



Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE
NAME

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CENTRE
NUMBER

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CHEMISTRY

5070/22

Paper 2 Theory

October/November 2016

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

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

DO **NOT** WRITE IN ANY BARCODES.

Section A

Answer **all** questions.

Write your answers in the spaces provided in the Question Paper.

Section B

Answer any **three** questions.

Write your answers in the spaces provided in the Question Paper.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

A copy of the Periodic Table is printed on page 20.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **18** printed pages and **2** blank pages.

Section A

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

A1 Choose from the following compounds to answer the questions below.



Each of these compounds can be used once, more than once or not at all.

Give a compound which

(a) is an acidic atmospheric pollutant from volcanic eruptions,

.....[1]

(b) is a saturated hydrocarbon,

.....[1]

(c) dissolves in water to form an aqueous solution which gives a white precipitate on addition of aqueous sodium hydroxide,

.....[1]

(d) reduces iron(III) oxide to iron in the blast furnace,

.....[1]

(e) contributes to the process of eutrophication.

.....[1]

[Total: 5]

A2 Farmers add fertilisers such as ammonium sulfate to the soil to increase the rate of plant growth.

(a) Write the formulae of the ions present in ammonium sulfate.

..... and [2]

(b) Describe a test for ammonium ions.

test

observation

[2]

(c) When ammonia dissolves in water, ammonium ions and hydroxide ions are formed.

Write the ionic equation for the reaction of aqueous ammonia with sulfuric acid.

.....[1]

[Total: 5]

A3 The alkanes are a homologous series of hydrocarbons.

(a) State **two** properties of a homologous series.

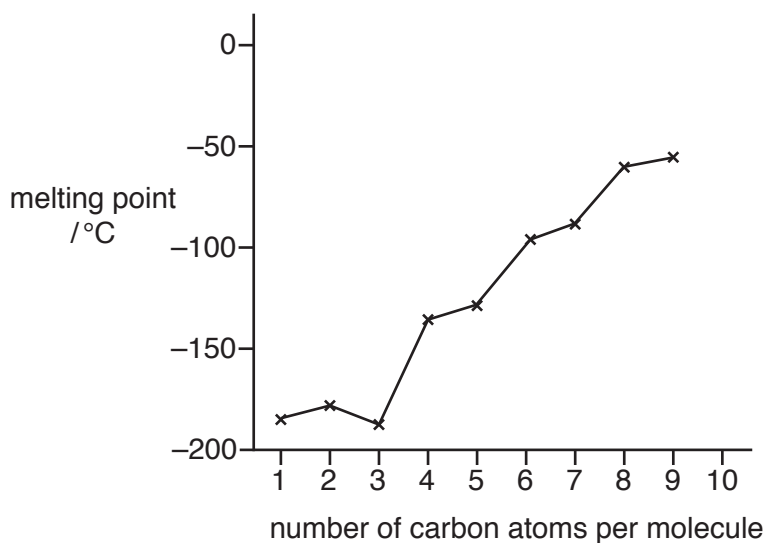
.....
.....[2]

(b) Draw the structures of the branched and unbranched alkanes having four carbon atoms.

Show all the atoms and all the bonds.

[2]

- (c) The graph shows how the melting points of the first nine unbranched alkanes vary with the number of carbon atoms per molecule.



- (i) Describe how the melting points of these alkanes change with the number of carbon atoms.

.....
.....
.....[2]

- (ii) Use the graph to estimate the melting point of the unbranched alkane which has ten carbon atoms.

.....°C [1]

- (d) (i) Construct the equation for the complete combustion of pentane, C_5H_{12} .

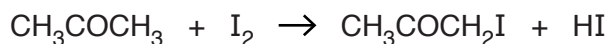
.....[2]

- (ii) Name the products of the incomplete combustion of pentane and explain why the incomplete combustion of hydrocarbons is hazardous to health.

.....
.....[2]

[Total: 11]

A4 Propanone, CH_3COCH_3 , reacts with iodine, I_2 , to form colourless products.



The reaction is catalysed by hydrochloric acid.

The table shows how the relative rate of this reaction changes when different concentrations of propanone, iodine and hydrochloric acid are used.

| experiment | concentration of CH_3COCH_3 in mol/dm^3 | concentration of I_2 in mol/dm^3 | concentration of hydrochloric acid in mol/dm^3 | relative rate of reaction |
|------------|--|--|---|---------------------------|
| 1 | 0.025 | 0.024 | 0.12 | 5.1 |
| 2 | 0.050 | 0.024 | 0.12 | 10.2 |
| 3 | 0.050 | 0.024 | 0.06 | 5.1 |
| 4 | 0.050 | 0.012 | 0.06 | 5.1 |

(a) Describe how increasing the concentration of each of these substances affects the relative rate of reaction.

propanone

iodine

hydrochloric acid

[3]

(b) Increasing the temperature increases the rate of this reaction.

Explain why, in terms of kinetic particle theory.

.....

.....

.....[2]

(c) Iodine has several isotopes.

What are isotopes?

.....

.....[1]

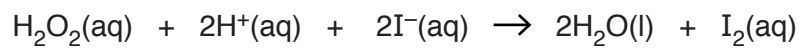
(d) Astatine, At, is a halogen.

Aqueous iodine reacts with aqueous astatide ions, At^- , to produce astatine.

Construct the ionic equation for this reaction.

.....[1]

(e) Aqueous hydrogen iodide reduces hydrogen peroxide to water.



Explain how iodide ions act as a reducing agent in this reaction.

.....
.....[1]

[Total: 8]

A5 Nickel carbonyl, $\text{Ni}(\text{CO})_4$, reacts with hydrogen iodide.



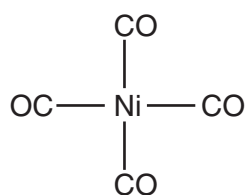
(a) Calculate the percentage by mass of nickel in nickel carbonyl.

..... % [2]

(b) Calculate the maximum volume of gas formed at room temperature and pressure when 1.71 g of nickel carbonyl reacts completely with hydrogen iodide.

maximum volume of gas formed [3]

(c) The structure of a nickel carbonyl molecule is shown.



Predict **two** physical properties of nickel carbonyl.

.....
.....[2]

- (d) The proton numbers and accurate relative atomic masses of cobalt and nickel are shown in the table.

| | cobalt | nickel |
|----------------------|--------|--------|
| proton number | 27 | 28 |
| relative atomic mass | 58.9 | 58.7 |

Suggest why cobalt has a higher relative atomic mass than nickel.

.....
.....
.....[2]

- (e) An aqueous solution of hydrogen iodide is a strong acid.

What is meant by the term *strong acid*?

.....
.....[1]

[Total: 10]

A6 Sodium and rubidium are alkali metals.

(a) Explain how metals conduct electricity.

.....[1]

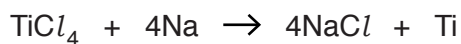
(b) State **two** trends in the properties of the alkali metals.

.....
.....[2]

(c) Name the products formed when rubidium reacts with water.

..... and [2]

(d) Titanium is extracted from titanium(IV) chloride by reduction with molten sodium.



Suggest why sodium reduces titanium(IV) chloride.

.....[1]

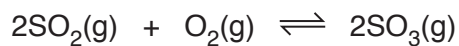
[Total: 6]

Section B

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

- B7** In the contact process, sulfur trioxide is made by the catalytic oxidation of sulfur dioxide. In a closed container the following equilibrium is set up.



The reaction is exothermic.

- (a)** Name the catalyst used in this reaction.

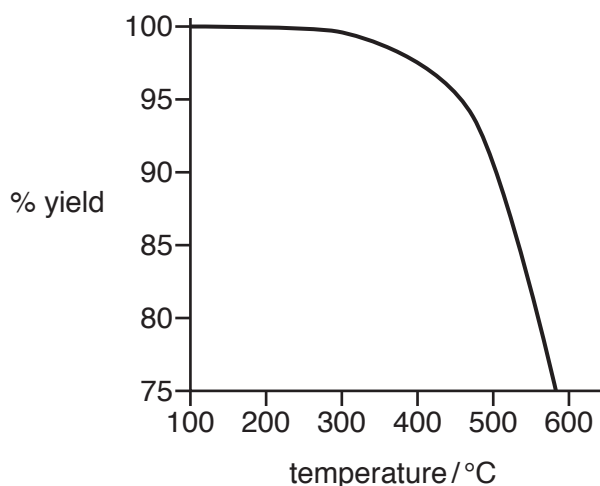
.....[1]

- (b)** Draw a 'dot-and-cross' diagram of an oxygen molecule.

Show only the outer shell electrons.

[1]

(c) The graph shows the percentage yield of sulfur trioxide at different temperatures.



(i) Describe how, and explain why, the percentage yield of sulfur trioxide changes with temperature.

.....

 [3]

(ii) Suggest why the reaction is carried out at 450 °C and not at 250 °C.

.....

 [2]

(d) Describe how, and explain why, the position of equilibrium changes when the pressure increases.

.....

 [2]

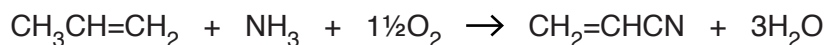
(e) Sulfur trioxide oxidises hydrogen bromide to form sulfur dioxide, bromine and water.

Construct the equation for this reaction.

..... [1]

[Total: 10]

B8 Propenenitrile, $\text{CH}_2=\text{CHCN}$, is made by passing a mixture of propene, ammonia and oxygen over a catalyst at 450°C .

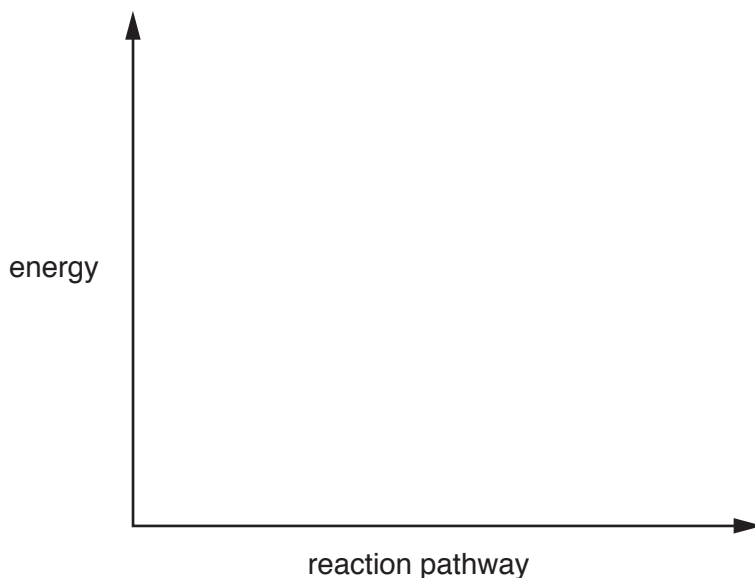


The reaction is exothermic.

(a) Draw an energy profile diagram for this reaction on the axes shown.

On your diagram label

- the reactants and products,
- the enthalpy change for the reaction,
- the activation energy.



[3]

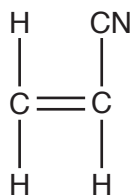
(b) Propenenitrile decolourises aqueous bromine.

Explain why.

.....

.....[1]

(c) The structure of propenenitrile is shown.



Draw the structure of the addition polymer formed from propenenitrile.

[2]

(d) The catalyst used in the reaction to make propenenitrile is molybdenum. Molybdenum is a transition element.

(i) State **two** physical properties of molybdenum.

.....
.....[2]

(ii) Molybdenum reacts with chlorine at room temperature to form molybdenum(VI) chloride, MoCl_6 . Molybdenum(VI) chloride has a melting point of 254°C .

Construct an equation for this reaction, including state symbols.

.....[2]

[Total: 10]

B9 Both copper and magnesium are metals.

(a) Explain why magnesium reacts with hydrochloric acid but copper does not.

.....[1]

(b) Brass is an alloy of copper and zinc. The table shows how the composition of brass influences its relative strength.

| composition of brass | | relative strength |
|----------------------|--------|-------------------|
| % copper | % zinc | |
| 90 | 10 | 2.6 |
| 80 | 20 | 3.0 |
| 70 | 30 | 3.3 |
| 60 | 40 | 3.6 |

How does the composition of brass affect its strength?

.....
.....[1]

(c) Use your knowledge of the structure of metals to explain why brass is stronger than pure copper.

You may include a labelled diagram in your answer.

.....
.....
.....
.....[3]

(d) Draw a labelled diagram to show how a steel rod can be electroplated with copper.

[3]

(e) A 11.09g sample of an oxide of copper contains 9.86g of copper.

Deduce the empirical formula of this oxide of copper.

empirical formula [2]

[Total: 10]

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