



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
NUMBER

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CHEMISTRY

5070/21

Paper 2 Theory

October/November 2010

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 a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, 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.

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.

For Examiner's Use

Section A

B6

B7

B8

B9

Total

This document consists of **16** printed pages and **4** blank pages.



Section A

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

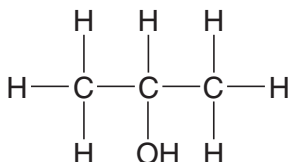
The total mark for this section is 45.

For
Examiner's
Use

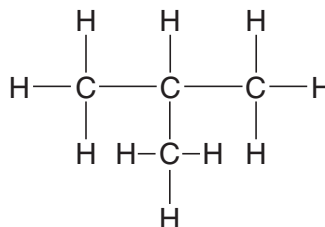
A1 The structural formulae of some compounds containing the element carbon are shown.



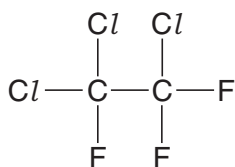
A



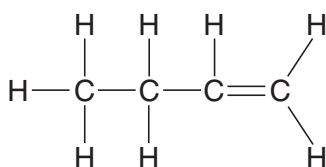
B



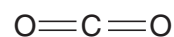
C



D



E



F

- (a) Choose from the compounds **A**, **B**, **C**, **D**, **E** and **F** to answer the questions below. Each compound can be used once, more than once or not at all.

Which one of these compounds is

- (i) responsible for the depletion of ozone in the upper atmosphere,

..... [1]

- (ii) a poisonous gas produced by the incomplete combustion of hydrocarbons,

..... [1]

- (iii) an unsaturated hydrocarbon, [1]

- (iv) formed when propene reacts with steam, [1]

- (v) a product of respiration, [1]

- (vi) an isomer of butane? [1]

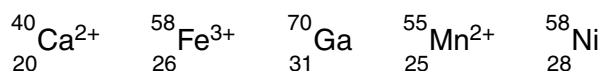
- (b) Name compound **B**.

..... [1]

[Total: 7]

A2 The symbols of some atoms and ions including their nucleon number and proton number are shown below.

For
Examiner's
Use



(a) Which **one** of these atoms or ions has the greatest number of protons?

.....[1]

(b) Which **two** of these atoms or ions have the same number of neutrons?

.....[1]

(c) State the number of electrons in the ion ${}^{55}_{25}\text{Mn}^{2+}$.

.....[1]

(d) Write the full electronic configuration of the ion ${}^{40}_{20}\text{Ca}^{2+}$.

.....[1]

(e) (i) Nickel, Ni, can be alloyed with other metals. Draw a diagram to show the structure of an alloy.

[2]

(ii) State **one** specific use of nickel other than its use in alloys.

.....[1]

(iii) Explain why alloys of nickel and iron are stronger than pure iron.

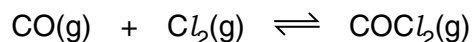
.....
.....

.....[2]

[Total:9]

- A3** Carbonyl chloride, COCl_2 , is a colourless, poisonous gas formed when carbon monoxide and chlorine combine in the presence of sunlight. The forward reaction is exothermic.

For
Examiner's
Use



- (a)** Predict and explain how each of the following affects the position of equilibrium in this reaction:

- (i)** increasing the concentration of chlorine;

.....

 [2]

- (ii)** increasing the pressure;

.....

 [2]

- (iii)** increasing the temperature.

.....

 [2]

- (b)** Carbonyl chloride reacts with ammonia to form urea, $(\text{NH}_2)_2\text{CO}$, and ammonium chloride.

Write an equation for this reaction.

..... [2]

(c) Urea can be used as a fertiliser.

For
Examiner's
Use

(i) How do fertilisers increase crop yields?

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

(ii) Urea is produced industrially by the reaction of ammonia with carbon dioxide.

The ammonia is manufactured using the Haber process by combining the elements nitrogen and hydrogen.

State the essential conditions in the Haber process which are necessary in order to produce a high yield of ammonia.

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

[Total: 12]

A4 Many inks contain salts of the metals potassium, iron, cobalt and nickel in addition to ethanoic acid and gallic acid.

For
Examiner's
Use

(a) (i) State **two** differences in the physical properties of the metals potassium and iron.

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

(ii) State **one** difference in the chemical properties of potassium and iron.

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

(b) Analysis of 21.25 g of gallic acid showed that it contained 10.50 g of carbon, 0.75 g of hydrogen and 10.00 g of oxygen.

Show that the empirical formula of gallic acid is $C_7H_6O_5$.

[3]

(c) Gallic acid can be used as a photographic developer. It reduces silver ions to silver.

(i) Write an equation for the reduction of silver ions to silver.

[1]

(ii) Explain why this is a reduction reaction.

.....[1]

(d) The blue colour of ink is due to the reaction between gallic acid and iron(III) ions.

Describe a standard test for iron(III) ions.

test.....

result [2]

[Total: 10]

A5 A student electrolysed an aqueous solution of potassium bromide using carbon electrodes.

For
Examiner's
Use

(a) Draw a labelled diagram of a suitable apparatus that can be used for this electrolysis.

[2]

(b) The ions present in an aqueous solution of potassium bromide are H^+ , OH^- , K^+ and Br^- .

(i) Describe what you would observe in the region of the anode during the electrolysis.

.....[1]

(ii) At the cathode, hydrogen gas is given off.

Describe a test for hydrogen.

test

result[2]

(iii) Write an equation for the reaction at the cathode.

.....[1]

(iv) Explain why potassium is **not** discharged at the cathode.

.....

.....[1]

[Total: 7]

Section B

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

The total mark for this section is 30.

For
Examiner's
Use

- B6** Part of Mendeleev's original Periodic Table showing an arrangement of elements according to their similar properties is shown below. The numbers are the atomic masses of the elements.

			Fe = 56
			Ni / Co = 59
H = 1			Cu = 63.4
	Be = 9.4	Mg = 24	Zn = 65.2
	B = 11	Al = 27.4	element X
	C = 12	Si = 28	element Y
	N = 14	P = 31	As = 75
	O = 16	S = 32	Se = 74.9
	F = 19	Cl = 35.5	Br = 80
Li = 7	Na = 23	K = 39	Rb = 85.4
		Ca = 40	Sr = 87.6

- (a) Mendeleev listed the elements in order of their atomic masses.

What determines the order of the elements in the **modern** Periodic Table?

.....[1]

- (b) Mendeleev predicted the properties of the undiscovered element X. You will find element X in the table above.

Study the pattern in which the elements are arranged in the table above. Deduce to which Group in the **modern** Periodic Table element X belongs.

.....[1]

- (c) Describe **two** other differences between Mendeleev's original Periodic Table and the modern Periodic Table.

.....

.....

.....

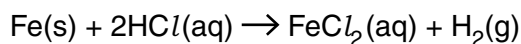
.....[2]

(d) Iron, cobalt and nickel have similar properties.

- (i) State the name of the block of elements in the modern Periodic Table which includes iron, cobalt and nickel.

..... [1]

- (ii) Iron reacts with dilute hydrochloric acid.



Use ideas about particles to describe and explain the effect of temperature on the speed of this reaction.

.....

 [2]

(e) Lithium, sodium and potassium are elements which show a trend in melting points and reaction with water.

- (i) Describe the trend in the reaction of these elements with water.

.....
 [1]

- (ii) Write an equation for the reaction of sodium with water.

[1]

(iii) The melting points of lithium, sodium and potassium are:

lithium 181 °C
 sodium 98 °C
 potassium 63 °C

Predict the melting point of rubidium.

..... [1]

[Total: 10]

- B7** The table shows the boiling points of the first four members of the alkane homologous series. It also shows the enthalpy changes when these alkanes undergo complete combustion.

For
Examiner's
Use

alkane	boiling point /°C	enthalpy change of combustion/kJ per mole
methane	– 161	– 890
ethane	– 88	–1560
propane	– 42	–2219
butane	0	–2877

- (a)** State **two** characteristics of a homologous series.

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

- (b)** Pentane is the next member of the alkane homologous series.

- (i)** Give the molecular formula of pentane.

..... [1]

- (ii)** Predict the boiling point of pentane.

..... [1]

- (c) (i)** What information in the table tells you that the combustion of alkanes is exothermic?

..... [1]

- (ii)** In terms of bond making and bond breaking, explain why the combustion of alkanes is exothermic.

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

- (iii) The difference in the enthalpy change of combustion from one alkane to the next is approximately the same. Suggest why.

For
Examiner's
Use

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

- (d) Methane is an atmospheric pollutant. Give one source of this pollutant.

.....[1]

[Total: 10]

B8 Proteins are naturally occurring macromolecules.

For
Examiner's
Use

- (a) (i)** What do you understand by the term *macromolecule*?

.....[1]

- (ii)** Name another naturally occurring macromolecule.

.....[1]

- (b)** Proteins can be hydrolysed to amino acids.

State a suitable reagent and condition for this hydrolysis.

reagent.....

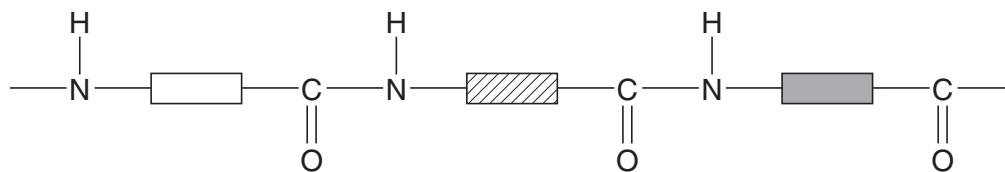
condition[2]

- (c)** The amino acids can be identified by paper chromatography.

Describe, with the aid of a labelled diagram, how paper chromatography can be used to identify particular amino acids.

.....
.....
.....
.....[4]

(d) The structure of a section of a protein can be represented as:



For
Examiner's
Use

(i) Describe **one** similarity in the structure of a protein and the structure of nylon.

..... [1]

(ii) Describe **one** way in which the structure of a protein differs from the structure of nylon.

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

[Total: 10]

- B9** Phosphine, PH_3 , is a gas which has a smell of garlic. It is formed when white phosphorus is warmed with aqueous sodium hydroxide.

For
Examiner's
Use



- (a)** Draw a 'dot-and-cross' diagram for phosphine.

Show only the outer electrons.

[1]

- (b) (i)** Calculate the maximum mass of phosphine formed when 1.86 g of phosphorus reacts with excess aqueous sodium hydroxide.

[2]

- (ii)** Calculate the volume of phosphine formed from 1.86 g of phosphorus at r.t.p.

[1]

- (c)** Phosphine decomposes into its elements on warming. Write an equation for this reaction.

.....[2]

- (d) Phosphine reacts with hydrogen iodide to form the salt phosphonium iodide, PH_4I .

Phosphonium salts react in a similar way to ammonium salts when warmed with aqueous sodium hydroxide.

For
Examiner's
Use

- (i) Write an equation for the reaction of phosphonium iodide with aqueous sodium hydroxide.

.....[1]

- (ii) What should you notice when sodium hydroxide is warmed with phosphonium iodide?

.....[1]

- (e) Phosphine is formed when water reacts with calcium phosphide, Ca_3P_2 .

Calcium phosphide is an ionic compound.

- (i) Write the formula for the phosphide ion.

.....[1]

- (ii) Predict one physical property of calcium phosphide.

.....[1]

[Total: 10]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II							III	IV	V	VI	VII	O				
1HHydrogen1																	
7LiLithium3	9BeBeryllium4							11BBoron5	12CCarbon6	14NNitrogen7	16OOxygen8	19FFluorine9	20NeNeon10				
23NaSodium11	24MgMagnesium12							27AlAluminium13	28SiSilicon14	31PPhosphorus15	32SSulfur16	35.5ClChlorine17	40ArArgon18				
39KPotassium19	40CaCalcium20	45ScScandium21	48TiTitanium22	51VVanadium23	52CrChromium24	55MnManganese25	56FeIron26	59CoCobalt27	59NiNickel28	64CuCopper29	65ZnZinc30	70GaGallium31	73GeGermanium32	75AsArsenic33	79SeSelenium34	80BrBromine35	84KrKrypton36
85RbRubidium37	88SrStrontium38	89YYttrium39	91ZrZirconium40	93NbNiobium41	96MoMolybdenum42	99TcTechnetium43	101RuRuthenium44	103RhRhodium45	106PdPalladium46	108AgSilver47	112CdCadmium48	115InIndium49	119SnTin50	122SbAntimony51	128TeTellurium52	127IIodine53	131XeXenon54
133CsCaesium55	137BaBarium56	139LaLanthanum57	178HfHafnium72	181TaTantalum73	184WTungsten74	186ReRhenium75	190OsOsmium76	192IrIridium77	195PtPlatinum78	197AuGold79	201HgMercury80	204TlThallium81	207PbLead82	210BiBismuth83	209PoPolonium84	210AtAstatine85	222RnRadon86
223FrFrancium87	226RaRadium88	227AcActinium89															
* 58–71 Lanthanoid series																	
† 90–103 Actinoid series																	
a X b a = relative atomic mass X = atomic symbol b = atomic (proton) number																	
Key																	
175LuLutetium71																	
173YbYtterbium70																	
169TmThulium69																	
167ErErbium68																	
165HoHolmium67																	
162DyDysprosium66																	
159TbTerbium65																	
157GdGadolinium64																	
152EuEuropium63																	
150SmSamarium62																	
147PmPromethium61																	
144NdNeodymium60																	
141PrPraseodymium59																	
140CeCerium58																	
238UUranium92																	
237NpNeptunium93																	
231PaProtactinium91																	
232ThThorium90																	
247BkBerkelium97																	
251CfCalifornium98																	
252EsEinsteinium99																	
257FmFermium100																	
258MdMendelevium101																	
259NoNobelium102																	
260LrLawrencium103																	