Haileybury

Candidate Name	
Current School	

Chemistry

Lower Sixth (Year 12) examination
SAMPLE PAPER
Entry 2020

Time allowed: 45 minutes

Maximum mark: 45

THE PERIODIC TABLE

Period	1	2					Group						3	4	5	6	7	0
1							1 H Hydrogen 1											4 He Helium 2
2	7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
3	23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
4	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	63.5 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
5	86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 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
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 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
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Relative atomic mass
Symbol
Name
Atomic number

1. Hydrogen chloride is formed in the reaction between hydrogen and chlorine.

The equation for the reaction is

$$H_2 + Cl_2 \rightarrow 2HCl$$

(a) Each molecule in this equation contains the same type of bonding.

Name this type of bonding.

(1)

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(b) The bonding in a hydrogen molecule is strong.

Explain why the boiling point of hydrogen is low.

(2)

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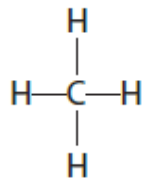
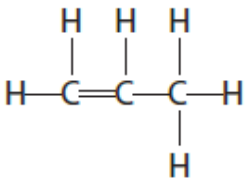
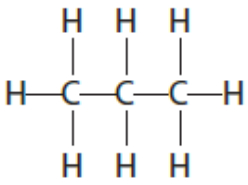
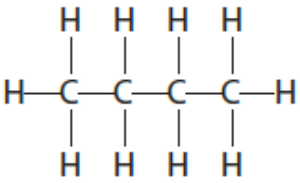
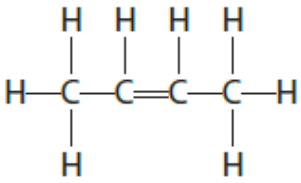
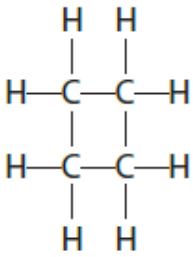
(c) Draw a dot and cross diagram to show the bonding in a hydrogen chloride molecule.

Show only the outer electrons in each atom.

(2)

2. The table shows the displayed formulae of some organic compounds.

A 	B 	C 
D 	E 	F 

(a) Explain why all of these compounds are described as hydrocarbons.

(2)

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(b) Why are B and E described as unsaturated?

(1)

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(c) Which letter represents the first member of the homologous series of alkanes?

(1)

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(d) Compound F has the same general formula as an alkene.

Why does F **not** decolourise bromine water?

(1)

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(e) One of the compounds in the table reacts with bromine to form G, a compound with the composition by mass C = 22.2%,
H = 3.7%, Br = 74.1%.

Show, by calculation, that the empirical formula of G is C_2H_4Br

(3)

3. Neodymium is a metal used in powerful magnets.

(a) One stage in the extraction of neodymium from its ore is to heat neodymium fluoride with calcium.

The table shows the melting points of the substances in this stage of the extraction.

Melting point in °C			
calcium	calcium fluoride	neodymium	neodymium fluoride
850	1418	1024	1410

(i) Balance the equation for this reaction.

(1)

……..NdF_3 + ……Ca → ……Nd + ……...CaF_2

(ii) At one point in this extraction, the temperature of the reaction mixture is 1100 °C.

Which two substances are solids at this temperature?

(1)

…… and ……

(iii) Suggest the most likely type of bonding present in neodymium fluoride.

(1)

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(iv) Neodymium reacts with oxygen to form neodymium oxide.
Suggest the formula of neodymium oxide.

(1)

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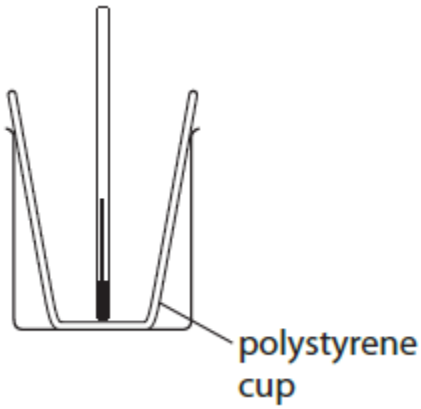
4. A student investigates the reactions between acids and alkalis. He uses this apparatus to measure the temperature change in the reaction between dilute hydrochloric acid (HCl) and aqueous sodium hydroxide (NaOH).



This is his method.

• add 25 cm3 of dilute hydrochloric acid to the polystyrene cup and record the steady temperature

• add some aqueous sodium hydroxide and stir the mixture

• record the maximum temperature of the mixture

The student repeats the experiment using different volumes of aqueous sodium hydroxide.

(a) What is the advantage of using a polystyrene cup rather than a glass beaker?

(1)

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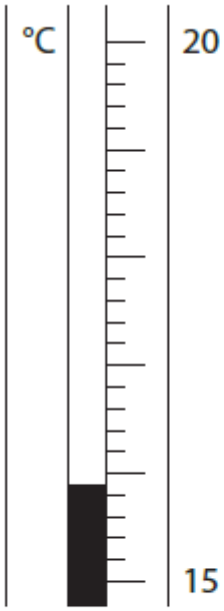
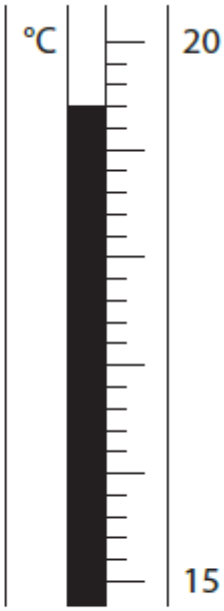
(b) These are the thermometer readings from one experiment.



before adding
aqueous sodium hydroxide



after adding
aqueous sodium hydroxide

Use these readings to complete the table.

(3)

temperature in °C after adding aqueous sodium hydroxide	
temperature in °C before adding aqueous sodium hydroxide	
temperature change in °C	

(c) The table shows the results of some experiments.

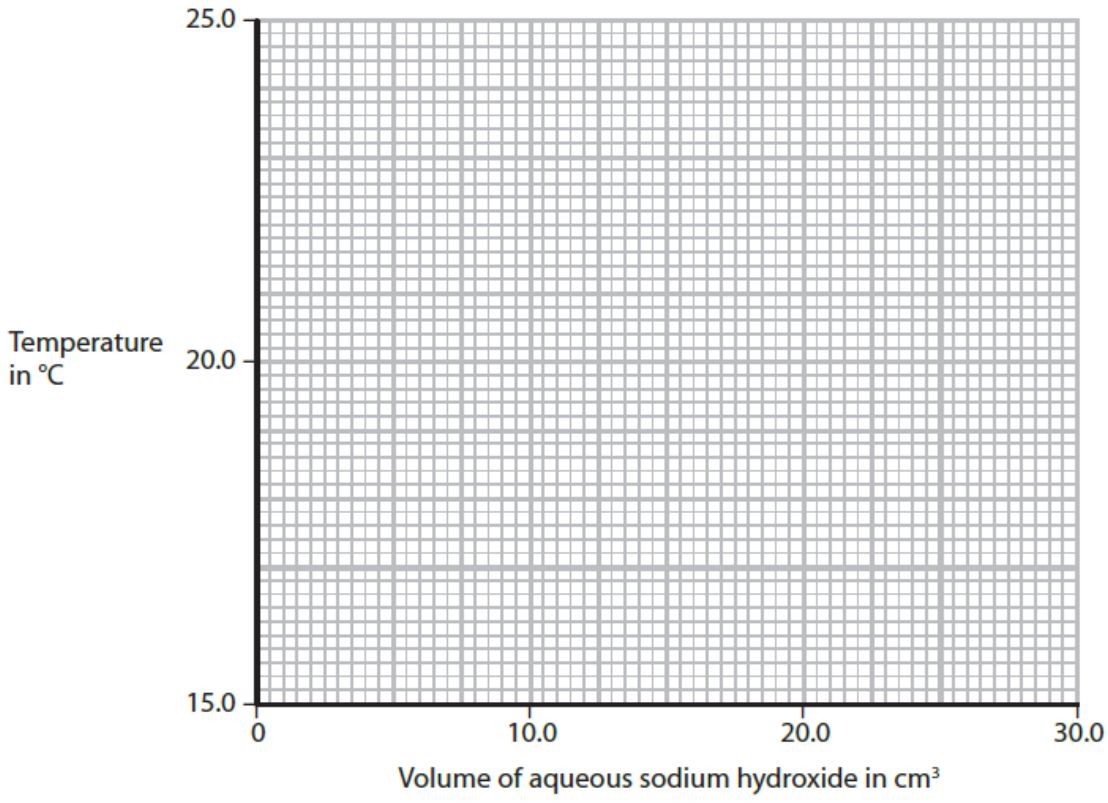
The initial temperature of both solutions in all the experiments is 17.6 °C.

Volume of aqueous sodium hydroxide added in cm^3	Temperature of mixture in °C
0.0	17.6
5.0	19.7
10.0	21.6
15.0	23.6
20.0	23.8
25.0	23.0
30.0	22.2

(i) Plot these results on the grid. Draw a straight line of best fit through the first four points, and another straight line of best fit through the last three points.

Extend both lines so that they cross each other.

(4)



(ii) For the point where the lines cross, write down

(2)

the temperature of the mixture = ……°C

the volume of aqueous sodium hydroxide = ……cm^3

(d) In a similar experiment, using a different acid and alkali, the student records these results.

volume of dilute sulfuric acid = 25.0 cm^3

volume of aqueous potassium hydroxide = 22.7 cm^3

initial temperature of each solution = 18.9 °C

final temperature of mixture = 24.7 °C

Calculate the heat energy change during this reaction using this equation.

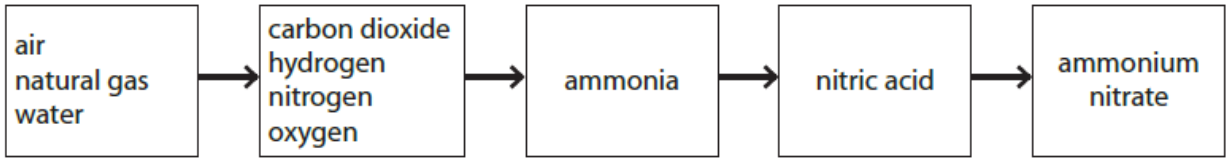
heat energy change = mass × 4.2 × temperature change

Assume that 1.0 cm3 of each solution has a mass of 1.0 g.

(3)

heat energy change = ……J

5. The flow diagram shows how a fertiliser is manufactured from raw materials.



The hydrogen needed is formed in two reactions.

(a) Reaction 1 occurs between steam and methane in natural gas.

Balance the equation for this reaction.

(1)

$$\ldots\ldots CH_4 + \ldots\ldots H_2O \rightarrow \ldots\ldots CO + \ldots\ldots H_2$$

(b) The equation for reaction 2 is

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g) \qquad \Delta H = -41 \text{ kJ/mol}$$

(i) Assuming that this reaction reaches equilibrium, explain what happens to the yield of hydrogen if the reaction is carried out at a higher pressure but at the same temperature.

(2)

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(c) The manufacturer produces a batch of 34 kg of ammonia.

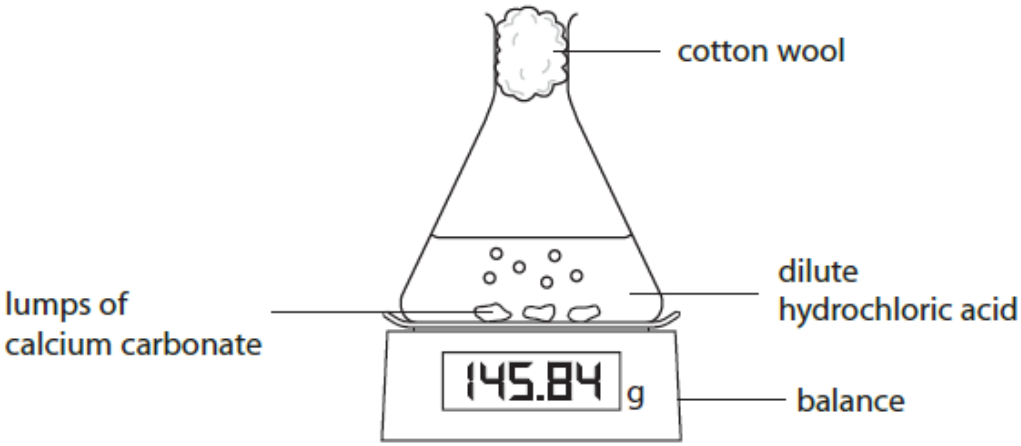
Calculate the maximum mass of ammonium nitrate that can be made from this mass of ammonia, using reaction 6 in part (c).

Give a unit for your answer.

(3)

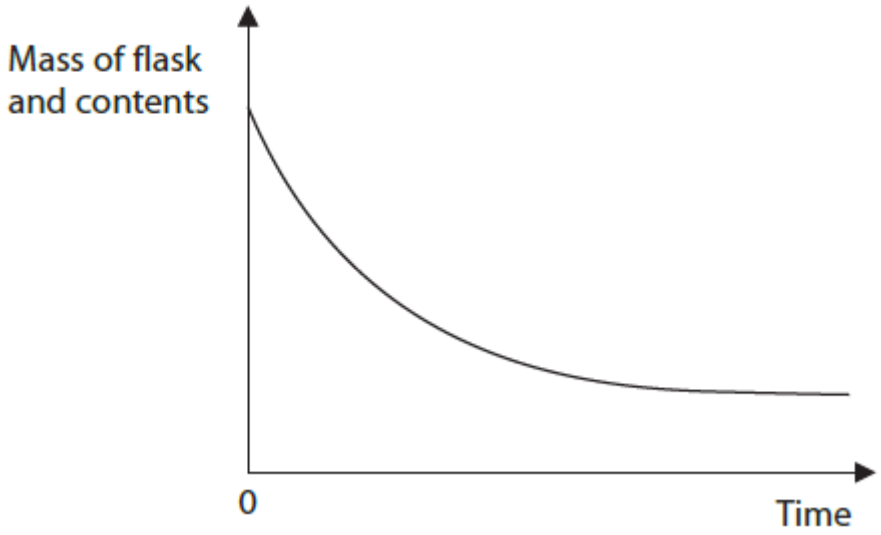
maximum mass of ammonium nitrate = ……unit …….

6. The diagram shows the apparatus used to investigate the rate of reaction between calcium carbonate and an excess of dilute hydrochloric acid.



The mass of the flask and contents is measured at regular time intervals.

The graph shows the results obtained.



(a) Explain why the mass of the flask and contents decreases with time. **(1)**

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(b) (i) The experiment is repeated using

□ the same mass of identical calcium carbonate lumps
□ the same volume of hydrochloric acid but of a higher concentration

Sketch on the graph above the curve that would be produced.

(2)

(ii) Explain, using the particle collision theory, how the rate of reaction changes with an increase in concentration of hydrochloric acid.

(3)

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7. Complete the table to show the number of protons, neutrons and electrons in each of the three isotopes of hydrogen.

(3)

	Isotope		
	^{1}H	^{2}H	^{3}H
number of protons			
number of neutrons			
number of electrons			