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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

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CHEMISTRY

0620/31

Paper 3 (Extended)

October/November 2013

1 hour 15 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 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.

Answer **all** questions.

Electronic calculators may be used.

A copy of the Periodic Table is printed on page 16.

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

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 **14** printed pages and **2** blank pages.



1 For each of the following, name an element which matches the description.

(a) It is used as a fuel in nuclear reactors.

..... [1]

(b) It is the only non-metal which is a good conductor of electricity.

..... [1]

(c) Inert electrodes are made from this metal.

..... [1]

(d) This gaseous element is used to fill balloons in preference to hydrogen.

..... [1]

(e) An element which can form an ion of the type X^{3-} .

..... [1]

(f) It has the same electron distribution as the calcium ion, Ca^{2+} .

..... [1]

(g) The element is in Period 5 and Group VI.

..... [1]

[Total: 7]

- 2 (a) Give **three** differences in physical properties between the Group I metal, potassium, and the transition element, iron.

1.
2.
3. [3]

- (b) The following metals are in order of reactivity.

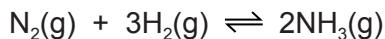
potassium
zinc
copper

For those metals which react with water or steam, name the products of the reaction, otherwise write 'no reaction'.

potassium
.....
zinc
.....
copper
..... [5]

[Total: 8]

- 3 Ammonia is manufactured by the Haber process.



The forward reaction is exothermic.

- (a) Describe how the reactants are obtained.

- (i) Nitrogen

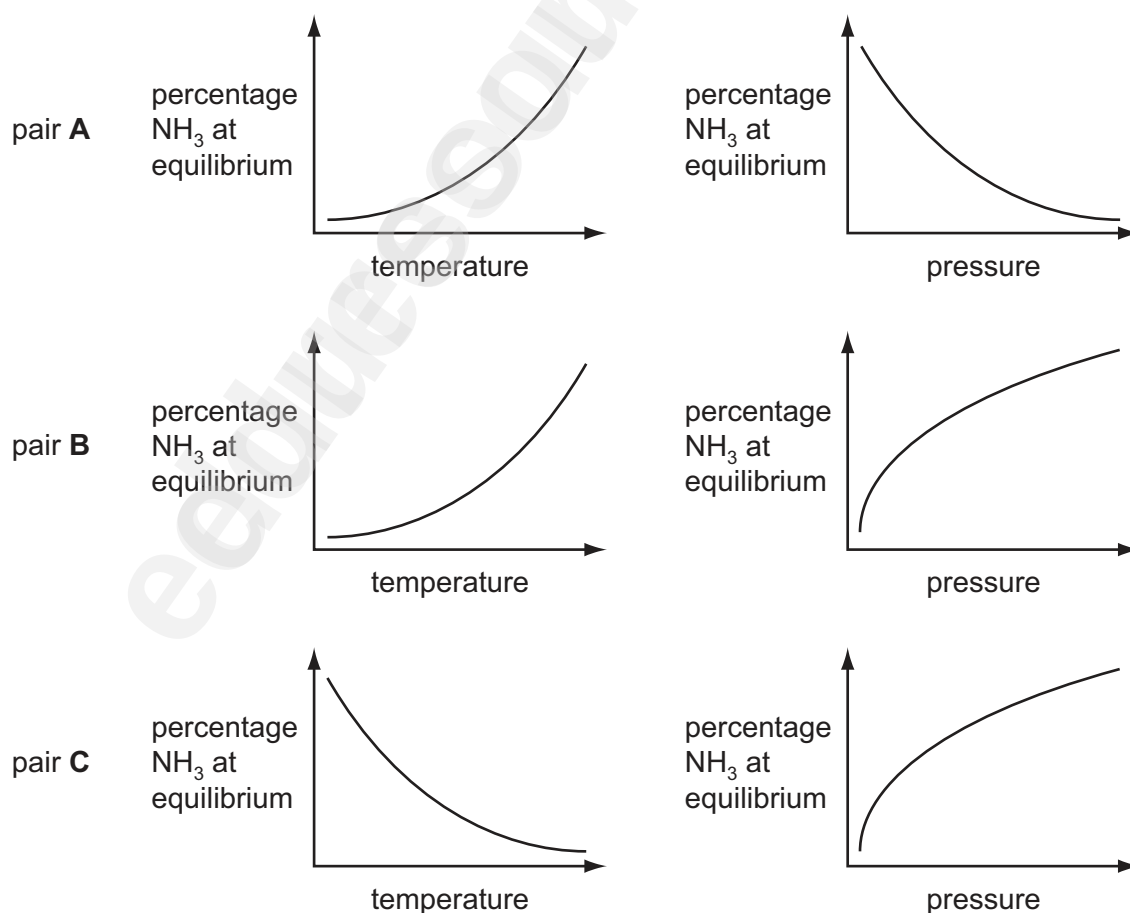
.....
..... [2]

- (ii) Hydrogen

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

- (b) The percentage of ammonia in the equilibrium mixture varies with temperature and pressure.

- (i) Which pair of graphs, **A**, **B** or **C**, shows correctly how the percentage of ammonia at equilibrium varies with temperature and pressure?



The pair with **both** graphs correct is [1]

- (ii) Give a full explanation of why the pair of graphs you have chosen in (i) is correct.

.....

.....

.....

.....

.....

.....

..... [6]

- (iii) Catalysts do not alter the position of equilibrium. Explain why a catalyst is used in this process.

.....

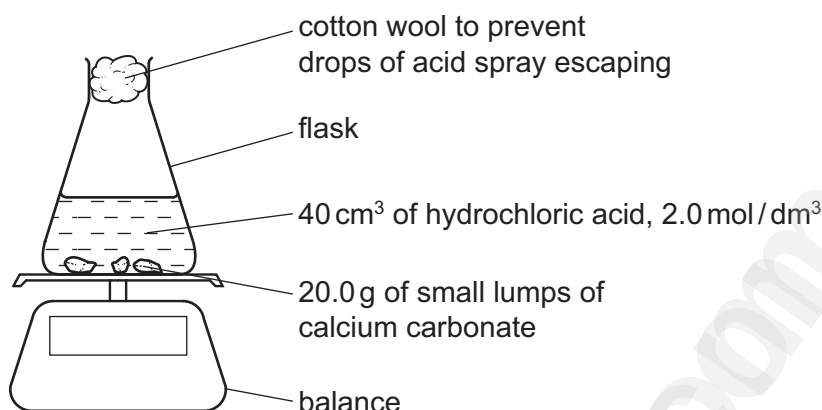
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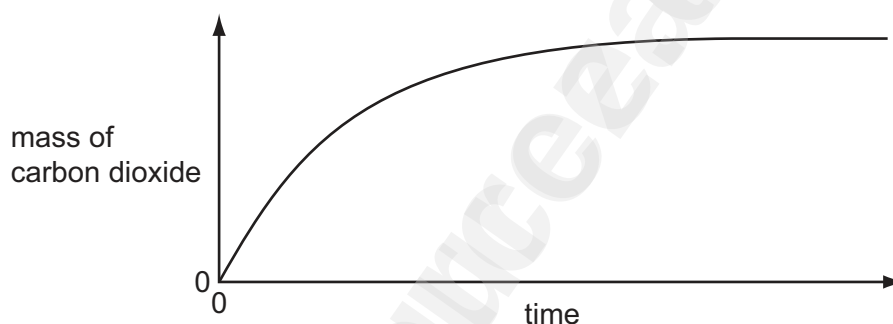
..... [2]

[Total: 14]

- 4 20.0 g of small lumps of calcium carbonate and 40 cm³ of hydrochloric acid, concentration 2.0 mol/dm³, were placed in a flask on a top pan balance. The mass of the flask and contents was recorded every minute.



The mass of carbon dioxide given off was plotted against time.



In all the experiments mentioned in this question, the calcium carbonate was in excess.

- (a) (i) Explain how you could determine the mass of carbon dioxide given off in the first five minutes.

..... [1]

- (ii) Label the graph **F** where the reaction rate is the fastest, **S** where it is slowing down and **0** where the rate is zero. [2]

- (iii) Explain how the shape of the graph shows where the rate is fastest, where it is slowing down and where the rate is zero.

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

- (b) Sketch on the same graph, the line which would have been obtained if 20.0 g of small lumps of calcium carbonate and 80 cm³ of hydrochloric acid, concentration 1.0 mol/dm³, had been used. [2]

(c) Explain in terms of collisions between reacting particles each of the following.

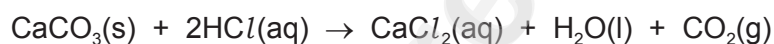
- (i) The reaction rate would be slower if 20.0 g of larger lumps of calcium carbonate and 40 cm³ of hydrochloric acid, concentration 2.0 mol/dm³, were used.

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

- (ii) The reaction rate would be faster if the experiment was carried out at a higher temperature.

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

- (d) Calculate the maximum mass of carbon dioxide given off when 20.0 g of small lumps of calcium carbonate react with 40 cm³ of hydrochloric acid, concentration 2.0 mol/dm³.



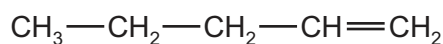
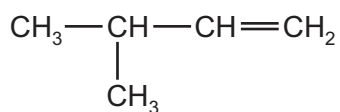
number of moles of HCl used =

mass of carbon dioxide = ... g [4]

[Total: 15]

- 5 The alkenes are unsaturated hydrocarbons. They form a homologous series, the members of which have the same chemical properties.
They undergo addition reactions and are easily oxidised.

(a) The following hydrocarbons are isomers.



(i) Explain why these two hydrocarbons are isomers.

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

(ii) Give the structural formula of another hydrocarbon which is isomeric with the above.

[1]

(b) Give the structural formula and name of each of the products of the following addition reactions.

(i) ethene and bromine

structural formula of product

name of product [2]

(ii) propene and hydrogen

structural formula of product

name of product [2]

(iii) but-1-ene and water

structural formula of product

name of product [2]

(c) Alkenes can be oxidised to carboxylic acids.

- (i) For example, propene, $\text{CH}_3-\text{CH}=\text{CH}_2$, would produce ethanoic acid, CH_3-COOH , and methanoic acid, $\text{H}-\text{COOH}$. Deduce the formulae of the alkenes which would form the following carboxylic acids when oxidised.

ethanoic acid and propanoic acid

only ethanoic acid

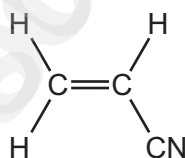
[2]

- (ii) Describe the colour change you would observe when an alkene is oxidised with acidified potassium manganate(VII).

[2]

(d) Alkenes polymerise to form addition polymers.

Draw the structural formula of poly(cyanoethene), include at least **two** monomer units. The structural formula of the monomer, cyanoethene, is given below.



[3]

[Total: 16]

- 6 Lead is an excellent roofing material. It is malleable and resistant to corrosion. Lead rapidly becomes coated with basic lead carbonate which protects it from further corrosion.

(a) Lead has a typical metallic structure which is a lattice of lead ions surrounded by a 'sea' of mobile electrons. This structure is held together by attractive forces called a metallic bond.

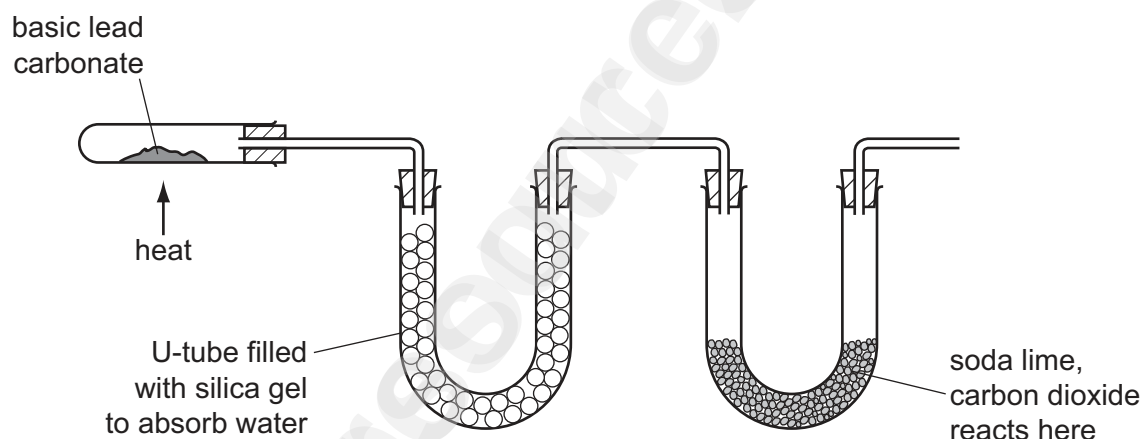
(i) Explain why there are attractive forces in a metallic structure.

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

(ii) Explain why a metal, such as lead, is malleable.

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

(b) Basic lead(II) carbonate is heated in the apparatus shown below. Water and carbon dioxide are produced.



(i) Silica gel absorbs water. Silica gel often contains anhydrous cobalt(II) chloride. When this absorbs water it changes from blue to pink. Suggest a reason.

..... [1]

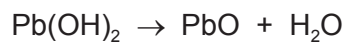
(ii) Soda lime is a mixture of sodium hydroxide and calcium oxide. Why do these two substances react with carbon dioxide?

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

(iii) Name **two** substances formed when soda lime reacts with carbon dioxide.

..... [2]

- (c) Basic lead(II) carbonate has a formula of the type $x\text{PbCO}_3 \cdot y\text{Pb(OH)}_2$ where x and y are whole numbers.
Determine x and y from the following information.



When heated, the basic lead(II) carbonate gave 2.112 g of carbon dioxide and 0.432 g of water.

Mass of one mole of CO_2 = 44 g

Mass of one mole of H_2O = 18 g

Number of moles of CO_2 formed = ... [1]

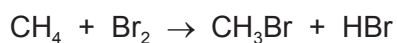
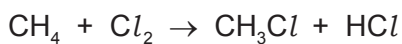
Number of moles of H_2O formed = ... [1]

x = ... and y = ...

Formula of basic lead(II) carbonate is [1]

[Total: 12]

- 7 (a) The following are two examples of substitution reactions. Only the reaction involving chlorine is a photochemical reaction.



- (i) Explain the phrase *substitution reaction*.

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

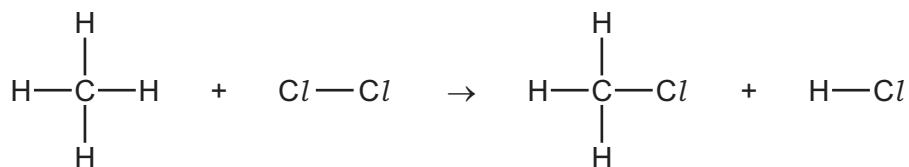
- (ii) How do photochemical reactions differ from other reactions?

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

- (b) Bond forming is exothermic, bond breaking is endothermic. Explain the difference between an exothermic reaction and an endothermic reaction.

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

- (c) Use the bond energies to show that the following reaction is exothermic.
Bond energy is the amount of energy (kJ/mol) which must be supplied to break one mole of the bond.



Bond energies in kJ/mol

Cl-Cl +242

C-Cl +338

C-H +412

H-Cl +431

bonds broken energy in kJ/mol

.....

.....

total energy = ...

bonds formed energy in kJ/mol

.....

.....

total energy = ...

.....

..... [4]

[Total: 8]

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DATA SHEET
The Periodic Table of the Elements

Group																		
I	II											III	IV	V	VI	VII	0	
												1 H Hydrogen 1						4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4																	
23 Na Sodium 11	24 Mg Magnesium 12											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10	
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36	
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	101 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54	
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86	
87 Fr Francium	226 Ra Radium	227 Ac Actinium																
58-71 Lanthanoid series																		
90-103 Actinoid series																		
a X b a = relative atomic mass X = atomic symbol b = proton (atomic) number																		
			140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	144 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71		
			232 Th Thorium 90	232 Pa Protactinium 91	238 U Uranium 92	238 Np Neptunium 93	244 Pu Plutonium 94	244 Am Americium 95	247 Cm Curium 96	250 Bk Berkelium 97	259 Cf Californium 98	267 Es Einsteinium 99	271 Fm Fermium 100	277 Md Mendelevium 101	285 No Nobelium 102	289 Lr Lawrencium 103		

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

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