



**8872/01**

**18 September 2017**

## 50 minutes

Additional Materials: Multiple Choice Answer Sheet  
Data Booklet

Write in soft pencil.  
Do not use staples, paper clips, glue or correction fluid.  
Write your name, PDG and NRIC / FIN 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 Multiple Choice 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.

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

Write your name, PDG and NRIC / FIN number, **including** the reference letter.

Shade the NRIC / FIN number.

Exam Title: JC2 Prelim

Exam Details: H1 Chemistry / Paper 1

Date: 18/09/2017

This document consists of **14** printed pages.

## Section A

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.*

How many atoms are present in 1 cm<sup>3</sup> of oxygen gas under room conditions?

- A**  $\frac{2 \times 6.02 \times 10^{23}}{24000}$
- B**  $\frac{1 \times 24000}{6.02 \times 10^{23}}$
- C**  $\frac{1 \times 6.02 \times 10^{23}}{24000}$
- D**  $\frac{6.02 \times 10^{23} \times 24000}{1 \times 1000}$

- 2 Cyanogen, a highly toxic gas, is composed of 46.2% carbon and 53.8% nitrogen by mass. At standard temperature and pressure, 1.16 g of cyanogen occupies 0.500 dm<sup>3</sup>.

What is the molecular formula of cyanogen?

- A** CN                      **B** CN<sub>2</sub>                      **C** C<sub>2</sub>N<sub>2</sub>                      **D** C<sub>2</sub>N

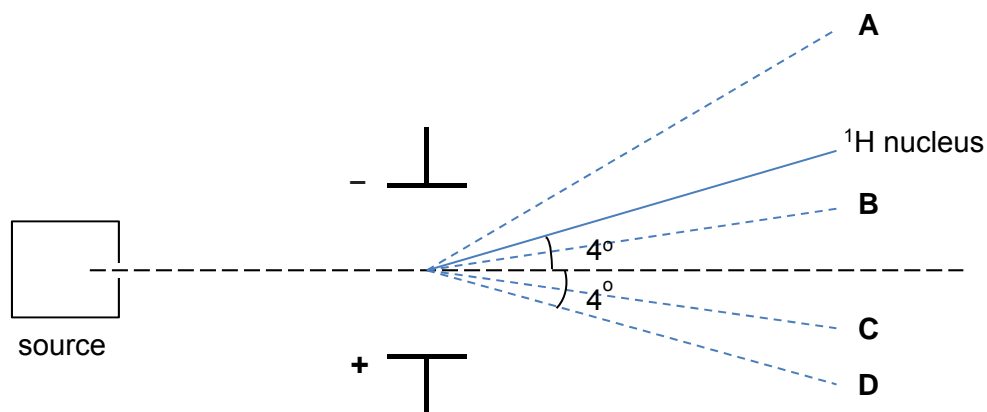
- 3 Gases given off during volcanic eruptions include CO, H<sub>2</sub>S and CS<sub>2</sub>.

A mixture of these gases was analysed by combustion in an excess of oxygen.

If the gases were in a CO : H<sub>2</sub>S : CS<sub>2</sub>, 1 : 3 : 1 mole ratio, what would be the SO<sub>2</sub> : CO<sub>2</sub> mole ratio in the mixture after combustion?

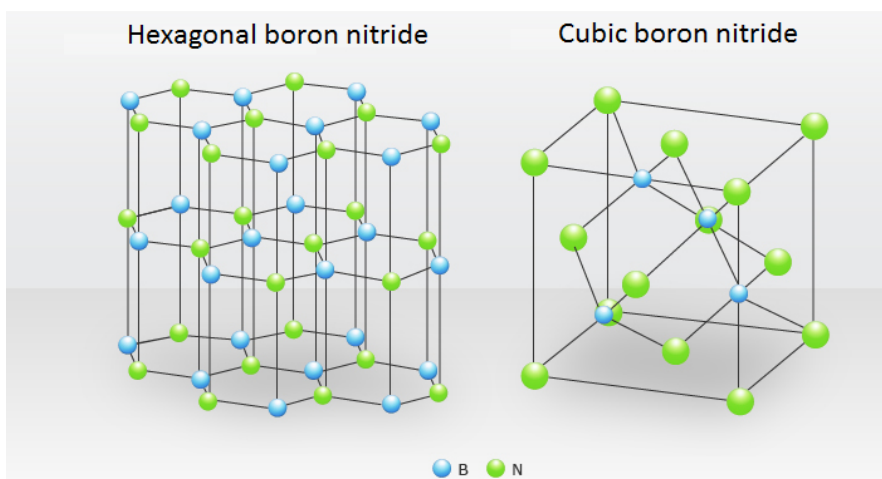
- A** 5 : 2                      **B** 3 : 2                      **C** 5 : 1                      **D** 1 : 1

- 4 When passed through an electric field, the  $^1\text{H}$  nucleus is deflected as shown below.



Which of the above beams represents the deflection for an ion  $^2\text{X}^{2-}$ ?

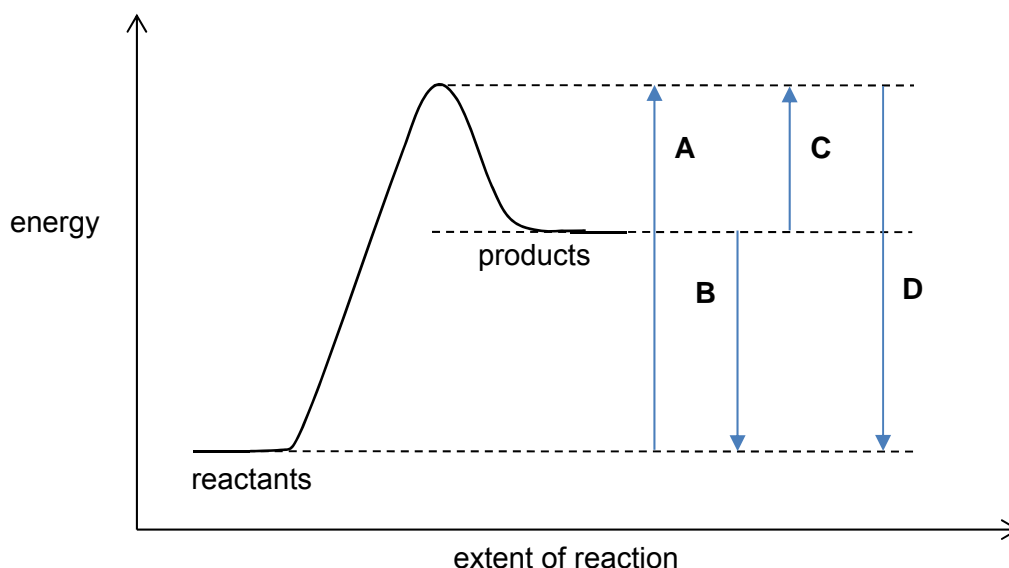
- 5 Boron nitride is found to exist in two possible forms, hexagonal boron nitride and cubic boron nitride as shown below. Hexagonal boron nitride is found to be similar in structure and bonding to graphite.



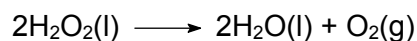
Based on the structures of the two forms of boron nitride, which of the following statements about boron nitride is true?

- A** Hexagonal boron nitride has a giant covalent structure whereas cubic boron nitride has a simple covalent structure.
- B** Hexagonal boron nitride has strong covalent bonds between its layers of atoms.
- C** Both forms of boron nitride are soft and slippery.
- D** Only the hexagonal form of boron nitride is a good conductor of electricity.

- 6 Which of the following isomers is likely to have the highest boiling point?
- A  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$   
 B  $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{CH}_3$   
 C  $(\text{CH}_3)_2\text{CHCH}(\text{CH}_3)_2$   
 D  $(\text{CH}_3)_3\text{CCH}_2\text{CH}_3$
- 7 Which of the following pairs of compounds shows the same shape and similar bond angles?
- A  $\text{AlCl}_3$  and  $\text{PCl}_5$   
 B  $\text{BeCl}_2$  and  $\text{H}_2\text{O}$   
 C  $\text{POCl}_3$  and  $\text{CCl}_4$   
 D  $\text{SO}_2$  and  $\text{CO}_2$
- 8 Which arrow on the reaction pathway diagram shows the enthalpy change of reaction for the reverse reaction?



- 9 The values for the standard enthalpy changes of formation of hydrogen peroxide and of water are  $-187.8 \text{ kJ mol}^{-1}$  and  $-285.8 \text{ kJ mol}^{-1}$  respectively.



What is the enthalpy change of reaction for the decomposition of hydrogen peroxide?

- A  $-98 \text{ kJ mol}^{-1}$     B  $-196 \text{ kJ mol}^{-1}$     C  $-398 \text{ kJ mol}^{-1}$     D  $-451 \text{ kJ mol}^{-1}$

- 10 In an experiment to measure the enthalpy change of neutralisation of hydrochloric acid, 20 cm<sup>3</sup> of solution containing 0.04 mol of HCl was placed in a plastic cup of negligible heat capacity.

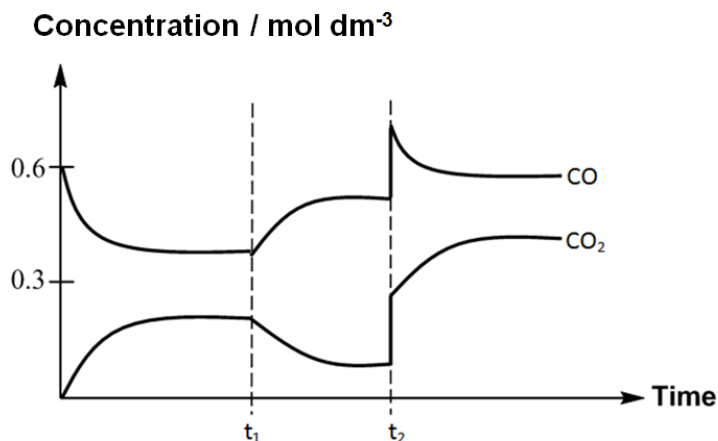
A 20 cm<sup>3</sup> sample of aqueous sodium hydroxide containing 0.04 mol of NaOH, at the same initial temperature, was added and the temperature rose by 15 °C.

If the heat capacity per unit volume of the final solution is 4.2 J K<sup>-1</sup>cm<sup>-3</sup>, what is the enthalpy change of neutralisation of hydrochloric acid?

- A  $40 \times 4.2 \times 288 \times 0.08 \text{ J mol}^{-1}$
- B  $\frac{20 \times 4.2 \times 15}{0.04} \text{ J mol}^{-1}$
- C  $\frac{40 \times 4.2 \times 15}{0.04} \text{ J mol}^{-1}$
- D  $\frac{40 \times 4.2 \times 288}{0.08} \text{ J mol}^{-1}$
- 11 At a temperature T K, 0.60 mol dm<sup>-3</sup> of CO and 0.30 mol dm<sup>-3</sup> of O<sub>2</sub> were introduced into a 5 dm<sup>3</sup> vessel and allowed to reach equilibrium.



The graph below shows the changes in the concentration of CO and CO<sub>2</sub> in the system with time. A change was made to the system at time, t<sub>1</sub> and t<sub>2</sub>.



What were the changes made at time, t<sub>1</sub> and t<sub>2</sub>?

- |   | t <sub>1</sub>                 | t <sub>2</sub>                    |
|---|--------------------------------|-----------------------------------|
| A | a catalyst was added           | volume of the system is increased |
| B | more CO <sub>2</sub> was added | the temperature was decreased     |
| C | the temperature was decreased  | more O <sub>2</sub> was added     |
| D | the temperature was increased  | volume of the system is decreased |

- 12 Pure carbon dioxide can be made to react with hot graphite, according to the following equation.



A mixture containing 0.10 mol of carbon dioxide and 0.20 mol of graphite was placed in a sealed 0.10 dm<sup>3</sup> container and heated to a fixed temperature. At equilibrium, 69% of graphite remained unreacted.

What is the value of  $K_c$  for this reaction?

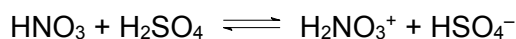
- A** 2.9                      **B** 3.3                      **C** 4.0                      **D** 7.6

- 13 The value of the ionic product of water,  $K_w$ , varies with temperature.

Temperature / °C	$K_w$ / mol <sup>2</sup> dm <sup>-6</sup>
25	$1.0 \times 10^{-14}$
62	$1.0 \times 10^{-13}$

What can be deduced from this information?

- A** Water is not a neutral liquid at 62 °C.  
**B** The ionic dissociation of water is an endothermic process.  
**C** The ionic dissociation of water increases by a factor of 5 between 25 °C and 62 °C.  
**D** The association of water molecules by hydrogen bonding increases as temperature rises.
- 14 The following equilibrium exists in a mixture of concentrated nitric acid and concentrated sulfuric acid.

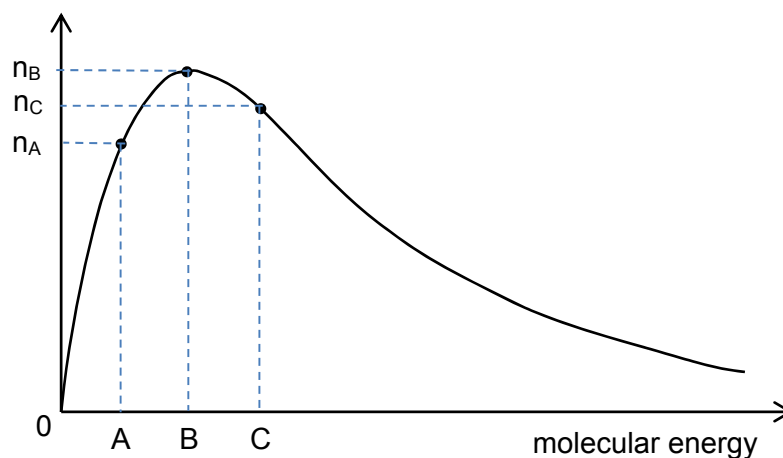


Which of the statements is correct?

- A** HNO<sub>3</sub> is a stronger acid than H<sub>2</sub>SO<sub>4</sub>.  
**B** The nitric acid acts as an oxidising agent.  
**C** The sulfuric acid acts as a dehydrating agent.  
**D** HNO<sub>3</sub> and H<sub>2</sub>NO<sub>3</sub><sup>+</sup> are a conjugate acid–base pair.

- 15 The Maxwell–Boltzmann distribution for gas **E** at a given temperature is shown below.

$n$  = number of molecules  
with a given energy



Which statement is correct for the number of molecules with molecular energies A, B and C?

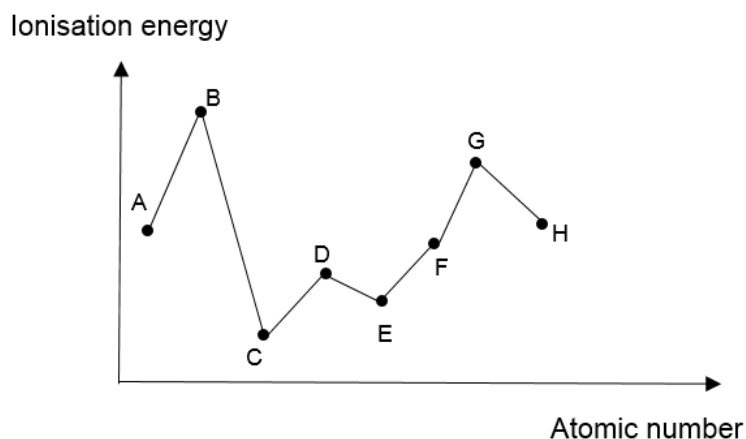
- A**  $n_C$  decreases when more gas **E** is added at the same temperature.
  - B**  $n_A$  decreases when temperature is lowered.
  - C**  $n_A$  and  $n_B$  increases when temperature is increased.
  - D** Addition of catalyst at the same temperature has no effect on  $n_A$ ,  $n_B$  and  $n_C$ .
- 16 A radioactive element has two isotopes, **F** and **G**, with half-lives of 3 min and 9 min respectively.

An experiment starts with  $h$  times as many atoms of **F** as of **G**. After 9 min, the number of atoms of **F** and **G** are both equal.

Given that radioactive decay is a first order reaction, what is the value of  $h$ ?

- A** 0.5                      **B** 2                      **C** 4                      **D** 8

- 17 The following graph shows the first ionisation energy of eight consecutive elements, from **A** to **H** in the Periodic Table with atomic number between 3 and 20.



Which of the following statements is correct?

- A** The chloride of **D** does not conduct electricity in the molten state.
  - B** **A** reacts with **C** to form a compound with giant ionic lattice structure.
  - C** The melting points of **A** to **H** follow the trend as shown by the graph.
  - D** The oxide of **H** gives a neutral pH when dissolved in water.
- 18 **X**, **Y** and **Z** are elements in Period 3 of the Periodic Table.
- A mixture containing the oxides of **X**, **Y** and **Z** was dissolved in excess dilute sulfuric acid and filtered. The oxide of **Z** was collected as a residue. When excess dilute sodium hydroxide was added to the filtrate, only a white precipitate of the hydroxide of **Y** was formed.

What are the possible identities of **X**, **Y** and **Z**?

	<b>X</b>	<b>Y</b>	<b>Z</b>
<b>A</b>	Al	Mg	Si
<b>B</b>	Al	Mg	P
<b>C</b>	Mg	Al	Si
<b>D</b>	Mg	Al	P

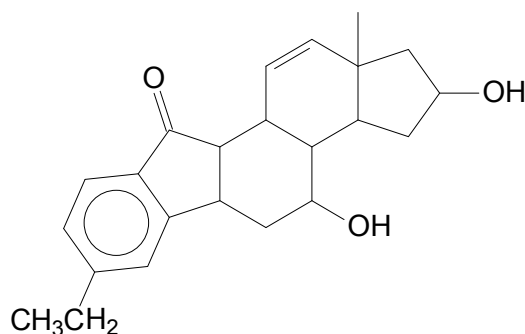


- 19 When alkane **N**,  $C_7H_{16}$ , was reacted with bromine under ultraviolet light, it produced **six** isomeric monobromo compounds, with the formula  $C_7H_{15}Br$ .

What is the likely identity of alkane **N**?

- A  $CH_3(CH_2)_5CH_3$   
 B  $(CH_3)_2CH(CH_2)_3CH_3$   
 C  $(CH_3)_3CCH_2CH_2CH_3$   
 D  $(CH_3)_3CCH(CH_3)_2$

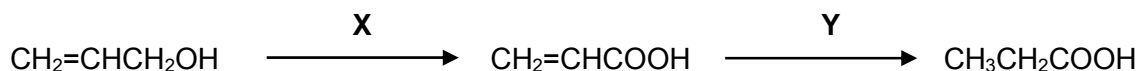
20



After heating the molecule above with steam and concentrated phosphoric acid, followed by subsequent heating with acidified potassium dichromate(VI), how many carboxylic acid groups are present in the resultant compound?

- A 0                      B 1                      C 3                      D 6

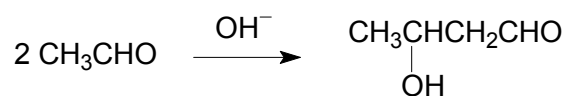
- 21 The compound,  $CH_2=CHCH_2OH$ , undergoes a sequence of reactions as follows:



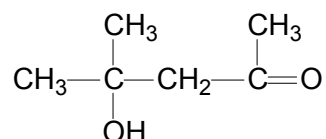
What could be the reagents for **X** and **Y**?

- |   | <b>X</b>               | <b>Y</b>                  |
|---|------------------------|---------------------------|
| A | acidified $K_2Cr_2O_7$ | $NaBH_4$                  |
| B | acidified $K_2Cr_2O_7$ | $H_2(g)$ with Ni catalyst |
| C | acidified $KMnO_4$     | $LiAlH_4$ in dry ether    |
| D | acidified $KMnO_4$     | $H_2(g)$ with Pt catalyst |

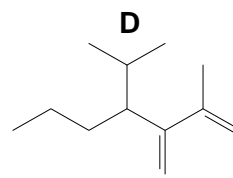
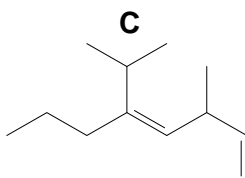
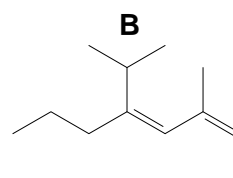
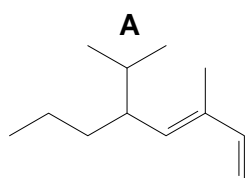
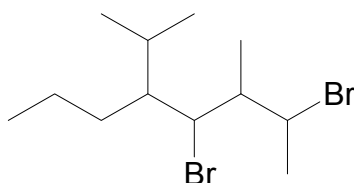
- 22 In the presence of a dilute alkali, some aldehydes and ketones undergo the 'aldol reaction' where they dimerise to form a hydroxylcarbonyl compound (an aldol). For example, ethanal dimerises in this way to form 3-hydroxybutanal.



Which of the following compounds will undergo the aldol reaction to produce the aldol shown below?



- A  $\text{CH}_3\text{COCH}_3$   
 B  $\text{CH}_3\text{CH}_2\text{CHO}$   
 C  $(\text{CH}_3)_2\text{CHCHO}$   
 D  $\text{CH}_3\text{CH}_2\text{COCH}_3$
- 23 Which of the following will **not** be obtained when the molecule below is heated with NaOH in ethanol?

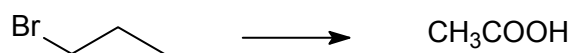


24 **Q** gives a yellow precipitate on warming with alkaline aqueous iodine.

Which of the following could be **not** be **Q**?

- A ethanal
- B ethanol
- C butan-2-ol
- D methyl ethanoate

25 Halogenoalkanes are very useful in making organic acids.



Which set of reagents, used in sequential order, would be the most suitable for this synthesis?

- A aqueous KOH, acidified  $\text{KMnO}_4$
- B aqueous KOH, acidified  $\text{Na}_2\text{Cr}_2\text{O}_7$
- C ethanolic KOH, acidified  $\text{KMnO}_4$
- D ethanolic KCN, dilute  $\text{H}_2\text{SO}_4$

## Section B

For each of the question in this section, one or more of the three numbered statements **1** to **3** may be correct.

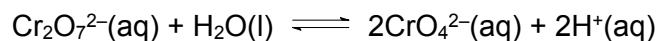
Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct.)

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

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>1, 2 and 3</b> are correct	<b>1 and 2</b> only are correct	<b>2 and 3</b> only are correct	<b>1 only</b> is correct

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

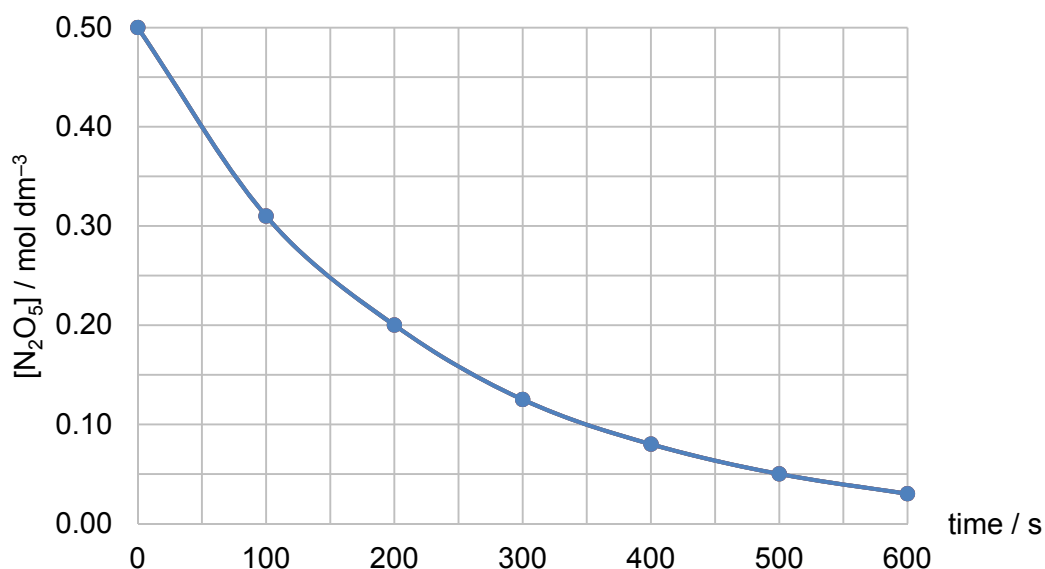
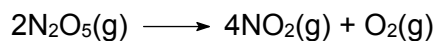
- 26** Orange dichromate(VI) ions,  $\text{Cr}_2\text{O}_7^{2-}$  and yellow chromate(VI) ions,  $\text{CrO}_4^{2-}$ , exist in equilibrium in aqueous solution.



Which of the following statement(s) about the equilibrium is correct?

- 1** Addition of strong alkali will shift the position of equilibrium to the right.
- 2** Addition of  $\text{K}^+$  (aq) will shift the position of equilibrium to the right.
- 3** This is a redox reaction.

- 27 The rate kinetics of decomposition of  $\text{N}_2\text{O}_5$  is investigated by plotting the concentration of  $\text{N}_2\text{O}_5$  with respect to time.



Which conclusions can be drawn from this result?

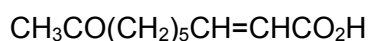
- 1  $[\text{NO}_2]$  is  $0.60 \text{ mol dm}^{-3}$  after 200 s.
  - 2 The rate equation is  $\text{rate} = k [\text{N}_2\text{O}_5]$ .
  - 3 The initial rate of production of  $\text{O}_2$  is approximately  $1 \times 10^{-3} \text{ mol dm}^{-3} \text{ s}^{-1}$ .
- 28 Which of the following statement(s) about the chlorides of Period 3 elements is correct?
- 1 The pH of the solutions of chlorides generally decreases across the period.
  - 2 When limited amount of water is added to the covalent chlorides, they give acidic white fumes.
  - 3 Adding  $\text{NaOH (aq)}$  to a solution of  $\text{AlCl}_3$  produces a white precipitate which is soluble in an excess of  $\text{NaOH}$ .

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

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>1, 2 and 3</b> are correct	<b>1 and 2</b> only are correct	<b>2 and 3</b> only are correct	<b>1 only</b> is correct

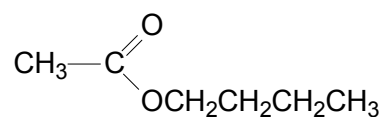
No other combination of statements is used as a correct response.

- 29** In a beehive, the queen bee secretes the substance below to cause worker bees to begin constructing royal colony cells.



From the structure shown, which of the following statements are true?

- 1** It gives a brick red precipitate with alkaline  $\text{Cu}^{2+}$  solution.
  - 2** It gives an orange precipitate with 2,4–dinitrophenylhydrazine solution.
  - 3** It decolourises aqueous bromine solution.
- 30** An ester with a fruity odour has the following structural formula.



From the structure shown, which of the following statements are true?

- 1** The name of the ester is butyl ethanoate.
- 2** It has the same empirical formula as propanone.
- 3** The ester reacts with  $\text{OH}^-$  in 1 : 2 ratio in a complete reaction.

<i>Question Number</i>	<i>Key</i>	<i>Question Number</i>	<i>Key</i>
1	<b>A</b>	16	<b>C</b>
2	<b>C</b>	17	<b>B</b>
3	<b>A</b>	18	<b>A</b>
4	<b>D</b>	19	<b>B</b>
5	<b>D</b>	20	<b>A</b>
6	<b>A</b>	21	<b>B</b>
7	<b>C</b>	22	<b>A</b>
8	<b>B</b>	23	<b>D</b>
9	<b>B</b>	24	<b>D</b>
10	<b>C</b>	25	<b>C</b>
11	<b>D</b>	26	<b>D</b>
12	<b>C</b>	27	<b>A</b>
13	<b>B</b>	28	<b>A</b>
14	<b>D</b>	29	<b>C</b>
15	<b>D</b>	30	<b>B</b>

<b>A</b>	<b>8</b>
<b>B</b>	<b>7</b>
<b>C</b>	<b>7</b>
<b>D</b>	<b>8</b>