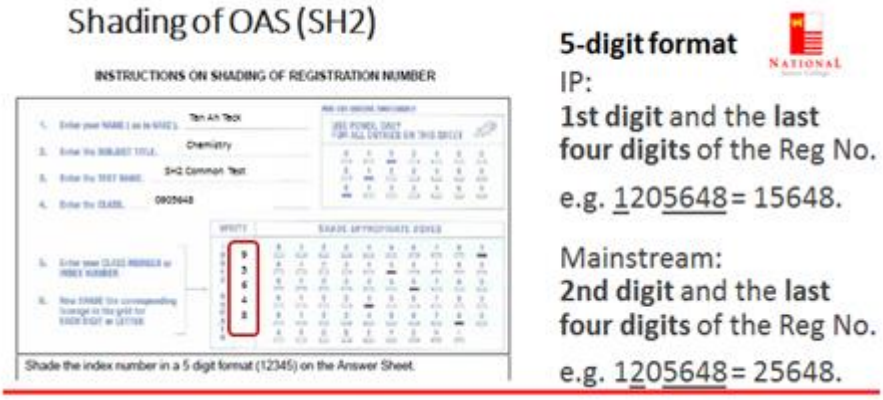
NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
SUBJECT CLASS		REGISTRATION NUMBER	

CHEMISTRY **9647/01**
Paper 1 Multiple Choice **Thu 17 Sep 2015**
Additional Materials: Multiple Choice Answer Sheet **1 hour**
Data Booklet

READ THESE INSTRUCTIONS FIRST



Write in soft pencil.

Write your name, subject class and registration number on the Optical Answer Sheet (OAS) in the spaces provided unless this has been done for you.

There are **40** questions in 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 Answer Sheet.

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.

This booklet consists of **19** printed pages and **1** blank page.

Section A

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

1 When scientists research on atomic nuclei, they often correlate the stability of isotopes with the proton to neutron ratio.

Which isotope has the same proton to neutron ratio as $^{18}_{8}O$?

A $^{9}_{5}B$ **B** $^{26}_{12}Mg$ **C** $^{36}_{16}S$ **D** $^{52}_{24}Cr$

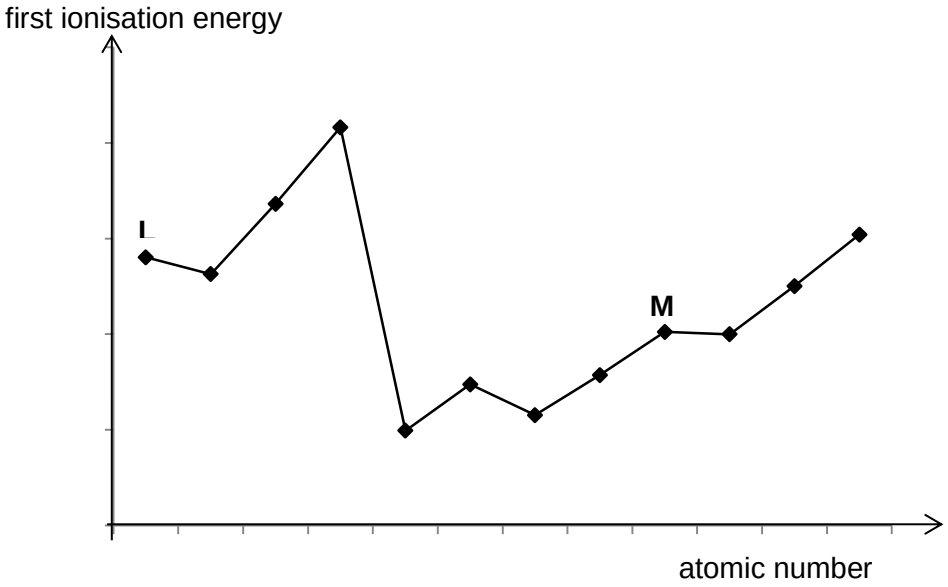
2 $\mathbf{A}_x\mathrm{O}_y$, a gaseous oxide of an element **A**, gives an acidic gas $\mathbf{A}\mathrm{O}_2$, on combustion with excess oxygen.

When 10 cm^3 of $\mathbf{A}_x\mathrm{O}_y$ is burnt in 40 cm^3 oxygen (in excess), the total volume of gas after cooling to the original temperature is unchanged. On shaking with excess aqueous potassium hydroxide, the volume is reduced to 20 cm^3. All volumes are measured at the same temperature and pressure.

What are the values of **x** and **y**?

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

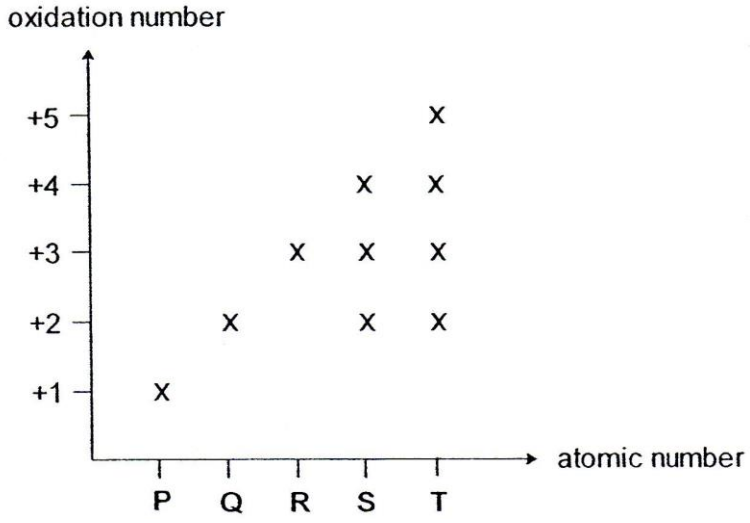
3 The diagram below shows the first ionisation energy of some elements with atomic numbers less than 20.



Which is the most likely formula of the chloride of **L** and **M**?

A **L**C*l* **B** **L**Cl_5 **C** **M**Cl_2 **D** **M**Cl_5

4 The figure below shows the stable oxidation numbers of five consecutive elements, **P** to **T**, plotted against their atomic numbers.



What are the likely atomic numbers of **P** to **T**?

A 1 to 5 **B** 3 to 7

C 11 to 15 **D** 19 to 23

5 When a sample of gas is compressed at constant temperature from 20 atm to 80 atm, its volume changes from 67.0 cm^3 to 15.5 cm^3.

Which is a possible explanation of this behaviour?

A The gas particles are adsorbed onto the vessel walls.

B The gas particles dimerised.

C The gas particles dissociated.

D The gas is liquefied at 80 atm.

6 The shapes of two species, **D** and **E**, are linear and T-shaped respectively.

What could **D** and **E** be?

	D	**E**
A	SO_2	BH_3
B	I_3^-	$BrCl_3$
C	CS_2	$AsCl_3$
D	H_2S	ICl_3

7 Some enthalpy changes of combustion are given below.

	ΔH_c / kJ mol^{-1}
$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$	−283
$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$	−286
$CH_3OH(l) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$	−715

What is the enthalpy change of the following reaction?

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

A −146 **B** −140 **C** +140 **D** +146

8 When a large current was passed through acidified aqueous nickel(II) sulfate, there was a simultaneous liberation, at the cathode, of x mol of a grey solid and y dm^3 of a diatomic gas (measured at s.t.p.).

How many moles of electrons passed through the cell?

A $x + \frac{y}{22.4}$ **B** $x + \frac{y}{11.2}$ **C** $2x + \frac{y}{22.4}$ **D** $2x + \frac{y}{11.2}$

9 The equation below shows the reaction of ethanoic acid with ethanol.

$$CH_3CO_2H(l) + C_2H_5OH(l) \rightleftharpoons CH_3CO_2C_2H_5(l) + H_2O(l)$$

ethyl ethanoate

Which statement is true when the above reaction has attained equilibrium?

A The equilibrium constant, K, is equal to 1.

B The reaction between the acid and the alcohol has stopped.

C The concentrations of the products and reactants are the same.

D The rate of formation and the rate of hydrolysis of ethyl ethanoate are the same.

10 A student wanted to determine the equilibrium constant for the decomposition of calcium carbonate, $CaCO_3$. He sealed 2.0 g of $CaCO_3$ in an evacuated 2.0 dm^3 metal flask and connected a pressure gauge to the flask. The flask was placed in an oven and heated to a temperature of 800 ^oC, at which an equilibrium was reached according to the following equation:

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

When the equilibrium was established, 1.40×10^{-2} mol of CO_2 was present in the flask.

What is the value of equilibrium constant, K_c, for this reaction at 800 °C?

A 3.27×10^{-2} **B** 1.63×10^{-2} **C** 1.40×10^{-2} **D** 7.00×10^{-3}

11 Water dissociates into ions according to the following equilibrium.

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq) \qquad \Delta H^\ominus = +57 \text{ kJ mol}^{-1} \text{ at } 25\ ^\circ\text{C}$$

Which statement is **not** true as temperature rises?

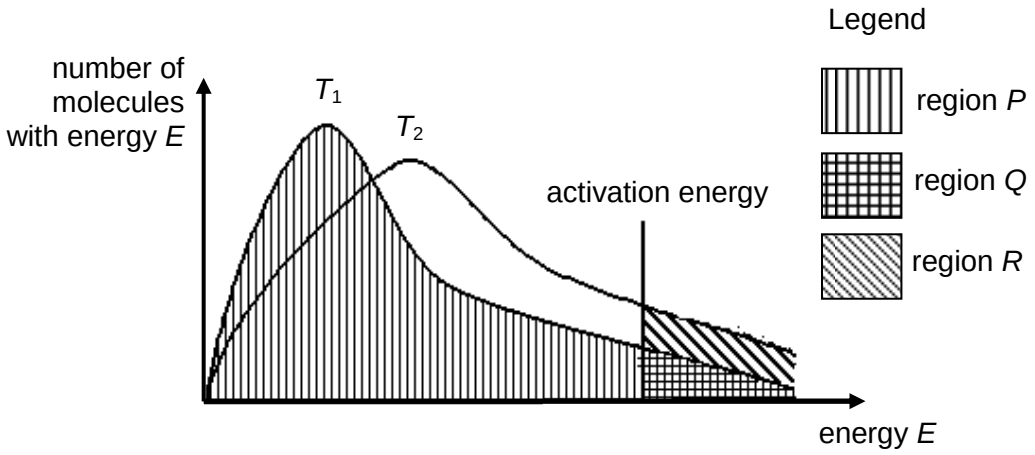
A The pH of water decreases.

B The dissociation constant of water increases.

C The extent of dissociation of water increases.

D The concentration of $H^+(aq)$ is higher than that of $OH^-(aq)$.

12 The distribution of the number of molecules with energy E is given in the sketch below for two temperatures, T_1, and a higher temperature T_2. The letters P, Q, R refer to the separate and differently shaded areas. The activation energy is marked on the energy axis.



Which is the fraction of the molecules with energy larger than the activation energy at T_2?

A $\frac{Q}{P}$ **B** $\frac{Q+R}{P}$ **C** $\frac{Q+R}{P+Q}$ **D** $\frac{Q+R}{P+Q+R}$

13 A diagonal relationship is said to exist between certain pairs of diagonally adjacent elements in the second and third periods of the Periodic Table. One such pair is beryllium and aluminium, where they share similar chemical properties.

Which is **not** a property of the compounds of beryllium?

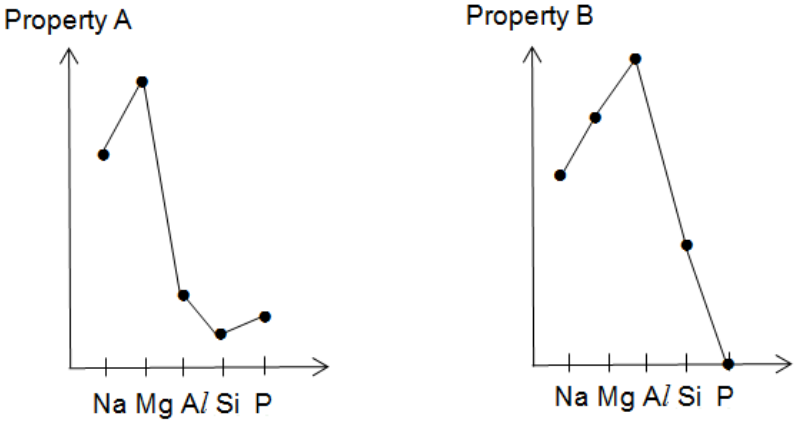
A Beryllium chloride has a high melting point.

B Beryllium chloride can form the dimer Be_2Cl_4.

C Effervescence is observed when aqueous sodium carbonate is added to beryllium chloride.

D Beryllium oxide reacts with carbon dioxide to form a salt.

14 The graphs below show the variation of two properties of some Period 3 elements and their compounds.



Which of the following correctly describes properties A and B?

	Property A	Property B
A	enthalpy change of vapourisation of the elements	pH of the oxides when added to water
B	first ionisation energy of the elements	enthalpy change of vapourisation of the elements
C	enthalpy change of vapourisation of the chlorides	electrical conductivity of the elements
D	electrical conductivity of the elements	pH of the chlorides when added to water

15 Which statement about the compounds of Group VII elements is **incorrect**?

A The oxidising power of halogens decreases down the group.

B The K_{sp} value of silver halides decreases down the group.

C The magnitude of the lattice energy of silver halides increases down the group.

D The magnitude of the hydration energy of gaseous halide ions decreases down the group.

16 **X** is a transition metal. In a concentrated aqueous solution of Cl^-, it forms a coloured complex ion, $[\mathbf{X}Cl_4]^{2-}$. When $[\mathbf{X}Cl_4]^{2-}$ is reduced to $[\mathbf{X}Cl_2]^-$, the solution turns colourless.

What is the ground state electronic configuration of **X**?

A [Ar] $3d^5\ 4s^1$

B [Ar] $3d^{10}\ 4s^1$

C [Ar] $3d^5\ 4s^2$

D [Ar] $3d^9\ 4s^2$

17 Which statement about the following reaction is true?

$$[Fe(CN)_6]^{3-} + 3C_2O_4^{2-} \rightleftharpoons [Fe(C_2O_4)_3]^{3-} + 6CN^- \qquad K_c = 3 \times 10^{-21}\ mol^3\ dm^{-9}$$

A It is a redox reaction.

B $[Fe(CN)_6]^{3-}$ is less stable than $[Fe(C_2O_4)_3]^{3-}$.

C The reaction is more feasible at high temperatures.

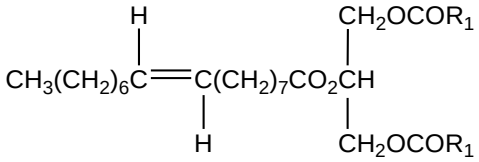
D The coordination numbers of $[Fe(CN)_6]^{3-}$ and $[Fe(C_2O_4)_3]^{3-}$ are 6 and 3 respectively.

18 Some vegetable oils contain 'trans fats' that are associated with undesirable increases in the amount of cholesterol in the blood.

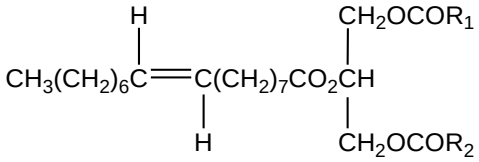
In the structures below, R_1 and R_2 are different hydrocarbon chains.

Which structure correctly illustrates an optically active 'trans fat'?

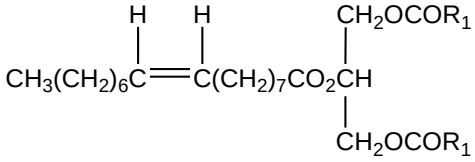
A



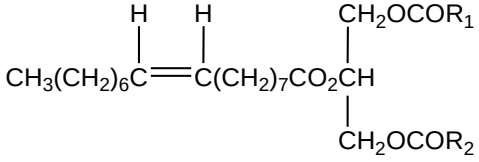
B



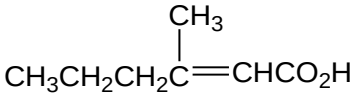
C



D



19 3-Methylhex-2-enoic acid is an unpleasant smelling chemical.

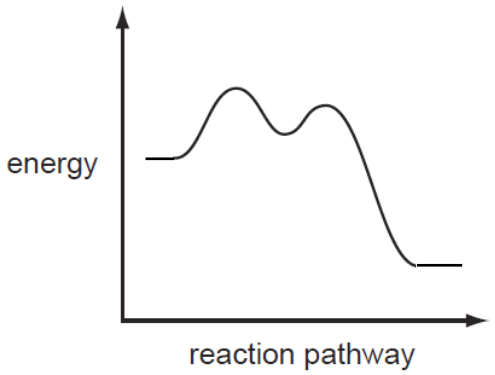


3-methylhex-2-enoic acid

When the compound is treated with cold dilute acidified potassium manganate(VII), how many stereoisomers does the product have?

A 1 **B** 2 **C** 4 **D** 8

20 A reaction profile diagram is shown below.

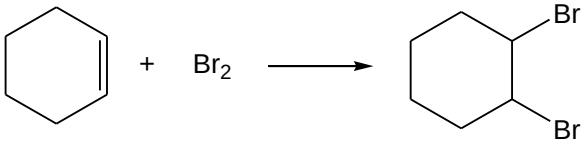


Which reaction does **not** have such a profile?

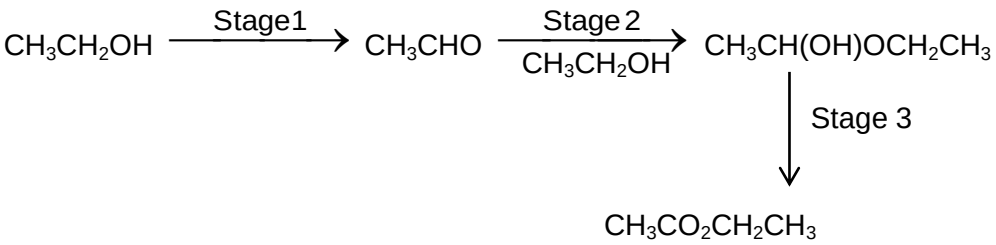
A $CH_3CHO + HCN \xrightarrow{NaCN} CH_3CH(OH)CN$

B $C_2H_5Br + NaOH \rightarrow C_2H_5OH + NaBr$

C $(CH_3)_3CBr + NaOH \rightarrow (CH_3)_3COH + NaBr$

D 

21 A new industrial preparation of ethyl ethanoate has been developed using cheap sources of ethanol.



Which process is involved at some stage in this reaction sequence?

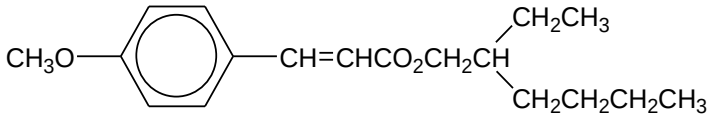
A electrophilic addition **B** nucleophilic addition

C nucleophilic substitution **D** condensation

22 Considering all the structural isomers of alcohols with the molecular formula $C_4H_{10}O$, what is the number of alcohols that will react with each of the following chemicals?

	hot acidified $KMnO_4$	alkaline aqueous iodine	Na metal
A	2	1	3
B	2	2	4
C	3	1	4
D	3	2	5

23 Which reagent reacts with the following organic compound to give **only** one organic product?



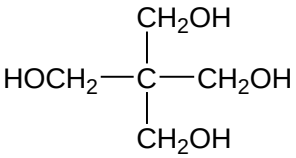
A hot NaOH(aq)

B hot acidified potassium dichromate(VI)

C bromine in hexane

D $NaBH_4$ in methanol

24 Pentaerythritol is used as an intermediate in the manufacture of paint.



pentaerythritol

Which statement about pentaerythritol is correct?

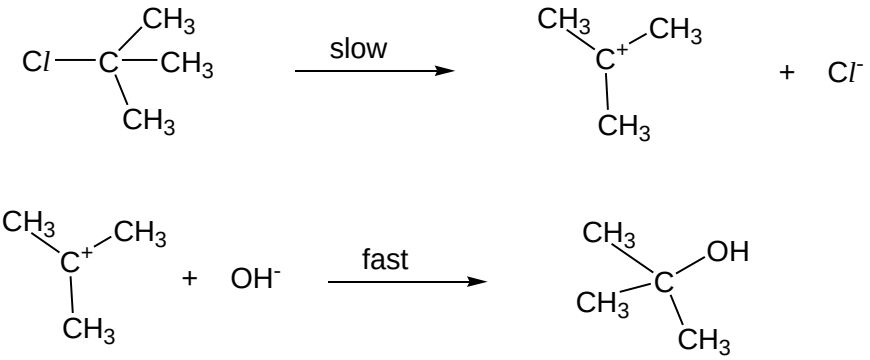
A It can react with HBr(aq).

B Its empirical and molecular formulae are different.

C It can undergo elimination with hot concentrated sulfuric acid to form an alkene.

D One mole of pentaerythritol gives two moles of hydrogen gas on reaction with excess sodium.

25 When heated with aqueous sodium hydroxide, the rate of hydrolysis of $(CH_3)_3CCl$ varies when it is dissolved in different solvents. The reaction follows the mechanism shown below.



The reaction proceeds faster when the carbocation is more stabilised.

Which series of solvents would result in an increasing rate of hydrolysis?

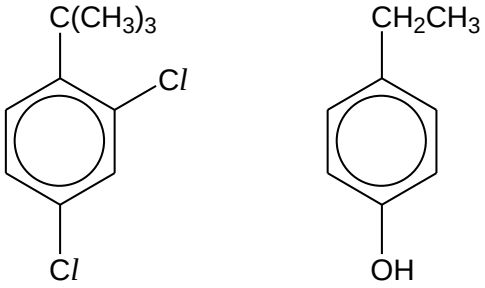
A $CH_3(CH_2)_4CH_3$, CH_3CH_2OH, $(CH_3)_2CO$, H_2O

B $CH_3(CH_2)_4CH_3$, $(CH_3)_2CO$, CH_3CH_2OH, H_2O

C H_2O, CH_3CH_2OH, $(CH_3)_2CO$, $CH_3(CH_2)_4CH_3$

D CH_3CH_2OH, H_2O, $(CH_3)_2CO$, $CH_3(CH_2)_4CH_3$

26 Which reagent can be used to distinguish between **Y** and **Z** shown below?



Y **Z**

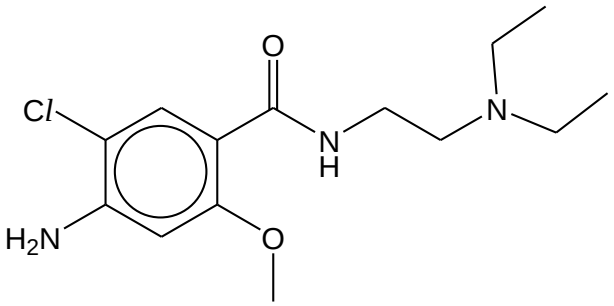
A hot ethanolic $AgNO_3(aq)$

B PCl_5

C $Na_2CO_3(aq)$

D hot acidified $KMnO_4(aq)$

27 Metoclopramide is a drug used to treat heartburn caused by gastroesophageal reflux disease (GERD).



metoclopramide

Which statement about metoclopramide is true?

A 1 mole of metoclopramide would react with 3 moles of CH_3COCl.

B It would decolourise aqueous bromine to form a white precipitate.

C It would dissolve in NaOH(aq) at room temperature.

D It is insoluble in dilute HCl.

28 Deuterium (^2_1D) is an isotope of hydrogen (^1_1H).

Which reaction would produce an organic product containing deuterium?

A $CH_3CH_2CN \xrightarrow[\text{heat}]{NaOD,\ D_2O}$

B $CH_3COCl \xrightarrow{NaOD,\ D_2O}$

C $CH_3CONHCH_3 \xrightarrow[\text{heat}]{NaOD,\ D_2O}$

D $CH_3COC_6H_5 \xrightarrow[\text{heat}]{NaOD,\ D_2O}$

29 0.10 mol each of the solids CH_3CH_2ONa, CH_3COONa and C_6H_5ONa are dissolved in three separate beakers each containing 1 dm^3 of water.

What is the expected trend for the pH of their resultant solutions?

	lowest pH ⟶		highest pH
A	CH_3CH_2ONa	CH_3COONa	C_6H_5ONa
B	CH_3CH_2ONa	C_6H_5ONa	CH_3COONa
C	CH_3COONa	C_6H_5ONa	CH_3CH_2ONa
D	CH_3COONa	CH_3CH_2ONa	C_6H_5ONa

30 Polypeptides can be enzymatically hydrolysed to form shorter peptide chains. When a nonapeptide was hydrolysed by enzymes, the following tripeptides were obtained.

gly-ala-leu

tyr-ser-leu

leu-gly-tyr

lys-gly-ala

ser-leu-gly

What is the sequence of this nonapeptide?

A gly-ala-leu-gly-ser-tyr-leu-gly-tyr

B gly-ala-leu-gly-tyr-ser-leu-gly-tyr

C lys-gly-ala-tyr-ser-leu-gly-tyr-ser

D lys-gly-ala-leu-gly-tyr-ser-leu-gly

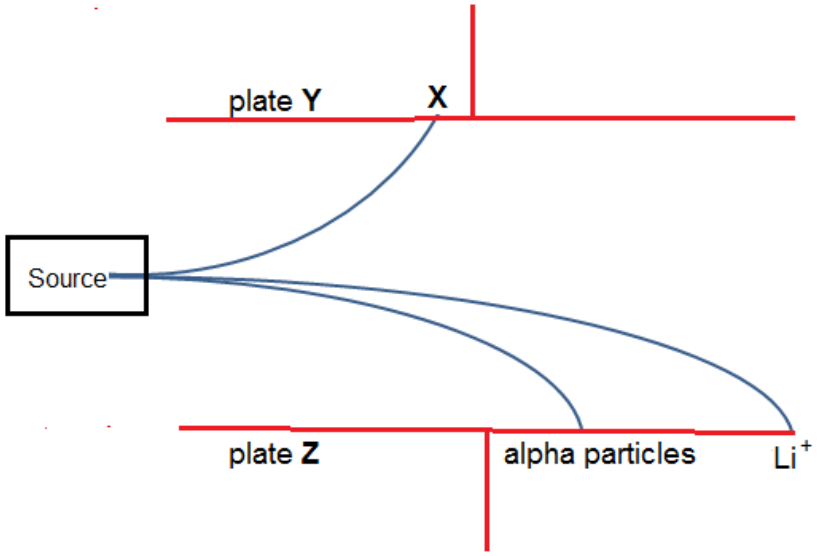
Section B

For each of the questions in this section, 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 that 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 Alpha particles, $^{4}_{2}He^{2+}$, are commonly emitted by larger radioactive nuclei during radioactive decay. The diagram below shows the path of a mixture of a charged species **X**, $^{7}_{3}Li^{+}$ and alpha particles after passing through an electric field.



Which statements are true?

1 **X** could be electron.

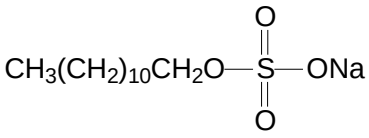
2 Plate **Y** is positive.

3 angle of deflection of alpha particles = $\frac{7}{4}$ x angle of deflection of Li^{+}

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

32 Long-chain alkanes are converted on an industrial scale into alkylsulfates for use as detergents. An example of an alkylsulfate is sodium lauryl sulfate.



sodium lauryl sulfate

Which properties of sodium lauryl sulfate can be deduced from its structure?

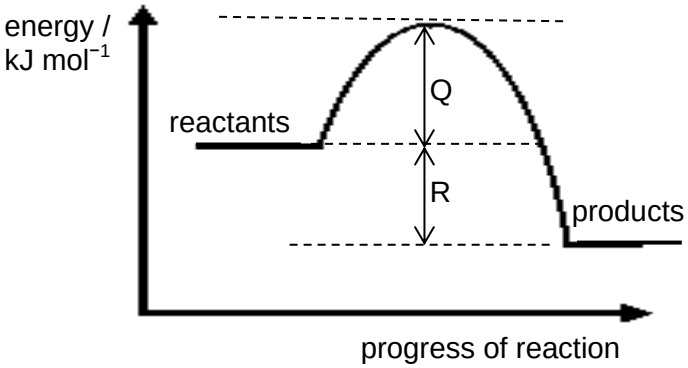
1 It exists as a solid at room temperature.

2 It is soluble in water.

3 It is soluble in oil.

33 The diagram below shows the energy profile for the following reaction:

$$2HN_3(l) + 2NO(g) \rightarrow H_2O_2(l) + 4N_2(g)$$



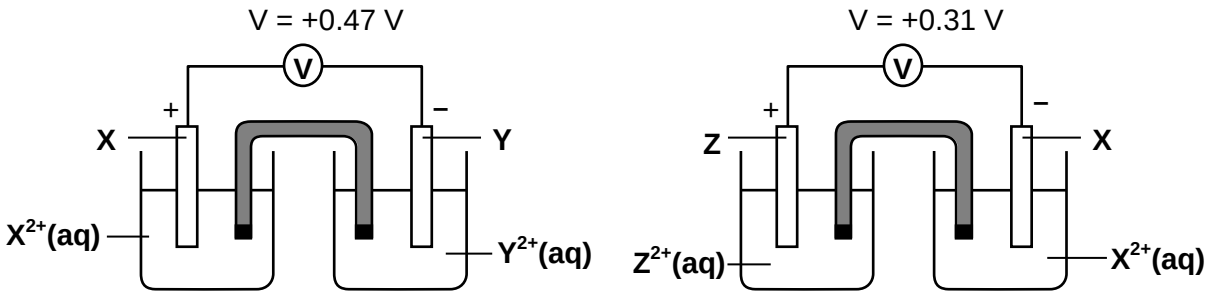
Which statement can be inferred from the information given above?

1 The reaction is feasible at all temperatures.

2 The enthalpy change for the reverse reaction is Q + R.

3 Adding a catalyst would alter the value of R.

34 Three metals **X**, **Y** and **Z**, are connected in pairs in two electrochemical cells as shown below.



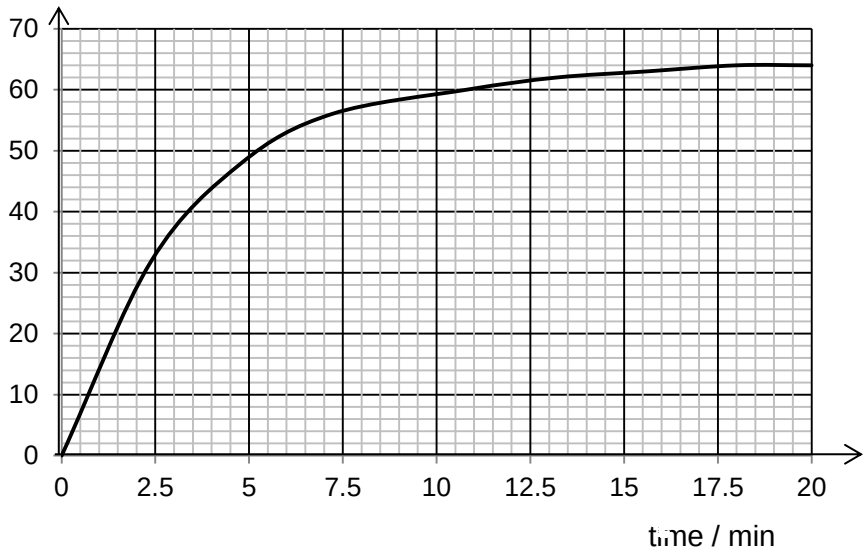
Which statements are true?

1 **Y** is the strongest reducing agent.

2 E_{cell} is +0.78 V when the two half-cells of $\mathbf{Y}^{2+}$(aq)|**Y**(s) and $\mathbf{Z}^{2+}$(aq)|**Z**(s) are connected together.

3 $\mathbf{Y}^{2+}$(aq) can oxidise both **X** and **Z**.

35 A student carried out a kinetics experiment using a freshly cut sodium (of known mass) in a large excess of pure ethanol at room conditions and measured the volume of gas liberated every minute. The graph below shows the results of the experiment.



Which of the following can be deduced from the above information?

1 This reaction has a constant half-life.

2 0.123 g of sodium was used in the reaction.

3 The order of reaction with respect to ethanol could be analysed by adding water to vary the concentration of ethanol.

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

36 Chlorine reacts with hot concentrated sodium hydroxide according to the equation below.

$$3Cl_2(g) + 6NaOH(aq) \rightarrow NaClO_3(aq) + 5NaCl(aq) + 3H_2O(l)$$

Which statements about the above reaction are true?

1 Sodium hydroxide acts as a reducing agent.

2 Chlorine undergoes disproportionation.

3 The oxidation state of the chlorine in one of the products is +5.

37 In an organic synthesis, a 62% yield of product is achieved.

Which conversions are consistent with the given information?

1 74 g of butan-2-ol (M_r = 74) $\rightarrow$ 44.64 g of butanone (M_r = 72)

2 72 g of butanone (M_r = 72) $\rightarrow$ 45.88 g of butan-2-ol (M_r = 74)

3 56 g of but-2-ene (M_r = 56) $\rightarrow$ 37.20 g of ethanoic acid (M_r = 60)

38 Which of the following can be classified as redox reactions?

1 CH_3COCH_3 + aqueous alkaline iodine

2 $CH_3CH{=}CH_2 + Br_2$

3 $CH_3CH_2NH_2 + CH_3CO_2H$

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

The following tests were carried out on separate fresh samples of $CrCl_3$(aq).

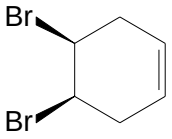
Which are the correct observations with the corresponding tests?

1 The colour of the solution changes when zinc powder is added.

2 When NaOH(aq) is added in excess, followed by H_2O_2(aq) and the mixture heated, an orange solution of $Cr_2O_7^{2-}$ is formed.

3 A greyish-green precipitate is obtained when excess NaOH(aq) is added.

40 Which statements regarding the following compound are correct?



1 When heated with alkaline $KMnO_4$, it gives a product that can react with 2,4-dinitrophenylhydrazine.

2 Upon reacting with hot acidified $KMnO_4$, the product is optically inactive.

3 Benzene can be produced when it is heated with ethanolic KOH.

End of paper

Blank Page

Answers

1.	C	2.	C	3.	D	4.	D	5.	A
6.	B	7.	B	8.	D	9.	A	10.	C
11.	D	12.	C	13.	A	14.	C	15.	C
16.	B	17.	C	18.	B	19.	C	20.	B
21.	B	22.	D	23.	C	24.	D	25.	B
26.	D	27.	B	28.	C	29.	C	30.	D
31.	B	32.	A	33.	D	34.	B	35.	B
36.	C	37.	B	38.	B	39.	D	40.	A