

**CTG:** \_\_\_\_\_

## JC2 PRELIMINARY EXAMINATION 2016

8872/01

# 25 August 2016

**1400hrs – 1450hrs**

## 50 minutes

Optical Mark Sheet  
Data Booklet[illegible]

### Section A & B: Multiple Choice Questions

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.

## Section A

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

- 1 A pure hydrocarbon is used in bottled gas for cooking and heating.

When 10 cm<sup>3</sup> of the hydrocarbon is burned in 70 cm<sup>3</sup> of oxygen (an excess), the final gaseous mixture contains 30 cm<sup>3</sup> of carbon dioxide and 20 cm<sup>3</sup> of unreacted oxygen. All gaseous volumes were measured under identical conditions

What is the formula of the hydrocarbon?

- A** C<sub>2</sub>H<sub>6</sub>  
**B** C<sub>3</sub>H<sub>6</sub>  
**C** C<sub>3</sub>H<sub>8</sub>  
**D** C<sub>4</sub>H<sub>10</sub>

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

Lead(IV) chloride will oxidise bromide ions to bromine. The Pb<sup>4+</sup> ions are reduced to Pb<sup>2+</sup> ions in this reaction.

If 6.980 g of lead(IV) chloride is added to an excess of sodium bromide solution, what mass of bromine would be produced?

- A** 0.799 g                      **B** 1.598 g                      **C** 3.196 g                      **D** 6.392 g

- 3 Which reaction does an element undergo the largest change in oxidation number?

- A**  $\text{Cl}_2 + 2\text{OH}^- \rightarrow \text{OCl}^- + \text{Cl}^- + \text{H}_2\text{O}$   
**B**  $3\text{Cl}_2 + 6\text{OH}^- \rightarrow \text{ClO}_3^- + 5\text{Cl}^- + 3\text{H}_2\text{O}$   
**C**  $3\text{MnO}_4^{2-} + 4\text{H}^+ \rightarrow \text{MnO}_2 + 2\text{MnO}_4^- + 2\text{H}_2\text{O}$   
**D**  $\text{Cr}_2\text{O}_7^{2-} + 6\text{Fe}^{2+} + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 6\text{Fe}^{3+} + 7\text{H}_2\text{O}$

- 4 Which compound has the greatest total number of lone pairs of electrons in the valence shells of all its atoms?

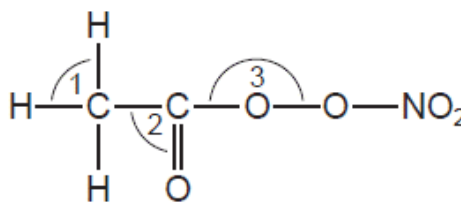
- A** CH<sub>3</sub>Cl                      **B** CO<sub>2</sub>                      **C** N<sub>2</sub>H<sub>4</sub>                      **D** NH<sub>4</sub>CN

- 5 Which option about  $\sigma$  bonds and  $\pi$  bonds in hydrocarbons is correct?

	$\sigma$ bonds	$\pi$ bonds
<b>A</b>	can be formed by p orbitals but not s orbitals	can be formed by s orbitals but not p orbitals
<b>B</b>	can be formed by s orbitals but not p orbitals	can be formed by p orbitals but not s orbitals
<b>C</b>	can be formed by either s or p orbitals	can be formed by either s or p orbitals
<b>D</b>	can be formed by either s or p orbitals	can be formed by p orbitals but not s orbitals

- 6 Organic nitrates in photochemical smog can cause breathing difficulties.

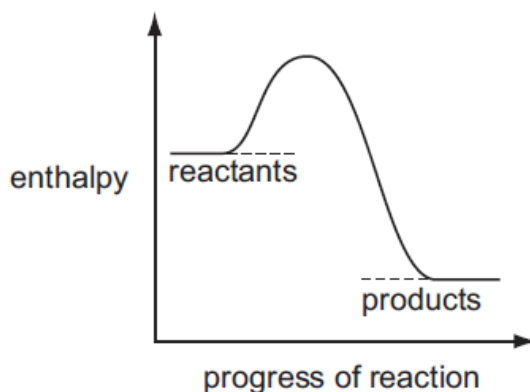
The diagram shows an example of an organic nitrate molecule.



What is the correct order of the bond angles shown in ascending order (smallest first)?

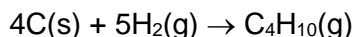
- A** 1→2→3                      **B** 2→1→3                      **C** 3→1→2                      **D** 3→2→1
- 7 Which of the following quantities has the same value as the standard enthalpy change of formation of carbon monoxide?
- A**  $\frac{1}{2} \Delta H_f^\theta (\text{CO}_2(\text{g}))$   
**B**  $\frac{1}{2} \Delta H_c^\theta (\text{graphite})$   
**C**  $\Delta H_c^\theta (\text{graphite}) - \Delta H_c^\theta (\text{CO}(\text{g}))$   
**D**  $\Delta H_f^\theta (\text{CO}_2(\text{g})) - \frac{1}{2} \Delta H_c^\theta (\text{graphite})$

- 8 A reaction pathway diagram is shown.



Which enthalpy change could the diagram **not** always apply to?

- A enthalpy change of combustion
  - B enthalpy change of formation
  - C enthalpy change of neutralisation
  - D lattice energy
- 9 Enthalpy change of combustion can be used to determine enthalpy change of formation. The following equation represents the enthalpy change of formation of butane.



By using the following standard enthalpy change of combustion data, what is the value of the standard enthalpy change of formation of butane?

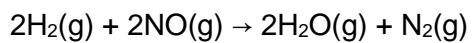
compound	$\Delta H_c / \text{kJ mol}^{-1}$
carbon	-394
hydrogen	-286
butane	-2877

- A -5883 kJ mol<sup>-1</sup>      B -129 kJ mol<sup>-1</sup>      C +129 kJ mol<sup>-1</sup>      D +5883 kJ mol<sup>-1</sup>
- 10 Butanedioate ions can be dehydrogenated to form *trans*-butenedioate ions. The enzyme fumarase speeds up this reaction.

How does fumarase speed up this reaction?

- A Fumarase is a protein which increases the concentration of reactants.
- B Fumarase raises the temperature of the reaction.
- C Fumarase is specific for this dehydrogenation reaction.
- D Fumarase lowers the activation energy of the dehydrogenation reaction.

- 11 The gas-phase reaction of hydrogen and nitrogen monoxide produces nitrogen and water.



From initial rates experiments, the following rate equation was derived.

$$\text{Rate} = k[\text{H}_2][\text{NO}]^2$$

The results of the initial rates experiments are shown.

$[\text{H}_2] / \text{mol dm}^{-3}$	$[\text{NO}] / \text{mol dm}^{-3}$	initial rate / $\text{mol dm}^{-3} \text{ min}^{-1}$
0.5	2.0	6.0
0.5	1.0	<b>h</b>
1.0	1.0	<b>i</b>
1.0	<b>J</b>	0.75

What are the missing values, **h**, **i** and **j**?

	<b>h</b>	<b>i</b>	<b>J</b>
<b>A</b>	1.5	3.0	0.25
<b>B</b>	1.5	3.0	0.50
<b>C</b>	3.0	6.0	0.50
<b>D</b>	3.0	6.0	0.25

- 12 The table below shows some data on two acid-base indicators.

indicator	approximate pH range of colour change	colour change	
		acid	alkali
bromocresol-green	3.8 – 5.5	yellow	blue
phenol-red	6.8 – 8.5	yellow	red

Which conclusion can be drawn about a solution in which bromocresol-green is blue and phenol-red is yellow?

- A** It is weakly acidic.
- B** It is neutral.
- C** It is weakly alkaline.
- D** It is strongly alkaline.

- 13** A solution was made by mixing 0.002 mol of  $\text{H}_2\text{SO}_4(\text{aq})$  and 0.003 mol  $\text{KOH}(\text{aq})$ . Water was added until the volume of the solution was  $2 \text{ dm}^3$ .

What is the pH of the solution?

- A** 3.0                      **B** 3.3                      **C** 10.7                      **D** 11.0

- 14** Element **L** does not react with water. Element **L** burns in air with a pale blue flame to form an acidic oxide.

What is element **L**?

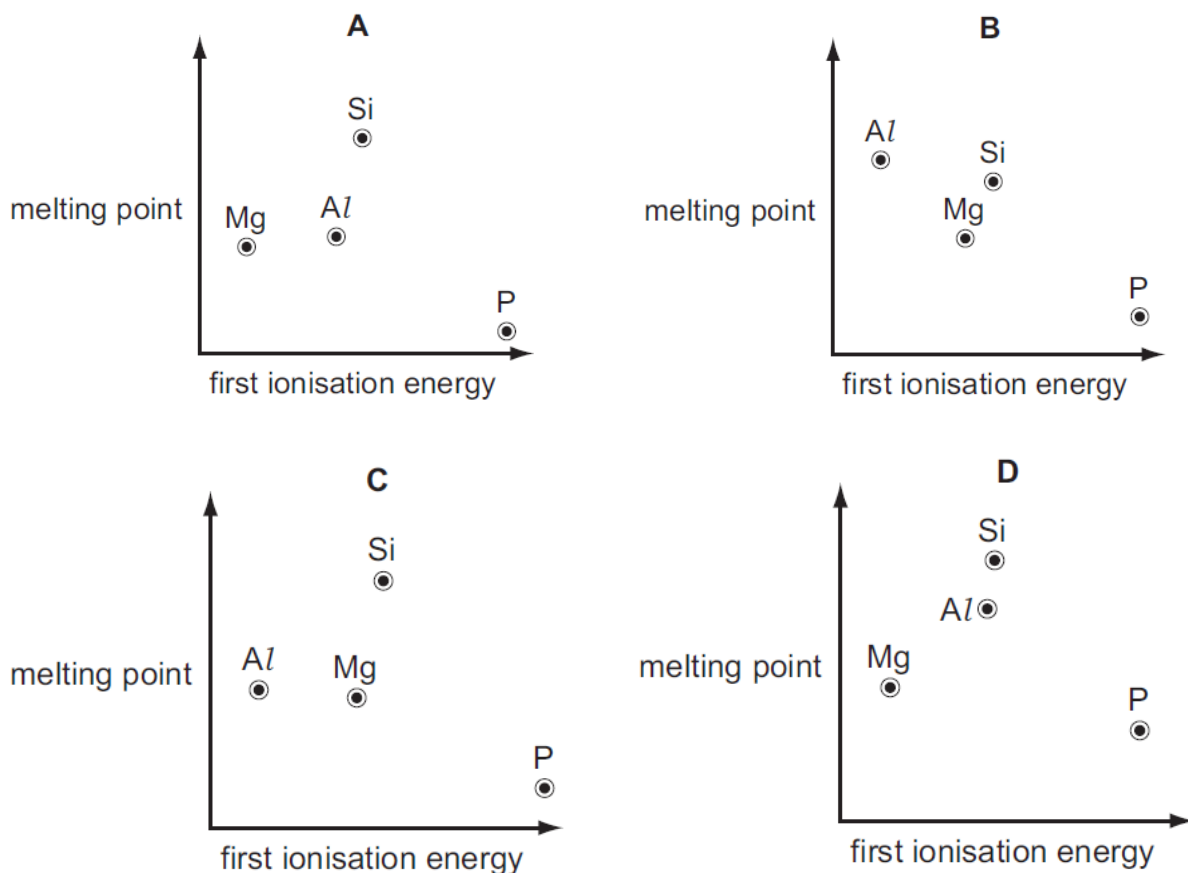
- A** Aluminum  
**B** Magnesium  
**C** Silicon  
**D** Sulfur

- 15** Why is the ionic radius of a chloride ion larger than the ionic radius of a sodium ion?

- A** A chloride ion has higher shielding effect than a sodium ion.  
**B** A chloride ion has a higher nuclear charge than a sodium ion.  
**C** Ionic radius increases regularly across the period.  
**D** Sodium is a metal while chlorine is a non-metal.

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

Which graph correctly shows the melting points of the elements Mg, Al, Si and P plotted against their first ionization energies?

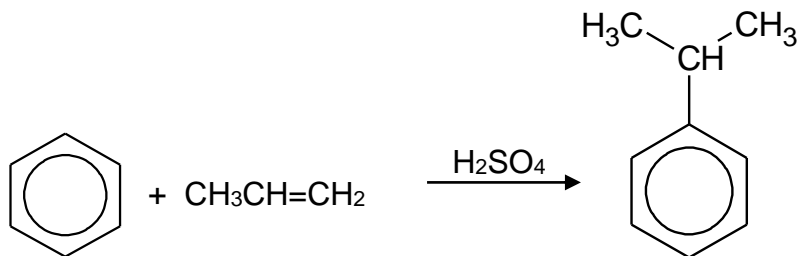


- 17 One of the reactions taking place in a catalytic converter in a car exhaust system is between nitrogen oxide and octane (unburned petrol). The products of this reaction is non-toxic.

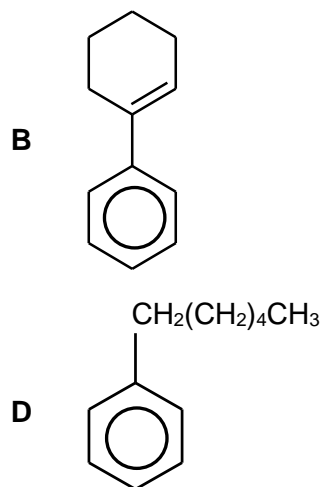
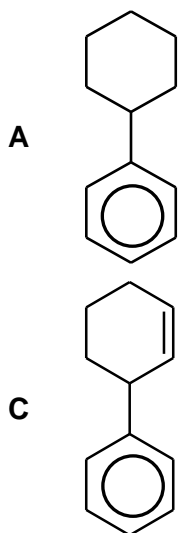
Which is the correct equation for the reaction?

- A  $\text{C}_8\text{H}_{16} + 16\text{NO} \rightarrow 8\text{CO} + 8\text{N}_2 + 8\text{H}_2\text{O}$
- B  $\text{C}_8\text{H}_{16} + 24\text{NO} \rightarrow 8\text{CO}_2 + 12\text{N}_2 + 8\text{H}_2\text{O}$
- C  $\text{C}_8\text{H}_{18} + 17\text{NO} \rightarrow 8\text{CO} + 8\frac{1}{2}\text{N}_2 + 9\text{H}_2\text{O}$
- D  $\text{C}_8\text{H}_{18} + 25\text{NO} \rightarrow 8\text{CO}_2 + 12\frac{1}{2}\text{N}_2 + 9\text{H}_2\text{O}$

- 18 The first stage of the cumene process for the industrial production of phenol is as follows.



Which one of the following would be the product of the reaction, under similar conditions, between benzene and cyclohexene?



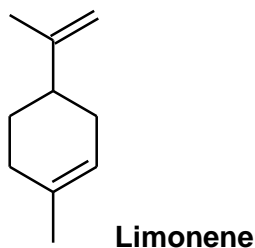
- 19 A bromoalkane, **X**, was heated under reflux with alcoholic potassium cyanide solution. The organic product formed was then heated under reflux with dilute sulfuric acid. From this mixture, 2-methylpropanoic acid was obtained.

Which of the following compounds could be **X**?

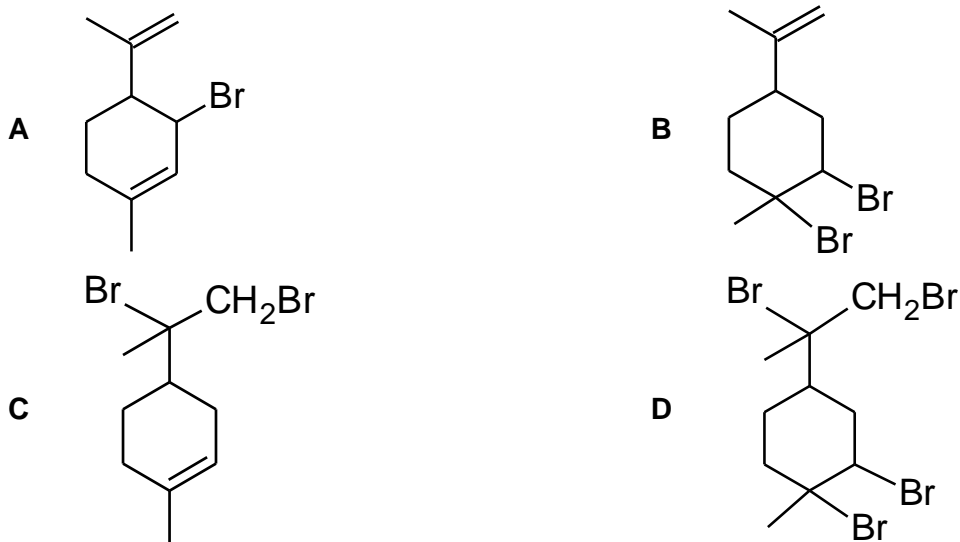
- A** 1-bromopropane  
**B** 2-bromopropane  
**C** 1-bromobutane  
**D** 2-bromobutane



- 20 Limonene is an oil formed in the peel of citrus fruits.



Which product is formed when bromine in  $\text{CCl}_4$  reacts with limonene at room temperature in the dark?



- 21 Most alcohols can be dehydrated to give alkenes.

Which alcohol can be dehydrated to give three different isomeric alkenes?

- A**  $\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{OH}$   
**B**  $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{OH}$   
**C**  $\text{CH}_3(\text{CH}_2)_2\text{CH}(\text{OH})\text{CH}_3$   
**D**  $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$
- 22 How many structural isomers with the molecular formula  $\text{C}_4\text{H}_8\text{O}$  can reduce Tollen's reagent to form a silver mirror?

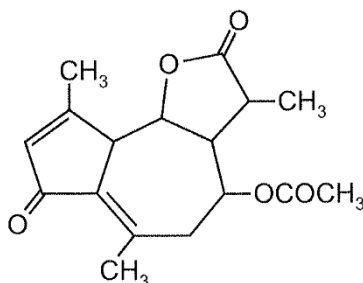
- A** 1                      **B** 2                      **C** 3                      **D** 4

- 23 The structures of two alarm pheromones for ants are given.



Which characteristic applies to both compounds?

- A Both can be obtained by the oxidation of alcohols.
  - B Both decolourise aqueous bromine.
  - C Both decolourise dilute alkaline potassium manganate(VII).
  - D Both give a positive test with Fehling's reagent.
- 24 Matricarin occurs in oil of chamomile.



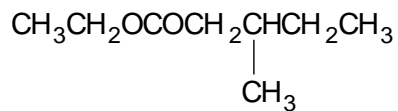
matricarin

Which statement about matricarin is correct?

- A It reacts with hot dilute sulfuric acid to form a product with two carboxylic acid groups.
- B It reacts with hot acidified potassium manganate(VII) to form a product with three carboxylic acid groups.
- C It reacts with hydrogen bromide gas to form a product with four bromine atoms.
- D It reacts with hydrogen cyanide, traces of sodium cyanide to form a product with one nitrogen atom.

25 An ester with an odour of banana has the following formula.

Which pairs of reactants, under suitable conditions, will produce this ester?



- A**  $\text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{CH}_2\underset{\text{CH}_3}{\text{CH}}\text{CH}_2\text{OH}$
- B**  $\text{CH}_3\text{CH}_2\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\underset{\text{CH}_3}{\text{CH}}\text{CH}_2\text{OH}$
- C**  $\text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{CH}_2\underset{\text{CH}_3}{\text{CH}}\text{CH}_2\text{CO}_2\text{H}$
- D**  $\text{CH}_3\text{CH}_2\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\underset{\text{CH}_3}{\text{CH}}\text{OH}$

**Section B**

For each 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:

<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</b> only is correct

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

- 26** In 2011 an international group of scientists agreed to add two new elements to the Periodic Table. Both elements had been made artificially and were called ununquadium (Uuq) and ununhexium (Uuh).

	Uuq	Uuh
proton number	114	116
nucleon number	289	292

Which statements about these elements are correct?

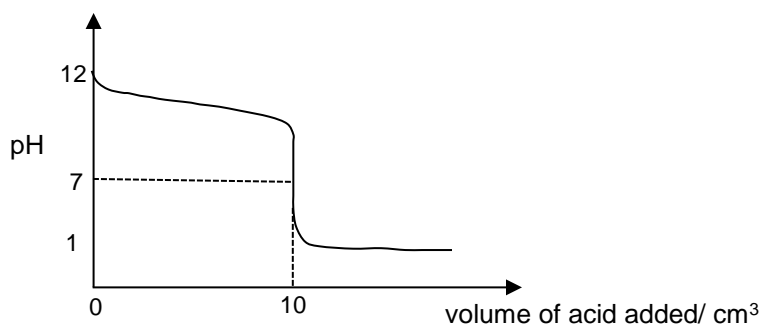
- 1** One atom of Uuh has one more neutron than one atom of Uuq.
  - 2** One  $\text{Uuq}^{2-}$  ion has the same number of electrons as one atom of Uuh.
  - 3** One  $\text{Uuh}^+$  ion has the same number of electrons as one  $\text{Uuq}^-$  ion.
- 27** What can be deduced from the following information?
- $$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}) \quad \Delta H = -98 \text{ kJ mol}^{-1}$$
- 1** Increasing the pressure increases the equilibrium yield of  $\text{SO}_3(\text{g})$ .
  - 2** Increasing the temperature decreases the rate of forward reaction.
  - 3** The maximum mass of  $\text{SO}_3(\text{g})$  that can be made from 64 g of  $\text{SO}_2(\text{g})$  is 160 g.

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 are correct</b>	<b>1 and 2 only are correct</b>	<b>2 and 3 only are correct</b>	<b>1 only is correct</b>

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

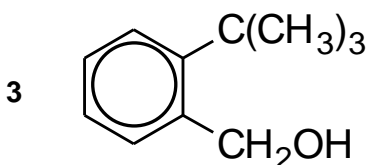
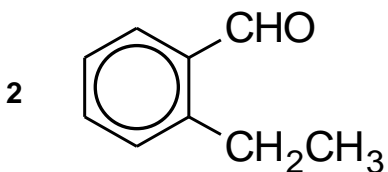
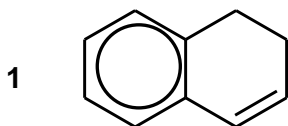
- 28** 20.0 cm<sup>3</sup> of 0.10 mol dm<sup>-3</sup> alkali, **X** was titrated against 0.10 mol dm<sup>-3</sup> acid, **Y**. The graph below shows the variation of pH during the titration.



What could be the identities of **X** and **Y**?

	<b>X</b>	<b>Y</b>
<b>1</b>	sodium hydroxide	sulfuric acid
<b>2</b>	sodium hydroxide	hydrochloric acid
<b>3</b>	sodium hydroxide	ethane-1,2-dioic acid

- 29** The following compounds are refluxed with acidified potassium manganate(VII). Which compounds will form benzene-1,2-dicarboxylic acid?



- 30 A liquid, L,  $C_7H_6Cl_2$ , gives a white precipitate when shaken for some time with aqueous silver nitrate. Which of the following structures could be L?

