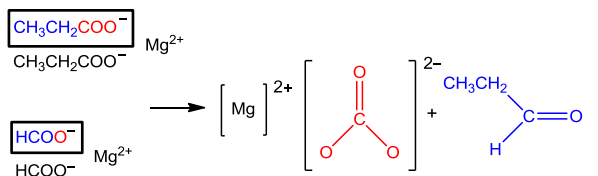
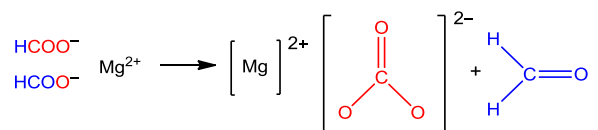
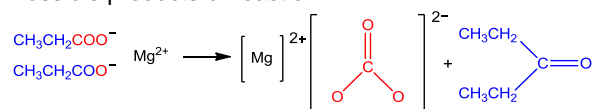
For D, the ester undergoes acid hydrolysis with hot  $\text{HCl}(\text{aq})$ .

23 B

From the given pattern:



Possible products of reaction:



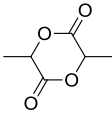
24 D

For **A**, alcohol and carboxylic acid do not decolourise aqueous bromine.

For **B**, both alcohol and carboxylic acid are able to form hydrogen bonds with water and hence lactic acid is soluble in water.

For **C**, there is no aldehyde present to reduce Fehling's reagent.

For **D**, two lactic acid molecules condense to form a

cyclic diester, , when heated in the presence of a strong acid catalyst.

25 B

**X**: Oxidation of alkene using cold  $\text{KMnO}_4$  and  $\text{H}_2\text{SO}_4(\text{aq})$  to form a diol.

**Y**: Addition of cold  $\text{HCN}$ ,  $\text{NaOH}(\text{aq})$  to aldehyde to form cyanohydrin.

**Z**: Acid hydrolysis of nitrile using  $\text{HCl}(\text{aq})$ , heat to form carboxylic acid.

N.B. Using  $\text{H}_2\text{O}(\text{g})$ ,  $\text{H}_3\text{PO}_4(\text{aq})$  is the hydration of alkene to form an alcohol.  
Using ethanolic  $\text{KCN}$ , heat is the conversion of  $\text{RX}$  to  $\text{RCN}$ .

26 D

Based on definition, bond energy ( $\Delta H_{\text{BE}}$ ) is the enthalpy change when 1 mol of any covalent bond between 2 atoms in the gaseous state is broken into individual gaseous atoms. Thus product of reaction must be  $\text{X}(\text{g})$  and  $\text{Y}(\text{g})$ .

For **1**, in  $\text{XY}_n(\text{g})$ , there are  $n$  mol of  $\text{X}-\text{Y}$  bonds. Hence,  $\text{BE}(\text{X}-\text{Y}) = \Delta H \div n$ .

For **2** and **3**, the products of the reaction are not  $\text{X}(\text{g})$  and  $\text{Y}(\text{g})$ .

27 A

For **1**, half-life is constant at 150 s. Thus reaction is 1<sup>st</sup> order wrt to  $\text{N}_2\text{O}_5$ .

For **2**, the initial rate is calculated from the gradient of the tangent drawn at  $t = 0$ .

Initial rate =  $0.5 \div 250 = 2.0 \times 10^{-3} \text{ mol dm}^{-3} \text{ s}^{-1}$

For **3**, based on the stoichiometry of the reaction, the rate of production of  $\text{O}_2$  is half that of the rate of consumption of  $\text{N}_2\text{O}_5$ .

Initial rate =  $2.0 \times 10^{-3} \div 2 = 1.0 \times 10^{-3} \text{ mol dm}^{-3} \text{ s}^{-1}$

28 B

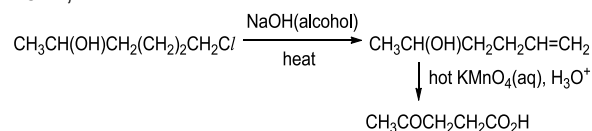
For **1**, **Q** and **Y** are not in the same period but instead they are in the same Group VIII of the Periodic Table. Their 1<sup>st</sup> IE is the highest in the period as they have the highest effective nuclear charge within the period.

For **2**, the small drop in IE is due to the electron being removed from the higher energy p subshell in **T** compared to the lower energy s subshell in **S**.

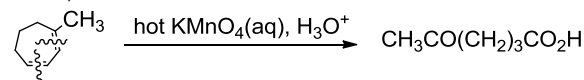
For **3**, the paired  $p^4$  electron in **W** experiences electronic repulsion, thus less energy is required to remove the paired electron in **W**.

29 C

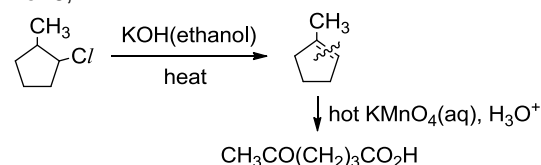
For **1**,



For **2**,



For **3**,



30 A

For **1**,  $\text{C}=\text{C}$  in **Y** will decolourise  $\text{Br}_2(\text{aq})$ . No decolourisation of  $\text{Br}_2(\text{aq})$  for **X**.

For **2**, ester group in **X** undergoes acid hydrolysis to form 3<sup>o</sup> alcohol which cannot be oxidised by  $\text{K}_2\text{Cr}_2\text{O}_7$ . There is no change in the colour of solution. However, the acid hydrolysis of **Y** formed 2<sup>o</sup> alcohol which can be oxidised by  $\text{K}_2\text{Cr}_2\text{O}_7$ . The colour of solution changes from orange to green.

For **3**, both the ester groups in **X** and **Y** undergo base hydrolysis. However, only **Y** shows a positive iodoform test due to presence of  $\text{CH}_3\text{CH}(\text{OH})-$  group after hydrolysis.