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Candidate surname

Other names

Centre Number

Candidate Number

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## Pearson Edexcel International GCSE (9–1)

Time 1 hour 15 minutes

Paper  
reference

**4CH1/2CR**

### Chemistry

Unit: 4CH1

PAPER: 2CR

**You must have:**

Calculator, ruler

Total Marks

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*
- Show all the steps in any calculations and state the units.

### Information

- The total mark for this paper is 70.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*

### Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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# The Periodic Table of the Elements

1	2	3	4	5	6	7	0																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	23 <b>Na</b> sodium 11	24 <b>Mg</b> magnesium 12	39 <b>K</b> potassium 19	40 <b>Ca</b> calcium 20	85 <b>Rb</b> rubidium 37	88 <b>Sr</b> strontium 38	133 <b>Cs</b> caesium 55	137 <b>Ba</b> barium 56	223 <b>Fr</b> francium 87	226 <b>Ra</b> radium 88	227 <b>Ac*</b> actinium 89	261 <b>Rf</b> rutherfordium 104	262 <b>Db</b> dubnium 105	266 <b>Sg</b> seaborgium 106	264 <b>Bh</b> bohrium 107	277 <b>Hs</b> hassium 108	268 <b>Mt</b> meitnerium 109	271 <b>Ds</b> darmstadtium 110	272 <b>Rg</b> roentgenium 111	204 <b>Tl</b> thallium 81	207 <b>Pb</b> lead 82	209 <b>Bi</b> bismuth 83	209 <b>Po</b> polonium 84	210 <b>At</b> astatine 85	209 <b>Rn</b> radon 86	112 <b>Cd</b> cadmium 48	119 <b>Sn</b> tin 50	122 <b>Sb</b> antimony 51	127 <b>I</b> iodine 53	128 <b>Te</b> tellurium 52	131 <b>Xe</b> xenon 54	135 <b>Bi</b> bismuth 83	137 <b>Ba</b> barium 56	138 <b>La*</b> lanthanum 57	140 <b>Y</b> yttrium 39	147 <b>Sc</b> scandium 21	150 <b>Zr</b> zirconium 40	152 <b>Nb</b> niobium 41	157 <b>Ta</b> tantalum 73	162 <b>Hf</b> hafnium 72	167 <b>Rh</b> rhodium 45	173 <b>Pd</b> palladium 46	178 <b>Ag</b> silver 47	181 <b>Cu</b> copper 29	186 <b>Zn</b> zinc 30	188 <b>Ga</b> gallium 31	190 <b>Ge</b> germanium 32	195 <b>As</b> arsenic 33	197 <b>Se</b> selenium 34	201 <b>Br</b> bromine 35	208 <b>Kr</b> krypton 36	209 <b>Pt</b> platinum 78	210 <b>Au</b> gold 79	216 <b>Hg</b> mercury 80	222 <b>Tl</b> thallium 81	223 <b>Pb</b> lead 82	226 <b>Bi</b> bismuth 83	228 <b>Po</b> polonium 84	234 <b>At</b> astatine 85	238 <b>Rn</b> radon 86	239 <b>Ac*</b> actinium 89	242 <b>Th</b> thorium 90	244 <b>Pa</b> protactinium 91	252 <b>U</b> uranium 92	257 <b>Np</b> neptunium 93	261 <b>Pu</b> plutonium 94	269 <b>Am</b> americium 95	271 <b>Cm</b> curium 96	285 <b>Bk</b> berkelium 97	287 <b>Cf</b> californium 98	289 <b>Es</b> einsteinium 99	293 <b>Fm</b> fermium 100	297 <b>Mn</b> manganese 25	298 <b>Tc</b> technetium 43	299 <b>Ru</b> ruthenium 44	301 <b>Rh</b> rhodium 45	303 <b>Pd</b> palladium 46	309 <b>Ag</b> silver 47	311 <b>Cu</b> copper 29	315 <b>Zn</b> zinc 30	327 <b>Ga</b> gallium 31	339 <b>Ge</b> germanium 32	354 <b>As</b> arsenic 33	374 <b>Se</b> selenium 34	390 <b>Br</b> bromine 35	401 <b>Kr</b> krypton 36	409 <b>Rb</b> rubidium 37	412 <b>Sr</b> strontium 38	424 <b>Y</b> yttrium 39	438 <b>Sc</b> scandium 21	451 <b>Zr</b> zirconium 40	462 <b>Nb</b> niobium 41	474 <b>Ta</b> tantalum 73	488 <b>Hf</b> hafnium 72	503 <b>Rh</b> rhodium 45	519 <b>Pd</b> palladium 46	543 <b>Ag</b> silver 47	563 <b>Cu</b> copper 29	587 <b>Zn</b> zinc 30	609 <b>Ga</b> gallium 31	635 <b>Ge</b> germanium 32	669 <b>As</b> arsenic 33	719 <b>Se</b> selenium 34	799 <b>Br</b> bromine 35	877 <b>Kr</b> krypton 36	897 <b>Rb</b> rubidium 37	912 <b>Sr</b> strontium 38	930 <b>Y</b> yttrium 39	959 <b>Sc</b> scandium 21	979 <b>Zr</b> zirconium 40	992 <b>Nb</b> niobium 41	1011 <b>Ta</b> tantalum 73	1029 <b>Hf</b> hafnium 72	1059 <b>Rh</b> rhodium 45	1077 <b>Pd</b> palladium 46	1113 <b>Ag</b> silver 47	1145 <b>Cu</b> copper 29	1187 <b>Zn</b> zinc 30	1247 <b>Ga</b> gallium 31	1312 <b>Ge</b> germanium 32	1392 <b>As</b> arsenic 33	1491 <b>Se</b> selenium 34	1641 <b>Br</b> bromine 35	1819 <b>Kr</b> krypton 36	1912 <b>Rb</b> rubidium 37	1936 <b>Sr</b> strontium 38	1962 <b>Y</b> yttrium 39	2018 <b>Sc</b> scandium 21	2044 <b>Zr</b> zirconium 40	2061 <b>Nb</b> niobium 41	2072 <b>Ta</b> tantalum 73	2083 <b>Hf</b> hafnium 72	2116 <b>Rh</b> rhodium 45	2131 <b>Pd</b> palladium 46	2164 <b>Ag</b> silver 47	2198 <b>Cu</b> copper 29	2240 <b>Zn</b> zinc 30	2300 <b>Ga</b> gallium 31	2371 <b>Ge</b> germanium 32	2454 <b>As</b> arsenic 33	2561 <b>Se</b> selenium 34	2709 <b>Br</b> bromine 35	2897 <b>Kr</b> krypton 36	2986 <b>Rb</b> rubidium 37	3008 <b>Sr</b> strontium 38	3036 <b>Y</b> yttrium 39	3086 <b>Sc</b> scandium 21	3136 <b>Zr</b> zirconium 40	3153 <b>Nb</b> niobium 41	3164 <b>Ta</b> tantalum 73	3175 <b>Hf</b> hafnium 72	3208 <b>Rh</b> rhodium 45	3223 <b>Pd</b> palladium 46	3256 <b>Ag</b> silver 47	3290 <b>Cu</b> copper 29	3332 <b>Zn</b> zinc 30	3392 <b>Ga</b> gallium 31	3463 <b>Ge</b> germanium 32	3546 <b>As</b> arsenic 33	3653 <b>Se</b> selenium 34	3801 <b>Br</b> bromine 35	3989 <b>Kr</b> krypton 36	4078 <b>Rb</b> rubidium 37	4100 <b>Sr</b> strontium 38	4128 <b>Y</b> yttrium 39	4178 <b>Sc</b> scandium 21	4228 <b>Zr</b> zirconium 40	4245 <b>Nb</b> niobium 41	4256 <b>Ta</b> tantalum 73	4267 <b>Hf</b> hafnium 72	4300 <b>Rh</b> rhodium 45	4315 <b>Pd</b> palladium 46	4348 <b>Ag</b> silver 47	4382 <b>Cu</b> copper 29	4424 <b>Zn</b> zinc 30	4484 <b>Ga</b> gallium 31	4555 <b>Ge</b> germanium 32	4638 <b>As</b> arsenic 33	4745 <b>Se</b> selenium 34	4893 <b>Br</b> bromine 35	5081 <b>Kr</b> krypton 36	5170 <b>Rb</b> rubidium 37	5192 <b>Sr</b> strontium 38	5220 <b>Y</b> yttrium 39	5270 <b>Sc</b> scandium 21	5320 <b>Zr</b> zirconium 40	5337 <b>Nb</b> niobium 41	5348 <b>Ta</b> tantalum 73	5359 <b>Hf</b> hafnium 72	5392 <b>Rh</b> rhodium 45	5407 <b>Pd</b> palladium 46	5440 <b>Ag</b> silver 47	5474 <b>Cu</b> copper 29	5516 <b>Zn</b> zinc 30	5576 <b>Ga</b> gallium 31	5647 <b>Ge</b> germanium 32	5730 <b>As</b> arsenic 33	5837 <b>Se</b> selenium 34	5985 <b>Br</b> bromine 35	6173 <b>Kr</b> krypton 36	6262 <b>Rb</b> rubidium 37	6284 <b>Sr</b> strontium 38	6312 <b>Y</b> yttrium 39	6362 <b>Sc</b> scandium 21	6412 <b>Zr</b> zirconium 40	6429 <b>Nb</b> niobium 41	6440 <b>Ta</b> tantalum 73	6451 <b>Hf</b> hafnium 72	6484 <b>Rh</b> rhodium 45	6499 <b>Pd</b> palladium 46	6532 <b>Ag</b> silver 47	6566 <b>Cu</b> copper 29	6608 <b>Zn</b> zinc 30	6668 <b>Ga</b> gallium 31	6739 <b>Ge</b> germanium 32	6822 <b>As</b> arsenic 33	6929 <b>Se</b> selenium 34	7077 <b>Br</b> bromine 35	7265 <b>Kr</b> krypton 36	7354 <b>Rb</b> rubidium 37	7376 <b>Sr</b> strontium 38	7404 <b>Y</b> yttrium 39	7454 <b>Sc</b> scandium 21	7504 <b>Zr</b> zirconium 40	7521 <b>Nb</b> niobium 41	7532 <b>Ta</b> tantalum 73	7543 <b>Hf</b> hafnium 72	7576 <b>Rh</b> rhodium 45	7591 <b>Pd</b> palladium 46	7624 <b>Ag</b> silver 47	7658 <b>Cu</b> copper 29	7700 <b>Zn</b> zinc 30	7760 <b>Ga</b> gallium 31	7831 <b>Ge</b> germanium 32	7914 <b>As</b> arsenic 33	8021 <b>Se</b> selenium 34	8169 <b>Br</b> bromine 35	8357 <b>Kr</b> krypton 36	8446 <b>Rb</b> rubidium 37	8468 <b>Sr</b> strontium 38	8496 <b>Y</b> yttrium 39	8546 <b>Sc</b> scandium 21	8596 <b>Zr</b> zirconium 40	8613 <b>Nb</b> niobium 41	8624 <b>Ta</b> tantalum 73	8635 <b>Hf</b> hafnium 72	8668 <b>Rh</b> rhodium 45	8683 <b>Pd</b> palladium 46	8716 <b>Ag</b> silver 47	8750 <b>Cu</b> copper 29	8792 <b>Zn</b> zinc 30	8852 <b>Ga</b> gallium 31	8923 <b>Ge</b> germanium 32	9006 <b>As</b> arsenic 33	9113 <b>Se</b> selenium 34	9261 <b>Br</b> bromine 35	9449 <b>Kr</b> krypton 36	9538 <b>Rb</b> rubidium 37	9560 <b>Sr</b> strontium 38	9588 <b>Y</b> yttrium 39	9638 <b>Sc</b> scandium 21	9688 <b>Zr</b> zirconium 40	9705 <b>Nb</b> niobium 41	9716 <b>Ta</b> tantalum 73	9727 <b>Hf</b> hafnium 72	9760 <b>Rh</b> rhodium 45	9775 <b>Pd</b> palladium 46	9808 <b>Ag</b> silver 47	9842 <b>Cu</b> copper 29	9884 <b>Zn</b> zinc 30	9944 <b>Ga</b> gallium 31	10015 <b>Ge</b> germanium 32	10098 <b>As</b> arsenic 33	10205 <b>Se</b> selenium 34	10353 <b>Br</b> bromine 35	10541 <b>Kr</b> krypton 36	10630 <b>Rb</b> rubidium 37	10652 <b>Sr</b> strontium 38	10680 <b>Y</b> yttrium 39	10730 <b>Sc</b> scandium 21	10780 <b>Zr</b> zirconium 40	10797 <b>Nb</b> niobium 41	10808 <b>Ta</b> tantalum 73	10819 <b>Hf</b> hafnium 72	10852 <b>Rh</b> rhodium 45	10867 <b>Pd</b> palladium 46	10900 <b>Ag</b> silver 47	10934 <b>Cu</b> copper 29	10976 <b>Zn</b> zinc 30	11036 <b>Ga</b> gallium 31	11107 <b>Ge</b> germanium 32	11190 <b>As</b> arsenic 33	11297 <b>Se</b> selenium 34	11445 <b>Br</b> bromine 35	11633 <b>Kr</b> krypton 36	11722 <b>Rb</b> rubidium 37	11744 <b>Sr</b> strontium 38	11772 <b>Y</b> yttrium 39	11822 <b>Sc</b> scandium 21	11872 <b>Zr</b> zirconium 40	11889 <b>Nb</b> niobium 41	11900 <b>Ta</b> tantalum 73	11911 <b>Hf</b> hafnium 72	11944 <b>Rh</b> rhodium 45	11959 <b>Pd</b> palladium 46	11992 <b>Ag</b> silver 47	12026 <b>Cu</b> copper 29	12068 <b>Zn</b> zinc 30	12128 <b>Ga</b> gallium 31	12200 <b>Ge</b> germanium 32	12283 <b>As</b> arsenic 33	12390 <b>Se</b> selenium 34	12538 <b>Br</b> bromine 35	12726 <b>Kr</b> krypton 36	12815 <b>Rb</b> rubidium 37	12837 <b>Sr</b> strontium 38	12865 <b>Y</b> yttrium 39	12915 <b>Sc</b> scandium 21	12965 <b>Zr</b> zirconium 40	12982 <b>Nb</b> niobium 41	12993 <b>Ta</b> tantalum 73	13004 <b>Hf</b> hafnium 72	13037 <b>Rh</b> rhodium 45	13052 <b>Pd</b> palladium 46	13085 <b>Ag</b> silver 47	13119 <b>Cu</b> copper 29	13161 <b>Zn</b> zinc 30	13221 <b>Ga</b> gallium 31	13292 <b>Ge</b> germanium 32	13375 <b>As</b> arsenic 33	13482 <b>Se</b> selenium 34	13630 <b>Br</b> bromine 35	13818 <b>Kr</b> krypton 36	13907 <b>Rb</b> rubidium 37	13929 <b>Sr</b> strontium 38	13957 <b>Y</b> yttrium 39	14007 <b>Sc</b> scandium 21	14057 <b>Zr</b> zirconium 40	14074 <b>Nb</b> niobium 41	14085 <b>Ta</b> tantalum 73	14096 <b>Hf</b> hafnium 72	14129 <b>Rh</b> rhodium 45	14144 <b>Pd</b> palladium 46	14177 <b>Ag</b> silver 47	14211 <b>Cu</b> copper 29	14253 <b>Zn</b> zinc 30	14313 <b>Ga</b> gallium 31	14384 <b>Ge</b> germanium 32	14467 <b>As</b> arsenic 33	14574 <b>Se</b> selenium 34	14722 <b>Br</b> bromine 35	14910 <b>Kr</b> krypton 36	15000 <b>Rb</b> rubidium 37	15022 <b>Sr</b> strontium 38	15050 <b>Y</b> yttrium 39	15100 <b>Sc</b> scandium 21	15150 <b>Zr</b> zirconium 40	15167 <b>Nb</b> niobium 41	15178 <b>Ta</b> tantalum 73	15189 <b>Hf</b> hafnium 72	15222 <b>Rh</b> rhodium 45	15237 <b>Pd</b> palladium 46	15270 <b>Ag</b> silver 47	15304 <b>Cu</b> copper 29	15346 <b>Zn</b> zinc 30	15406 <b>Ga</b> gallium 31	15477 <b>Ge</b> germanium 32	15560 <b>As</b> arsenic 33	15667 <b>Se</b> selenium 34	15815 <b>Br</b> bromine 35	16003 <b>Kr</b> krypton 36	16092 <b>Rb</b> rubidium 37	16114 <b>Sr</b> strontium 38	16142 <b>Y</b> yttrium 39	16192 <b>Sc</b> scandium 21	16242 <b>Zr</b> zirconium 40	16259 <b>Nb</b> niobium 41	16270 <b>Ta</b> tantalum 73	16281 <b>Hf</b> hafnium 72	16314 <b>Rh</b> rhodium 45	16329 <b>Pd</b> palladium 46	16362 <b>Ag</b> silver 47	16396 <b>Cu</b> copper 29	16438 <b>Zn</b> zinc 30	16498 <b>Ga</b> gallium 31	16569 <b>Ge</b> germanium 32	16652 <b>As</b> arsenic 33	16759 <b>Se</b> selenium 34	16907 <b>Br</b> bromine 35	17095 <b>Kr</b> krypton 36	17184 <b>Rb</b> rubidium 37	17206 <b>Sr</b> strontium 38	17234 <b>Y</b> yttrium 39	17284 <b>Sc</b> scandium 21	17334 <b>Zr</b> zirconium 40	17351 <b>Nb</b> niobium 41	17362 <b>Ta</b> tantalum 73	17373 <b>Hf</b> hafnium 72	17406 <b>Rh</b> rhodium 45	17421 <b>Pd</b> palladium 46	17454 <b>Ag</b> silver 47	17488 <b>Cu</b> copper 29	17530 <b>Zn</b> zinc 30	17590 <b>Ga</b> gallium 31	17661 <b>Ge</b> germanium 32	17744 <b>As</b> arsenic 33	17851 <b>Se</b> selenium 34	18000 <b>Br</b> bromine 35	18188 <b>Kr</b> krypton 36	18277 <b>Rb</b> rubidium 37	18299 <b>Sr</b> strontium 38	18327 <b>Y</b> yttrium 39	18377 <b>Sc</b> scandium 21	18427 <b>Zr</b> zirconium 40	18444 <b>Nb</b> niobium 41	18455 <b>Ta</b> tantalum 73	18466 <b>Hf</b> hafnium 72	18499 <b>Rh</b> rhodium 45	18514 <b>Pd</b> palladium 46	18547 <b>Ag</b> silver 47	18581 <b>Cu</b> copper 29	18623 <b>Zn</b> zinc 30	18683 <b>Ga</b> gallium 31	18754 <b>Ge</b> germanium 32	18837 <b>As</b> arsenic 33	18944 <b>Se</b> selenium 34	19092 <b>Br</b> bromine 35	19280 <b>Kr</b> krypton 36	19370 <b>Rb</b> rubidium 37	19392 <b>Sr</b> strontium 38	19420 <b>Y</b> yttrium 39	19470 <b>Sc</b> scandium 21	19520 <b>Zr</b> zirconium 40	19537 <b>Nb</b> niobium 41	19548 <b>Ta</b> tantalum 73	19559 <b>Hf</b> hafnium 72	19592 <b>Rh</b> rhodium 45	19607 <b>Pd</b> palladium 46	19640 <b>Ag</b> silver 47	19674 <b>Cu</b> copper 29	19716 <b>Zn</b> zinc 30	19776 <b>Ga</b> gallium 31	19847 <b>Ge</b> germanium 32	19930 <b>As</b> arsenic 33	20037 <b>Se</b> selenium 34	20185 <b>Br</b> bromine 35	20373 <b>Kr</b> krypton 36	20462 <b>Rb</b> rubidium 37	20484 <b>Sr</b> strontium 38	20512 <b>Y</b> yttrium 39	20562 <b>Sc</b> scandium 21	20612 <b>Zr</b> zirconium 40	20629 <b>Nb</b> niobium 41	20640 <b>Ta</b> tantalum 73	20651 <b>Hf</b> hafnium 72	20684 <b>R</b>

**Answer ALL questions.**

Some questions must be answered with a cross ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1 (a) Two substances are needed to cause iron to rust.

Name these two substances.

(2)

1 .....

2 .....

- (b) The box gives the names of some substances.

calcium	copper	gold
iodine	methane	zinc

Use words from the box to answer these questions.

- (i) Give the name of a non-metallic element.

(1)

.....

- (ii) Give the name of a compound.

(1)

.....

- (iii) Give the name of the metal that is lowest in the reactivity series.

(1)

.....

**(Total for Question 1 = 5 marks)**

.....



2 Crude oil is a mixture of hydrocarbons.

(a) This passage is about the industrial separation of crude oil.

Complete the passage by adding the missing words.

(3)

Crude oil is ..... to form vapour.

The vapour is passed through a ..... column.

The refinery gases are collected at the top of the column because they have low

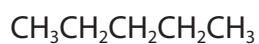
.....

(b) Bitumen is collected at the bottom of the column.

Give one use of bitumen.

(1)

(c) One of the hydrocarbons in crude oil is an alkane with this structural formula.



(i) Give the name of this alkane.

(1)

(ii) Calculate the relative molecular mass ( $M_r$ ) of this alkane.

(1)

$M_r =$  .....



(d) Catalytic cracking is used to convert long-chain alkanes into shorter-chain alkanes.

Give the name of the catalyst and the temperature used in catalytic cracking.

(2)

catalyst .....

temperature .....

(e) Catalytic cracking also produces alkenes.

Decane ( $C_{10}H_{22}$ ) can undergo cracking to give  $C_4H_{10}$  and two different alkenes.

Complete the equation for this cracking process.

(2)



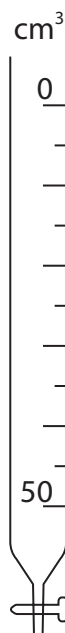
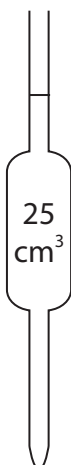
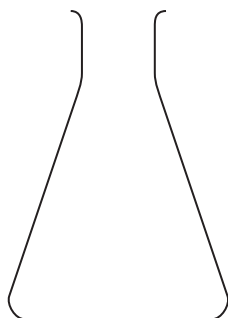
**(Total for Question 2 = 10 marks)**



3 A student does a titration to find the concentration of a solution of dilute sulfuric acid.

The student uses these solutions and this apparatus.

- dilute sulfuric acid
- potassium hydroxide solution of concentration  $0.240 \text{ mol/dm}^3$
- methyl orange indicator



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(a) The student wants to find the volume of sulfuric acid needed to neutralise 25.0 cm<sup>3</sup> of the potassium hydroxide solution.

Describe how the student should do this titration.

Assume that all pieces of apparatus are clean and dry.

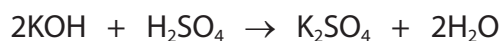
(6)

Area with horizontal dotted lines for writing the answer.



- (b) The student needs  $15.00 \text{ cm}^3$  of sulfuric acid to neutralise  $25.0 \text{ cm}^3$  of the potassium hydroxide solution.

This is the equation for the reaction.



- (i) Calculate the amount, in moles, of KOH in  $25.0 \text{ cm}^3$  of potassium hydroxide solution of concentration  $0.240 \text{ mol/dm}^3$ .

(2)

amount of KOH = ..... mol

- (ii) Calculate the amount, in moles, of  $\text{H}_2\text{SO}_4$  in  $15.00 \text{ cm}^3$  of the sulfuric acid.

(1)

amount of  $\text{H}_2\text{SO}_4$  = ..... mol

- (iii) Calculate the concentration, in  $\text{mol/dm}^3$ , of the sulfuric acid.

(2)

concentration of sulfuric acid = .....  $\text{mol/dm}^3$

**(Total for Question 3 = 11 marks)**





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4 This question is about alcohols, carboxylic acids and their reactions.

(a) The boxes give some information about a carboxylic acid.

Complete the boxes by giving the missing information.

(3)

structural formula	CH <sub>3</sub> COOH
name	
	CH <sub>2</sub> O
displayed formula	

(b) Ethanol can be oxidised to produce a carboxylic acid.

(i) Give the names of the two reagents used in this oxidation reaction.

(2)

1 .....

2 .....

(ii) Which of these colour changes occurs during the reaction?

(1)

- A** green to orange
- B** orange to green
- C** red to yellow
- D** yellow to red



(c) Alcohols and carboxylic acids can be heated together to form esters.

- (i) State why it is better to heat the mixture using a water bath rather than directly with a Bunsen burner flame.

(1)

- (ii) An ester has the structural formula  $\text{CH}_3\text{CH}_2\text{COOCH}_3$

Which of these is the name of this ester?

(1)

- A ethyl methanoate
- B methyl ethanoate
- C methyl propanoate
- D propyl methanoate

**(Total for Question 4 = 8 marks)**

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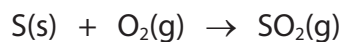
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5 This question is about three stages in the manufacture of sulfuric acid.

(a) In stage 1, sulfur is burned in oxygen to form sulfur dioxide gas.



(i) State one environmental problem caused by the release of sulfur dioxide into the atmosphere.

(1)

(ii) A mass of 6.4 tonnes of sulfur is burned to produce sulfur dioxide gas.

Calculate the maximum volume, in  $\text{dm}^3$ , of sulfur dioxide gas that can be produced at rtp.

[molar volume of sulfur dioxide gas at rtp =  $24 \text{ dm}^3$ ]

[1 tonne =  $10^6 \text{ g}$ ]

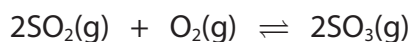
Give your answer in standard form.

(3)

maximum volume = .....  $\text{dm}^3$



(b) In stage 2, sulfur dioxide is reacted with oxygen to form sulfur trioxide gas.



The yield of sulfur trioxide is approximately 98%.

(i) A catalyst is used in this reaction.

Explain how a catalyst increases the rate of a reaction.

(2)

(ii) The temperature is kept constant.

Give a reason why increasing the pressure would increase the yield of sulfur trioxide.

(1)

(iii) Suggest why it is not necessary to increase the pressure in stage 2.

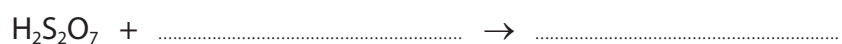
(1)

(c) In stage 3, the sulfur trioxide is reacted with concentrated sulfuric acid to form a liquid called oleum,  $\text{H}_2\text{S}_2\text{O}_7$

The oleum is then added to water to form concentrated sulfuric acid.

Complete the chemical equations for these two reactions.

(2)



(d) Sulfuric acid reacts with ammonia to form ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$

Calculate the percentage by mass of nitrogen in ammonium sulfate.

$[M_r \text{ of } (\text{NH}_4)_2\text{SO}_4 = 132]$

(2)

percentage = ..... %

**(Total for Question 5 = 12 marks)**



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6 A teacher prepares the insoluble salt lead(II) bromide ( $\text{PbBr}_2$ ) by mixing solutions of lead(II) nitrate and sodium bromide.

(a) Describe what the teacher should do next to obtain a pure, dry sample of lead(II) bromide.

(3)

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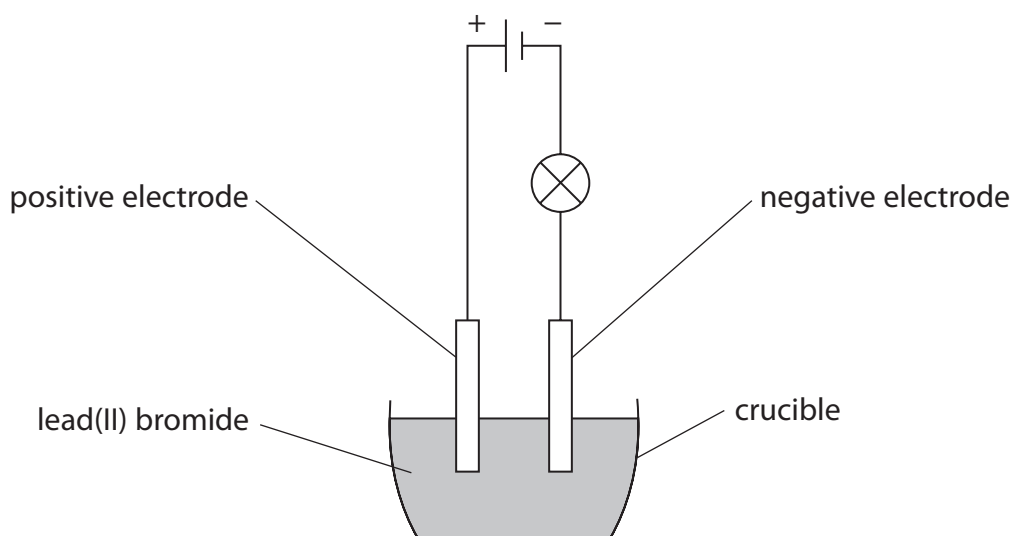
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- (b) The teacher then sets up a circuit in a fume cupboard using the pure, dry sample of lead(II) bromide.



Explain why the lamp does not light when the lead(II) bromide is solid.

(2)

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- (c) The teacher heats the lead(II) bromide.

When the lead(II) bromide is molten, the lamp lights and bromine forms at the positive electrode.

- (i) State what observation would be made at the positive electrode.

(1)

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(ii) Explain how bromide ions in the molten lead(II) bromide become bromine molecules at the positive electrode.

(4)

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(d) Write an ionic half-equation for the reaction that occurs at the negative electrode.

Include state symbols in your equation.

(2)

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**(Total for Question 6 = 12 marks)**

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7 The reaction between hydrogen and chlorine is exothermic.

This is the equation for the reaction.



(a) State the meaning of the term **exothermic**.

(1)

(b) The table gives the bond energies for the H—H and H—Cl bonds.

<b>Bond</b>	H—H	H—Cl
<b>Bond energy in kJ/mol</b>	436	431

Use the equation and information from the table to calculate the bond energy of the Cl—Cl bond.

(4)

bond energy = ..... kJ/mol



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(c) Explain why this reaction is exothermic.

Refer to bond-breaking and bond-making in your answer.

(3)

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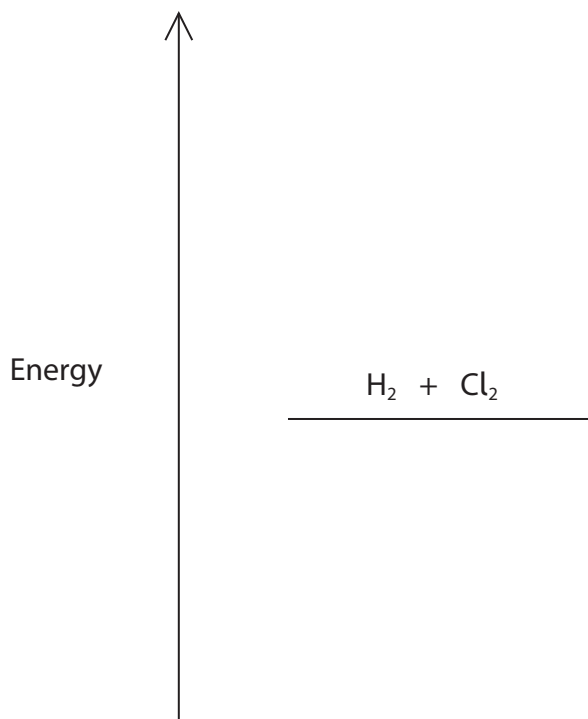
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(d) Complete the reaction profile diagram to show the position of the products, the enthalpy change ( $\Delta H$ ) and the activation energy ( $E_a$ ) for the reaction.

(4)



(Total for Question 7 = 12 marks)

TOTAL FOR PAPER = 70 MARKS



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