ANGLO-CHINESE JUNIOR COLLEGE
DEPARTMENT OF CHEMISTRY
Preliminary Examination

CHEMISTRY **9729/01**
Higher 2

Paper 1 Multiple Choice

29 August 2018
1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and tutorial class on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** 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 Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **18** printed pages.

1 The Basic Oxygen steel-making process is a method of preparing steel from carbon-rich molten pig iron. The process is basic because chemical bases are added to remove impurities. One such impurity is phosphorus pentoxide, P_4O_{10}. Calcium oxide, CaO, is added to remove it and the only product of the reaction is the salt, calcium phosphate, $Ca_3(PO_4)_2$.

How many moles of CaO reacted with one mole of P_4O_{10} in this reaction?

A 1

B 1.5

C 3

D 6

2 Two moles of an oxidising agent, XO_4^- in the presence of excess acid oxidised 96 dm^3 of nitrogen dioxide gas at room temperature and pressure to NO_3^-.

What is the number of moles of electrons accepted by one mole of XO_4^-?

A 1 **B** 2 **C** 3 **D** 4

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

The ion $\mathbf{T}^+$ contains 28 electrons and 35 neutrons.

Which of the following statements about $\mathbf{T}^+$ or **T** is correct?

A **T** and Ga^{3+} are isoelectronic species.

B The elemental form of **T** can be oxidised by chlorine.

C The electronic configuration of $\mathbf{T}^+$ ion is $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^9\,4s^1$.

D The angle of deflection of $^{27}Al^{3+}$ is approximately three times that of $\mathbf{T}^+$ in an electric field.

4 Which of the following species has a different bond angle from the rest?

A ICl_3 **B** SF_3^+ **C** ClO_3^- **D** N_2H_4

5 What will happen to the volume of a bubble of air submerged in water under a lake at 10.0 ^{o}C and 2.00 atm if it rises to the surface where the temperature is 20.0 ^{o}C and the pressure is 1.00 atm?

A The volume will increase by a factor of 2.00.

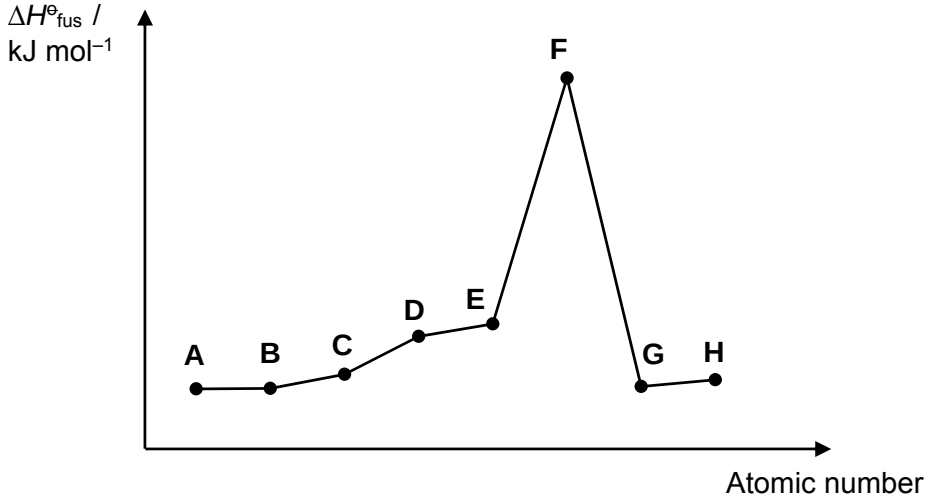
B The volume will increase by a factor of 2.07.

C The volume will decrease by a factor of 2.00.

D The volume will decrease by a factor of 1.93.

6 The graph below shows the variation in the standard enthalpy change of fusion, $\Delta H^{\ominus}_{fus}$ for 8 consecutive elements from period 2 to 3 in the periodic table.

Standard enthalpy change of fusion is the heat absorbed when one mole of a substance changes its state from solid to liquid under standard conditions.



Which of the following statements is true based on the information deduced from the above graph?

A The chlorides become more acidic from **A** to **C**.

B An oxide of **E** dissolves in water to form an alkaline solution.

C Element **G** has a higher first ionisation energy than element **F** and **H**.

D Element **D** has a lower electrical conductivity as compared to element **F**.

7 Some enthalpy changes of combustion are given below.

	ΔH_c / kJ mol^{-1}
CO(g)	–283
H_2(g)	–286
$CH_3OH(l)$	–715

What is the enthalpy change of the following reaction, in kJ mol^{-1}?

$$CO(g) + 2H_2(g) \longrightarrow CH_3OH(l)$$

A –146

B +146

C –140

D +140

8 The reaction of nitrogen monoxide and hydrogen gas

$$2NO(g) + 2H_2(g) \longrightarrow N_2(g) + 2H_2O(g)$$

is thought to involve the following steps:

I $NO + NO \rightleftharpoons N_2O_2$ (fast)

II $N_2O_2 + H_2 \longrightarrow H_2O + N_2O$ (slow)

III $N_2O + H_2 \longrightarrow N_2 + H_2O$ (fast)

Which of the following about the reaction is true?

A H_2 acts as the catalyst.

B The rate equation for the reaction is rate = $k[N_2O_2][H_2]$.

C The overall order of the reaction is 3.

D Increasing the concentration of NO does not change the rate of reaction.

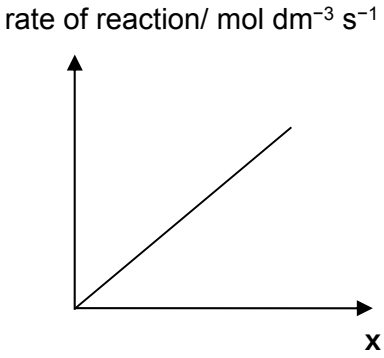
9 Hydrogen peroxide reacts with acidified iodide ions liberating iodine according to the equation below:

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \longrightarrow I_2(aq) + 2H_2O(l)$$

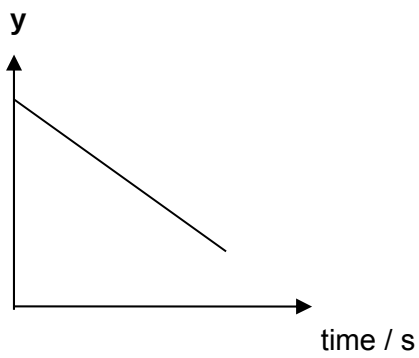
The kinetics of this reaction was investigated and it was found to have the following rate equation: rate = $k[H_2O_2]\,[I^-]$

Two series of experiments were conducted, giving rise to **Graph A** and **Graph B**.

Graph A



Graph B

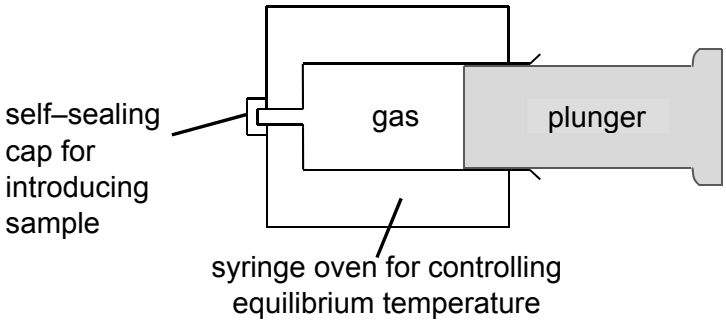


Which of the following shows the correct labelling of the x-axis for **Graph A** and y-axis for **Graph B**?

	x-axis	y-axis
A	$[H_2O_2]\,[I^-]$ / mol^2 dm^{-6}	$[H^+]$ / mol dm^{-3}
B	$[H^+]$ / mol dm^{-3}	$[H_2O_2]$ / mol dm^{-3}
C	$[H_2O_2]\,[I^-]$ / mol^2 dm^{-6}	$[I^-]$ / mol dm^{-3}
D	$[H^+]$ / mol dm^{-3}	$[I^-]$ / mol dm^{-3}

10 A gaseous dimer, **Z**, is introduced into an empty gas syringe which has a movable, tightly–fitting plunger. The gas is allowed to expand until equilibrium is reached at a controlled temperature at which 20 % of **Z** dissociates into its monomer **W**.

$$\mathbf{Z}(g) \rightleftharpoons 2\mathbf{W}(g)$$



Which of the following statements is correct?

A The forward reaction is exothermic.

B The value of the equilibrium constant, K_p is 0.167 atm.

C The pressure inside the syringe at equilibrium will be higher than the atmospheric pressure.

D The dissociation of dimer **Z** will be favoured when the plunger is pushed back into the equilibrium mixture.

11 The acid dissociation constants for the diprotic acid, malonic acid $H_2C_3H_2O_4$ are $K_{a1} = 1.5 \times 10^{-3}$ and $K_{a2} = 2.0 \times 10^{-6}$.

What is the K_b for $HC_3H_2O_4^-$?

A $K_w \times K_{a1}$

B $K_w \times K_{a2}$

C K_w / K_{a1}

D K_w / K_{a2}

12 Hardness in tap water can be determined by titrating a sample against a reagent which forms complex ions with dissolved metal ions. The indicator for this titration requires the pH to be maintained at about 10.

Which of the following, in aqueous solution, could be used to maintain the pH at about 10?

A 10 cm^3 of 2.0 g dm^{-3} of sodium hydroxide neutralised by 10 cm^3 of 0.025 mol dm^{-3} of ethanoic acid

B 5 cm^3 of 1.7 g dm^{-3} of ammonia neutralised by 10 cm^3 of 0.025 mol dm^{-3} hydrochloric acid

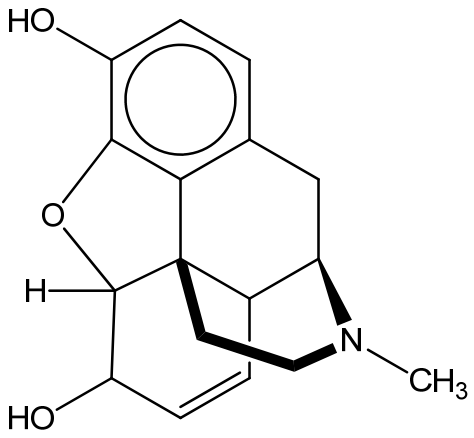
C 20 cm^3 of 0.05 mol dm^{-3} of hydrochloric acid neutralised by 5 cm^3 of 1.7 g dm^{-3} ammonia

D 10 cm^3 of 0.05 mol dm^{-3} of ethanoic acid neutralised by 5 cm^3 of 2.0 g dm^{-3} of sodium hydroxide

13 The solubility product of some sparingly soluble lead compounds are shown below. Which compound will have the lowest concentration of $Pb^{2+}(aq)$ ions in a saturated solution?

	compound	numerical value of solubility product (at 25 ^oC)
A	lead(II) fluoride	2.7×10^{-8}
B	lead(II) bromide	4.0×10^{-5}
C	lead(II) iodide	7.1×10^{-9}
D	lead(II) sulfate	1.6×10^{-8}

14 Morphine is a powerful narcotic painkiller which could be isolated from opium poppy. Though it relieves pain effectively, it can cause addiction so readily that it should only be used in the cases where other pain medications are inadequate.



morphine

Which of the following claims about morphine is true?

1 There are 5 chiral carbons present in the molecule.

2 There are 7 C–C bonds formed by $sp^3 – sp^3$ overlap.

3 The molecule cannot exhibit cis-trans isomerism at the C=C double bond.

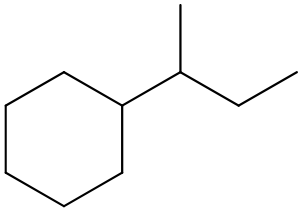
A 1 only

B 2 only

C 2 and 3 only

D 1, 2 and 3

15 Compound **L** reacts with limited chlorine gas in the presence of sunlight.



compound **L**, $C_{10}H_{20}$

Assuming that only mono-chlorination takes place and ignoring the relative rates of abstraction of the different type of hydrogen atom, which of the following statements is **incorrect**?

A The maximum number of chlorinated products formed is 8.

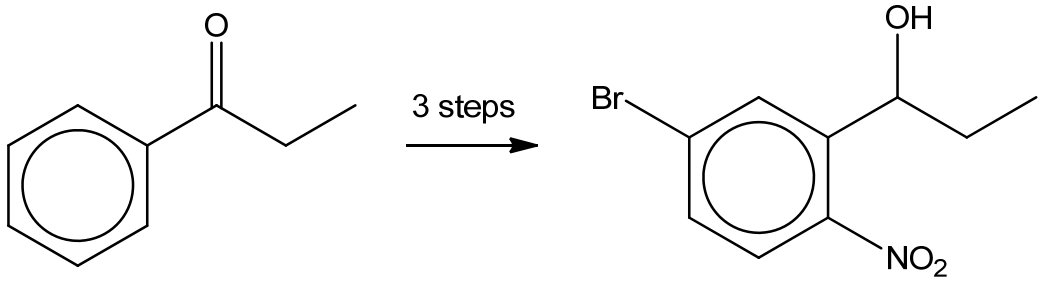
B $C_{20}H_{38}$ is present in small quantities in the products.

C Homolytic fission occurs in both initiation and propagation step.

D The ratio of primary to secondary to tertiary chloroalkanes formed is 3:6:2.

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

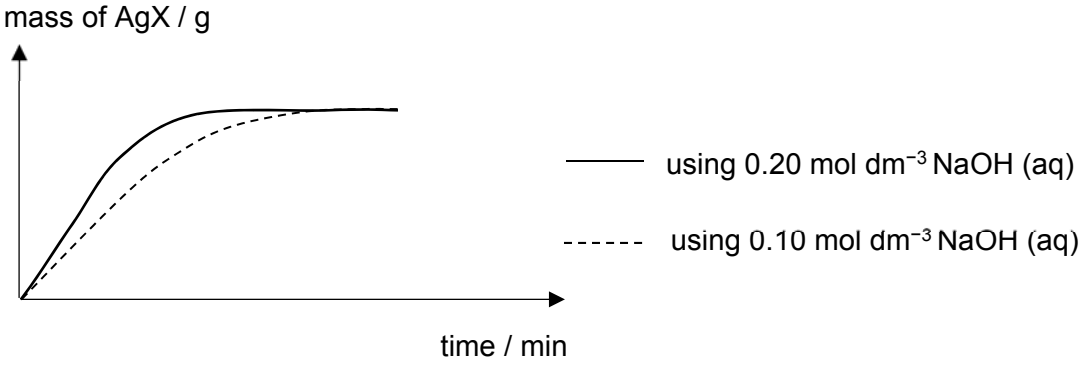
The following transformation takes place in three steps.



Which of the following shows the best choice of reagents and conditions to carry out the transformation?

	step 1	step 2	step 3
A	H_2, Pt	conc HNO_3, conc H_2SO_4	Br_2, $FeBr_3$
B	Br_2, $FeBr_3$	H_2, Pt	conc HNO_3, conc H_2SO_4
C	H_2, Pt	Br_2, $FeBr_3$	conc HNO_3, conc H_2SO_4
D	Br_2, $FeBr_3$	conc HNO_3, conc H_2SO_4	H_2, Pt

17 A halogen-containing compound, **U**, is heated with 2 different concentrations of aqueous sodium hydroxide. After acidifying the mixture and adding excess aqueous silver nitrate, the mass of silver halide formed is analysed over a period of time. The following graph for the mass of silver halide precipitate against time was obtained.



Which of the following is the likely structure of **U**?

A

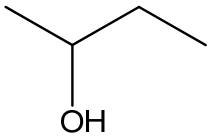
B

C

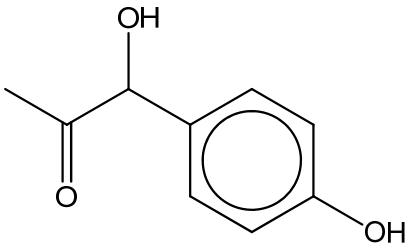
D

18 The following two compounds react with alkaline aqueous iodine to form yellow precipitate of tri-iodomethane as one of the products.

What is the ratio of sodium hydroxide used to react with 1 mol of compound **V** and 1 mol of compound **W** respectively?



compound **V**



compound **W**

	compound **V**	compound **W**
A	4	4
B	4	6
C	6	4
D	6	5

19 A fresh salad with tomatoes may contain compound $CH_3CH_2CH_2CH{=}CHCHO$ which provides an aroma for tomatoes. What will be the final product, **P** in this sequence of reactions?

$$CH_3CH_2CH_2CH{=}CHCHO \xrightarrow[\text{then } H_2O]{NaBH_4 \text{ in } CH_3OH} \mathbf{O} \xrightarrow[\text{heat}]{K_2Cr_2O_7/H^+} \mathbf{P}$$

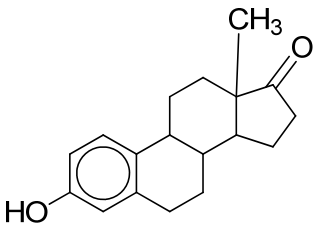
A $CH_3CH_2CH_2CH{=}CHCOOH$

B $CH_3CH_2CH_2CH_2CH_2COOH$

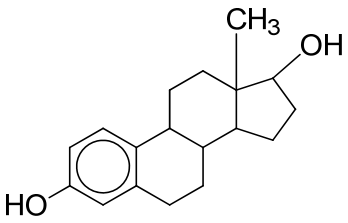
C $CH_3CH_2CH_2CH{=}CHCH_2OH$

D $CH_3CH_2CH_2COOH$

20 Two female sex hormones are oestrone and oestradiol.



oestrone



oestradiol

Which of the following reagents could be used to distinguish between the two hormones?

1 $SOCl_2$

2 $KMnO_4/H^+$

3 $LiAlH_4$ in dry ether

A 1, 2 and 3

B 1 and 2 only

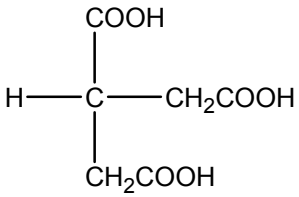
C 2 and 3 only

D 1 only

21 Ethanoic acid can be made by direct carbonylation of methanol, in presence of a rhodium catalyst.

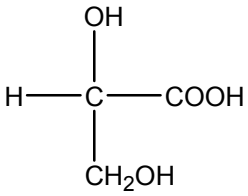
$$CH_3OH + CO \xrightarrow{\text{rhodium catalyst}} CH_3COOH$$

Which of the following can produce compound **S** using a similar method?

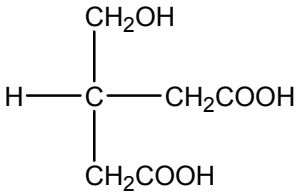


compound **S**

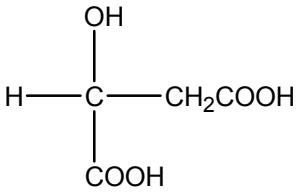
A



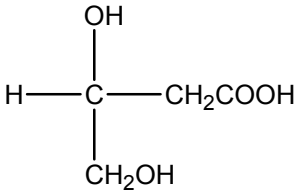
B



C



D



22 Benzylamine has the formula $C_6H_5CH_2NH_2$ and is a common precursor in organic synthesis.

Which of the following statements about benzylamine is correct?

1 It reacts with excess CH_3CH_2Cl to form the compound, $C_{13}H_{22}NCl$.

2 It reacts with CH_3COOH to form $C_6H_5CH_2NHCOCH_3$.

3 It can be distinguished from $CH_3CH_2NH_2$ by the use of aqueous bromine.

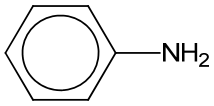
A 1, 2 and 3

B 1 and 2 only

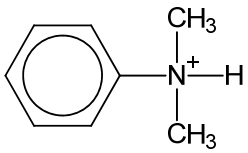
C 1 only

D 2 and 3 only

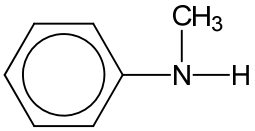
23 The structures of some nitrogen containing compounds are shown below.



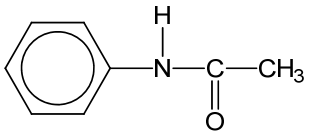
compound **H**



compound **I**



compound **J**



compound **K**

What is the order of increasing basicity of the nitrogen containing compounds?

	least basic ⟶			most basic
A	**I**	**H**	**K**	**J**
B	**I**	**K**	**H**	**J**
C	**I**	**K**	**J**	**H**
D	**K**	**I**	**J**	**H**

24 *Use of Data Booklet is relevant to this question.*

Which statements about the elements chlorine, bromine and iodine are correct?

1 The oxidising power decreases from chlorine to iodine.

2 The bond length of the molecule increases from chlorine to iodine.

3 The magnitude of the first electron affinity increases from chlorine to iodine.

A 1 and 2 only

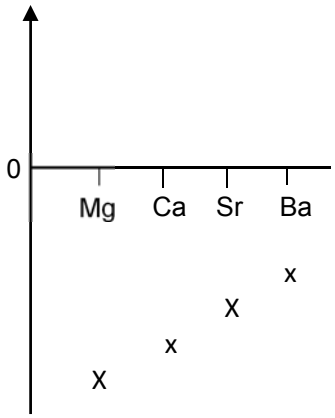
B 1 and 3 only

C 2 and 3 only

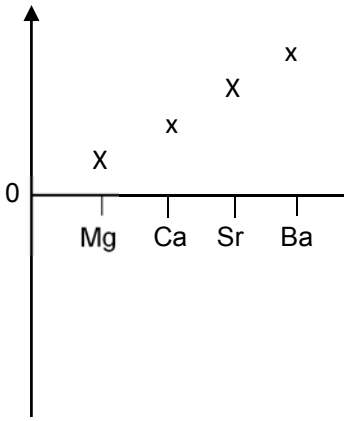
D 1, 2 and 3

25 Which diagram correctly shows the trend in a property of the Group 2 elements Mg, Ca, Sr, Ba?

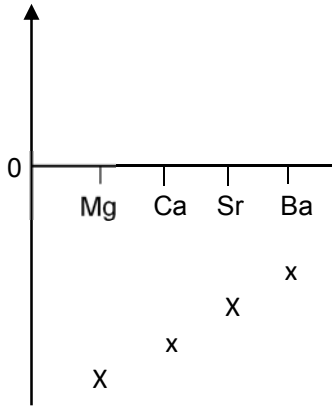
A ΔH_{hyd}, the enthalpy change of hydration of $M^{2+}(g)$



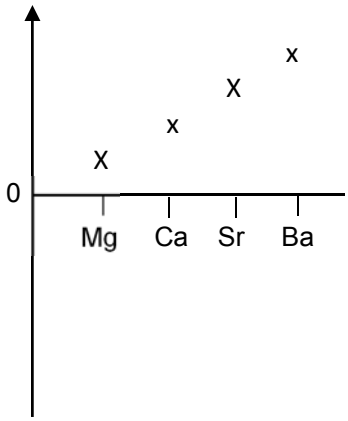
B *I*, the first ionisation energy



C $E^{\ominus}$, the standard electrode potential of $M^{2+}(aq)|M(s)$ electrode



D Electronegativity value



26 Three half cells are constructed as follows.

Half cell **I**: an electrode of metal **Q** in a 1.0 M solution of $\mathbf{Q}^{+}$(aq) ions

Half cell **II**: an electrode of metal **R** in a 1.0 M solution of $\mathbf{R}^{+}$(aq) ions

Half cell **III**: an electrode of Cu metal in a 1.0 M solution of Cu^{2+}(aq) ions

The half cells are connected in pairs, as shown below, to form a series of galvanic cells. For each cell, the polarity of the electrodes and the voltage generated are recorded.

half cells used	positive electrode	negative electrode	voltage (V)
I and **III**	Cu	**Q**	0.57
II and **III**	Cu	**R**	1.10
I and **II**	**Q**	**R**	0.53

Which one of the following lists the metals in order of **increasing** strength as reducing agents?

A **R**, **Q**, Cu

B **Q**, Cu, **R**

C Cu, **R**, **Q**

D Cu, **Q**, **R**

27 Some standard redox potential ($E^{\ominus}$) values are given in the table below.

electrode reaction	$E^{\ominus}$/ V
$Fe^{3+}(aq) + e \rightleftharpoons Fe^{2+}(aq)$	+0.77
$Sn^{4+}(aq) + 2e \rightleftharpoons Sn^{2+}(aq)$	+0.15
$Ce^{4+}(aq) + e \rightleftharpoons Ce^{3+}(aq)$	+1.45

Which of the following reactions would occur under standard conditions?

1 $Ce^{4+}(aq) + Fe^{2+}(aq) \longrightarrow Ce^{3+}(aq) + Fe^{3+}(aq)$

2 $Sn^{2+}(aq) + 2Fe^{3+}(aq) \longrightarrow Sn^{4+}(aq) + 2Fe^{2+}(aq)$

3 $2Ce^{4+}(aq) + Sn^{2+}(aq) \longrightarrow 2Ce^{3+}(aq) + Sn^{4+}(aq)$

A 1, 2 and 3

B 1 and 2 only

C 2 and 3 only

D 1 only

28 A current was passed through two cells connected in series. The first cell contained molten sodium chloride while the other contained a molten aluminium salt.

What would be the mass of aluminium liberated from the other cell if 4.6g of sodium was liberated from the first cell?

A 0.9 g

B 1.8 g

C 2.7 g

D 3.6 g

29 Which of the following does **not** act as a ligand in the formation of complexes?

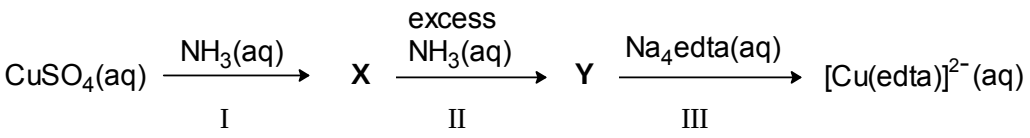
A SCN^-

B Cl^-

C AlH_4^-

D $C_2O_4^{2-}$

30 A reaction scheme starting from aqueous copper(II) sulfate solution is shown below. Both **X** and **Y** are copper-containing species.



Which of the following statements is true?

1 NH_3 acts as a ligand in reaction I.

2 Reaction II is a redox reaction.

3 The entropy of the system increases when reaction III occurs.

A 1 only

B 3 only

C 1 and 3 only

D 1, 2 and 3 only