2019 VJC H2 Chem Prelim P1
For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 *Use of the Data Booklet is relevant to this question.*

Which of the following statements are **incorrect**?

1 Both isotopes of $^{56}_{22}Ti$ and $^{58}_{22}Ti$ have more neutrons than electrons.

2 The first ionisation energy increases continuously from sodium to phosphorus as the number of protons increases but number of inner quantum shells remains the same.

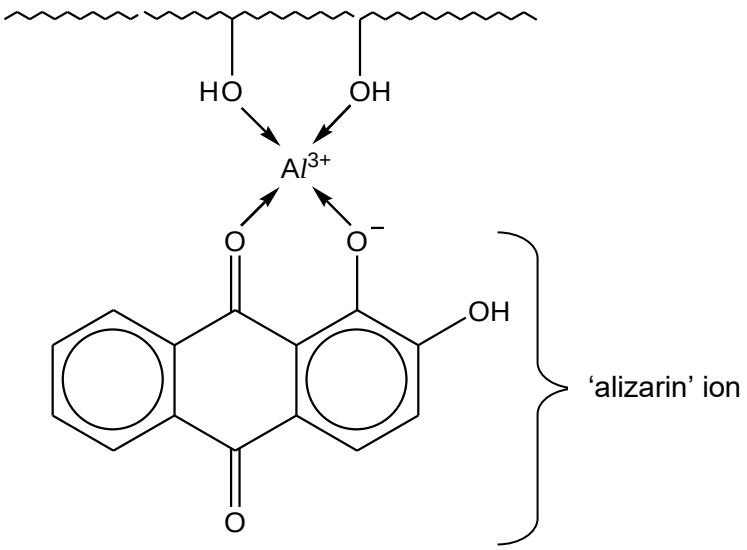
3 The second ionisation energy of chromium is lower than the second ionisation energy of manganese as manganese has one more proton than chromium.

A **1, 2** and **3**
B **2** and **3** only
C **2** only
D **3** only

2 In which of the following pairs does the first substance have a higher melting point than the second substance?

	first substance	second substance
A	$CH_3CH_2OCH_3$	$CH_3CH_2NHCH_3$
B	$CH_3CH_2CH_2CH_2OH$	$CH_3CHClCH_2CH_2OH$
C	RbCl	KCl
D	$H_2NCH_2COCO_2H$	$H_2NCH_2CH_2CO_2H$

3 The dye 'alizarin' sticks fast to cotton when a 'mordant' containing aluminium ion is used. Under alkaline conditions, the aluminium ions become bonded to the hydroxyl groups of cotton. The dye 'alizarin' can then bond with the aluminium ions, giving the structure below which dyes cotton red.



Which statement is correct?

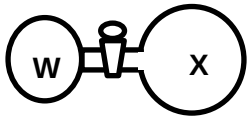
A The formula for 'alizarin' ion is $C_{14}H_9O_4^-$.

B There are 12 carbon atoms in the 'alizarin' ion that are sp^2 hybridised.

C In the absence of a mordant, alizarin can bind to cotton via hydrogen bonding.

D There is a decrease in the bond angles about the oxygen atoms of the cotton hydroxyl groups upon binding to aluminium ions.

4 Two vessels **W** and **X** are connected by a closed valve. Vessel **X** contains three times the volume of **W**.



W contains argon gas at 20 °C at a pressure of 1.00×10^5 Pa while **X** has been evacuated. In an experiment, the valve is opened and the temperature of the whole system is raised to T °C. The final pressure in the system decreases by 6.82×10^4 Pa.

What is the final temperature in the system?

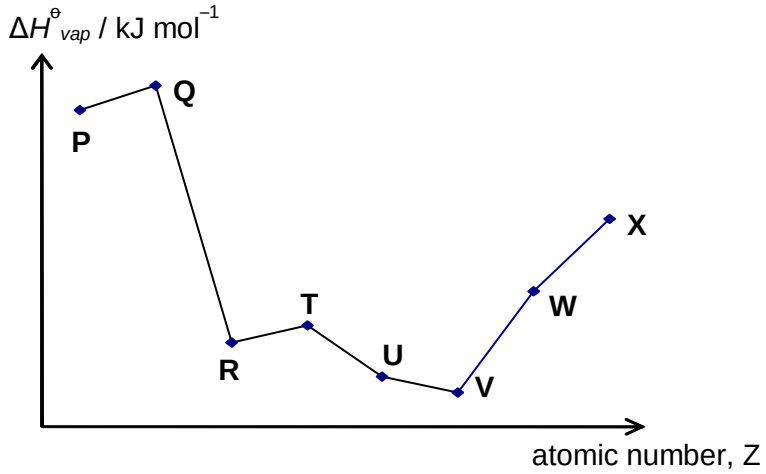
A 99.7 °C

B 373 °C

C 526 °C

D 799 °C

5 The graph below shows the variation in the standard enthalpy change of vaporisation, $\Delta H^{\ominus}_{vap}$, for eight consecutive elements in the Periodic Table, all with atomic number, $10 \leq Z \leq 20$.



Which one of the following statements is **incorrect**?

A Effervescence of hydrogen gas is observed when sodium is added to the solution containing chloride of element **P**.

B Element **U** is the most electronegative element among all the eight elements.

C When a mixture of the oxides of element **R** and element **W** is dissolved in water, the solution is approximately neutral.

D The oxide of element **Q** has a lower melting point than the oxide of element **T**.

6 Given a sample of strontium carbonate that was mixed with strontium nitrate, two separate experiments using the same mass of the solid mixture were conducted.

Experiment **1**: Excess dilute hydrochloric acid was added to the sample and volume of gas evolved was found to be 75 cm^3.

Experiment **2**: The sample was heated strongly to constant mass and the volume of gas evolved was found to be 200 cm^3.

All volumes were measured at the same temperature and pressure.

What is the mole ratio of strontium nitrate to strontium carbonate in the sample?

A 2 : 3

B 5 : 3

C 5 : 6

D 9 : 5

7 When H_2SO_4 is used to make an aqueous solution, the solution is found to contain H_2SO_4 molecules, H^+ ions, HSO_4^- ions and SO_4^{2-} ions.

Which one of the following statements best describes the system?

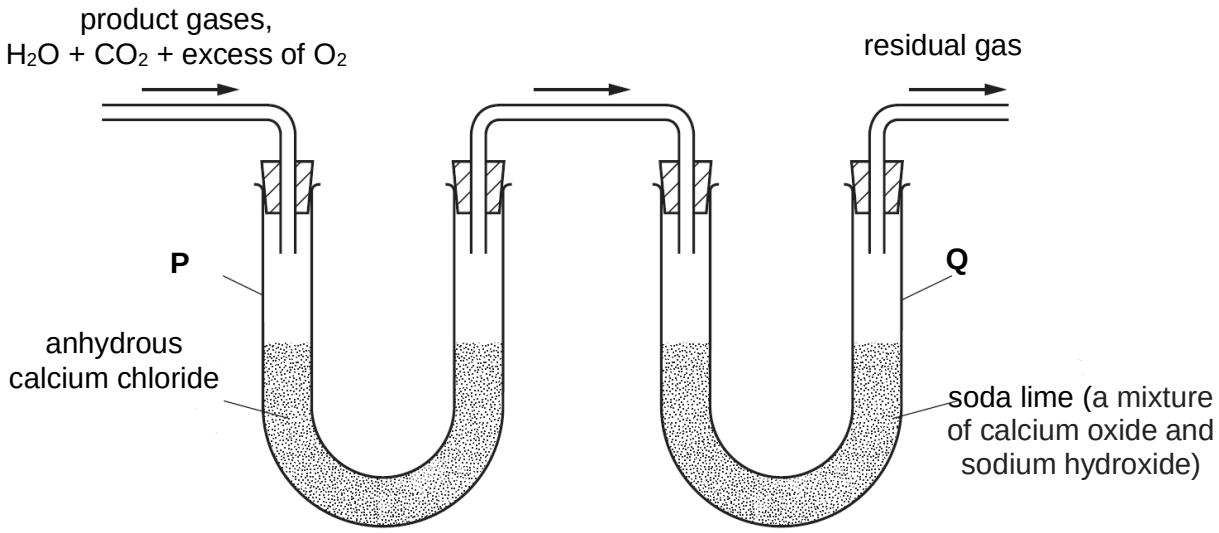
A The solution contains equal number of moles of H^+ ions and HSO_4^- ions.

B The solution contains equal number of moles of HSO_4^- ions and SO_4^{2-} ions.

C The number of moles of H_2SO_4 dissociated is equal to the sum of the number of moles of H^+ ions and HSO_4^- ions.

D The number of moles of H_2SO_4 dissociated is equal to the sum of the number of moles of HSO_4^- ions and SO_4^{2-} ions.

8 A 10 cm^3 sample of the hydrocarbon C_3H_8 is burned in excess oxygen and the product gases are collected as follows.



The increase in mass of the collecting vessels **P** and **Q** are M_P and M_Q respectively and the volume of the residual gas is V_R.

Which one of the following statements is **incorrect**?

A The ratio $\frac{V_R}{10}$ is equal to 5.

B The ratio $\frac{M_Q}{M_P}$ is equal to 1.8.

C The volume of residual gas, V_R, only contains excess O_2.

D The increase in mass in vessel **P**, M_P, is smaller than the increase in vessel **Q**, M_Q.

9 Which one of the following pairs contains identical enthalpy change values?

A	first ionisation energy of oxygen	–1 x first electron affinity of oxygen
B	standard enthalpy change of combustion of C(graphite)	standard enthalpy change of formation of $CO_2(g)$
C	standard enthalpy change of neutralization between $H_2SO_4(aq)$ and $NaOH(aq)$	standard enthalpy change of neutralization between $H_2SO_4(aq)$ and $NH_3(aq)$
D	bond energy of $F_2(g)$	standard enthalpy change of atomisation of $F_2(g)$

10 The table below gives the enthalpy changes and entropy changes for the dissolution of sodium chloride and magnesium chloride.

		$\Delta H^{\ominus}_{sol}$, kJ mol^{-1}	$\Delta S^{\ominus}_{sol}$, J mol^{-1} K^{-1}
I	$NaCl(s) + (aq) \rightarrow Na^+(aq) + Cl^-(aq)$	+3.87	+43.0
II	$MgCl_2(s) + (aq) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq)$	–155	–97.1

Which one of the following statements can be supported by the information given?

A Reaction **II** is more spontaneous than reaction **I** at higher temperatures.

B The hydration energy of Mg^{2+} is more exothermic than the hydration energy of Na^+.

C The system becomes more disordered when there is greater number of product particles.

D The lattice energy of $MgCl_2$ is more exothermic than the sum of the hydration energies of its ions.

11 When 10 g of calcium carbonate was added to 100 cm^3 of 0.10 mol dm^{-3} hydrochloric acid, the volume of CO_2 produced was recorded as follows:

time / s	0	50	75	100	125	150	175	200	225	250
total volume of CO_2 given off / cm^3	0	60	78	90	99	105	108	114	120	120

Which one of the following statements **cannot** be deduced from these results?

A The rate constant is around 0.02 s^{-1}.

B The rate of the reaction decreases with time

C The half-life of the reaction is around 50 seconds.

D The reaction is first order with respect to hydrochloric acid.

12 In the upper atmosphere, nitrogen oxides participate in the decomposition of ozone, O_3, via the following elementary steps:

reaction **I** : $O_3 \rightarrow O_2 + O$
reaction **II** : $O + NO_2 \rightarrow O_2 + NO$
reaction **III** : $O_3 + NO \rightarrow O_2 + NO_2$

Which of the following statements can be deduced from the information given?

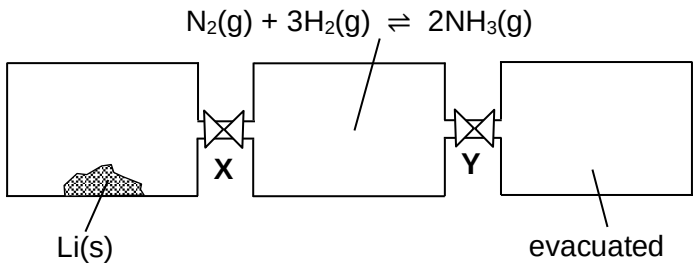
1 The overall equation for the decomposition of ozone is $2O_3 \rightarrow 3O_2$.

2 Reaction **II** must take place before reaction **III** can occur.

3 Both NO and NO_2 can behave as a catalyst for the decomposition of ozone.

A **1**, **2** and **3**
B **1** and **2** only
C **1** and **3** only
D **2** and **3** only

13 Three vessels of equal volume are connected by taps, **X** and **Y**, as shown:



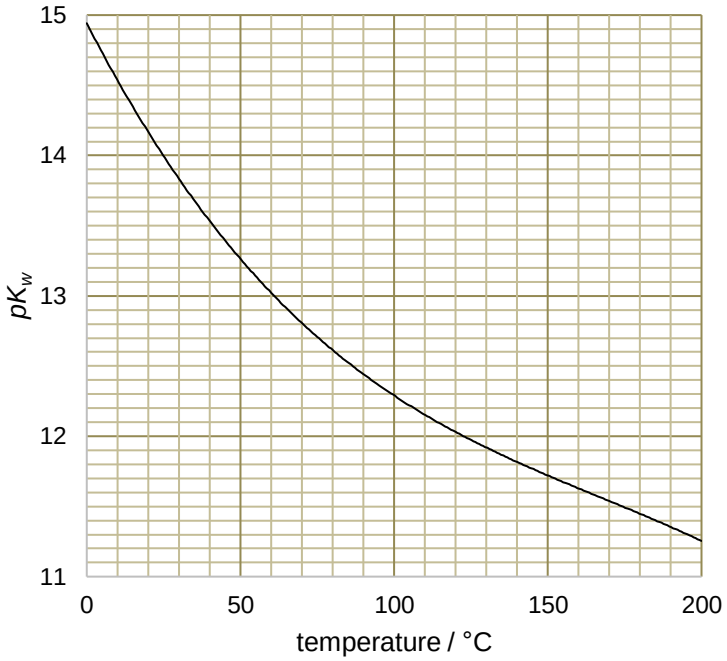
At the start, both taps are closed. The left-hand vessel contains lithium only, the middle vessel has the indicated reaction at equilibrium and the right-hand vessel is evacuated.

Lithium reacts with nitrogen at room temperature to form solid Li_3N.

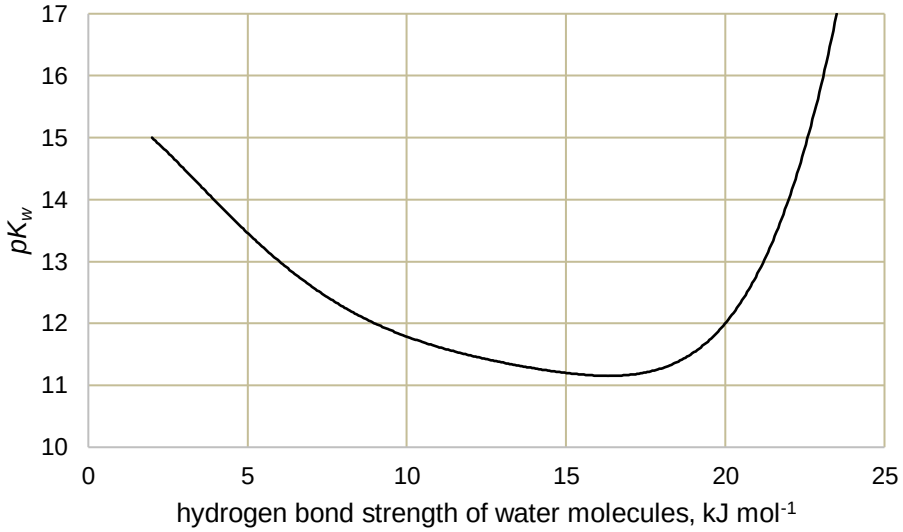
Which one of the following actions will result in the most ammonia in the equilibrium mixture?

A open **X** only
B open **Y** only
C open **X** and **Y**
D keep both **X** and **Y** closed

14 The graphs of pK_w against temperature and pK_w against strength of hydrogen bond of water molecules are given below.



graph 1: pK_w against temperature



graph 2: pK_w against hydrogen bond strength of water molecules

Which one of the following statements can be deduced from the graphs?

A The formation of extremely strong hydrogen bonds favours the dissociation of water molecules.

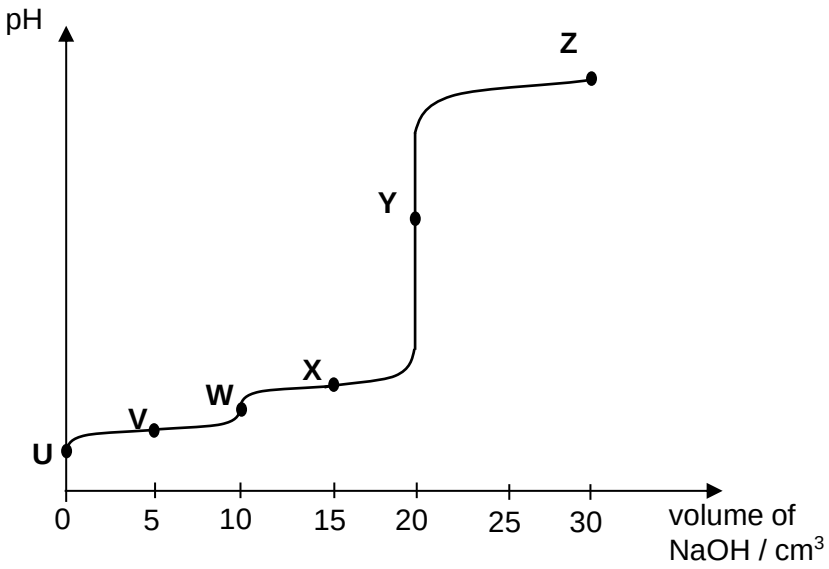
B There is more H^+ than OH^- present with increasing temperature.

C The pH of water increases with increasing temperature.

D The pH of water at 100 °C is 6.2.

15 Oxalic acid, $H_2C_2O_4$, is a relatively strong acid despite being an organic acid. The two pK_a values for oxalic acid is 1.23 and 4.19.

The titration curve between 0.10 mol dm^{-3} $H_2C_2O_4$ and 0.20 mol dm^{-3} NaOH is given below.



Which of the following statements are correct?

1 The volume of $H_2C_2O_4$ used in the titration is 20.0 cm^3.

2 The initial pH of $H_2C_2O_4$ is 1.1 [Ignore the effects of the second pK_a].

3 The points **V**, **X** and **Z** are made up of conjugate acid–base pairs.

4 The first end-point can be followed by using methyl orange indicator and the second end-point can be followed by using phenolphthalein indicator.

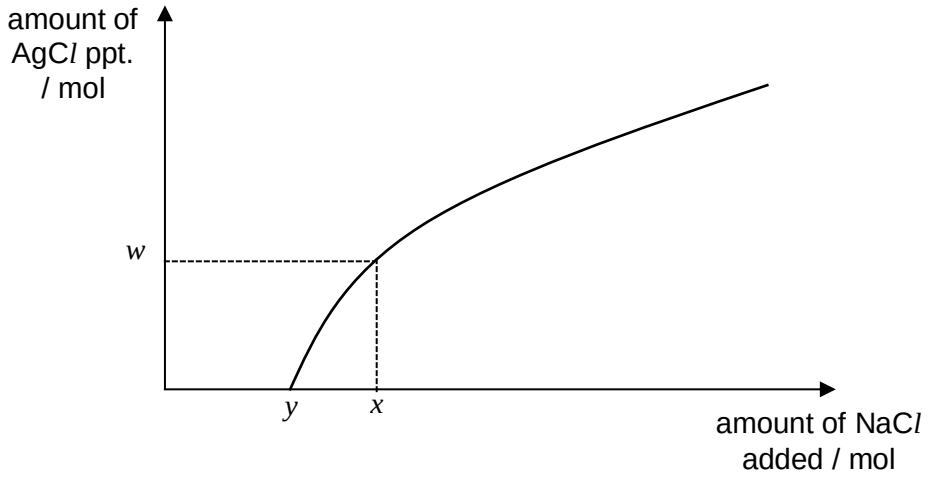
A **1**, **2** and **3** only

B **1**, **2** and **4** only

C **1** and **2** only

D **2** and **4** only

16 When solid NaC*l* was added to a 1 dm^3 solution containing z mol of Ag^+ ions, the amount of AgC*l* precipitated was found to change as follows:



Which one of the following gives the correct expression for the solubility product of AgC*l*?

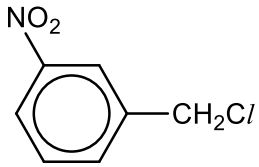
A $(z–w).(x–w)$

B $(w).(x–y)$

C $(z).(x)$

D $(y).(y)$

17 Which one of the following types of reaction is compound **K** **not** likely to undergo?



compound **K**

A electrophilic addition

B electrophilic substitution

C nucleophilic substitution

D reduction

18 The hydride ion, H^-, is a strong reducing agent, a good nucleophile and a good base.

Which one of the following conversions would the hydride ion **not** be expected to bring about?

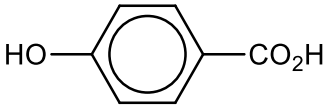
A C_2H_5Br to C_2H_6

B CH_3CH_3 to $CH_2=CH_2$

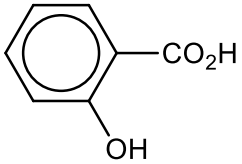
C CH_3CHO to CH_3CH_2OH

D CH_3CO_2H to $CH_3CO_2^-$

19 Which option correctly describes the comparison of the melting point and the first pK_a between 4–hydroxybenzoic acid and 2–hydroxybenzoic acid?



4–hydroxybenzoic acid



2–hydroxybenzoic acid

	melting point of 4–hydroxybenzoic acid	first pK_a of 4–hydroxybenzoic acid
A	lower	lower
B	lower	higher
C	higher	higher
D	higher	lower

20 In which one of the following processes is the organic product a gas at room temperature and pressure?

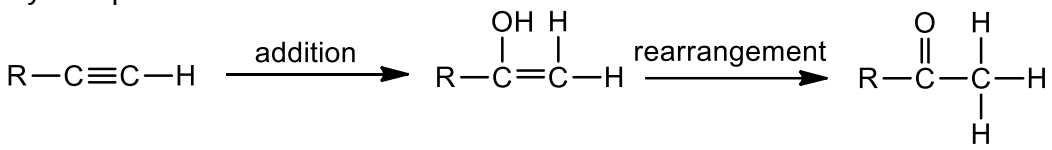
A substitution of ethanol by hydrogen bromide

B dehydration of ethanol

C esterification of ethanoic acid by ethanol

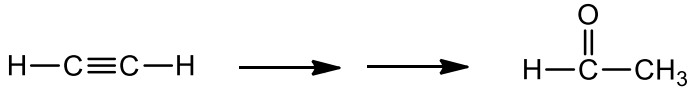
D oxidation of ethanal by acidified potassium dichromate(VI)

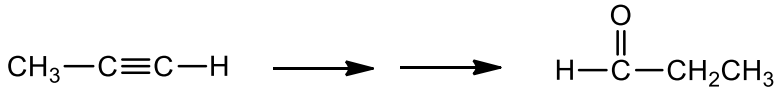
21 An alkyne (C≡C) undergoes addition of water in a similar mechanism as an alkene. However, the enol (C=C-OH) that is formed is unstable and would undergo rearrangement to form a carbonyl compound.

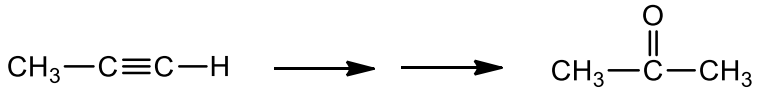


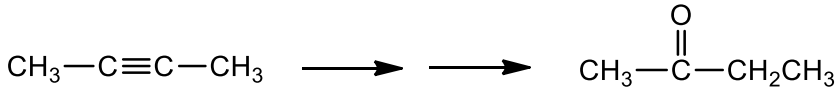
alkyne enol carbonyl

Which compound is **unlikely** to be formed when the following alkynes undergo addition of water?

A 

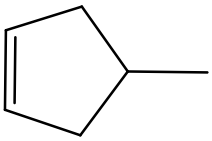
B 

C 

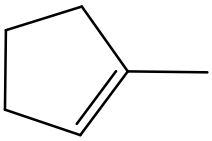
D 

22 Which one of the following compounds react with hot acidified $KMnO_4$ and the resultant product formed will give a positive test with **both** 2,4–dinitrophenylhydrazine and PCl_5?

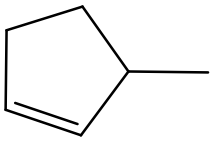
A



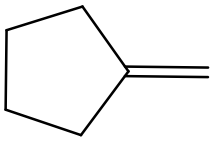
B



C

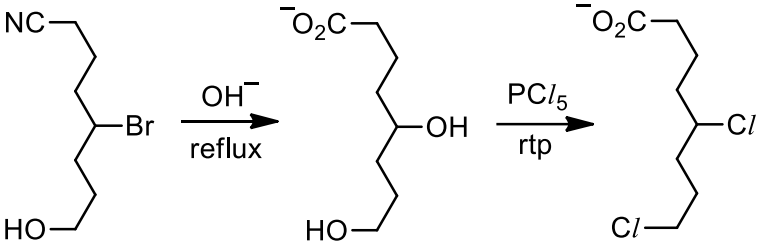


D

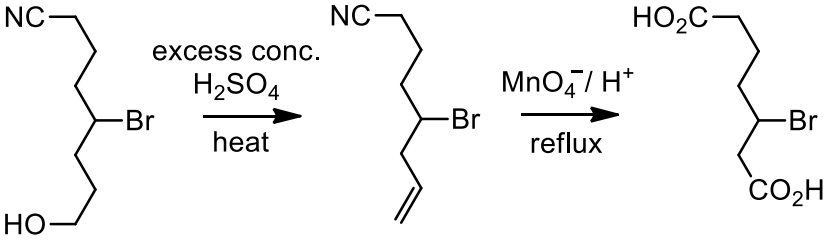


23 Which one of the following 2-stage processes will **not** yield the final product as shown?

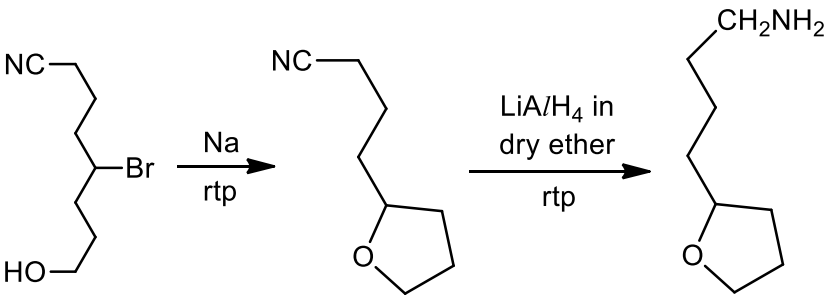
A



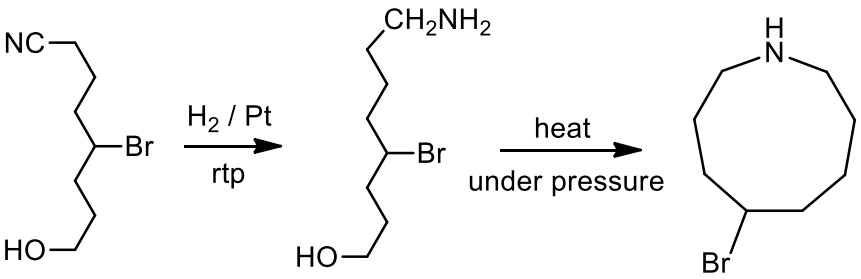
B



C



D



24 Compound **Z** releases a gas that turns damp red litmus paper blue upon addition of hot aqueous NaOH. Which compounds could be **Z**?

1 $CH_3CH_2CH_2CN$

2 $CH_3CH_2CONHCH_3$

3 $CH_3CH_2CO_2NH_4$

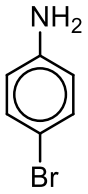
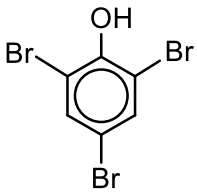
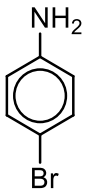
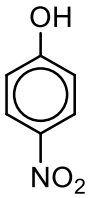
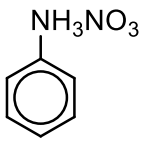
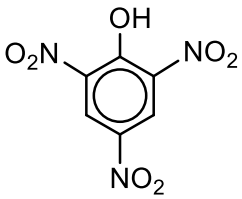
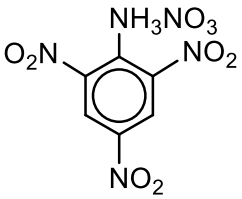
A **1**, **2** and **3**

B **1** and **3** only

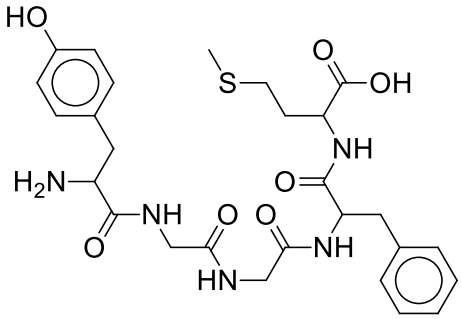
C **1** only

D **2** and **3** only

25 Which one of the following options shows the correct products when phenol and phenylamine react with the reagents and conditions indicated?

	reagents and conditions	product of phenol	product of phenylamine
A	Br_2(aq) room temperature		
B	Br_2 in CCl_4 room temperature		
C	HNO_3(aq) room temperature		
D	HNO_3(concentrated) room temperature		

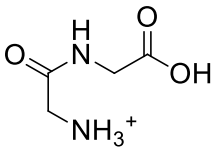
26 To reduce pain during stress, animals generate their own opiates. One such opiate is called *encephalin*, a pentapeptide as shown below:



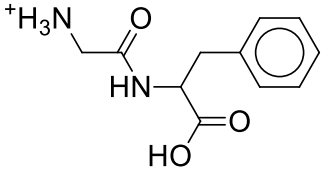
encephalin

Which one of the following dipeptides is **not** a product of the partial hydrolysis of *encephalin* with 6 mol dm^{-3} HC*l*?

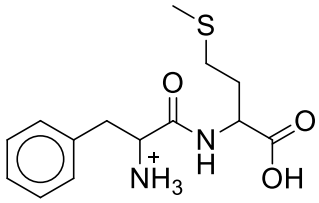
A



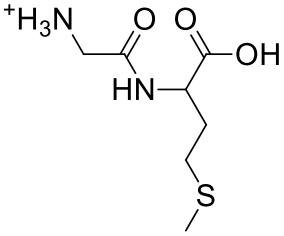
B



C



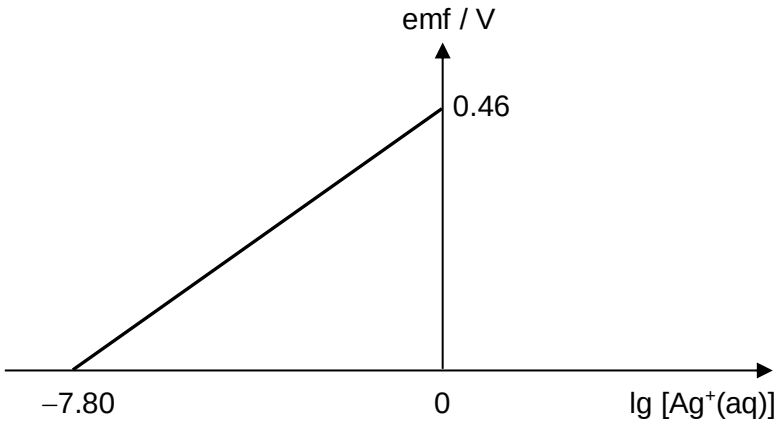
D



27 *Use of the Data Booklet is relevant to this question.*

An electrochemical cell is made up of $\mathbf{X}^{2+}$(aq)|**X**(s) and Ag^{+}(aq)|Ag(s) half-cells. **X**(s) is the negative electrode and the concentration of $\mathbf{X}^{2+}$(aq) is kept at 1.00 mol dm^{-3} throughout.

The graph below shows the variation in electromotive force (emf) of the above electrochemical cell with lg [Ag^{+}(aq)] at 298 K.



Which of the following statements are correct?

1 The direction of electron flow in the external circuit will be reversed when the concentration of Ag^{+}(aq) is 1.00 x 10^{-6} mol dm^{-3}.

2 The standard electrode potential of the $\mathbf{X}^{2+}$(aq)|**X**(s) half-cell is +0.34 V.

3 The emf of the given cell under standard conditions will be +0.46 V.

A **2** and **3** only

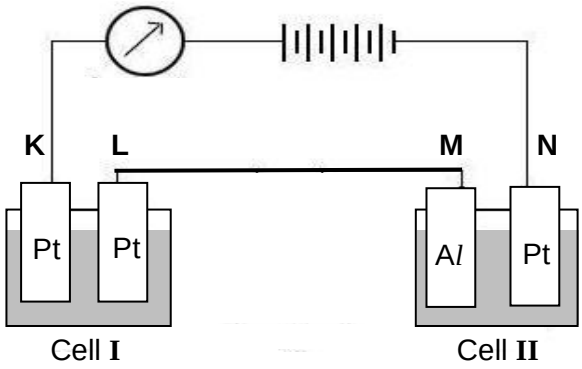
B **1** and **3** only

C **1** and **2** only

D **2** only

28 *Use of the Data Booklet is relevant to this question.*

An experiment involving the electrolysis of aqueous copper(II) sulfate in Cell **I** and aqueous sulfuric acid in Cell **II** was carried out.



Given that relative formula mass of Al_2O_3 is 102.0 and the mass of Al_2O_3 formed at electrode **M** is 0.142 g.

What is the maximum mass of copper deposited at electrode **L** after complete electrolysis?

[Note: Assume that all the O_2 produced at electrode **M** completely reacted to form Al_2O_3.]

A 0.133 g

B 0.236 g

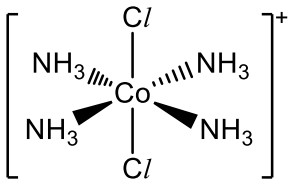
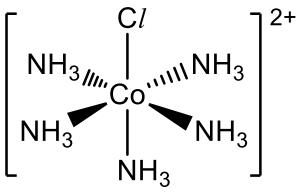
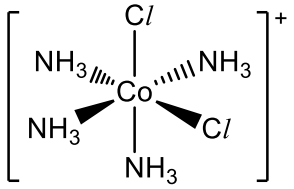
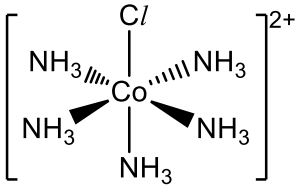
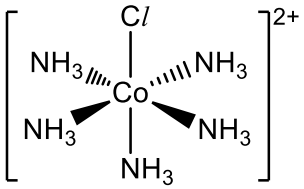
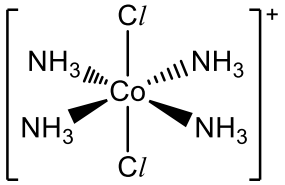
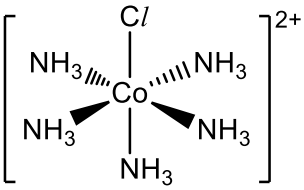
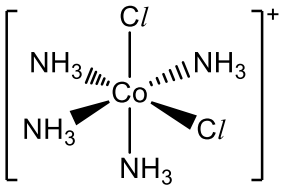
C 0.265 g

D 0.530 g

29 Two different complexes, **K** and **L**, can be obtained by reacting aqueous cobalt(III) chloride with ammonia under various conditions. Different proportions of chloride are precipitated when each of the complexes is treated with aqueous silver nitrate.

	Formula	Number of moles of AgCl precipitated per mole of complex	Does the complex have a dipole moment?
K	$CoCl_3(NH_3)_5$	2	yes
L	$CoCl_3(NH_3)_4$	1	no

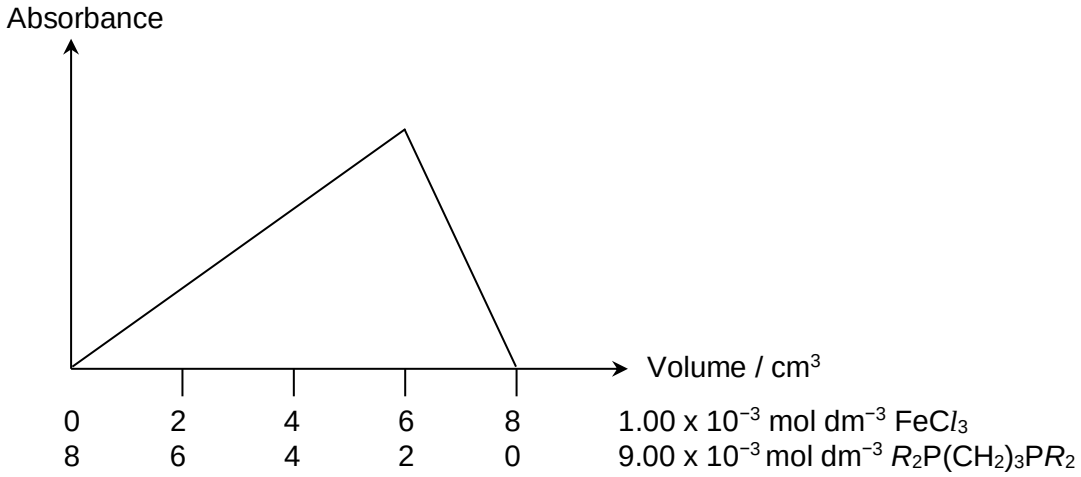
Which one of the following options shows the correct structures of **K** and **L**?

	K	**L**
A		
B		
C		
D		

30 In this question, '*R*' represents a phenyl group.

2-bis(diphenylphosphino)propane, $R_2P(CH_2)_3PR_2$, is a commonly used ligand which forms a complex ion with many metal ions.

In the graph below, the intensity of visible light absorbance for different mixtures containing 1.00×10^{-3} mol dm^{-3} $FeCl_3$(aq) and 9.00×10^{-3} mol dm^{-3} $R_2P(CH_2)_3PR_2$ are shown.



Which one of the following statements is **not** true?

A The formula of the complex ion formed is $[Fe(R_2P(CH_2)_3PR_2)_3]^{3+}$.

B Each $R_2P(CH_2)_3PR_2$ can form three dative covalent bonds with Fe^{3+} ion

C The coordination number of the complex ion formed is 6.

D H_2O molecule is a weaker ligand than $R_2P(CH_2)_3PR_2$.

H2 CHEMISTRY PAPER 1 ANSWERS

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