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CHEMISTRY

0620/43

Paper 4 Theory (Extended)

May/June 2020

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Blank pages are indicated.

(viii) Draw a structural isomer of compound **D**.

Show all of the atoms and all of the bonds.

[1]

(b) Some acids are described as weak acids.

State the meaning of the term *weak acid*.

weak

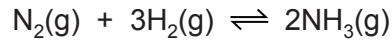
acid

[2]

[Total: 10]

2 Ammonia is manufactured by the Haber process.

(a) The equation for the reaction is shown.



(i) State what is meant by the symbol \rightleftharpoons .

..... [1]

(ii) State **one** source of hydrogen used in the manufacture of ammonia.

..... [1]

(b) The table shows some data for the production of ammonia.

pressure / atm	temperature / °C	percentage yield of ammonia
250	350	58
100	450	28
400	450	42
250	550	20

Deduce the effect on the percentage yield of ammonia of:

- increasing the pressure of the reaction

.....

- increasing the temperature of the reaction.

.....

[2]

(c) Explain, in terms of particles, what happens to the rate of this reaction when the temperature is increased.

.....

.....

.....

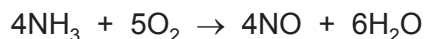
.....

.....

..... [3]

(d) Ammonia, NH_3 , is used to produce nitric acid, HNO_3 . This happens in a three-stage process.

Stage 1 is a redox reaction.



(i) Identify what is oxidised in **stage 1**.

Give a reason for your answer.

substance oxidised

reason

.....

[2]

(ii) In this reaction the predicted yield of NO is 512g. The actual yield is 384g.

Calculate the percentage yield of NO in this reaction.

percentage yield of NO = [1]

(iii) The equation for the reaction in **stage 2** is shown.

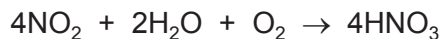


Which major environmental problem does NO_2 cause if it is released into the atmosphere?

.....

..... [1]

(iv) The equation for the reaction in **stage 3** is shown.



Calculate the volume of O_2 gas, at room temperature and pressure (r.t.p.), needed to produce 1260 g of HNO_3 .
Use the following steps.

- Calculate the number of moles of HNO_3 .

moles of HNO_3 =

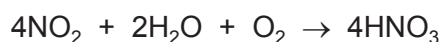
- Deduce the number of moles of O_2 that reacted.

moles of O_2 =

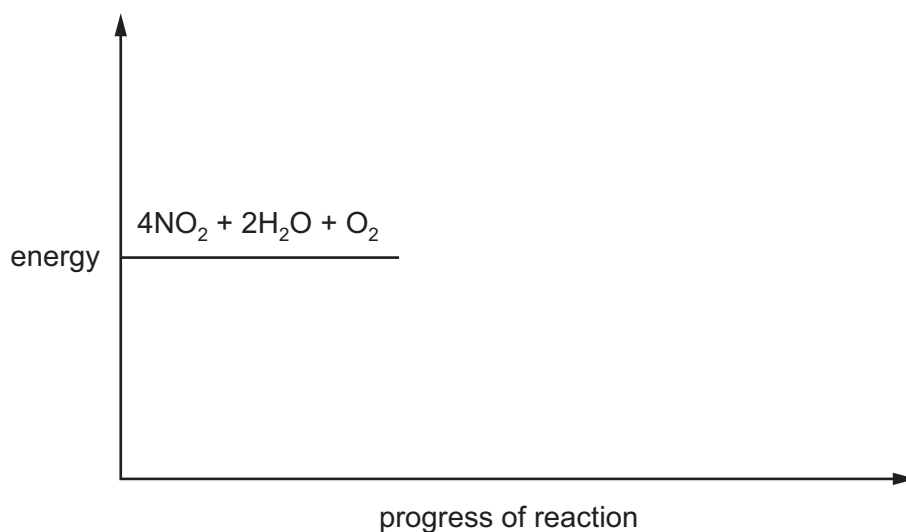
- Calculate the volume of O_2 gas that reacts at room temperature and pressure (r.t.p.).

volume of O_2 gas = dm^3
[4]

(e) The reaction in **stage 3** is exothermic.



Complete the energy level diagram for this reaction. Include an arrow that clearly shows the energy change during the reaction.



[3]

[Total: 18]

3 Chlorine is in Group VII of the Periodic Table.

(a) Two isotopes of chlorine are chlorine-35 and chlorine-37.

(i) State why these two isotopes of chlorine have the same chemical properties.

.....

 [2]

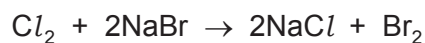
(ii) Complete the table to show the number of electrons, neutrons and protons in each atom and ion.

	number of electrons	number of neutrons	number of protons
$^{35}_{17}\text{Cl}$			
$^{37}_{17}\text{Cl}^-$			

[3]

(b) (i) Chlorine reacts with aqueous sodium bromide.

The equation for the reaction is shown.



State the type of reaction shown.

..... [1]

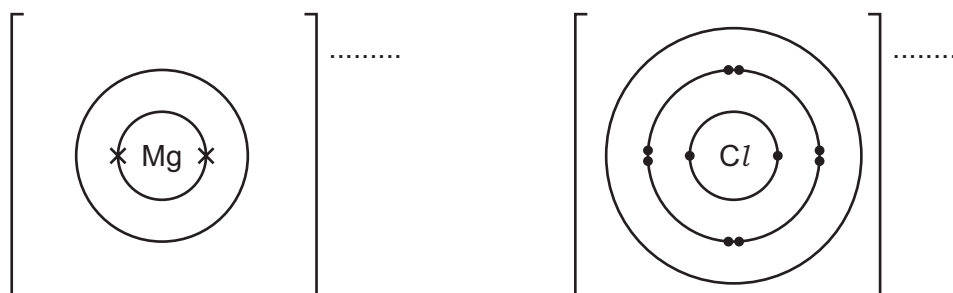
(ii) Why is there **no** reaction between iodine and aqueous sodium bromide?

..... [1]

(c) Magnesium reacts with chlorine to form magnesium chloride.

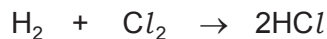
Complete the dot-and-cross diagram to show the electron arrangement of the ions in magnesium chloride. Give the charges on the ions.

The inner shells have been completed.

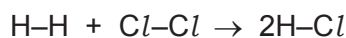


[3]

(d) Hydrogen and chlorine react to form hydrogen chloride gas, as shown in the equation.



This equation can be represented as shown.



Some bond energies are shown in the table.

bond	bond energy in kJ/mol
H-H	436
Cl-Cl	243
H-Cl	432

Calculate the energy change for the reaction between hydrogen and chlorine, using the following steps.

- Calculate the energy needed to break the bonds.

..... kJ

- Calculate the energy released when bonds are formed.

..... kJ

- Calculate the energy change for the reaction.

..... kJ/mol
[3]

[Total: 13]

- 4 (a) Filtration and chlorination are two stages in water treatment.

State the purpose of each stage.

filtration

.....

chlorination

.....

[2]

- (b) A student uses anhydrous copper(II) sulfate to test for the presence of water.

- (i) What colour change is seen if water is present?

from to [2]

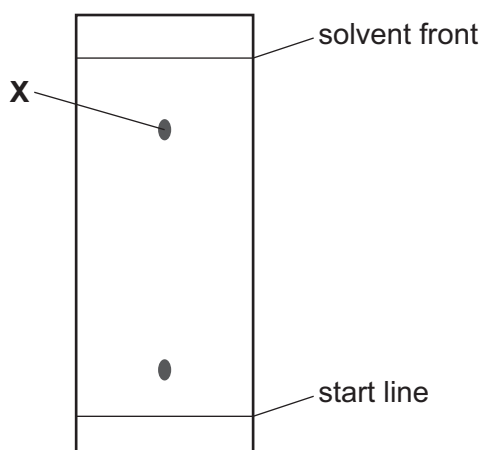
- (ii) The purity of a sample of water can be assessed by measuring its boiling point.

How is the boiling point of water affected by impurities?

..... [1]

- (c) Chromatography can be used to test the purity of substances.

The diagram shows the chromatogram of a coloured substance.



- (i) How does this chromatogram show that this substance is **not** pure?

..... [1]

- (ii) Draw a circle round the correct R_f value for the spot labelled **X**.

0.2 0.4 0.8 1.2 [1]

- (iii) State how a colourless substance can be made visible on a chromatogram.

..... [1]

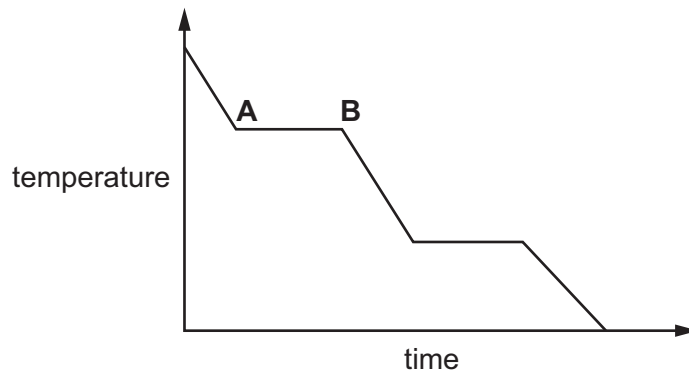
[Total: 8]

5 (a) Complete the table about solids, liquids and gases.

	particle separation	particle arrangement	type of motion
solid		regular	vibrate only
liquid	touching		random
gas	apart	random	

[3]

(b) The graph shows the change in temperature as a sample of a gas is cooled.



Name the change of state taking place between **A** and **B**.

..... [1]

(c) A bottle of liquid perfume is left open at the front of a room.

After some time, the perfume is smelt at the back of the room.

Name the **two** physical processes taking place.

1

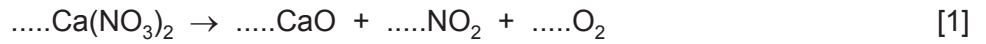
2

[2]

[Total: 6]

6 (a) An endothermic reaction occurs when calcium nitrate is heated.

(i) Balance the equation for this reaction.



(ii) State the type of reaction shown by the equation.

..... [1]

(b) Describe the test for a nitrate ion.

test

.....

result

.....

[3]

[Total: 5]

7 Aluminium is extracted by electrolysis. Iron is extracted from its ore by reduction with carbon.

(a) What is meant by the term *electrolysis*?

.....
 [2]

(b) Name the main ore of aluminium.

..... [1]

(c) (i) Explain why aluminium **cannot** be extracted by reduction with carbon.

..... [1]

(ii) Describe the role of cryolite in the extraction of aluminium by electrolysis.

..... [1]

(iii) Name the product formed at the positive electrode.

..... [1]

(iv) Write the ionic half-equation for the reaction at the negative electrode.

..... [2]

(d) Aluminium is used in overhead electricity cables.

Give **two** properties of aluminium that make it suitable for use in overhead electricity cables.

1

2

[2]

(e) Iron is a transition element.

(i) Iron forms hydrated iron(III) oxide when it rusts.

Write a word equation to represent the formation of rust.

..... [2]

(ii) Give **two** ways in which the properties of transition elements differ from the properties of Group I metals.

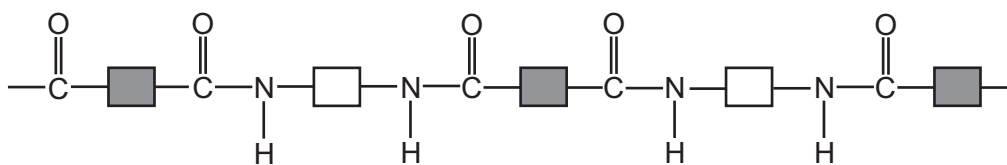
1

2

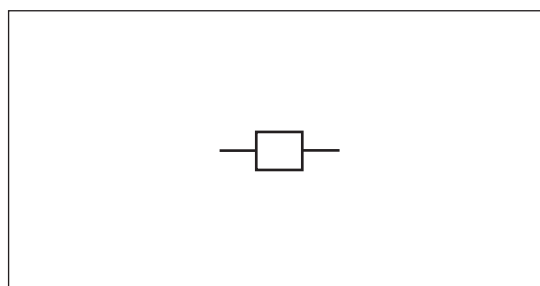
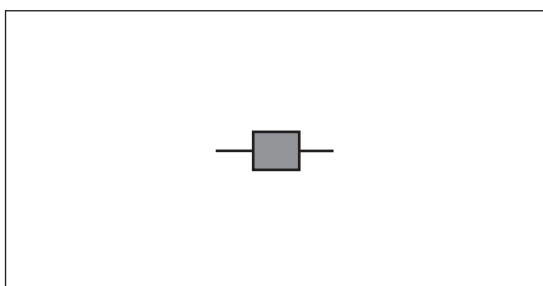
[2]

[Total: 14]

- 8 (a) Part of the synthetic polymer, nylon, is shown in the diagram.



- (i) Circle **one** amide linkage **on the diagram**. [1]
- (ii) Complete the structures of the **two** monomers that react to form nylon.



[2]

- (iii) Name the other product formed when nylon is produced.

..... [1]

- (b) Items made from nylon are often disposed of by burying them in the ground. This is called landfill.

Why is the disposal of nylon using landfill a problem?

.....
 [1]

- (c) Give the name of a natural polymer.

..... [1]

[Total: 6]

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The Periodic Table of Elements

		Group											
I	II	III	IV	V	VI	VII	VIII						
1	2	3	4	5	6	7	8	9	10			11	12
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	Al aluminium 13	Si silicon 14	P phosphorus 15	S sulfur 16	Cl chlorine 17	Ar argon 18			K potassium 19	Ca calcium 20
11	12	13	14	15	16	17	18	19	20			21	22
Na sodium 23	Mg magnesium 24	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40					Sc scandium 45	Ti titanium 48
37	38	39	40	41	42	43	44	45	46	47	48	49	50
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium —	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106	Ag silver 108	Cd cadmium 112	In indium 115	Sn tin 119
55	56	57–71	72	73	74	75	76	77	78	79	80	81	82
Cs caesium 133	Ba barium 137	lanthanoids	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207
87	88	89–103	104	105	106	107	108	109	110	111	112	113	114
Fr francium —	Ra radium —	actinoids	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —	Fl flerovium —	Lv livermorium —

1
H
hydrogen
1

Key
atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

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