Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination 2015
Year 6

H2 CHEMISTRY 9647/01

Paper 1 Multiple Choice **29 September 2015**

1 hour

Additional Materials: Optical Mark Sheet
Data Booklet

INSTRUCTIONS TO CANDIDATES

1 Write your **name** and **class** on this question paper.

2 There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Optical Mark Sheet.

3 Each correct answer will score one mark. A mark will not be deducted for wrong answer.

4 Any rough working should be done in this booklet.

5 You may use a calculator.

[Turn over

Section A

For each question, there are four possible answers, **A, B, C,** and **D**. Choose the **one** you consider to be correct.

1 *The use of Data Booklet is relevant to this question.*

Peroxodisulfate ions convert iodide ions into iodine slowly.

$S_2O_8^{2-}(aq) + 2I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq)$

The rate of the reaction can be increased by the addition of catalysts such as aqueous iron(III) ions.

A possible catalyst reaction pathway involves the following steps:

Step 1 $2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq)\ aq) + I_2(aq)$

Step 2 $S_2O_8^{2-}(aq) + 2Fe^{2+}(aq)\ aq) \rightarrow 2Fe^{3+}(aq) + 2SO_4^{2-}(aq)$

Which of the following statements is incorrect?

A Fe^{2+} is a stronger reducing agent than I^-.

B $S_2O_8^{2-}$ is a stronger oxidising agent than Fe^{3+}.

C The $E^{\ominus}_{cell}$ for step 2 is more positive than step 1.

D Aqueous cobalt(II) ions can be used as a catalyst for this reaction.

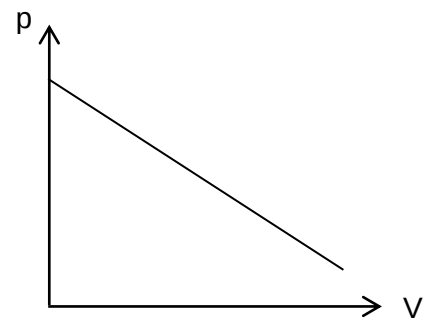
2 0.5 g of zinc powder was found to reduce an acidified solution of 25.50 cm^3 of 0.200 mol dm^{-3} VO_2^+. Which one of the following is the reduced product of VO_2^+?

A VO_3^- **B** VO^{2+}

C V^{3+} **D** V^{2+}

3 Which graph best represents the behaviour of a fixed mass of ideal gas at constant temperature?

A



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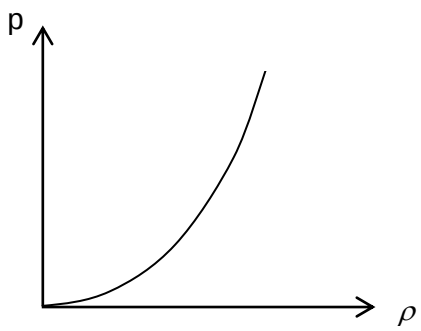

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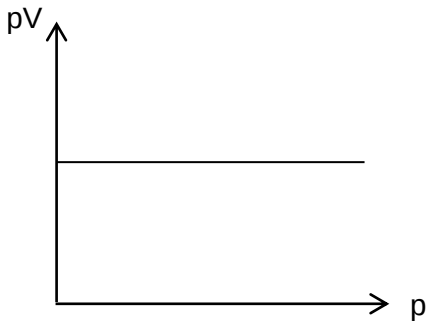

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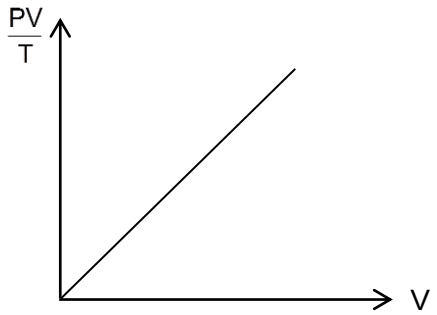


4 The interhalogen compound BrF_3 is a volatile liquid which autoionises as follows.

$$2BrF_3 \rightleftharpoons BrF_2^+ + BrF_4^-$$

The electrical conductivity of BrF_3 decreases with increasing temperature.
Which one of the following statement is correct?

A The autoionisation process is endothermic and the shape of the anion is square planar.

B The autoionisation process is exothermic and the shape of the cation is linear.

C The autoionisation process is endothermic and the shape of the anion is tetrahedral.

D The autoionisation process is exothermic and the shape of the cation is bent.

5 The reaction between gaseous hydrogen and iodine monochloride is highly exothermic. The two–step mechanism of the reaction is shown below:

Step I: $H_2(g) + ICl(g) \rightarrow HI(g) + HCl(g)$

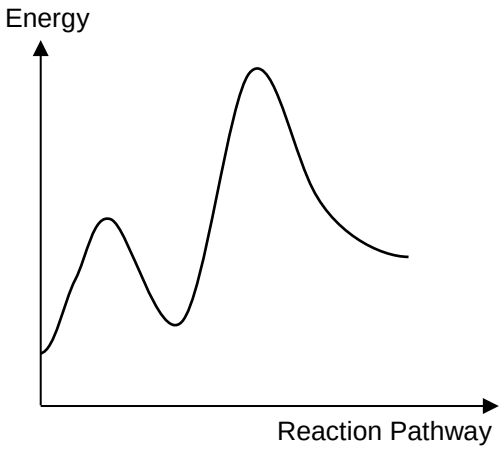
Step II: $HI(g) + ICl(g) \rightarrow I_2(g) + HCl(g)$

3 experiments were carried out to study the rate of the above reaction.

Experiment Number	Initial concentration of H_2 / mol dm^{-3}	Initial concentration of ICl / mol dm^{-3}	Initial reaction rate / mol dm^{-3} s^{-1}
1	2.0	2.0	0.0034
2	4.0	1.0	0.0034
3	2.0	1.0	0.0017

Which of the following graphs most likely describes the energy profile of the above reaction?

A



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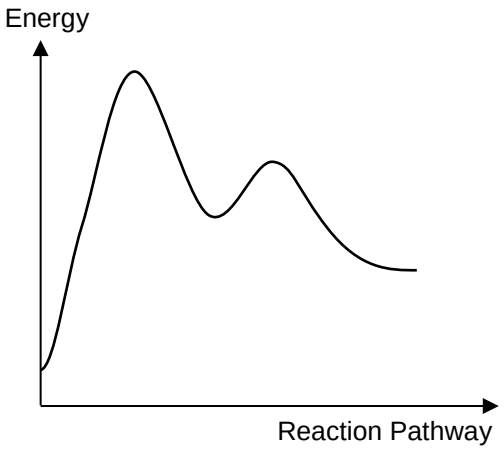

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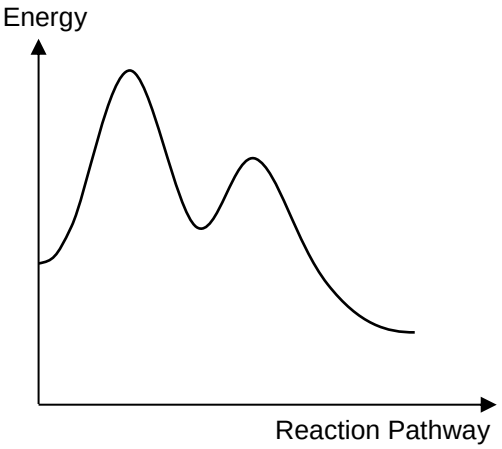

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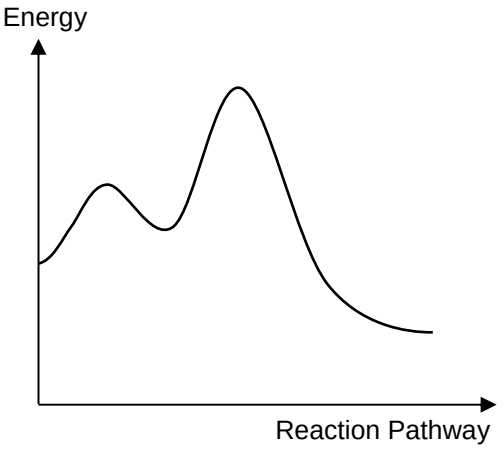


6 Sulfuric acid, one of the most important industrial chemicals, can carry out several functions in chemical reactions.

Three examples of industrial reactions in which sulfuric acid is used are shown below.

Reaction 1 $Al_2O_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2O$

Reaction 2 $Cu + H_2SO_4 \rightarrow CuO + SO_2 + H_2O$

Reaction 3 $(CH_3)_3COH + H_2SO_4 \rightarrow (CH_3)_2CCH_2 + H_2SO_4 + H_2O$

What is the function of sulfuric acid in each reaction?

	Reaction 1	**Reaction 2**	**Reaction 3**
A	dehydrating	oxidising	catalytic
B	acidic	acidic	dehydrating
C	dehydrating	oxidising	dehydrating
D	acidic	oxidising	dehydrating

7 $H_2PO_4^- + HBO_3^{2-} \rightleftharpoons HPO_4^{2-} + H_2BO_3^-$

The equilibrium constant for the reaction represented by the equation above is greater than 1.0. Which of the following gives the correct relative strengths of the acid and base in the reaction?

	Acids		**Bases**
A	$H_2PO_4^- > H_2BO_3^-$	and	$HPO_4^{2-} > HBO_3^{2-}$
B	$H_2BO_3^- > H_2PO_4^-$	and	$HBO_3^{2-} > HPO_4^{2-}$
C	$H_2PO_4^- > H_2BO_3^-$	and	$HBO_3^{2-} > HPO_4^{2-}$
D	$H_2BO_3^- > H_2PO_4^-$	and	$HPO_4^{2-} > HBO_3^{2-}$

8 The solubility of $Pb(OH)_2$ in water at 25°C is 1.06×10^{-5} mol dm^{-3}.

What is the solubility of $Pb(OH)_2$ in a buffer solution of pH 12.8 at the same temperature?

A 1.06×10^{-5} mol dm^{-3}

B 1.06×10^{-8} mol dm^{-3}

C 1.19×10^{-12} mol dm^{-3}

D 1.19×10^{-15} mol dm^{-3}

9 A student was given aqueous H_2CO_3 and $NaHCO_3$ of the same concentration. He was asked to make an acidic buffer of pH 7.

Given that the two aqueous solutions are of the same concentration, what is the volume of each solution required to make the acidic buffer?
(K_a of $H_2CO_3 = 4.3 \times 10^{-7}$ mol dm^{-3})

	Vol. of H_2CO_3(aq) / cm^3	Vol. of $NaHCO_3$(aq) / cm^3
A	11.63	50.00
B	31.68	50.00
C	78.93	50.00
D	215.00	50.00

10 In an acidic solution, bromate(V) ions react with bromide to form bromine according to the following equation:

$$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + H_2O(l)$$

Mixture	**Volume of BrO_3^-(aq)/ cm^3**	**Volume of Br^-(aq)/ cm^3**	**Volume of H^+(aq)/ cm^3**	**Volume of water/ cm^3**	**Relative rate of formation of Br_2(aq)**
I	50	250	300	400	8
II	50	250	600	100	32
III	100	250	600	50	64
IV	50	125	150	675	1

Which of the following shows the correct rate law for the reaction above?

A rate = $k\,[Br^-][BrO_3^-][H^+]^2$

B rate = $k\,[Br^-][BrO_3^-][H^+]$

C rate = $k\,[Br^-]^2[BrO_3^-][H^+]^2$

D rate = $k\,[Br^-]^2[BrO_3^-][H^+]$

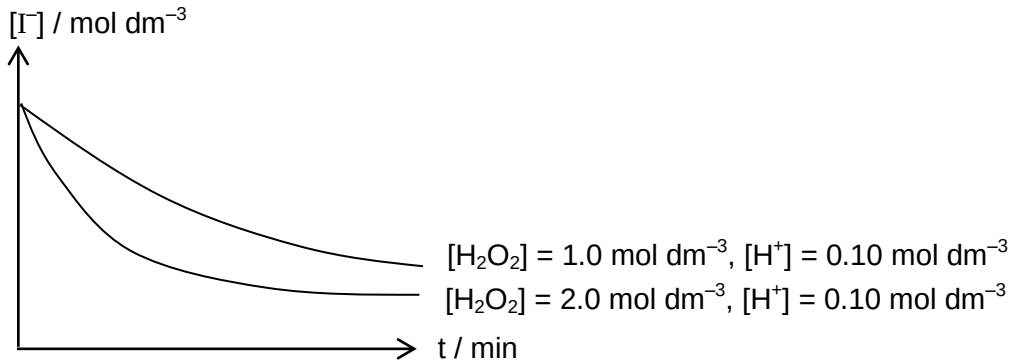
11 When an acidified solution of hydrogen peroxide is mixed with a solution of potassium iodide, the following reaction occurs:

$$H_2O_2 + 2I^- + 2H^+ \rightarrow 2H_2O + I_2$$

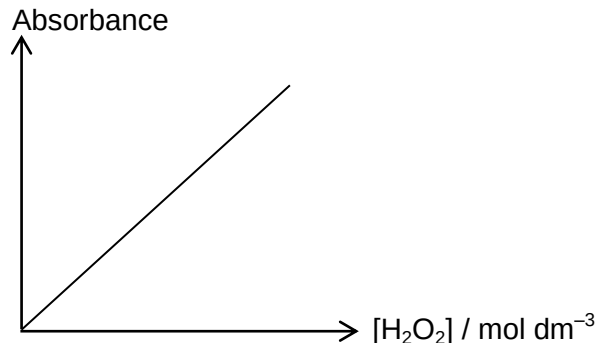
The order of reaction with respect to concentration of hydrogen peroxide may be determined by performing experiment(s) and then graphically analysing the results.

Which of the following plot will **not** allow you to determine the order of hydrogen peroxide conclusively?

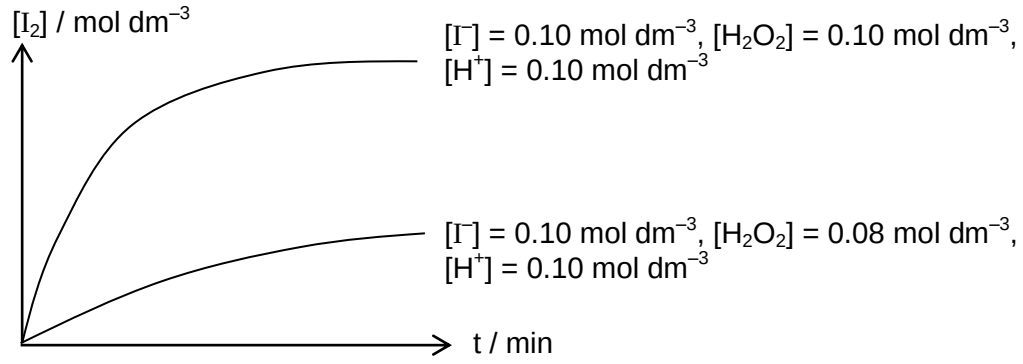
A



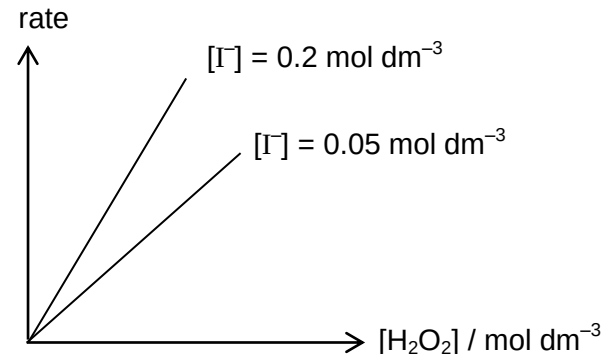
B



C



D



12 Which one of the statements below concerning the Period 3 elements (Na to Ar) is correct?

A The hydrides of the elements become more acidic from Na to C*l*.

B The maximum oxidation state is shown by sulfur.

C The melting points of the elements decrease across the Period.

D The ionic radius decreases across the Period.

13 The elements **P** and **Q** are in groups VI and VII respectively in the same period.

Which of the following statements regarding **P** and **Q** is most likely to be true?

A $\mathbf{PQ_2}$ is linear in shape.

B $\mathbf{PQ_4}$ is a non–polar molecule.

C **P** is more electronegative than **Q**.

D The first ionisation energy of **P** will likely be less endothermic than that of **Q**.

14 Which of the following statements concerning $\mathbf{X_2}$ (where **X** = C*l*, Br and I) and their compounds is **true**?

A $\mathbf{X_2}$ is liberated when $\mathbf{X^-}$ ion reacts with concentrated sulfuric acid.

B The pH of 0.1 mol dm^{-3} aqueous solution of H**X** decreases in the order HC*l* > HBr > HI.

C When a mixture of $\mathbf{X_2}$ and cyclohexane is irradiated with ultraviolet light, white fumes of H**X** are observed.

D The enthalpy change for the reaction $2H\mathbf{X} \rightleftharpoons H_2 + \mathbf{X_2}$ is least endothermic for HI and most endothermic for HC*l*.

15 A mixture of iodine and chlorine was reacted with with excess aqueous sodium thiosulfate(VI). The resulting solution was colourless. When excess aqueous barium nitrate was then added, a white precipitate **T** was formed. Precipitate **T** was filtered off and the filtrate was treated with excess silver nitrate. The precipitate formed was filtered off and washed with excess aqueous ammonia. The mixture was again filtered leaving behind precipitate **U**. The resultant filtrate was treated with aqueous lead nitrate to give a white precipitate **V**.

Which anion is present in each of the precipitates respectively?

	Precipitate **T**	Precipitate **U**	Precipitate **V**
A	$C\mathit{l}^-$	I^-	SO_4^{2-}
B	SO_4^{2-}	I^-	$C\mathit{l}^-$
C	SO_4^{2-}	$C\mathit{l}^-$	I^-
D	I^-	SO_4^{2-}	$C\mathit{l}^-$

16 *The use of Data Booklet is relevant to this question.*

A series of reagents were added, in sequence, to a sample of $CuSO_4(aq)$. The procedures are described in the table below:

Step	*Procedure*	*Observation*
1	Add $NH_3(aq)$ in excess	Blue solution turned deep blue
2	Add $Sn^{2+}(aq)$	Deep blue solution remains
3	Add excess dilute $H_2SO_4(aq)$	Deep blue solution decolourised Reddish–brown solid formed

Which of the following statement is false?

A The reddish–brown solid is copper metal.

B NH_3 is a stronger ligand than H_2O as it replaces the latter in $Cu(H_2O)_6^{2+}$ to form $Cu(NH_3)_4^{2+}$.

C Addition of H^+ in step 3 causes the formation of $Cu(H_2O)_6^{2+}$ which then undergoes redox reaction with Sn^{2+}.

D The copper containing complex ion in the deep blue solution is a stronger oxidising agent than that in the blue solution.

17 Chlorofluoroalkanes, commonly known as CFCs, undergo homolytic fission in the presence of ultraviolet radiation in the stratosphere.

Which radical is likely to be produced from the radiation on $CHFCl*Cl*CF_2Cl*$?

A $CHFCl*C\bullet F_2$

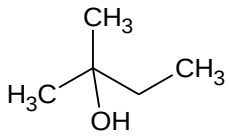
B $CHFCl*C\bullet FCl*$

C $\bullet CHCl*CF_2Cl*$

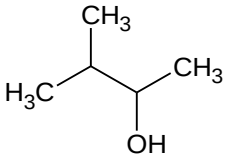
D $\bullet CFCl*CF_2Cl*$

18 What would be obtained when 2–methyl but–2–ene is heated under reflux with concentrated sulfuric acid followed by water?

A

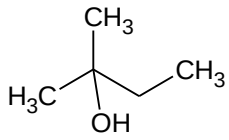


Major product

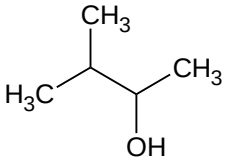


Minor product

B

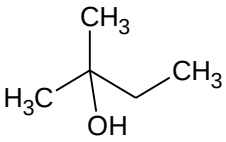


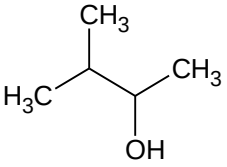
Minor product



Major product

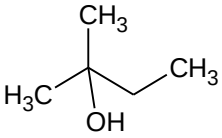
C





Both products in same proportion

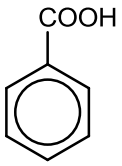
D



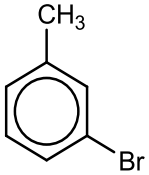
Sole product

19 Which one of the following **cannot** be made directly from methylbenzene?

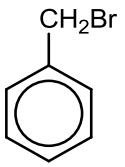
A



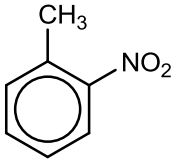
B



C



D



20 Which reagent gives a colourless homogeneous solution when added to phenol?

A aqueous bromine

B aqueous sodium carbonate

C aqueous sodium hydroxide

D neutral aqueous iron(III) chloride

21 A compound **R** was boiled with aqueous NaOH and the resulting mixture was cooled and acidified. The final products included a product $C_2H_4O_2$ and an alcohol which produces a yellow precipitate with alkaline aqueous iodine.

Compound **R** is

A $CH_3COOCH_2CH_2CH_3$ **B** $CH_3CH_2COOCH_2CH_3$

C $CH_3CH_2COOCH_3$ **D** $(CH_3)_2CHOCOCH_3$

22 An organic compound has the following properties:

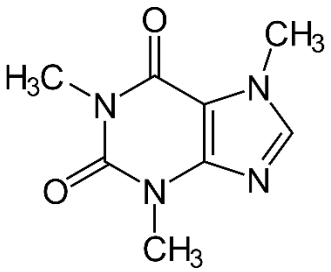
(i) It forms a brick–red precipitate with Fehling's solution.
(ii) 1 mol of the compound gives 2 mol of CO_2 upon oxidation with $KMnO_4$.
(iii) 1 mol of the compound burns in air by reacting with 6.5 mol of O_2 gas.

Which compound could give these results?

A $CH_3COCH_2C(OH)(CH_3)CH_2CHO$ **B** $HCOCH=CHCH(CH_3)CO_2H$

C $CH_2=CHCH_2COCH_2CH=CH_2$ **D** $CH_3(CH_2)_2C_6H_4CHO$

23 Which of the following statements about the following caffeine molecule is false?



A It can react with HCN via nucleophilic addition.

B The molecule contains 5 sp^2 hybridised carbon atoms.

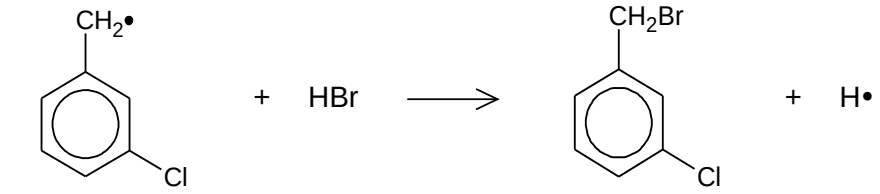
C It can undergo basic hydrolysis reaction to give a gas that turns damp red litmus blue.

D 1 mol of caffeine reacts with only 1 mol of HC*l* via acid–base reaction.

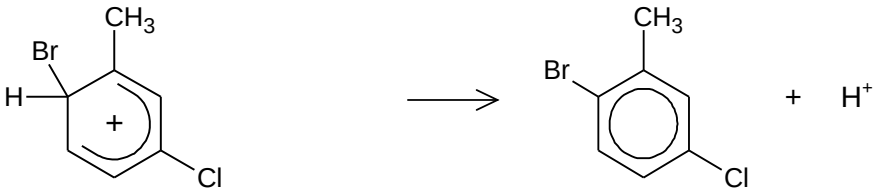
24 A mixture of 3–chloromethylbenzene, iron filings and liquid bromine is placed in a sunny spot in the laboratory. The reaction that occurs takes place in a number of steps to give several products.

Which of the following could be one of the steps?

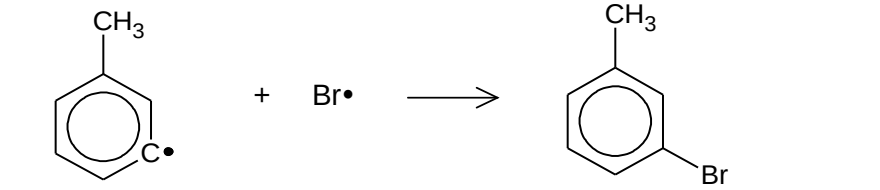
A



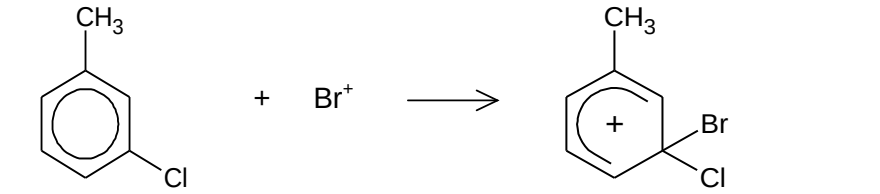
B



C



D



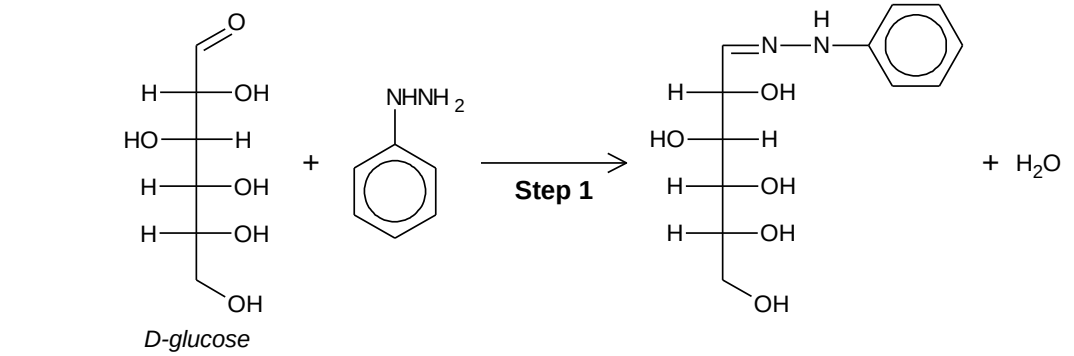
25 The table below shows the results of simple tests on two compounds **A** and **B**.

Reagent	Result	
	A	**B**
2,4–dinitrophenylhydrazine	Positive	Positive
Aqueous sodium carbonate	Positive	Negative
Tollen's reagent	Positive	Negative
Alkaline aqueous iodine	Negative	Positive

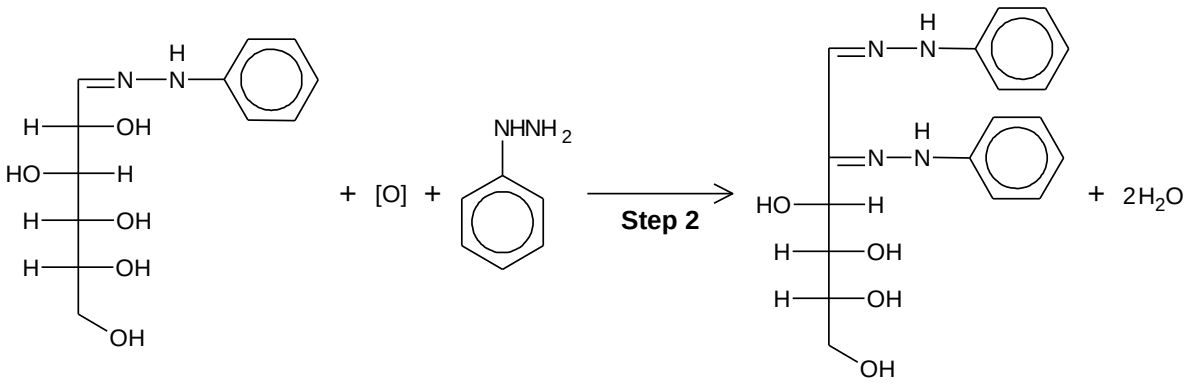
From the results, **A** and **B** could be

	A	**B**
A	$CH_3COCH_2CO_2H$	$CH_3COC_6H_5$
B	$HO_2CCH_2CH_2CO_2H$	$C_6H_5COC_6H_5$
C	$HO_2CCH_2CH_2CHO$	CH_3COCH_3
D	$CH_3CH_2CO_2H$	CH_3CH_2CHO

26 An osazone is a carbohydrate derivative formed from the reaction between a simple sugar like *D*–glucose and phenylhydrazine. The reaction pathway is shown as follows.



D-glucose

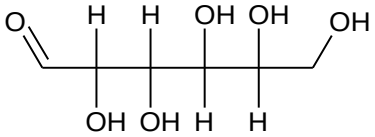


glucose osazone

Students **I** to **III** each made a comment about this reaction.

I : The transformation in **Step 1** involves a nucleophile.

II : All the water molecules formed in **Step 2** are a result of condensation reactions.

III : *D*–mannose,  , yields the same osazone as *D*–glucose.

Which of these students are **correct**?

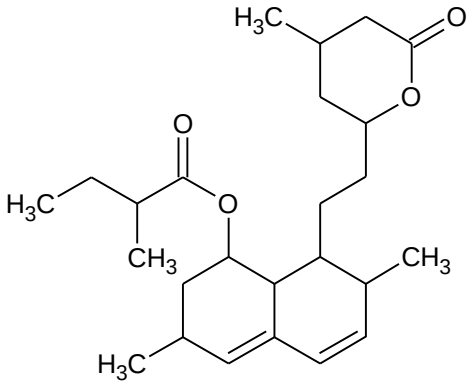
A **I** and **II**

B **I** and **III**

C **II** and **III**

D **I**, **II** and **III**

27 Monacolin K is sold as an anti cholesterolemic supplement.



Monacolin K

Which of the following statement about Monacolin K is true?

A 1 mol of Monacolin K reacts with 3 mol of hydrochloric acid under reflux.

B Monacolin K has 10 π electrons.

C Monacolin K will undergo condensation with hydrazine.

D Monacolin K will form a product with 12 chiral centres upon reacting with bromine in tetrachloromethane.

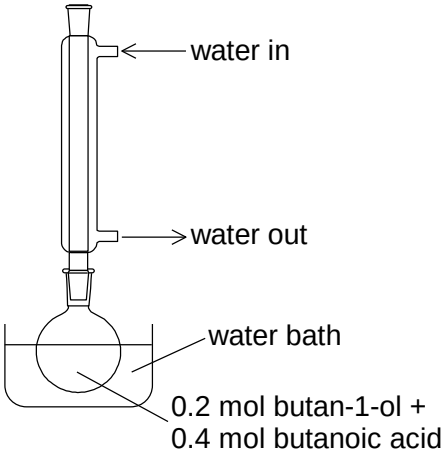
28 Esters find wide applications as flavours used to enhance foods and beverages. For example, butyl butanoate, which gives a flavour of pineapples, can be made by reacting together butanoic acid and butan–1–ol in the presence of concentrated sulfuric acid.

Data about these three compounds and butyl butanoate are given the table below.

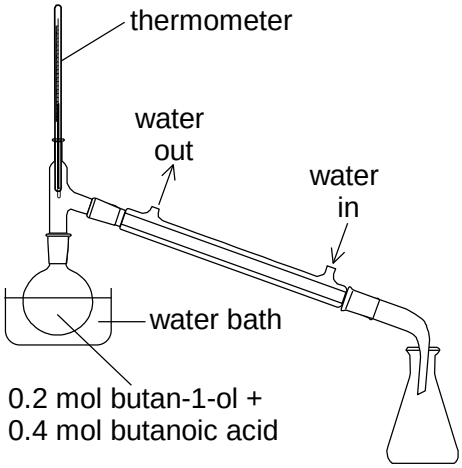
compound	M_r	boiling point / °C	density / g cm^{-3}
butyl butanoate	144	165	0.87
butanoic acid	88.0	164	1.14
butan–1–ol	74.0	118	0.81
concentrated sulfuric acid	98.1	337	1.84

Which of the following is most suitable for the synthesis of butyl butanoate?

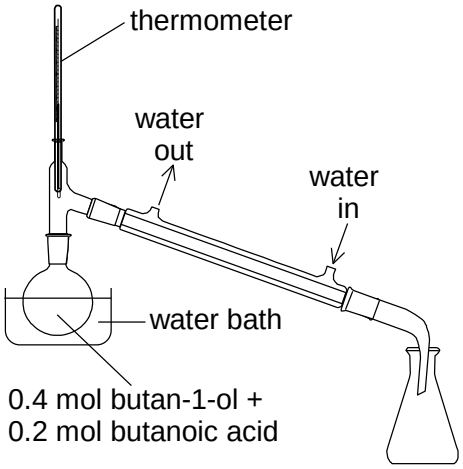
A



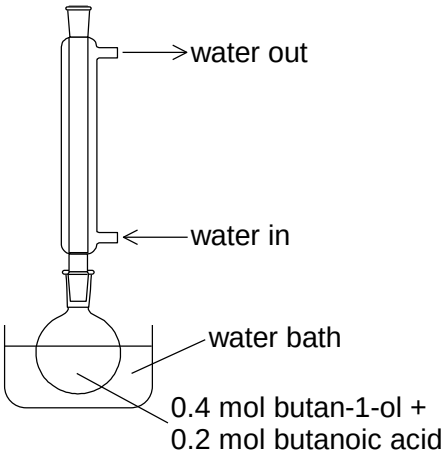
B



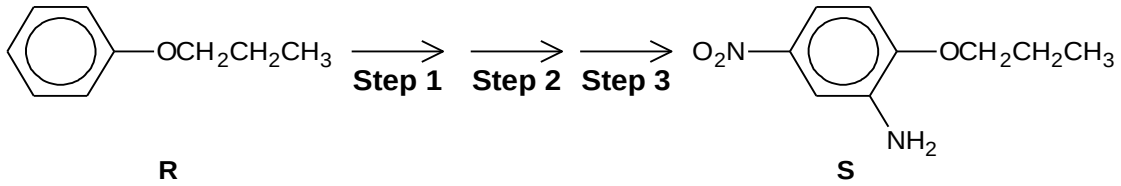
C



D



29 5–nitro–2–propoxyphenylamine, **S**, is an artificial sweetening agent which is 4000 times as sweet as sucrose. It can be made from propoxybenzene, **R**, whose reactivity is similar to that of phenol.



R **S**

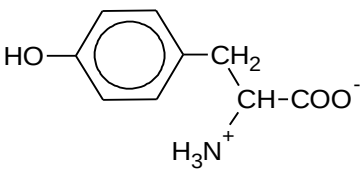
Which of the following could be a sequence for converting **R** to **S**?

	Step 1	**Step 2**	**Step 3**
A	dil HNO_3, heat	Sn, conc HC*l*, heat	NaOH(aq), r.t.p.
B	dil HNO_3, r.t.p.	Sn, conc HC*l*, r.t.p.	NaOH(aq), heat
C	conc HNO_3, r.t.p.	H_2, Ni, heat	–
D	conc HNO_3, conc H_2SO_4, 30 °C	$LiAlH_4$ in dry ether, r.t.p.	NaOH(aq), r.t.p.

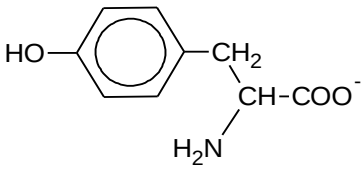
30 Tyrosine, 2–amino–4–(4–hydroxyphenyl)propanoic acid, is one of the twenty amino acids that are used by cells to synthesise proteins.

Which of the following structures represents tyrosine at pH 12?

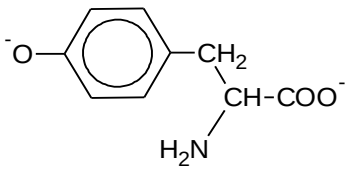
A



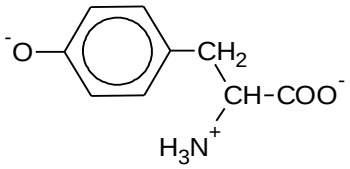
B



C



D



Section B

For each question, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements which you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Which of the compounds will likely be soluble in acetone, CH_3COCH_3?

1 water

2 2–methylbutanoyl chloride

3 *cis*–3,4–dichlorohex–3–ene

32 Which of the following is correct when 60 cm^3 of 0.10 mol dm^{-3} $Ba(OH)_2$ is added to 200 cm^3 of 0.10 mol dm^{-3} ethanoic acid?

(K_a of ethanoic acid = 1.8 x 10^{-5} mol dm^{-3})

1 The pH of the final solution is less than 7.

2 The pH would increase significantly if a further 40 cm^3 of 0.10 mol dm^{-3} of $Ba(OH)_2$ was added.

3 When a few drops of phenolphthalein are added, the final solution turns pink.

33 Magnesium reacts readily with dilute hydrochloric acid to form magnesium chloride and hydrogen.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

The standard enthalpy change for this reaction can be measured in the laboratory.

What further information is needed in order to calculate the standard enthalpy change of formation of magnesium chloride?

1 $\Delta H_{solution}^{\ominus}$ for $MgCl_2(aq)$

2 $\Delta H_f^{\ominus}$ for $HCl(aq)$

3 first and second ionisation energies of Mg

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

34 The conversion of sulfur dioxide to sulfur trioxide is the second step in the Contact Process:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g),\ \Delta H = -197\ kJ\ mol^{-1}$$

The reaction is usually carried out at 400 °C, 1 atm and with a V_2O_5 catalyst.

Which of the following statements is/are true regarding the reaction?

1 Increasing the pressure of the reaction shifts the position of the equilibrium rightwards, but does not result in a change in the equilibrium constant.

2 Increasing the temperature of the reaction shifts the position of the equilibrium leftwards, and increases the rate constants of both the forward and backward reactions.

3 In the reaction mechanism, the V_2O_5 catalyst is likely to undergo a reduction first, followed by an oxidation.

35 Which of the following statements is/are true about first row transition metals?

1 The atomic radii of transition metals are relatively invariant across the period because the changes in effective nuclear charge are small.

2 The highest oxidation state of each transition metal will correspond to the loss of all 4s and 3d electrons of the metal.

3 The third ionisation energy of iron is lower than expected because the electron is removed from the 4s orbital, resulting in lower inter–electronic repulsion.

36 Consider the following reaction:

$$2\mathbf{X}_2(g) + \mathbf{Y}_2(g) \rightleftharpoons 2\mathbf{X}_2\mathbf{Y}(g)$$

One mole of $\mathbf{X}_2$ and one mole of $\mathbf{Y}_2$ were mixed. The reaction was allowed to proceed under constant pressure of 3 atm and constant temperature of 350 K. The yield of gaseous $\mathbf{X}_2\mathbf{Y}$ at equilibrium was found to be 0.5 mol at this pressure and temperature.

Which of the following statements is/are true regarding the reaction at 3 atm and 350 K?

1 The total volume of gases decreased after the equilibrium was established.

2 At equilibrium, the number of moles of $\mathbf{Y}_2$ present is 1.5 times that of $\mathbf{X}_2$.

3 At equilibrium, the partial pressure of $\mathbf{X}_2$ is greater than the partial pressure of $\mathbf{X}_2\mathbf{Y}$.

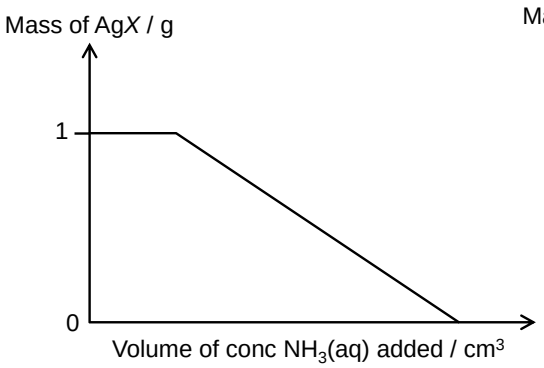
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

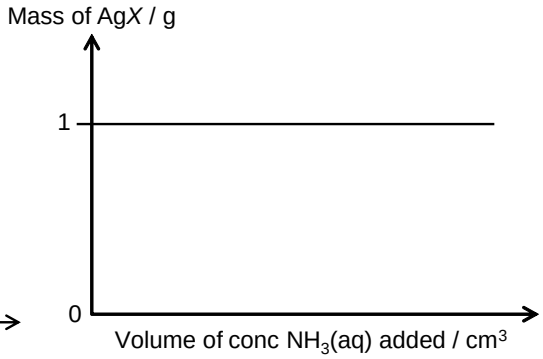
No other combination of statements is used as a correct response.

37 A student was given two solid samples of Ag*X*, where *X* could be C*l*, Br or I. He was told to add concentrated ammonia solution gradually to 1 g of each sample, and to plot mass of Ag*X* against the volume of ammonia solution added.

He obtained the following graphs at the end of his experiment.



Graph obtained for Sample **I**



Graph obtained for Sample **II**

Which of the following can be deduced from this experiment?

1 Sample **I** can only be AgBr.

2 Sample **II** can only be AgI.

3 Mass of Sample **I** decreases after a certain volume of ammonia is added because a soluble complex is formed between Ag^+ ions and NH_3 molecules.

38 In which of the following pairs of species will the d–block elements have the same electronic configuration?

1 VO^{2+} and $TiCl_3$

2 MnO_4^- and $Cr_2O_7^{2-}$

3 Cr and $Co(H_2O)_6^{3+}$

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

39 Cyclopentadiene is an important precursor in both organic and inorganic synthesis.

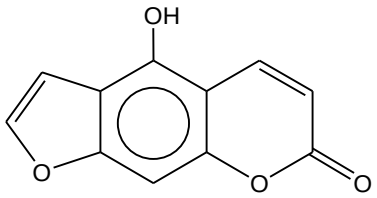
Which of the following is true regarding the cyclopentadiene?

1 Cyclopentadiene turns reddish–brown aqueous bromine colourless.

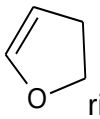
2 2 moles of CO_2 gas are liberated upon treating 1 mole of cyclopentadiene with hot acidified $KMnO_4$.

3 Cyclopentadiene can be produced by treating 3–bromo–cyclopentene with KOH in ethanol under reflux.

40 Bergaptol belongs to the family of furanocoumarins which are used medicinally to promote skin pigmentation. It has a structure as shown below:



Bergaptol

Which of the following statement(s) is/are true? You may assume that 

ring remains unreacted.

1 Bergaptol undergoes nucleophilic addition.

2 Bergaptol will react with lithium aluminium hydride.

3 Only one organic product will be formed when bergaptol reacts with acidified potassium manganate (VII).