

Please check the examination details below before entering your candidate information

|                                                                                                   |  |                                                                                                                               |                                                                                                                               |
|---------------------------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Candidate surname                                                                                 |  | Other names                                                                                                                   |                                                                                                                               |
| <b>Pearson Edexcel</b>                                                                            |  | Centre Number                                                                                                                 | Candidate Number                                                                                                              |
| <b>International</b>                                                                              |  | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| <b>Advanced Level</b>                                                                             |  |                                                                                                                               |                                                                                                                               |
| <b>Wednesday 9 January 2019</b>                                                                   |  |                                                                                                                               |                                                                                                                               |
| Morning (Time: 1 hour 30 minutes)                                                                 |  | Paper Reference <b>WCH01/01</b>                                                                                               |                                                                                                                               |
| <b>Chemistry</b><br><b>Advanced Subsidiary</b><br><b>Unit 1: The Core Principles of Chemistry</b> |  |                                                                                                                               |                                                                                                                               |
| Candidates must have: <b>Scientific calculator</b><br><b>Ruler</b>                                |  |                                                                                                                               | Total Marks                                                                                                                   |

### Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*

### Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (\*) are ones where the quality of your written communication will be assessed  
– *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

### Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

Turn over ►

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## SECTION A

Answer ALL the questions in this section. You should aim to spend no more than 20 minutes on this section. For each question, select one answer from A to D and put a cross in the box ☐. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☐.

- 1 The European Union limit for nitrogen dioxide in the atmosphere is  $0.0209 \text{ cm}^3$  in  $1 \text{ m}^3$ . In units of parts per million (ppm) this is

- ☐ A  $2.09 \times 10^{-5}$   
☐ B  $2.09 \times 10^{-2}$   
☐ C 20.9  
☐ D  $2.09 \times 10^4$

(Total for Question 1 = 1 mark)

- 2 A sample of blood plasma contains 3.10 mg of sodium ions in  $1 \text{ cm}^3$ . The concentration, in  $\text{mol dm}^{-3}$ , of sodium ions in the plasma is

- ☐ A  $1.35 \times 10^{-1}$   
☐ B  $2.82 \times 10^{-1}$   
☐ C  $1.35 \times 10^{-4}$   
☐ D  $2.82 \times 10^{-4}$

(Total for Question 2 = 1 mark)

- 3 Dilute sulfuric acid is mixed with a solution of barium chloride. The reaction that occurs is

- ☐ A displacement.  
☐ B neutralisation.  
☐ C precipitation.  
☐ D redox.

(Total for Question 3 = 1 mark)



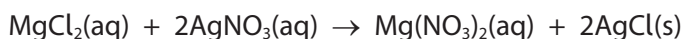
- 4 How many **atoms** are there in  $120\text{ cm}^3$  of ammonia gas at room temperature and pressure (r.t.p.)?

[Molar volume of gas at r.t.p. =  $24\,000\text{ cm}^3\text{ mol}^{-1}$  Avogadro constant =  $6.0 \times 10^{23}\text{ mol}^{-1}$ ]

- ☐ A  $3.0 \times 10^{21}$   
☐ B  $1.2 \times 10^{22}$   
☐ C  $1.5 \times 10^{22}$   
☐ D  $1.2 \times 10^{25}$

(Total for Question 4 = 1 mark)

- 5 The reaction of magnesium chloride with silver nitrate gives a precipitate of silver chloride.



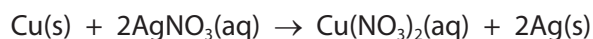
A solution containing 0.001 mol of magnesium chloride reacts with excess silver nitrate. What is the mass of the precipitate formed?

[Molar mass/ $\text{g mol}^{-1}$ :  $\text{AgCl} = 143.4$ ]

- ☐ A 0.072 g  
☐ B 0.143 g  
☐ C 0.287 g  
☐ D 0.574 g

(Total for Question 5 = 1 mark)

- 6 When 0.127 g of copper is added to excess silver nitrate solution, the following reaction occurs.



What mass of silver is formed?

[Molar masses/ $\text{g mol}^{-1}$ :  $\text{Cu} = 63.5$   $\text{Ag} = 107.9$ ]

- ☐ A 0.216 g  
☐ B 0.254 g  
☐ C 0.432 g  
☐ D 0.863 g

(Total for Question 6 = 1 mark)



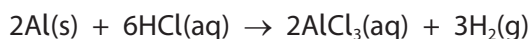
- 7 The molecular formula of phosphorus(V) oxide is  $\text{P}_4\text{O}_{10}$ .  
What is the percentage by mass of phosphorus in this oxide?

[Molar masses /  $\text{g mol}^{-1}$ : O = 16.0 P = 31.0]

- ☐ A 28.6%  
☐ B 42.9%  
☐ C 43.7%  
☐ D 56.3%

(Total for Question 7 = 1 mark)

- 8 Aluminium reacts with hydrochloric acid.



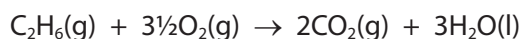
What is the maximum volume of hydrogen at room temperature and pressure (r.t.p.)  
that can be formed from 0.135 g of aluminium?

[Molar volume of gas at r.t.p. =  $24\,000\text{ cm}^3\text{ mol}^{-1}$  Molar mass Al =  $27.0\text{ g mol}^{-1}$ ]

- ☐ A  $60\text{ cm}^3$   
☐ B  $80\text{ cm}^3$   
☐ C  $120\text{ cm}^3$   
☐ D  $180\text{ cm}^3$

(Total for Question 8 = 1 mark)

- 9  $150\text{ cm}^3$  of ethane is mixed with  $700\text{ cm}^3$  of oxygen. The equation for the reaction is



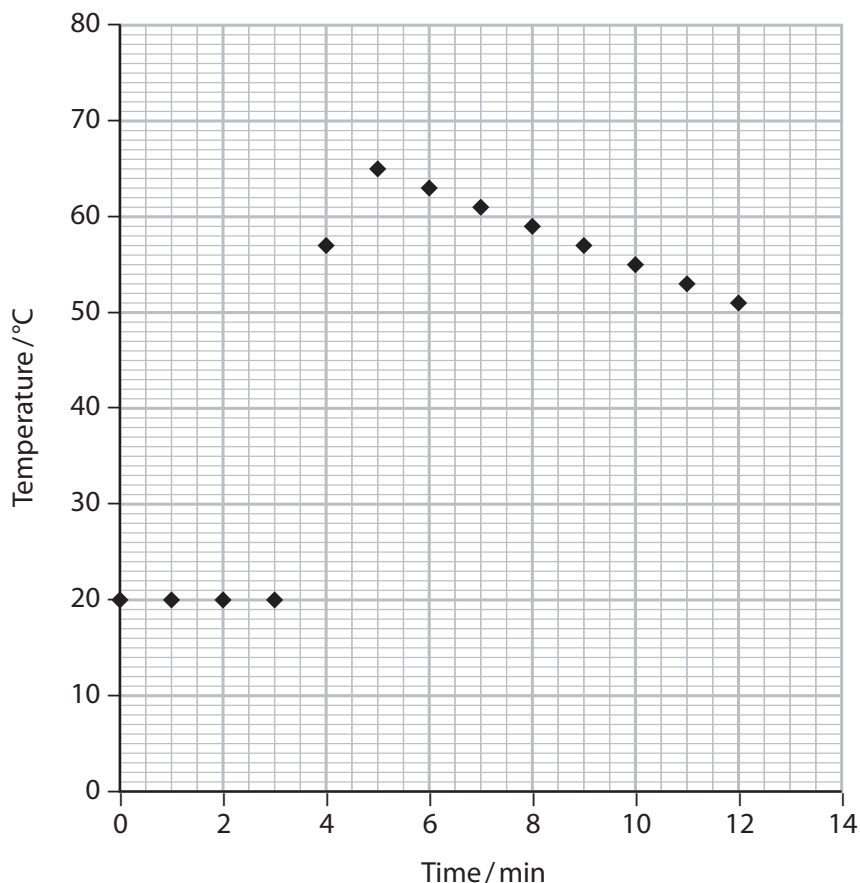
What is the total volume of gas when the reaction is complete?  
All gas volumes are measured at the same temperature and pressure.

- ☐ A  $150\text{ cm}^3$   
☐ B  $300\text{ cm}^3$   
☐ C  $325\text{ cm}^3$   
☐ D  $475\text{ cm}^3$

(Total for Question 9 = 1 mark)



- 10 In an experiment to determine the enthalpy change for the reaction between zinc and copper(II) sulfate, a cooling curve was used to estimate the temperature change. The zinc was added to the copper(II) sulfate solution at  $3\frac{1}{2}$  minutes and the results were plotted on a graph.



What is the temperature change?

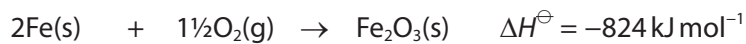
- ☐ A 45°C  
☐ B 48°C  
☐ C 65°C  
☐ D 68°C

(Total for Question 10 = 1 mark)

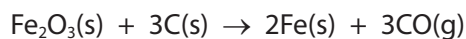
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11 The enthalpy changes of two reactions are



For the reaction



the enthalpy change is

- ☐ A  $-494 \text{ kJ mol}^{-1}$
- ☐ B  $+494 \text{ kJ mol}^{-1}$
- ☐ C  $-714 \text{ kJ mol}^{-1}$
- ☐ D  $+714 \text{ kJ mol}^{-1}$

(Total for Question 11 = 1 mark)

12 Which change would have a **negative**  $\Delta H$  value?

- ☐ A  $\text{Cl(g)} + \text{e}^- \rightarrow \text{Cl}^-\text{(g)}$
- ☐ B  $\text{Cl}_2\text{(g)} \rightarrow 2\text{Cl(g)}$
- ☐ C  $\text{Na(s)} \rightarrow \text{Na(l)}$
- ☐ D  $\text{Na(g)} \rightarrow \text{Na}^+\text{(g)} + \text{e}^-$

(Total for Question 12 = 1 mark)

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13 The combustion of magnesium may be represented by two equations.



The units of  $\Delta H$  for equation (1) are  $\text{kJ mol}^{-1}$ . The units of  $\Delta H$  for equation (2) are

- ☐ A  $\text{kJ mol}^{-1}$   
☐ B  $(\text{kJ mol}^{-1}) \div 2$   
☐ C  $(\text{kJ mol}^{-1}) \times 2$   
☐ D  $(\text{kJ mol}^{-1})^2$

(Total for Question 13 = 1 mark)

14 Which of the species, Ne,  $\text{F}^-$  and  $\text{Na}^+$ , have the electronic structure  $1s^2 2s^2 2p^6$ ?

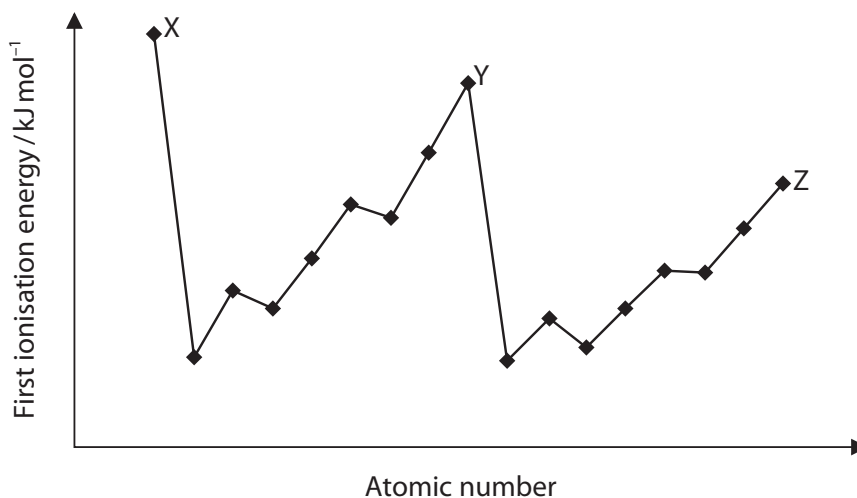
- ☐ A Ne only  
☐ B Ne and  $\text{F}^-$  only  
☐ C Ne and  $\text{Na}^+$  only  
☐ D Ne,  $\text{F}^-$  and  $\text{Na}^+$

(Total for Question 14 = 1 mark)

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- 15 The graph shows the variation of first ionisation energy with atomic number for successive elements in the Periodic Table.



The elements X, Y and Z are

- ☐ A alkali metals.  
☐ B alkaline earth metals.  
☐ C halogens.  
☐ D noble gases.

(Total for Question 15 = 1 mark)

- 16 The electrostatic interactions involved in a covalent bond are electron-electron, nucleus-nucleus and electron-nucleus. What types of interaction occur?

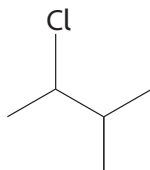
|                            | electron-electron | nucleus-nucleus | electron-nucleus |
|----------------------------|-------------------|-----------------|------------------|
| <input type="checkbox"/> A | attraction        | attraction      | repulsion        |
| <input type="checkbox"/> B | repulsion         | repulsion       | attraction       |
| <input type="checkbox"/> C | attraction        | repulsion       | attraction       |
| <input type="checkbox"/> D | repulsion         | attraction      | attraction       |

(Total for Question 16 = 1 mark)

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17 What is the name of the organic compound with the structure shown?



- ☐ A 2-chloro-1,1-dimethylpropane  
☐ B 2-chloro-3,3-dimethylpropane  
☐ C 2-chloro-3-methylbutane  
☐ D 1-chloro-2,3-dimethylbutane

(Total for Question 17 = 1 mark)

18 Methane is considered a better fossil fuel than coal because methane

- ☐ A is not a greenhouse gas.  
☐ B is mainly obtained from renewable sources.  
☐ C produces less carbon dioxide per kWh of power generated.  
☐ D has no effect on the ozone layer.

(Total for Question 18 = 1 mark)

19 How many  $\sigma$  bonds are there in the organic compound with the skeletal structure shown?



- ☐ A 2  
☐ B 3  
☐ C 10  
☐ D 11

(Total for Question 19 = 1 mark)

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**20** But-2-ene reacts with acidified potassium manganate(VII) at room temperature.  
The organic product of this reaction is

- ☐ **A** butane-1,2-diol.
- ☐ **B** butane-1,3-diol.
- ☐ **C** butane-1,4-diol.
- ☐ **D** butane-2,3-diol.

(Total for Question 20 = 1 mark)

**TOTAL FOR SECTION A = 20 MARKS**

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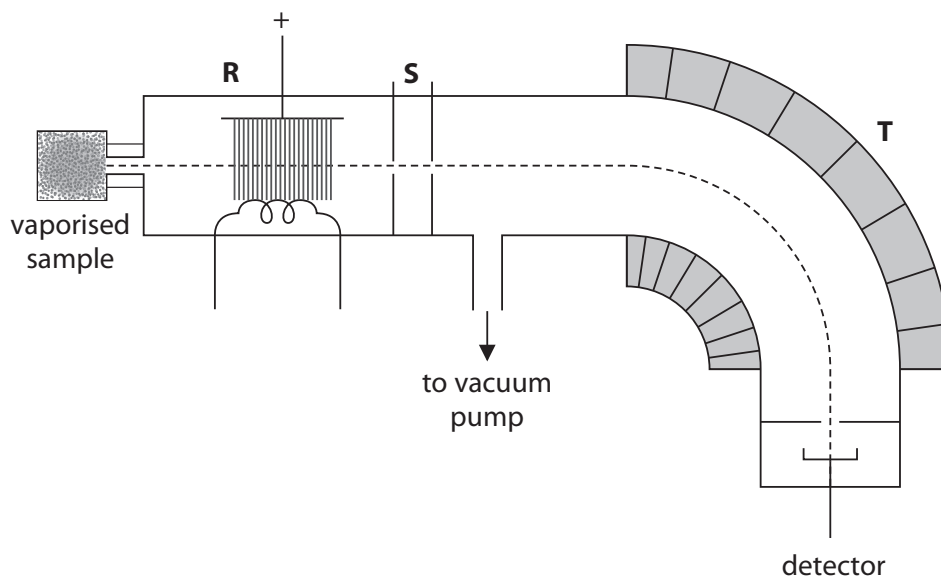
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## SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

- 21 Mass spectrometry is used to determine the relative atomic masses of elements. The diagram shows the main features of a mass spectrometer.



- (a) After vaporisation, the sample passes through three stages before reaching the detector.
- (i) The first stage is ionisation, which occurs at **R**. Describe fully the ionisation process for the element nickel, Ni, writing an equation to illustrate it.

State symbols are not required.

(2)

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- (ii) Describe the processes occurring at **S** and **T**.

(2)

**S** .....

.....

**T** .....

.....



P 5 4 4 5 7 A 0 1 1 2 4

(iii) Explain why the sample needs to be ionised.

(1)

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(b) The tallest peak in a mass spectrum (called the base peak) is given a height of 100 and the heights of all the other peaks are given relative to the base peak. A sample of the element nickel is analysed in a mass spectrometer and found to have two significant peaks.

| m / e | Relative peak height |
|-------|----------------------|
| 58    | 100                  |
| 60    | 39.8                 |

(i) Calculate the relative atomic mass of nickel in this sample.  
Give your answer to one decimal place.

(2)

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- (ii) Use the relative peak heights to calculate the percentage abundance of the two isotopes in the sample.

(2)

- (iii) The mass spectrum of this sample of nickel had a very small peak at  $m/e = 29$ . Identify the species responsible for this peak. Write an equation to show how it is formed.

State symbols are not required.

(2)

- (c) Mass spectrometry is also used to identify chemical compounds. State **one** application for this use of the technique.

(1)

(Total for Question 21 = 12 marks)



**22** Enthalpy changes of combustion are very important in thermochemistry because they can be used to determine enthalpy changes that cannot be measured directly.

(a) Define standard enthalpy change of combustion.

(2)

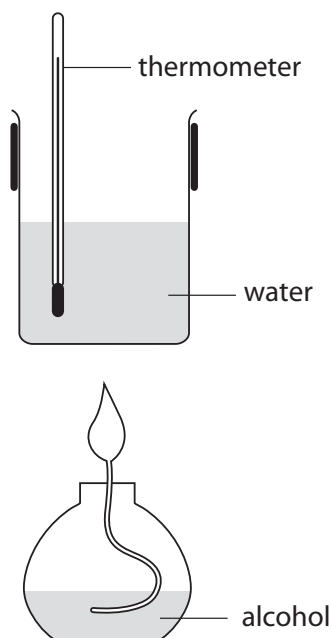
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(b) A class of students used the apparatus below to determine the enthalpy change of combustion for some alcohols.



One student obtained the following results for ethanol.

| Measurement              | Value  |
|--------------------------|--------|
| Mass of water / g        | 250.00 |
| Mass of ethanol used / g | 0.55   |
| Temperature rise / °C    | 9.5    |



- (i) Calculate the energy transferred in the student's experiment.

(1)

Use the expression

Energy transferred (J) = mass of water  $\times$  4.18  $\times$  temperature change

- (ii) Calculate the enthalpy change of combustion of ethanol.  
Give a sign and units with your answer.

(3)

- (c) Most of the students obtained similar results for the enthalpy change of combustion of ethanol. The class mean was  $-840 \text{ kJ mol}^{-1}$  compared with the Data Book value of  $-1367 \text{ kJ mol}^{-1}$ .

- (i) Calculate the percentage error in the mean value obtained by the class compared to the Data Book value.

(1)



\*(ii) One student suggested that the difference between the students' values and the Data Book value was due to the uncertainties in measuring the masses and temperatures. Explain why this suggestion is incorrect.

No calculation is required.

(2)

\*(iii) Suggest **one** factor that could have caused the difference between the students' values and the Data Book value. Justify your answer.

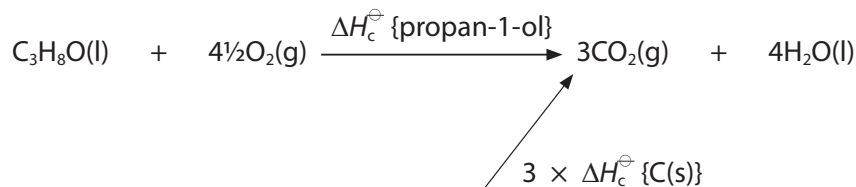
(2)



(d) The standard enthalpy change of formation of propan-1-ol cannot be measured directly.

- (i) Complete the Hess cycle below, which may be used to calculate the standard enthalpy change of formation of propan-1-ol. Add missing enthalpy changes, arrows and species. Include state symbols.

(3)



.....( ) + .....( ) + .....( )

- (ii) Use your completed cycle in (d)(i) and the data in the table, to calculate the standard enthalpy change of formation of propan-1-ol.

(2)

| Substance   | $\Delta H_c^\ominus / \text{kJ mol}^{-1}$ |
|-------------|-------------------------------------------|
| carbon      | –394                                      |
| hydrogen    | –286                                      |
| propan-1-ol | –2021                                     |

(Total for Question 22 = 16 marks)



**23** This question is about the bonds that chlorine forms in its chemical compounds.

(a) Chlorine forms a covalent bond in its compound with hydrogen.

(i) Give the electronic configuration of chlorine using the s p d notation.

(1)

(ii) Draw a dot-and-cross diagram of hydrogen chloride, showing outer electrons only.

(1)

(iii) Describe fully the formation of the covalent bond in hydrogen chloride in terms of orbital overlap.

(3)

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- (b) Chlorine forms ionic bonds with metals such as sodium and silver. The lattice energies of ionic compounds provide information about their bonds. The table below shows the experimental and calculated values for the lattice energy of sodium chloride and silver chloride.

| Compound        | Lattice energy / $\text{kJ mol}^{-1}$ |            |
|-----------------|---------------------------------------|------------|
|                 | Experimental                          | Calculated |
| sodium chloride | -780                                  | -770       |
| silver chloride | -905                                  | -833       |

- (i) Draw a dot-and-cross diagram of sodium chloride, showing outer electrons only.

(1)

- \*(ii) Explain why the experimental and calculated values for the lattice energy of sodium chloride are similar whereas those for silver chloride differ significantly.

(3)

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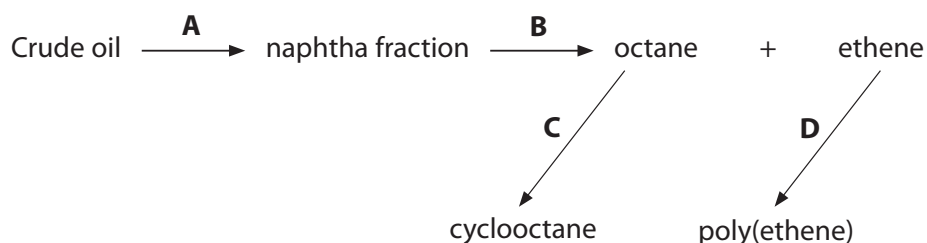
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(Total for Question 23 = 9 marks)



- 24** The diagram summarises some of the processes involved in the production of alkanes from crude oil, and their uses.



- (a) Name the processes shown in the diagram.

(4)

A.....

B.....

C.....

D.....

- (b) State what happens to the compounds present in crude oil during process **A**. Identify the property of the compounds which allows this process to work.

(2)

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- (c) The naphtha fraction comprises alkanes with a minimum of four and a maximum of ten carbon atoms. Write an equation for the formation of octane and ethene in process **B**. State symbols are not required.

(2)



- (d) (i) Write an equation for the reaction occurring in process **C**.  
State symbols are not required.

(1)

- (ii) Octane is converted into cyclooctane on a large scale.  
Explain why cyclooctane is added to petrol.

(2)

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- (e) Using displayed formulae, write a balanced equation for process **D**.  
State symbols are not required.

(2)

(Total for Question 24 = 13 marks)



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25 Alkanes and alkenes react with halogens.

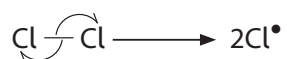
(a) The reaction of methane with chlorine is a free radical substitution.



(i) State the essential condition for this reaction.

(1)

(ii) The first stage in the mechanism of this reaction is the formation of the chlorine free radical.



Explain fully what a curly half-arrow represents in this equation.

(2)

(iii) Write the two equations of the propagation stage of the reaction.  
Curly half-arrows are **not** required.

(2)

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- (iv) Chloromethane is also formed in the termination stage of the reaction.  
Explain why the amount of chloromethane formed in the propagation stage is very much greater than the amount formed in the termination stage.

(3)

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- (b) Bromine reacts with propene in normal laboratory conditions.

- (i) State the type and mechanism of this reaction.

(1)

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- (ii) Draw the structure of the product of this reaction.

(1)

(Total for Question 25 = 10 marks)

**TOTAL FOR SECTION B = 60 MARKS**  
**TOTAL FOR PAPER = 80 MARKS**



## 24

P 5 4 4 5 7 A 0 2 4 2 4