

8872/01

17 September 2015

50 minutes

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and shade your exam index number on the Answer Sheet in the spaces provided.

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.

A *Data Booklet* is provided. Do not write anything on the *Data Booklet*.

SECTION A

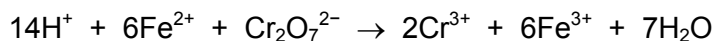
For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

- 1** ${}^9_4\text{Be}$ is used in the production of 'fast neutrons'.
How many neutrons are present in 0.09 g of ${}^9_4\text{Be}$?
[L = Avogadro constant]

A 0.01 L **B** 0.04 L **C** 0.05 L **D** 0.09 L

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

Ferrochrome, an alloy of iron and chromium, can be dissolved in dilute sulfuric acid to produce a mixture of FeSO_4 and $\text{Cr}_2(\text{SO}_4)_3$. The FeSO_4 reacts with $\text{Na}_2\text{Cr}_2\text{O}_7$ in acid solution according to the following equation.



When 1.00 g of ferrochrome is dissolved in dilute sulfuric acid, and the resulting solution titrated, 13.10 cm^3 of 0.100 mol dm^{-3} $\text{Na}_2\text{Cr}_2\text{O}_7$ is required for complete reaction.

What is the percentage by mass of Fe in the sample of ferrochrome?

A 1.22 **B** 4.39 **C** 12.2 **D** 43.9

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

In an experiment, a sample of Americium element (Am) was vaporised, ionised and passed through an electric field. Analysis revealed that a beam of ${}^{241}\text{Am}^+$ gives an angle of deflection of 2° .

What would be the angle of deflection for a sample of singly charged calcium ions?

A 12.0°
B 6.0°
C 2.0°
D 0.3°

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

In some types of spectroscopy, it is important to know if ions are isoelectronic.

Which ion is **not** isoelectronic with K^+ ?

A Ca^{2+} **B** Cl^- **C** S^{2-} **D** Ti^{3+}

- 5 Use of the Data Booklet is relevant to this question.

Some isotopes are unstable and decompose naturally. In one type of decomposition, a neutron in the nucleus decomposes to form a proton, which is retained in the nucleus, and an electron, which is expelled from the atom.

Which change describes a process of this sort?

- A $^{11}\text{C} \longrightarrow ^{12}\text{C}$
 B $^{22}\text{Na} \longrightarrow ^{22}\text{Ne}$
 C $^{32}\text{P} \longrightarrow ^{31}\text{P}$
 D $^{40}\text{K} \longrightarrow ^{40}\text{Ca}$

- 6 The Valence Shell Electron Pair Repulsion theory (VSEPR) is used to predict the shapes of molecules.

Which shape is correctly predicted by VSEPR?

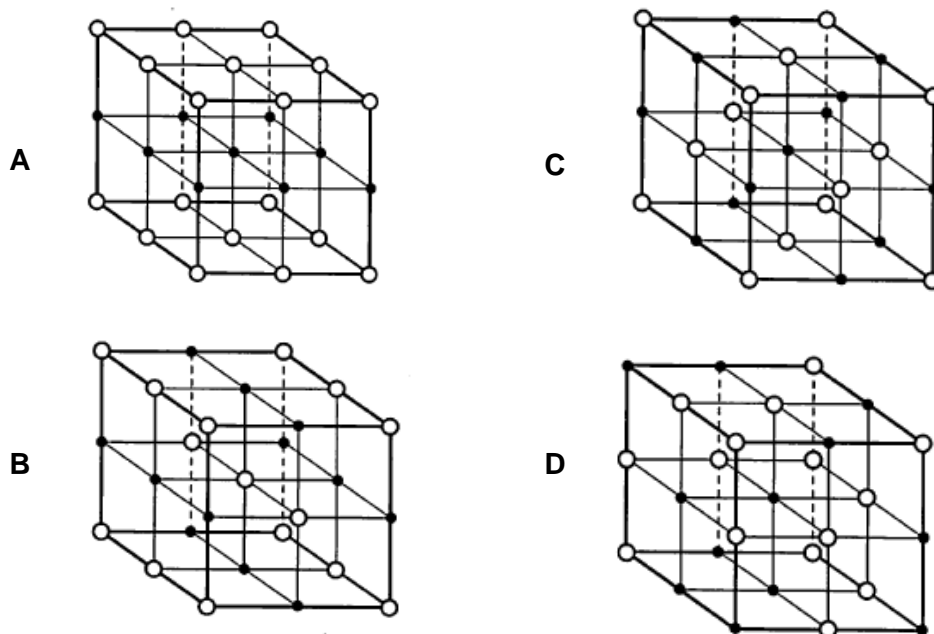
	number of bonded electron pairs around central atom	number of lone pairs around central atom	shape
A	2	2	non-linear
B	2	2	tetrahedral
C	3	1	trigonal planar
D	3	1	linear

- 7 2-methylpropan-1-ol and butan-1-ol are structural isomers. 2-methylpropan-1-ol has a lower boiling point.

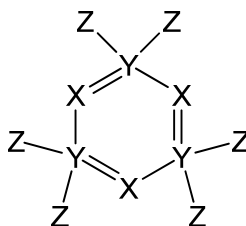
Which statement explains why the boiling point of 2-methylpropan-1-ol is lower than that of butan-1-ol?

- A 2-methylpropan-1-ol cannot form hydrogen bonds.
 B 2-methylpropan-1-ol has weaker covalent bonds than butan-1-ol.
 C 2-methylpropan-1-ol has weaker van der Waals' forces than butan-1-ol.
 D 2-methylpropan-1-ol molecules have more surface area than butan-1-ol molecules.

- 8 Which diagram best represents the structure of solid magnesium oxide?



- 9 A stable molecule containing atoms of the elements, **X**, **Y** and **Z** has the following structure.



Which elements could be **X**, **Y** and **Z**?

	X	Y	Z
A	N	P	Cl
B	O	S	Cl
C	B	C	H
D	P	Si	H

- 10 What is the effect of a catalyst on the rate constants, k_1 for the forward reaction and k_{-1} for the reverse reaction and on the equilibrium constant K , for a reversible reaction?

	k_1	k_{-1}	K
A	Increase	Decrease	No effect
B	Increase	Increase	No effect
C	Increase	Increase	Increase
D	No effect	No effect	Increase

- 11 Lead is the final product formed by a series of changes in which the rate-determining step is the radioactive decay of uranium-238. This radioactive decay is a first-order reaction with a half-life of 4.5×10^9 years.

How long would it take for a rock sample, originally lead-free, to contain a molar proportion of uranium to lead of 1:3?

- A 1.5×10^9 years
B 2.25×10^9 years
C 9.0×10^9 years
D 13.5×10^9 years
- 12 The enthalpy change of formation of $\text{Mn}(\text{NO}_3)_2(\text{s})$ is -696 kJ mol^{-1} .
The enthalpy change of formation of $\text{MnO}_2(\text{s})$ is -520 kJ mol^{-1} .
The enthalpy change of formation of $\text{NO}_2(\text{g})$ is $+33 \text{ kJ mol}^{-1}$.

On heating, $\text{Mn}(\text{NO}_3)_2$ decomposes into MnO_2 and NO_2 .



What is the value of the standard enthalpy change of this reaction?

- A -242 kJ mol^{-1}
B -209 kJ mol^{-1}
C $+209 \text{ kJ mol}^{-1}$
D $+242 \text{ kJ mol}^{-1}$
- 13 For which equation is the enthalpy change correctly described as an enthalpy change of formation?
- A $\text{C}(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$
B $\text{C}(\text{s}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO}(\text{g})$
C $2\text{N}(\text{g}) + 4\text{O}(\text{g}) \rightarrow \text{N}_2\text{O}_4(\text{g})$
D $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$

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

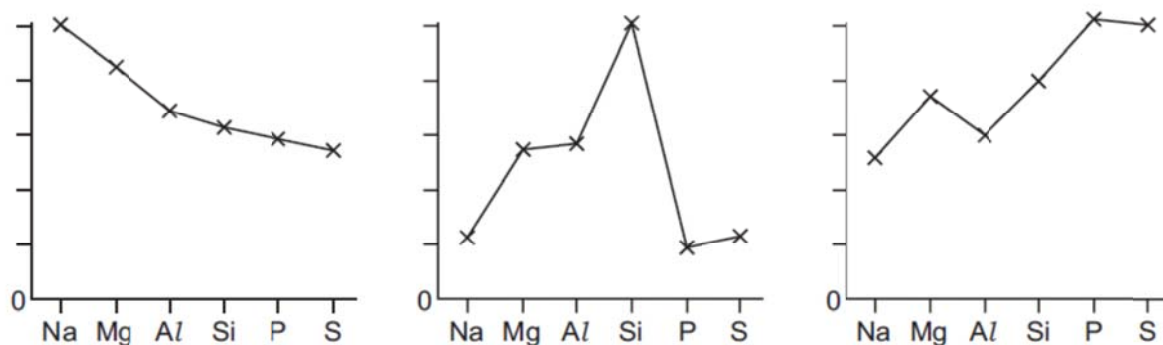
In an experiment to calculate the enthalpy change of combustion of a fuel, 1.5 g (0.0326 mol) of the fuel was used to heat 200 g of water. The temperature of the water rose from 25 °C to 55 °C.

What is the experimental value for the enthalpy change of combustion, ΔH_c , of the fuel?

- A $-1410 \text{ kJ mol}^{-1}$
 B -769 kJ mol^{-1}
 C $-30.7 \text{ kJ mol}^{-1}$
 D $-16.7 \text{ kJ mol}^{-1}$
- 15 A 1 dm³ solution was made by mixing 0.0040 mol of HCl(aq) and 0.0025 mol of NaOH(aq).

What was the pH of the resulting solution?

- A 2.19
 B 2.40
 C 2.60
 D 2.82
- 16 The trends in three physical properties of the elements Na, Mg, Al, Si, P and S are shown in the graphs.



Which physical property is **not** illustrated?

- A atomic radius
 B electrical conductivity
 C first ionisation energy
 D melting point

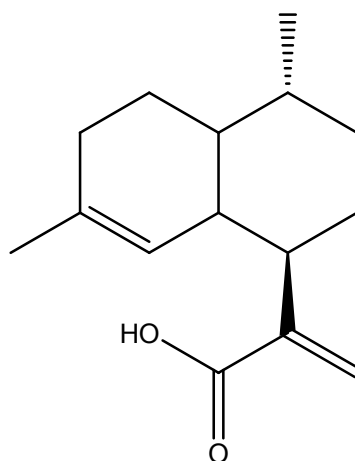
- 17 **X**, **Y** and **Z** are compounds of three elements in Period 3. Their electrical conductivities are shown in the table.

	X	Y	Z
conductivity of the compound in the molten state	good	does not conduct	does not conduct
conductivity of the mixture obtained by adding the compound to water	good	good	does not conduct

What could be compounds **X**, **Y** and **Z**?

	X	Y	Z
A	Al_2O_3	SiCl_4	NaF
B	NaF	Al_2O_3	SiCl_4
C	NaF	SiCl_4	SiO_2
D	SiCl_4	Al_2O_3	SiO_2

- 18 The diagram shows the structure of artemisinin acid, an intermediate for making the anti-malarial drug, artemisin.



artemisinin acid

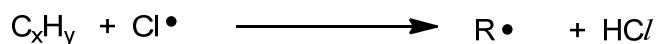
Student X stated that the atoms in the two rings all lie in the same plane.

Student Y stated that this molecule displays *cis-trans* isomerism at the $\text{C}=\text{C}$ double bond.

Which of the students are correct?

- A** both X and Y
- B** neither X nor Y
- C** X only
- D** Y only

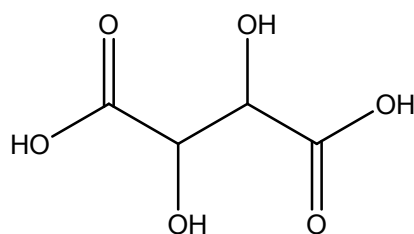
- 19 When heated with chlorine, an alkane, C_xH_y , undergoes free radical substitution. In a propagation step, the free radical $R\cdot$ is formed by the loss of one hydrogen atom.



How many different forms of $R\cdot$ are theoretically possible when 3-methylpentane is reacted with chlorine under this condition?

- A 3 B 4 C 5 D 6

- 20 Tartaric acid, which is added to foods to give a sour taste, has the following formula.



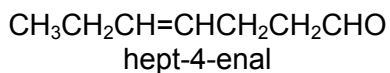
tartaric acid

What reacts completely with 1 mol of tartaric acid?

- A 2 mol of $PCl_5(s)$
 B 4 mol of $HCl(g)$
 C 4 mol of $Na(s)$
 D 4 mol of $NaOH(aq)$
- 21 Compounds **X**, **Y** and **Z** all react with 2,4-dinitrophenylhydrazine but only two of them will cause a reduction in the oxidation number of the metal present in Tollens' reagent. Which combination would be **X**, **Y** and **Z**?

	X	Y	Z
A	CH_3CH_2CHO	C_6H_5CHO	
B	CH_3CH_2CHO	C_6H_5CHO	$CH_3CH_2CO_2CH_3$
C	CH_3CONH_2	CH_3COCH_3	C_6H_5CHO
D	CH_3CHO	C_6H_5CHO	CH_3CH_2CHO

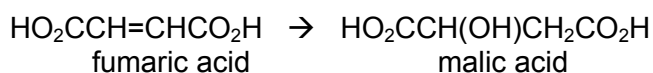
- 22 Hept-4-enal is present in cow's milk.



Which row correctly shows the product formed when hept-4-enal is treated with the given reducing agent?

	reducing agent	product
A	$\text{H}_2 + \text{Ni}$	$\text{CH}_3(\text{CH}_2)_5\text{CH}_2\text{OH}$
B	$\text{H}_2 + \text{Ni}$	$\text{CH}_3(\text{CH}_2)_5\text{CH}_3$
C	NaBH_4	$\text{CH}_3(\text{CH}_2)_5\text{CH}_2\text{OH}$
D	NaBH_4	$\text{CH}_3(\text{CH}_2)_5\text{CHO}$

- 23 One reaction in the Krebs cycle, in which energy is released to the human body, is the conversion of fumaric acid into malic acid.



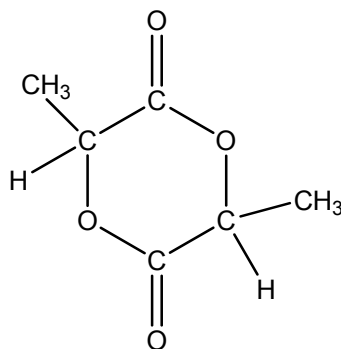
Which reagent(s) could achieve this conversion in the laboratory?

- A** $\text{Br}_2(\text{aq})$ followed by hot $\text{NaOH}(\text{aq})$
 - B** acidified $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$
 - C** cold alkaline $\text{KMnO}_4(\text{aq})$
 - D** steam and H_2SO_4
- 24 Chlorofluorocarbons (CFCs) have been widely used in aerosol sprays, refrigerators and in making foamed plastics, but are now known to destroy ozone in the upper atmosphere.

What will **not** destroy ozone, and therefore can be used as a replacement for CFCs?

- A** CHBr_3
- B** CCl_3CBr_3
- C** $\text{CHCl}_3/\text{FCCl}_2/\text{F}_2$
- D** $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$

25 Compound **Z** can be made from 2-hydroxypropanoic acid.



compound **Z**

What should be heated with 2-hydroxypropanoic acid in order to make compound **Z**?

- A** acidified potassium dichromate(VI)
- B** aluminium oxide
- C** concentrated sulfuric acid
- D** aqueous sodium hydroxide

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.

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

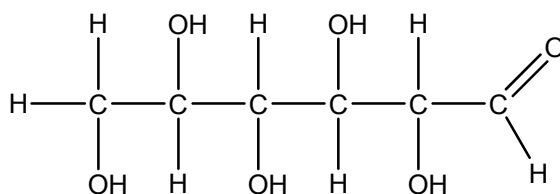
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

26 Which of the following changes represent the reduction of bromine?

- 1** $\text{Br}_2 \rightarrow \text{BrI}$
- 2** $\text{Br}_2 \rightarrow \text{BrF}$
- 3** $\text{Br}_2 \rightarrow \text{BrO}^-$

27 Which types of intermolecular forces can exist between adjacent glucose molecules?



glucose

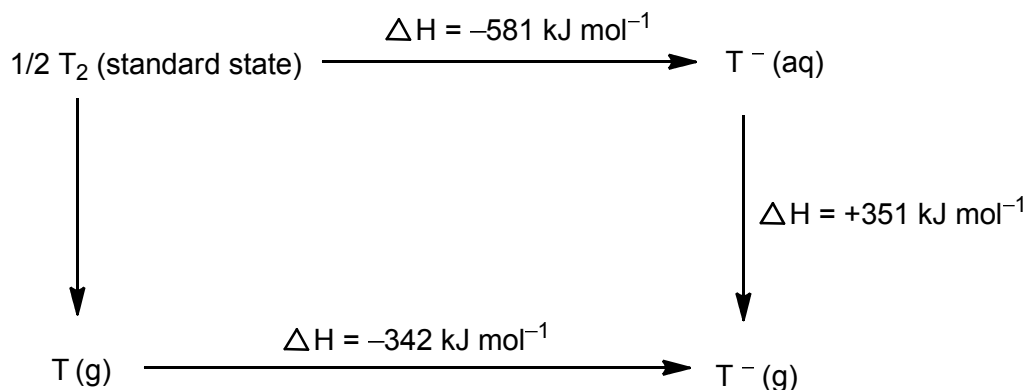
- 1** hydrogen bonding
- 2** permanent dipole-dipole forces
- 3** instantaneous dipole-induced dipole forces

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.

28 The diagram illustrates the energy changes of a set of reactions.



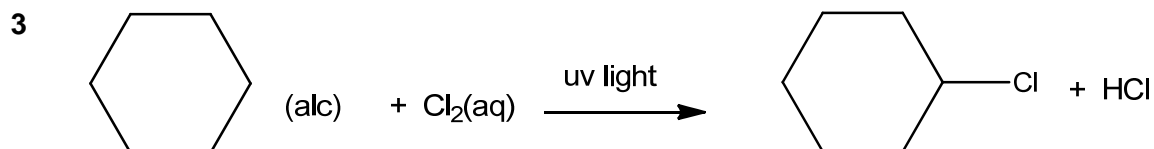
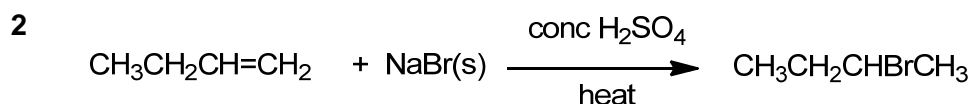
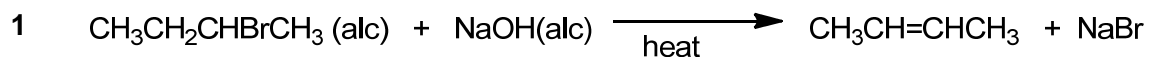
Which of the following can be deduced from this diagram?

- 1 The enthalpy change for the transformation $\text{T}(\text{g}) \rightarrow \text{T}^- (\text{aq})$ will be exothermic.
- 2 The enthalpy change for the transformation $\text{T}^- (\text{g}) \rightarrow \frac{1}{2}\text{T}_2(\text{standard state})$ is $+230 \text{ kJ mol}^{-1}$.
- 3 The enthalpy change for the reaction $\frac{1}{2}\text{T}_2(\text{standard state}) \rightarrow \text{T}(\text{g})$ is -112 kJ mol^{-1} .

29 The reaction conditions for three different transformations are given.

Which transformation(s) has the correct conditions?

[(alc) indicates an alcoholic solution.]

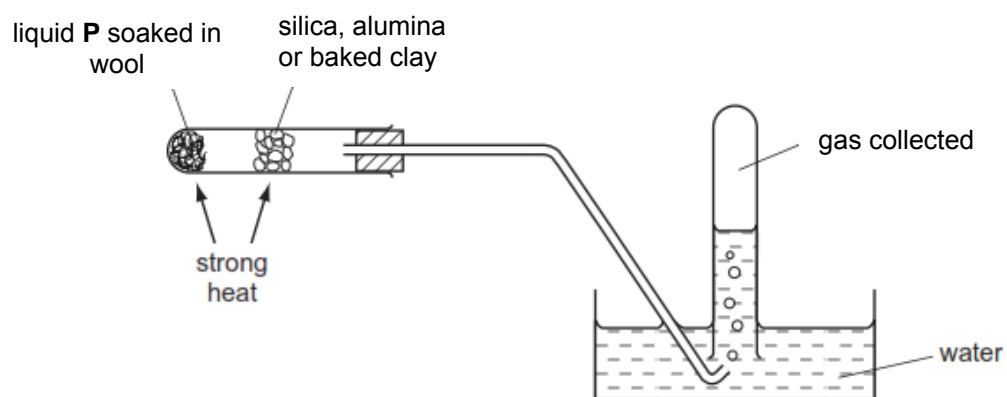


The responses **A** to **D** should be selected on the basis of

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.

- 30** The diagram shows an experimental set-up which can be used in several different experiments.



Which processes could be demonstrated by using the above apparatus?

- 1** oxidation of ethanol (liquid **P**)
- 2** dehydration of ethanol (liquid **P**)
- 3** cracking of paraffin (liquid **P**)