RAFFLES INSTITUTION
2018 YEAR 6 PRELIMINARY EXAMINATION

Higher 2

CHEMISTRY   9729/01

Paper 1 Multiple Choice   **24 September 2018**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Do not open this question booklet until you are told to do so.

Write in **soft pencil**.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number in the spaces provided on the Answer Sheet.

There are **thirty** questions in this section. 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 the question booklet.

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

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

1 A sample of iron contains three isotopes: iron-54, iron-56 and iron-58. Its relative atomic mass is 55.849. One of the isotopes has a percentage abundance of 91.8%.

isotope	accurate isotopic mass	percentage abundance
iron-54	53.94	x
iron-56	55.94	y
iron-58	57.93	z

Which row gives the correct values of x, y and z?

	x	y	z
A	91.8	6.37	1.83
B	1.83	91.8	6.37
C	6.37	91.8	1.83
D	1.83	6.37	91.8

2 S_2Cl_x disproportionates completely in water to give S and SO_2 in the ratio of 3:1.

What is the value of x?

A   2   C   6
B   4   D   8

3 Which ion would undergo the greatest deflection in an electric field?

A $^{15}N_2^+$ C $^{12}C^{16}O^{2+}$
B $^{12}C^{16}O_2^{3+}$ D $^{16}O^{18}O^{2+}$

4   The radioactive isotope $^{241}_{95}$Am is a synthetic isotope used in ionisation smoke detectors.
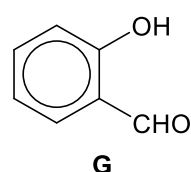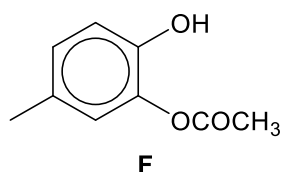
$^{241}_{95}$Am decays to give an element **E** and emits a high energy α-particle (which is a helium nucleus, $^{4}_{2}$He). No other particle is produced.

$$^{241}_{95}\text{Am} \rightarrow {}^{4}_{2}\text{He} + \textbf{E}$$
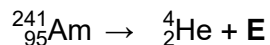
Which row in the table correctly describes the nuclear make-up of element **E**?

|	number of protons	number of neutrons
A	91	144
B	91	237
C	93	144
D	93	237

5   Which statement about both molecules shown below is correct?

F   **G**

A   Both can turn hot acidified potassium dichromate(VI) from orange to green.

B   **G** can form intramolecular hydrogen bonding while **F** cannot.

C   Both molecules have the same number of π electrons.

**D**   Both molecules are planar.

6 Which graph represents the correct behaviour for a fixed mass of an ideal gas?
(Assume that all temperatures are measured in Kelvin.)
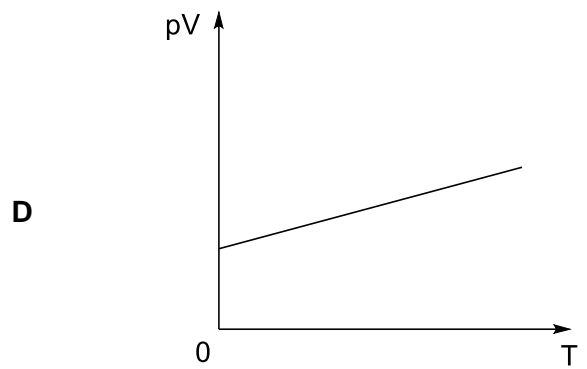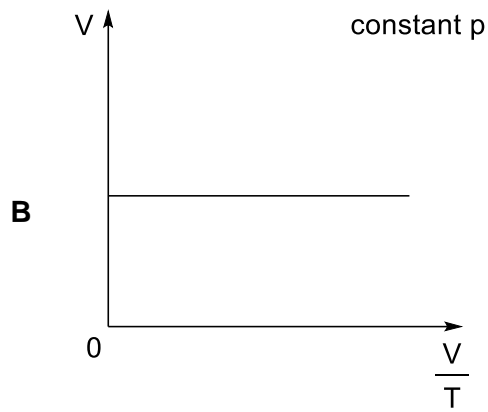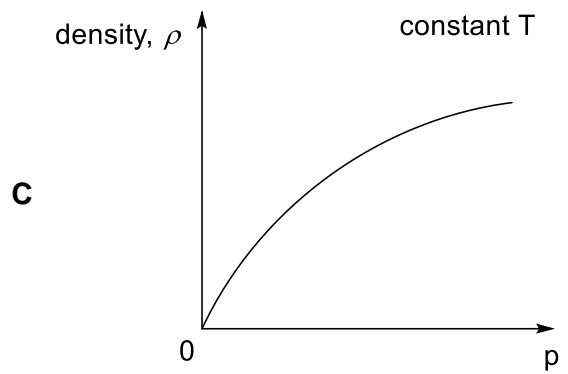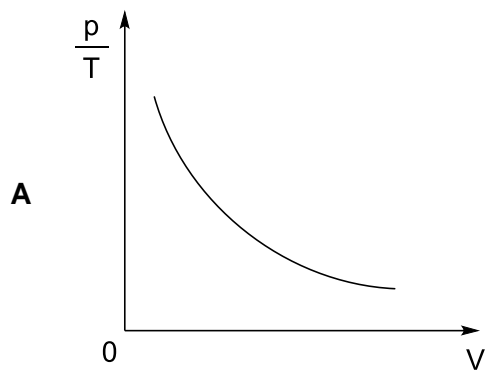
7 *Use of the Data Booklet is relevant to this question.*

Methane undergoes free radical substitution with bromine in the presence of UV light.

Which energy profile diagram represents the propagation steps that lead to the formation of bromomethane?
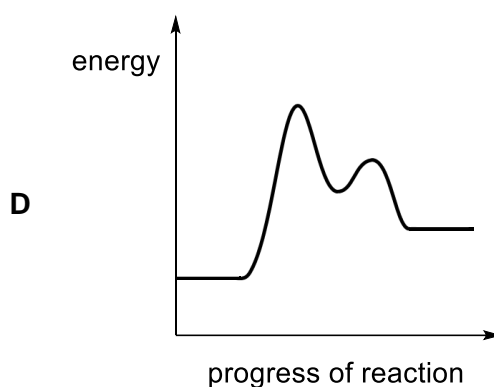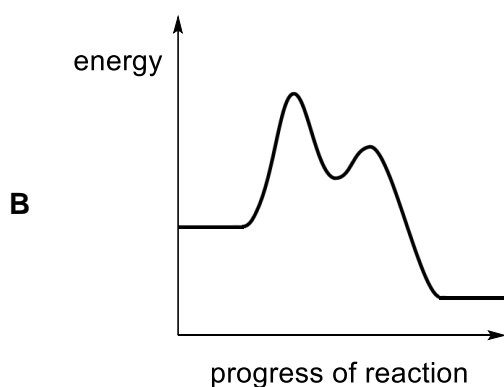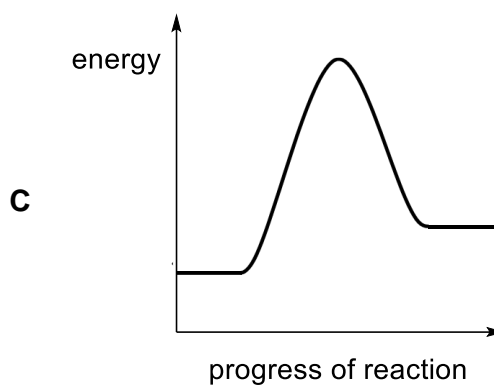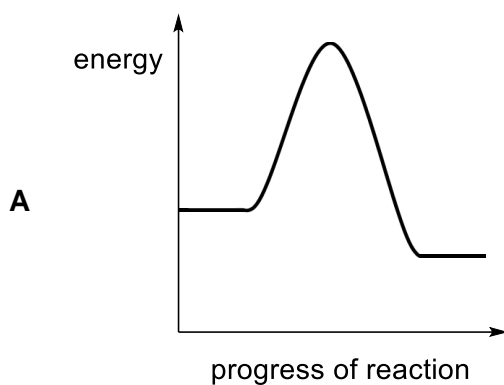
8 Which is **not** a trend from left to right across the elements of the third period of the Periodic Table?

    A   The maximum oxidation number increases.

    B   The melting point of the oxides decreases.

    C   The pH of the aqueous solutions of the chlorides decreases.

    D   The nature of bonding of the chlorides change from ionic to covalent.

9 Elements **J**, **K** and **L** are elements in Period 3 of the Periodic Table. The melting point of element **J** is higher than that of element **K**. Only the oxide of element **L** is insoluble in water.

Which row in the table gives the correct identities of elements **J**, **K** and **L**?

	J	K	L
A	Cl	P	Mg
B	Na	Mg	Si
C	P	S	Al
D	S	P	Si

10 The reaction between NO_2 and SO_2 is a key stage in the formation of acid rain.

$$NO_2(g) + SO_2(g) \longrightarrow NO(g) + SO_3(g)$$
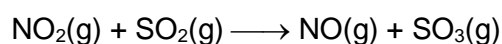
A series of experiments was conducted with various concentrations of NO_2 and SO_2 in the absence of air.

experiment	$[NO_2]$ / mol dm^{-3}	$[SO_2]$ / mol dm^{-3}	relative rate
1	0.010	0.20	1
2	0.020	0.20	2
3	0.040	0.40	8

The half-life of NO_2 in experiment 1 was 48 seconds.

Which row gives the correct half-life of NO_2 in experiments 2 and 3?

	half-life in experiment 2	half-life in experiment 3
A	24 s	6 s
B	24 s	24 s
C	48 s	24 s
D	48 s	48 s

11 A pink coloured compound, **M**, reacts with OH^- to give a colourless compound, **N**.

$$\text{M} \quad + \quad OH^- \quad \longrightarrow \quad \text{N}$$
pink   colourless
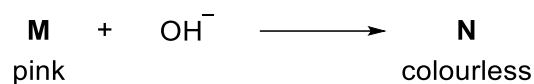
A series of experiments was carried out using different volumes of the 2 reagents, **M**(aq) and NaOH(aq).

The following results were obtained.

experiment	volume of 0.001 mol dm^{-3} **M** / cm^3	volume of 0.1 mol dm^{-3} NaOH / cm^3	volume of water / cm^3	time taken for pink colour to fade / s
1	1	10	4	100
2	2	10	3	100
3	1	5	9	200
4	2	20	8	?

Which conclusions follow from these results?

1   The reaction is first order with respect to **M**.

2   The reaction is first order with respect to OH^-.

3   The time taken for the pink colour to fade in experiment 4 was 50 s.

A   1 and 2   **C**   1 and 3

B   2 and 3   **D**   1, 2 and 3

12 Consider the following reversible reaction.

$$Q(g) + R(g) \rightleftharpoons S(g) \qquad \Delta H < 0$$

After equilibrium was reached, the system was disturbed and the changes to the system were monitored. The changes were as follows.

[S]	K_p	rate of forward reaction	rate of backward reaction
increased	unchanged	increased	increased

What was the disturbance applied?

A addition of a catalyst

B increase in temperature

C compression of reaction mixture

D addition of an inert gas at constant volume

13 The graph below shows how the fraction of $NH_3(g)$ in the equilibrium mixture of the Haber process varies with temperature at pressures of p_1 and p_2.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H_r = \textbf{\textit{x}} \text{ kJ mol}^{-1}$$
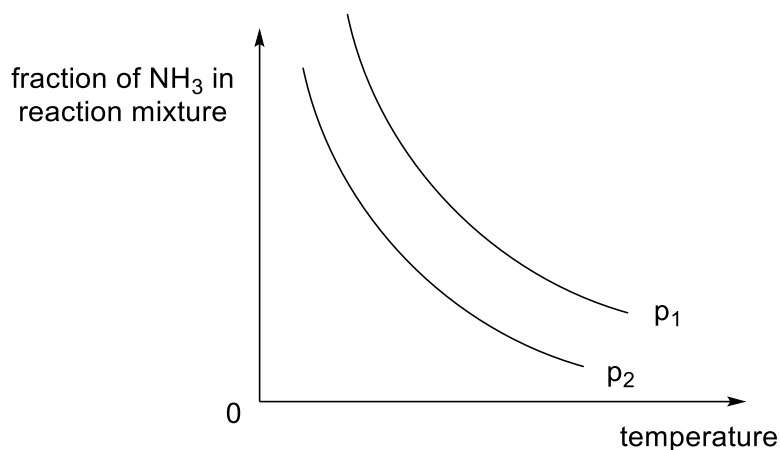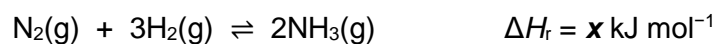
Which row in the table is correct?

A	$\textbf{\textit{x}} < 0$	$p_1 > p_2$
B	$\textbf{\textit{x}} < 0$	$p_1 < p_2$
C	$\textbf{\textit{x}} > 0$	$p_1 > p_2$
D	$\textbf{\textit{x}} > 0$	$p_1 < p_2$

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

Which expression gives the pH of a 0.2 mol dm^{-3} NH$_3$(aq) solution at 25 °C?
(K_a of NH$_4^+$ = 5.6 × 10^{-10} mol dm^{-3})

A $\quad -\lg\sqrt{0.2 \times 5.6 \times 10^{-10}}$

B $\quad 14 + \lg\sqrt{0.2 \times 5.6 \times 10^{-10}}$

C $\quad -\lg\sqrt{0.2 \times \dfrac{1.0 \times 10^{-14}}{5.6 \times 10^{-10}}}$

D $\quad 14 + \lg\sqrt{0.2 \times \dfrac{1.0 \times 10^{-14}}{5.6 \times 10^{-10}}}$

15 Which pairs of substances, when mixed in equal volumes, produce a buffer solution?

1   0.05 mol dm^{-3} HCl(aq) and 0.08 mol dm^{-3} Na$_3$PO$_4$(aq)

2   0.05 mol dm^{-3} CH$_3$CO$_2$H(aq) and 0.08 mol dm^{-3} NaOH(aq)

3   0.08 mol dm^{-3} HO$_2$C–CO$_2$H(aq) and 0.05 mol dm^{-3} NaOH(aq)

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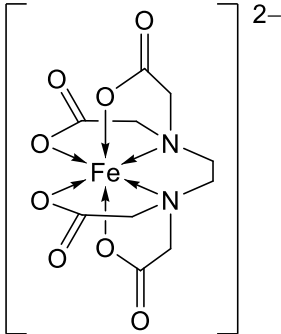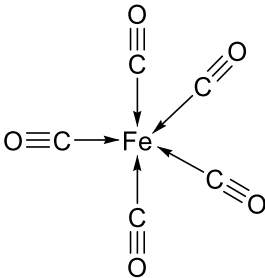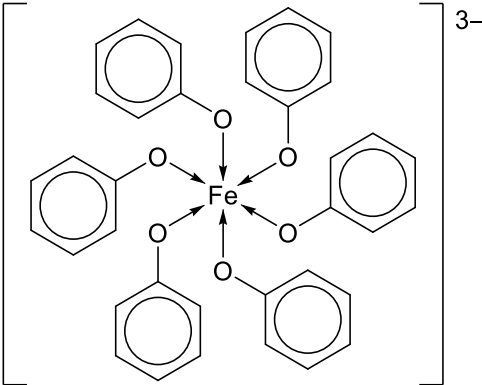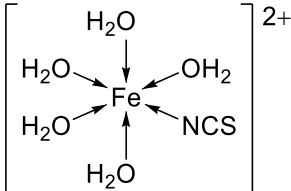
B   1 and 3   **D**   1, 2 and 3

16 Iron can form complexes with variable oxidation states.

Which row gives the **incorrect** oxidation number of Fe in the iron complex?

	iron complex	oxidation number of Fe
A		+4
B		0
C		+3
D		+3

17 Adding concentrated HC*l* to CuSO$_4$(aq) causes the colour of the solution to change from blue to green.

Which row best explains this observation?

	number of d-electrons in copper	energy gap between the d-orbitals
A	changes	changes
B	changes	remains the same
C	remains the same	changes
D	remains the same	remains the same

18 Compound **T** is a derivative of a drug used to treat inflammatory and autoimmune diseases.
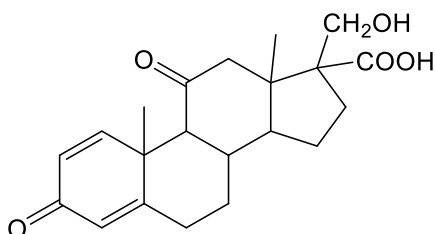
T

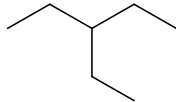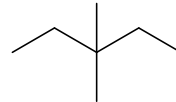Compound **T** is heated with hydrogen in the presence of a nickel catalyst.
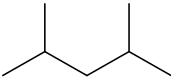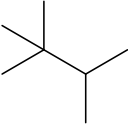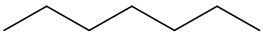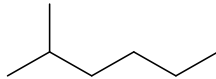
What is the number of stereoisomers for the product formed?

|			
A	2^5	**C**	2^8
B	2^6	**D**	2^9

19 **U** and **V** are structural isomers with molecular formula C_7H_{16}.

Both **U** and **V** produce the same number of possible structural isomers upon reaction with chlorine to form monochlorinated compounds with the formula $C_7H_{15}Cl$.

Which pairs are possible structures of **U** and **V**?

	U	V
1		
2		
3		

A 1 only

B 1 and 3

C 2 and 3

D 1, 2 and 3

20 Equal amounts of compounds **X**, **Y** and **Z** are added separately to three test-tubes containing equal concentrations of ethanolic silver nitrate solution. The test-tubes are then placed in a heated water bath. No precipitate forms in one of the tubes. In the other two tubes, precipitates form at different rates.
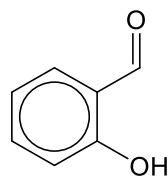

X   **Y**   **Z**
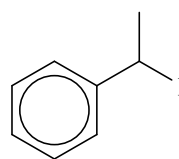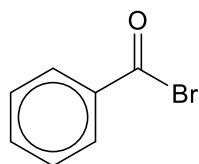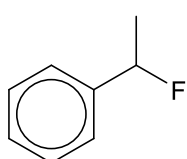
Which row in the table is correct?

	compound which does not form precipitate	colour of precipitate which forms the fastest
A	Y	yellow
B	Z	pale cream
C	X	yellow
D	X	pale cream

21 3-phenylpropanal and 2-hydroxybenzaldehyde are used in essential oils.
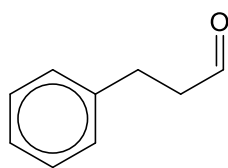
3-phenylpropanal   2-hydroxybenzaldehyde

Which reagents could be used to distinguish between the two compounds?

    1   Fehling's reagent

    2    $[Ag(NH_3)_2]^+$

    3    $SOCl_2$
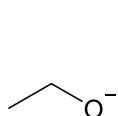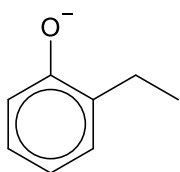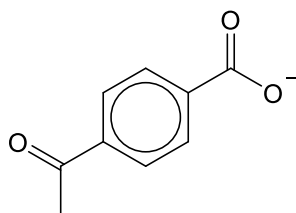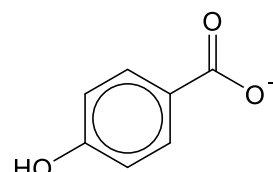
A   1 only   **C**   2 and 3

B   1 and 2   **D**   3 only

22 Consider the following four compounds.

    E   **F**   **G**   **H**

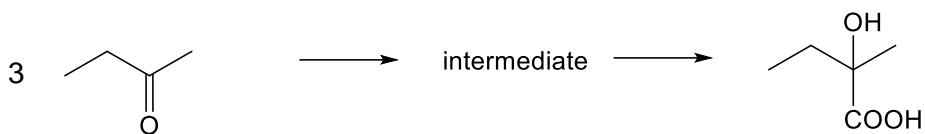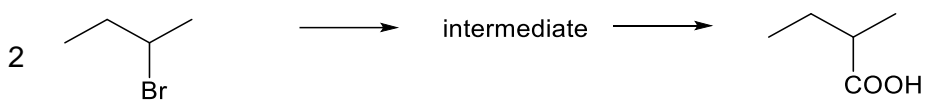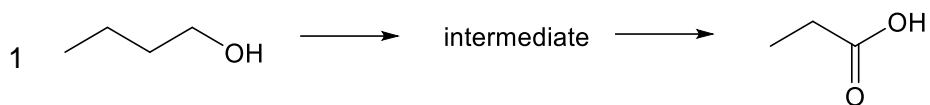What is the relative order, in decreasing basicity, of these compounds?

A   E > F > H > G

B   G > H > F > E

C   E > F > G > H

D   H > G > F > E

23 Which pair of reactions could have the same reaction intermediate?

1 propan-1-ol ($CH_3CH_2CH_2OH$) ⟶ intermediate ⟶ propanoic acid (with OH and O)

2 2-bromobutane (with Br) ⟶ intermediate ⟶ 2-methylbutanoic acid (COOH)

3 butanone (with O) ⟶ intermediate ⟶ 2-hydroxy-2-methylbutanoic acid (OH, COOH)

4 1-chlorobutane (with Cl) ⟶ intermediate ⟶ butane-1,2-diol (OH, OH)

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

24 Which row gives the synthetic route that will lead to the highest yield of the product?
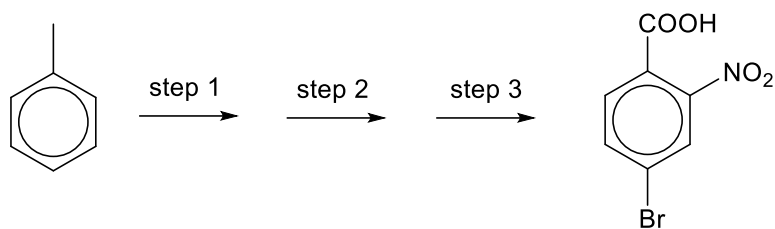
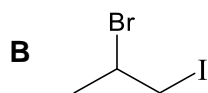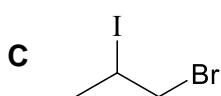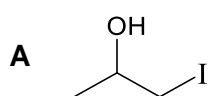|	step 1	step 2	step 3
A	FeBr$_3$, Br$_2$	KMnO$_4$, H$_2$SO$_4$, heat	conc. H$_2$SO$_4$, conc. HNO$_3$, heat
B	KMnO$_4$, H$_2$SO$_4$, heat	FeBr$_3$, Br$_2$	conc. H$_2$SO$_4$, conc. HNO$_3$, heat
C	conc. H$_2$SO$_4$, conc. HNO$_3$, heat	KMnO$_4$, H$_2$SO$_4$, heat	FeBr$_3$, Br$_2$
D	conc. H$_2$SO$_4$, conc. HNO$_3$, heat	FeBr$_3$, Br$_2$	KMnO$_4$, H$_2$SO$_4$, heat

25 Which product will **not** be formed in the following reaction?
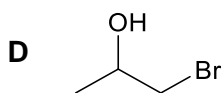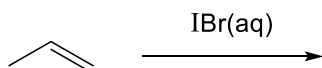
26 Which species could be an intermediate of the following reaction?

Br / excess conc. NH_3 in ethanol / heat in sealed tube

A

C

B

D
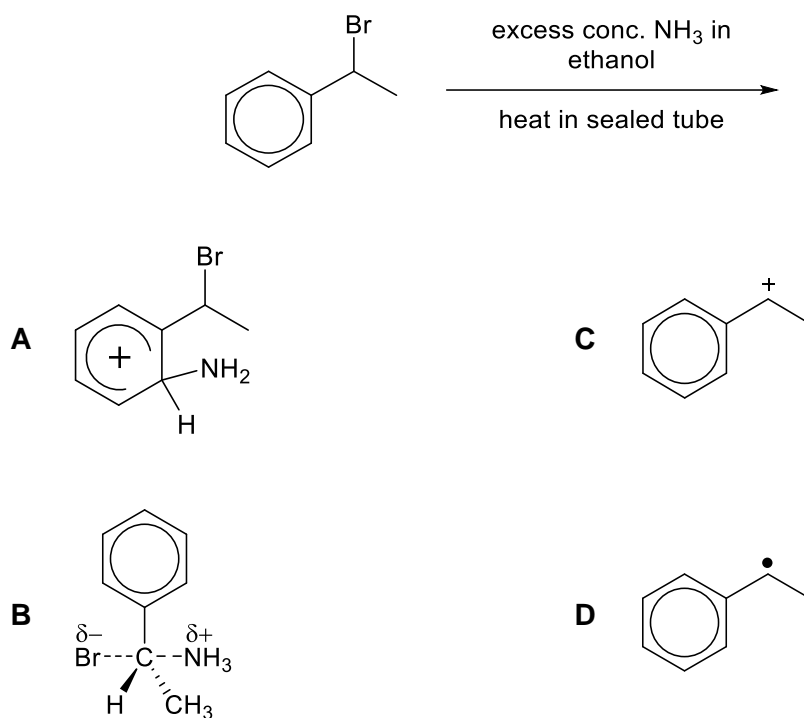
27 A non-cyclic organic compound has the molecular formula $C_4H_5O_2N$. The compound is neutral and does not decolourise Br_2 in CCl_4.

Which pair of functional groups could be present in this molecule?

    1   one amide group and one ketone group

    2   one ester group and one amine group

    3   one ester group and one nitrile group

A   1 only   **C**   1 and 2

B   3 only   **D**   2 and 3

28 The solubility products of $ZnCO_3$ and Ag_2CO_3 in water are shown in the table below.

carbonate	solubility product at 25 °C
$ZnCO_3$	1.46×10^{-10} mol² dm⁻⁶
Ag_2CO_3	8.46×10^{-12} mol³ dm⁻⁹

A solution contains 0.02 mol dm⁻³ $Zn(NO_3)_2$ and 0.02 mol dm⁻³ $AgNO_3$ at 25 °C.
Zn^{2+} and Ag^+ can be separated by adding solid Na_2CO_3 slowly.

Which statement is correct?

A Ag_2CO_3 will be precipitated before $ZnCO_3$.

B The solubility of Ag_2CO_3 in water is 2.04×10^{-4} mol dm⁻³.

C At any point in time, only one compound, Ag_2CO_3 or $ZnCO_3$, can be precipitated.

D When the more soluble compound first starts to precipitate, the concentration of carbonate ions in the solution is 2.12×10^{-8} mol dm⁻³.

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

The anodising of aluminium allows highly reactive aluminium to be safely used as a construction material.

A piece of aluminium object was placed in dilute sulfuric acid and anodised with a direct current of 1.4 A. After *t* seconds, the mass of the oxide layer formed is 23.7 g.

Which expression gives the time taken, *t*, for this anodisation?

A $\dfrac{23.7 \times 96500}{102 \times 1.4}$

B $\dfrac{3 \times 23.7 \times 96500}{2 \times 102 \times 1.4}$

C $\dfrac{3 \times 102 \times 1.4}{2 \times 23.7 \times 4 \times 96500}$

D $\dfrac{3 \times 23.7 \times 4 \times 96500}{2 \times 102 \times 1.4}$

30 In an electrolysis set-up in a beaker, an alloy containing **X**, **Y** and **Z** was used as an electrode as shown.
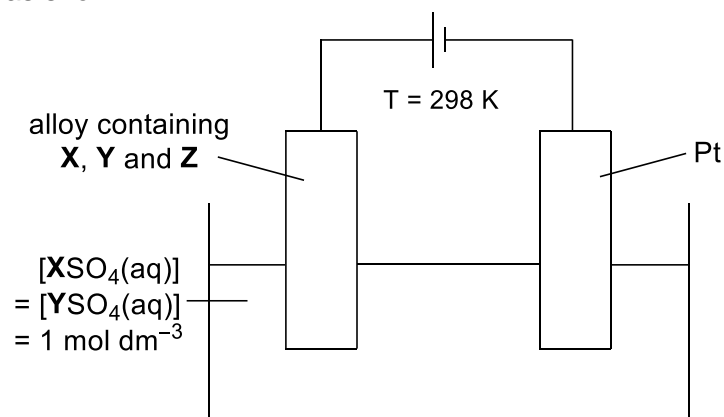
After some time, the amounts of **X** and **Y** in the alloy decreased while unreacted **Z** was found at the bottom of the beaker. **X** was also deposited on the platinum electrode.

Based on the information above, which options are correct?

    1   $E^{\ominus}(X^{2+}/X) > E^{\ominus}(H_2O/H_2)$

    2   $E^{\ominus}(Z^{2+}/Z) < E^{\ominus}(X^{2+}/X) < E^{\ominus}(Y^{2+}/Y)$

    3   When the polarity of the battery is reversed, H_2 is produced at the Pt electrode.

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