



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0620/41

October/November 2020

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

- 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.

- 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 **20** pages. Blank pages are indicated.

- 1 (a) This question is about elements.

aluminium
carbon
iron
hydrogen
oxygen
silicon
sodium
sulfur

Answer the following questions about these elements.

Each element may be used once, more than once or not at all.

- (i) Name the element that can be used as a fuel.

..... [1]

- (ii) Name the element that forms an oxide with a similar structure to diamond.

..... [1]

- (iii) Name the element that forms an amphoteric oxide.

..... [1]

- (iv) Name the element that has oxidation states of +2 and +3.

..... [1]

- (v) Name the element extracted from bauxite.

..... [1]

- (vi) Name the element that has atoms with the electronic structure 2,6.

..... [1]

(b) Iron rusts when it is in contact with oxygen and water.

(i) Explain how sacrificial protection prevents rusting.

.....

.....

.....

..... [2]

(ii) State one **other** method of rust prevention.

..... [1]

[Total: 9]

2 Zinc is extracted from an ore containing zinc sulfide.

(a) State the name of this zinc ore.

..... [1]

(b) This ore is converted to zinc oxide, ZnO.

Zinc oxide is then reacted with carbon.

(i) Write a chemical equation for the reaction of zinc oxide with carbon.

..... [1]

(ii) State what type of chemical change happens to the zinc in zinc oxide in this reaction.

Explain your answer.

chemical change

explanation

.....

.....

[2]

(iii) Explain why aluminium is **not** extracted from aluminium oxide by heating with carbon.

.....

..... [1]

(iv) Suggest an alternative method for the extraction of zinc from zinc oxide.

..... [1]

(c) Brass is an alloy of zinc.

Explain, in terms of particles, why brass is harder than pure zinc.

.....

.....

.....

.....

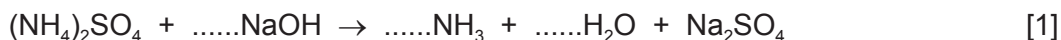
..... [3]

[Total: 9]

- 3 (a) Aqueous ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$, is warmed with aqueous sodium hydroxide.

The pungent-smelling gas ammonia, NH_3 , is produced.

Balance the equation for this reaction.



- (b) A 2.8 g sample of impure ammonium sulfate is found to contain 0.7 g of impurities.

Calculate the percentage of ammonium sulfate in this sample.

percentage of ammonium sulfate = % [1]

- (c) Describe a test for ammonia gas.

test

result

[2]

- (d) Ammonia gas is prepared at the front of a laboratory.

The pungent smell of ammonia spreads throughout the laboratory slowly.

- (i) Name the process that occurs when ammonia gas spreads throughout the laboratory.

..... [1]

- (ii) Explain, using ideas about particles, why ammonia gas spreads throughout the laboratory.

.....

.....

.....

..... [2]

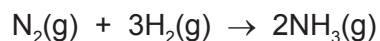
- (iii) Explain why carbon dioxide gas, CO_2 , will spread throughout the laboratory at a slower rate than ammonia gas, NH_3 .

.....

..... [1]

- (e) Ammonia is produced in the Haber process.

The equation for the reaction is shown.



- (i) In the Haber process, a temperature of 450 °C and a pressure of 200 atmospheres are used in the presence of finely-divided iron.

A larger equilibrium yield of ammonia would be produced if a lower temperature and a higher pressure are used.

Explain why a lower temperature and a higher pressure are **not** used.

lower temperature

.....

higher pressure

.....

[2]

- (ii) State the role of iron in the Haber process.

..... [1]

- (f) Ammonia is a weak base.

- (i) Explain the meaning of the term *base*.

.....

..... [1]

- (ii) Suggest the pH of aqueous ammonia.

..... [1]

[Total: 13]

4 Air is a mixture of gases.

- (a) State the percentage of clean dry air which is oxygen. Give your answer to the nearest whole number.

..... % [1]

(b) Oxygen and nitrogen are useful gases that can be obtained from air.

- (i) Name the process used to separate oxygen and nitrogen from liquid air.

..... [2]

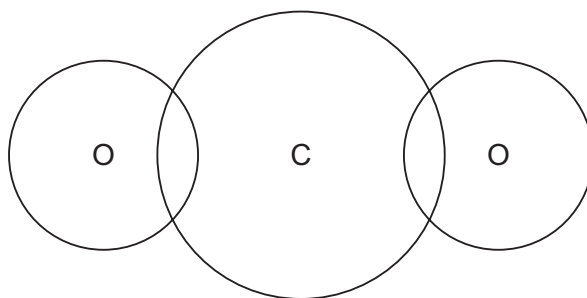
- (ii) State the property of oxygen and nitrogen that allows these gases to be separated using this process.

..... [1]

(c) Carbon dioxide, CO_2 , is a covalent molecule.

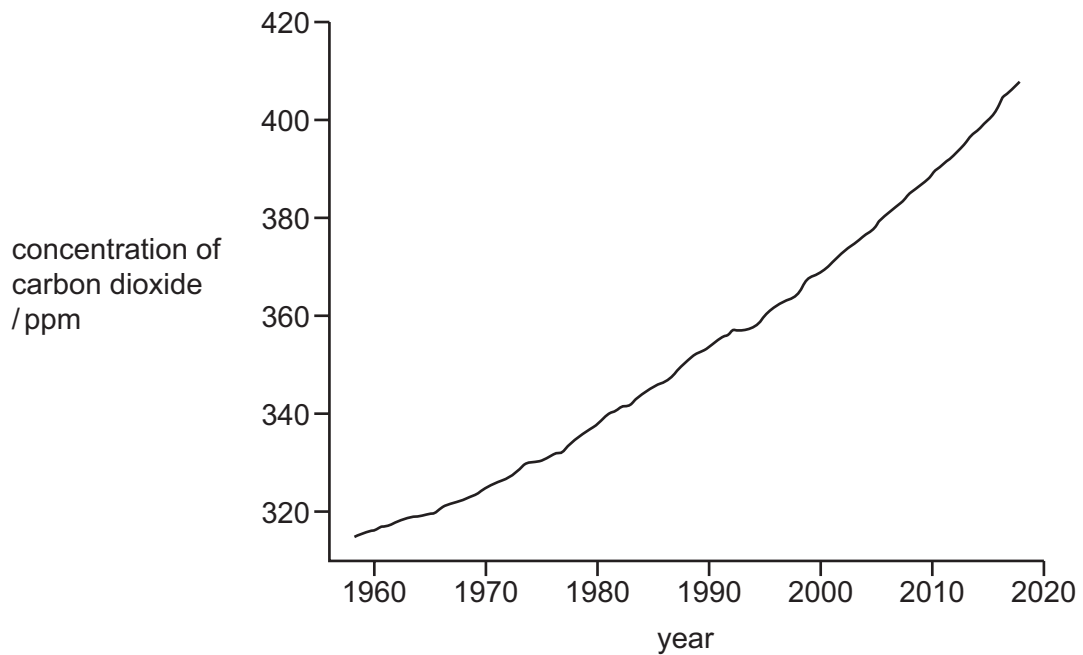
Complete the diagram to show the electron arrangement in one molecule of CO_2 .

Show only the outer electrons.



[2]

- (d) The graph shows the concentration of carbon dioxide in the atmosphere over a 60-year period, measured in parts per million (ppm).



The data shown in the graph is of global concern.

Explain why.

.....

.....

.....

.....

.....

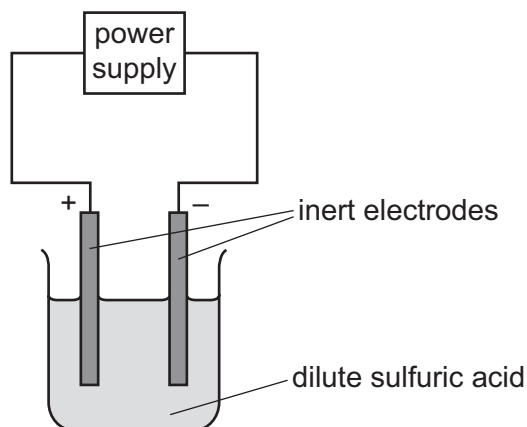
..... [3]

- (e) Name the process in the carbon cycle by which plants remove carbon dioxide from the atmosphere.

..... [1]

[Total: 10]

- 5 (a) Dilute sulfuric acid is electrolysed using the apparatus shown in the diagram.



- (i) State what is meant by the term *electrolysis*.

.....

 [2]

- (ii) Explain why inert electrodes are used.

.....
 [1]

- (iii) Name the products formed at each electrode.

negative electrode
 positive electrode [2]

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

..... [2]

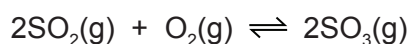
- (b) Sulfuric acid is manufactured using the Contact process. This manufacture involves four stages.

- (i) **Stage 1** involves the combustion of sulfur to form sulfur dioxide.

Write the chemical equation for **stage 1**.

..... [1]

- (ii) The equation for **stage 2** is shown.



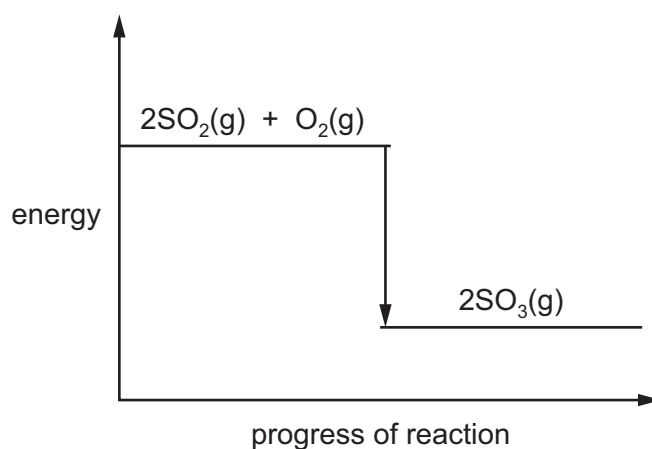
The reaction can reach equilibrium.

Explain what is meant by the term *equilibrium*.

.....

 [2]

- (iii) The energy level diagram for the forward reaction in **stage 2** is shown.



Explain what the diagram shows about the energy changes in the forward reaction.

.....

 [2]

(c) In **stage 3** sulfur trioxide, SO_3 , is converted to oleum, $\text{H}_2\text{S}_2\text{O}_7$.

In **stage 4** oleum reacts to form sulfuric acid, H_2SO_4 .

State what oleum reacts with in **stage 4**.

..... [1]

(d) A sample of sulfuric acid, H_2SO_4 , has a concentration of 0.75 mol/dm^3 .

Calculate the concentration of sulfuric acid in g/dm^3 .

..... g/dm^3 [2]

[Total: 15]

6 (a) Ethane, propane and butane are members of the same homologous series.

(i) Name this homologous series.

..... [1]

(ii) State **two** ways members of the same homologous series are similar.

1

2 [2]

(b) One mole of ethane, C_2H_6 , contains 6.02×10^{23} molecules.

Calculate how many molecules are in 15 g of ethane.

number of ethane molecules = [1]

(c) Propane reacts with chlorine.

(i) Write the formula of the product which does not contain carbon.

..... [1]

(ii) Draw the structure of an organic product formed. Show all of the atoms and all of the bonds.

[1]

(iii) State the name of this type of reaction.

..... [1]

- (d) (i) Aqueous bromine was added to a sample of ethene.

Give the colour change seen.

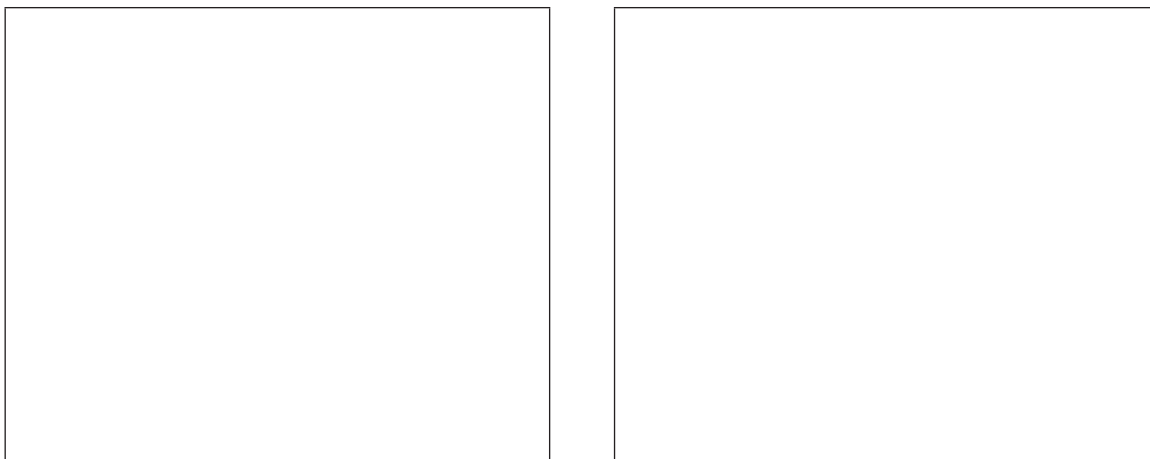
from to [2]

- (ii) Explain, in terms of bonding, why there is no colour change when aqueous bromine is added to ethane.

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

- (e) There are two structural isomers with the formula C_4H_{10} .

- (i) Draw the structures of both of these isomers, showing all of the atoms and all of the bonds.



[2]

- (ii) Butane is formed when longer chain hydrocarbons are cracked.

Complete the chemical equation to show the other product when butane is formed by cracking.



(f) A compound contains 85.7% carbon and 14.3% hydrogen by mass.

(i) Calculate the empirical formula of this compound.

Show your working.

..... [2]

(ii) The molecular mass of the compound is 112.

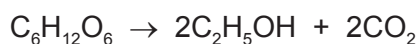
Calculate the molecular formula of this compound.

..... [1]

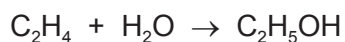
[Total: 16]

- 7 (a) Ethanol can be manufactured by two different methods.

Method 1: fermentation of a sugar, $C_6H_{12}O_6$



Method 2: reaction of ethene with steam



- (i) Give **one** advantage of using fermentation compared with Method 2.

.....
 [1]

- (ii) Give **one** disadvantage of using fermentation compared with Method 2.

.....
 [1]

- (b) Ethanol reacts with acidified potassium manganate(VII) to form water and a product that turns litmus red.

- (i) State the name of the product that turns the litmus red.

..... [1]

- (ii) State the type of reaction that ethanol undergoes when it reacts with acidified potassium manganate(VII).

..... [1]

- (c) Ethanol reacts with methanoic acid to form an ester.

- (i) Name the ester formed in this reaction.

..... [1]

- (ii) Draw the structure of the ester formed.
 Show all of the atoms and all of the bonds.

[1]

(d) The table shows the melting points of ethanol and sodium chloride.

substance	melting point/°C
ethanol	−114
sodium chloride	801

The difference in melting points is due to differences in attractive forces between particles in these substances.

Name the type of attractive force in each substance, which is responsible for the difference in melting points.

ethanol

sodium chloride

[2]

[Total: 8]

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The Periodic Table of Elements

Group																			
I	II											III	IV	V	VI	VII	VIII		
		1Hhydrogen1																	
		Key atomic number atomic symbol name relative atomic mass																	
3Li lithium 7	4Be beryllium 9													5B boron 11	6C carbon 12	7N nitrogen 14	8O oxygen 16	9F fluorine 19	10Ne neon 20
11Na sodium 23	12Mg magnesium 24													13Al aluminium 27	14Si silicon 28	15P phosphorus 31	16S sulfur 32	17Cl chlorine 35.5	18Ar argon 40
19K potassium 39	20Ca calcium 40	21Sc scandium 45	22Ti titanium 48	23V vanadium 51	24Cr chromium 52	25Mn manganese 55	26Fe iron 56	27Co cobalt 59	28Ni nickel 59	29Cu copper 64	30Zn zinc 65	31Ga gallium 70	32Ge germanium 73	33As arsenic 75	34Se selenium 79	35Br bromine 80	36Kr krypton 84		
37Rb rubidium 85	38Sr strontium 88	39Y yttrium 89	40Zr zirconium 91	41Nb niobium 93	42Mo molybdenum 96	43Tc technetium —	44Ru ruthenium 101	45Rh rhodium 103	46Pd palladium 106	47Ag silver 108	48Cd cadmium 112	49In indium 115	50Sn tin 119	51Sb antimony 122	52Te tellurium 128	53I iodine 127	54Xe xenon 131		
55Cs caesium 133	56Ba barium 137	57–71 lanthanoids	72Hf hafnium 178	73Ta tantalum 181	74W tungsten 184	75Re rhenium 186	76Os osmium 190	77Ir iridium 192	78Pt platinum 195	79Au gold 197	80Hg mercury 201	81Tl thallium 204	82Pb lead 207	83Bi bismuth 209	84Po polonium —	85At astatine —	86Rn radon —		
87Fr francium —	88Ra radium —	89–103 actinoids	104Rf rutherfordium —	105Db dubnium —	106Sg seaborgium —	107Bh bohrium —	108Hs hassium —	109Mt meitnerium —	110Ds darmstadtium —	111Rg roentgenium —	112Cn copernicium —	114Fl flerovium —	116Lv livermorium —	116Lv livermorium —	116Lv livermorium —	116Lv livermorium —	—		

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
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 —

actinoids

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