



Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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CHEMISTRY

5070/21

Paper 2 Theory

October/November 2018

1 hour 30 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 an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Section A

Answer **all** questions.

Write your answers in the spaces provided in the Question Paper.

Section B

Answer any **three** questions.

Write your answers in the spaces provided in the Question Paper.

Electronic calculators may be used.

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

A copy of the Periodic Table is printed on page 20.

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 **18** printed pages and **2** blank pages.

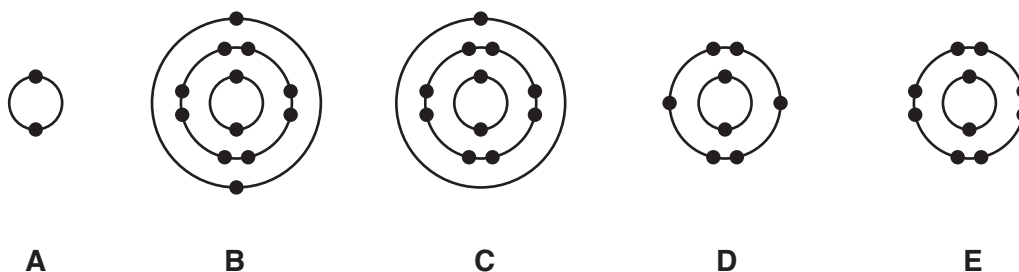


Section A

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

- 1 The electronic configurations of five atoms are shown.



- (a) Which electronic configuration represents each of the following descriptions?

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

- (i) a sodium atom

.....[1]

- (ii) an atom of a reactive non-metallic element

.....[1]

- (iii) an atom with a proton (atomic) number of 12

.....[1]

- (iv) an atom of a noble gas which is used to fill balloons

.....[1]

- (v) an atom which forms a noble gas electronic configuration when it gains two electrons

.....[1]

3

- (b) Chlorine has two naturally occurring isotopes.

One isotope of chlorine is represented by the symbol shown.



- (i) Deduce the number of neutrons in one atom of this isotope of chlorine.

.....[1]

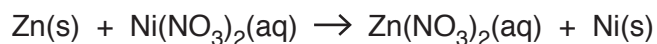
- (ii) Chlorine has diatomic molecules.

What is the meaning of the term *diatomic*?

.....[1]

[Total: 7]

- 2 Zinc reacts with aqueous nickel(II) nitrate.



- (a) (i) By referring to the equation, explain why this is a redox reaction.

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

- (ii) Construct the ionic equation for this reaction.

.....[1]

- (b) Draw a labelled diagram to show how a fork made of nickel is electroplated with silver.

[3]

- (c) Aqueous ammonia is added, with mixing, to a solution containing zinc ions until no further change occurs.

What observations would be made during this test?

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

- (d) Blocks of zinc are attached to the underside of ships made of iron to stop them from rusting.

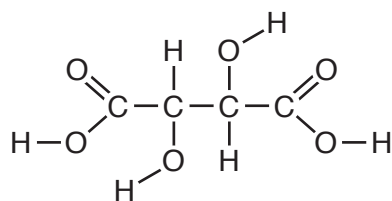
Explain how zinc stops the ships from rusting.

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

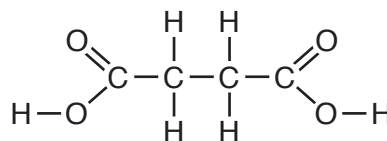
[Total: 10]

- 3 Tartaric acid and succinic acid are colourless organic acids.

The structures of these acids are shown.



tartaric acid



succinic acid

- (a) Name the group which is present in tartaric acid but not in succinic acid.

.....[1]

- (b) Tartaric acid is reduced to succinic acid by acidified aqueous potassium iodide.

What colour change would you observe in the reaction mixture when this reaction is carried out?

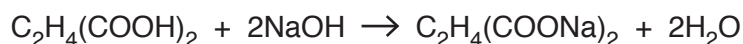
from to [2]

- (c) Succinic acid is a weak acid.

What is the meaning of the term *weak acid*?

.....
[1]

- (d) Succinic acid is neutralised by aqueous sodium hydroxide.



Calculate the minimum volume of 0.0200 mol/dm^3 sodium hydroxide required to neutralise 25.0 cm^3 of 0.0500 mol/dm^3 succinic acid.

Give your answer to **three** significant figures.

volume cm^3 [3]

[Total: 7]

[Turn over]

4 The alkanes are a homologous series of saturated hydrocarbons.

(a) (i) Write the general formula for the alkane homologous series.

.....[1]

(ii) Each member of a particular homologous series has the same general formula.

Give one other characteristic of a homologous series.

.....[1]

(b) What is the meaning of the term *saturated*?

.....[1]

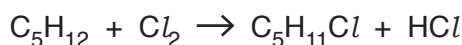
(c) Construct the equation for the complete combustion of pentane, C_5H_{12} .

.....[2]

(d) Draw the structure of a branched alkane with the formula C_5H_{12} . Show all of the atoms and all of the bonds.

[1]

(e) Chlorine reacts with pentane.



(i) What name is given to this type of chemical reaction?

.....[1]

(ii) What essential condition is needed for chlorine to react with pentane?

.....[1]

- (f) A hydrocarbon contains 90% carbon by mass.
- (i) Deduce the empirical formula of this hydrocarbon.

empirical formula[2]

- (ii) What additional piece of information is needed to deduce the molecular formula of this hydrocarbon?

.....[1]

[Total: 11]

5 The Periodic Table is an arrangement of elements in groups and periods.

- (a) Describe how the position of an element in the Periodic Table is related to its electronic configuration.

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

- (b) Aluminium is an element in Group III of the Periodic Table.

Deduce the electronic configuration of the aluminium ion.

.....[1]

- (c) Aluminium reacts with oxygen to form aluminium oxide, Al_2O_3 .

- (i) Construct the equation for this reaction.

.....[1]

- (ii) Aluminium oxide reacts with both acids and alkalis.

Name the type of oxide which reacts with both acids and alkalis.

.....[1]

- (d) (i) Draw a 'dot-and-cross' diagram of a molecule of oxygen.

Only draw the outer shell electrons.

[2]

- (ii) Describe and explain the difference in the rate of diffusion of the gases oxygen and nitrogen.

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

(iii) Oxygen reacts with hydrogen to form water.

Sulfur reacts with hydrogen to form hydrogen sulfide.

Some properties of hydrogen sulfide are listed.

- It is a gas at room temperature.
- It reacts with aqueous sodium hydroxide.
- It is a reducing agent.
- It burns in air.

Describe four ways in which the properties of water differ from those of hydrogen sulfide.

1.
2.
3.
4.

[2]

[Total: 10]

Section B

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

- 6 Some properties of the Group V elements are shown.

element	electrical conductivity of solid	melting point /°C	boiling point /°C
nitrogen	non-conductor	−210	−196
phosphorus	non-conductor	44	281
arsenic	non-conductor		
antimony	poor conductor	631	1587
bismuth	conducts	271	1564

- (a) Use the information in the table.

- (i) Predict the physical state of nitrogen at −200 °C.

Explain your answer.

.....
[2]

- (ii) Predict the melting point of arsenic.

.....[1]

- (b) Use the information in the table to explain how the structure and bonding in nitrogen differ from the structure and bonding in bismuth.

.....

[2]

- (c) Antimony, Sb, reacts with chlorine to form antimony(III) chloride.

Construct the equation for this reaction.

.....[1]

(d) Nitrogen is present in dry air.

(i) State the percentage by volume of nitrogen in dry air.

.....[1]

(ii) Nitrogen oxides are atmospheric pollutants.

The concentration of nitrogen oxides in the exhausts from car engines is decreased by using a catalytic converter.

Describe the reactions that occur in a catalytic converter which help to remove nitrogen oxides from car exhausts.

.....

.....

.....[2]

(iii) State one **other** source of nitrogen oxides in the atmosphere.

.....[1]

[Total: 10]

7 The products of respiration are carbon dioxide and water.

(a) Complete the equation for respiration.



(b) Carbon dioxide and methane are greenhouse gases which contribute to global warming.

(i) State one effect on the environment of an increase in global warming.

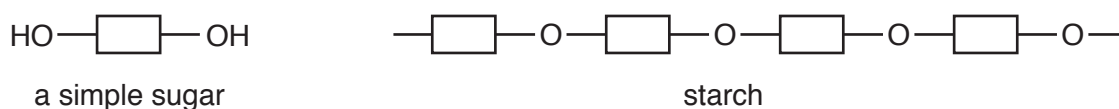
.....[1]

(ii) Describe how the carbon cycle regulates the amount of carbon dioxide in the atmosphere.

.....

[2]

(c) Simple sugars can be polymerised to form starch.



(i) Deduce the formula of the molecule eliminated when simple sugars polymerise to form starch.

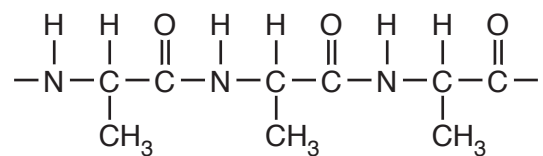
.....[1]

(ii) State the reagent and conditions needed to hydrolyse starch into simple sugars.

.....
[2]

(d) The amino acid alanine can form polymers.

Part of the structure of poly(alanine) is shown.



(i) On the diagram, draw a circle around all of the atoms in one amide linkage. [1]

(ii) Draw the structure of the monomer used to make poly(alanine).

[1]

[Total: 10]

- 8 Chromium is a transition element.

Sodium is an element in Group I of the Periodic Table.

- (a) Explain how both chromium and sodium conduct electricity.

.....
[1]

- (b) Describe two differences in the physical properties of chromium and sodium.

1.
 2.[2]

- (c) An alloy of iron and chromium is stronger than pure iron.

Use ideas about the structure of metals to explain why the alloy is stronger.

.....

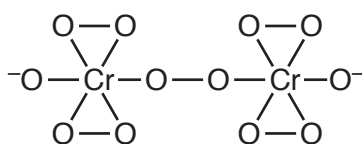
[2]

- (d) Molten chromium reacts with steam to form chromium(III) oxide, Cr_2O_3 , and hydrogen.

Construct the equation for this reaction.

.....[1]

- (e) The structure of an ion containing chromium is shown.

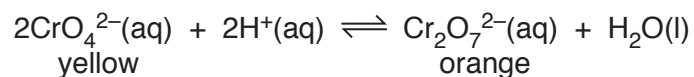


Write the formula for this ion.

.....[1]

- (f) Adding dilute acid to yellow $\text{CrO}_4^{2-}(\text{aq})$ forms orange $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$.

The ionic equation for this reaction is shown.



- (i) Describe and explain what you would observe when a few drops of concentrated aqueous sodium hydroxide are added to the orange solution.

.....

[2]

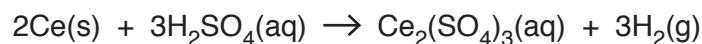
- (ii) Suggest why a change in pressure has no effect on the reaction shown.

.....[1]

[Total: 10]

- 9 Cerium is a metal with a relative atomic mass of 140.

Cerium powder reacts with sulfuric acid.



- (a) Describe and explain, using ideas about collisions between particles, how the rate of this reaction changes when the concentration of sulfuric acid is decreased.

All other conditions stay the same.

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

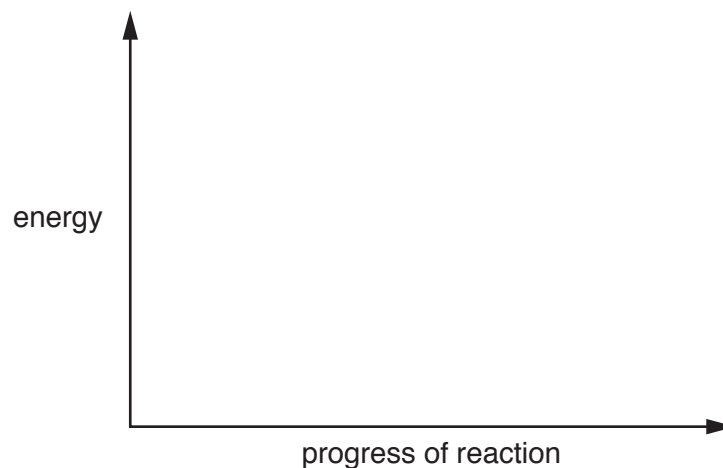
- (b) Describe and explain how the rate of this reaction changes when large pieces of cerium are used instead of cerium powder.

All other conditions stay the same.

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

- (c) The reaction of cerium with sulfuric acid is exothermic.

Complete the energy profile diagram to show the enthalpy change for this reaction.



[2]

- (d) Calculate the maximum volume of hydrogen, in dm^3 , formed when 12.6 g of cerium reacts with excess sulfuric acid at room temperature and pressure.

[A_r : Ce, 140]

volume dm^3 [3]

- (e) The formula of cerium carbonate is $\text{Ce}_2(\text{CO}_3)_3$.

Calculate the percentage by mass of cerium in cerium carbonate.

..... % [2]

[Total: 10]

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The Periodic Table of Elements

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11 Na sodium 23	12 Mg magnesium 24	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40								19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —	119 Uu ununoctium —	120 Uub unbihrium —	121 Uut untrium —	122 Uub unbium —	123 Uut untrium —	124 Uub unbium —	125 Uut untrium —	126 Uub unbium —	127 Uut untrium —	128 Uub unbium —	129 Uut untrium —	130 Uub unbium —	131 Uut untrium —	132 Uub unbium —	133 Uut untrium —	134 Uub unbium —	135 Uut untrium —	136 Uub unbium —	137 Uut untrium —	138 Uub unbium —	139 Uut untrium —	140 Uub unbium —	141 Uut untrium —	142 Uub unbium —	143 Uut untrium —	144 Uub unbium —	145 Uut untrium —	146 Uub unbium —	147 Uut untrium —	148 Uub unbium —	149 Uut untrium —	150 Uub unbium —	151 Uut untrium —	152 Uub unbium —	153 Uut untrium —	154 Uub unbium —	155 Uut untrium —	156 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untrium —	442 Uub unbium —	443 Uut untrium —	444 Uub unbium —	445 Uut untrium —	446 Uub unbium —	447 Uut untrium —	448 Uub unbium —	449 Uut untrium —	450 Uub unbium —	451 Uut untrium —	452 Uub unbium —	453 Uut untrium —	454 Uub unbium —	455 Uut untrium —	456 Uub unbium —	457 Uut untrium —	458 Uub unbium —	459 Uut untrium —	460 Uub unbium —	461 Uut untrium —	462 Uub unbium —	463 Uut untrium —	464 Uub unbium —	465 Uut untrium —	466 Uub unbium —	467 Uut untrium —	468 Uub unbium —	469 Uut untrium —	470 Uub unbium —	471 Uut untrium —	472 Uub unbium —	473 Uut untrium —	474 Uub unbium —	475 Uut untrium —	476 Uub unbium —	477 Uut untrium —	478 Uub unbium —	479 Uut untrium —	480 Uub unbium —	481 Uut untrium —	482 Uub unbium —	483 Uut untrium —	484 Uub unbium —	485 Uut untrium —	486 Uub unbium —	487 Uut untrium —	488 Uub unbium —	489 Uut untrium —	490 Uub unbium —	491 Uut untrium —	492 Uub unbium —	493 Uut untrium —	494 Uub unbium —	495 Uut untrium —	496 Uub unbium —	497 Uut untrium —	498 Uub unbium —	499 Uut untrium —	500 Uub unbium —	501 Uut untrium —	502 Uub unbium —	503 Uut untrium —	504 Uub unbium —	505 Uut untrium —	506 Uub unbium —	507 Uut untrium —	508 Uub unbium —	509 Uut untrium —	510 Uub unbium —	511 Uut untrium —	512 Uub unbium —	513 Uut untrium —	514 Uub unbium —	515 Uut untrium —	516 Uub unbium —	517 Uut untrium —	518 Uub unbium —	519 Uut untrium —	520 Uub unbium —	521 Uut untrium —	522 Uub unbium —	523 Uut untrium —	524 Uub unbium —	525 Uut untrium —	526 Uub unbium —	527 Uut untrium —	528 Uub unbium —	529 Uut untrium —	530 Uub unbium —	531 Uut untrium —	532 Uub unbium —	533 Uut untrium —	534 Uub unbium —	535 Uut untrium —	536 Uub unbium —	537 Uut untrium —	538 Uub unbium —	539 Uut untrium —	540 Uub unbium —	541 Uut untrium —	542 Uub unbium —	543 Uut untrium —	544 Uub unbium —	545 Uut untrium —	546 Uub unbium —	547 Uut untrium —	548 Uub unbium —	549 Uut untrium —	550 Uub unbium —	551 Uut untrium —	552 Uub unbium —	553 Uut untrium —	554 Uub unbium —	555 Uut untrium —	556 Uub unbium —	557 Uut untrium —	558 Uub unbium —	559 Uut untrium —	560 Uub unbium —	561 Uut untrium —	562 Uub unbium —	563 Uut untrium —	564 Uub unbium —	565 Uut untrium —	566 Uub unbium —	567 Uut untrium —	568 Uub unbium —	569 Uut untrium —	570 Uub unbium —	571 Uut untrium —	572 Uub unbium —	573 Uut untrium —	574 Uub unbium —	575 Uut untrium —	576 Uub unbium —	577 Uut untrium —	578 Uub unbium —	579 Uut untrium —	580 Uub unbium —	581 Uut untrium —	582 Uub unbium —	583 Uut untrium —	584 Uub unbium —	585 Uut untrium —	586 Uub unbium —	587 Uut untrium —	588 Uub unbium —	589 Uut untrium —	590 Uub unbium —	591 Uut untrium —	592 Uub unbium —	593 Uut untrium —	594 Uub unbium —	595 Uut untrium —	596 Uub unbium —	597 Uut untrium —	598 Uub unbium —	599 Uut untrium —	600 Uub unbium —	601 Uut untrium —	602 Uub unbium —	603 Uut untrium —	604 Uub unbium —	605 Uut untrium —	606 Uub unbium —	607 Uut untrium —	608 Uub unbium —	609 Uut untrium —	610 Uub unbium —	611 Uut untrium —	612 Uub unbium —	613 Uut untrium —	614 Uub unbium —	615 Uut untrium —	616 Uub unbium —	617 Uut untrium —	618 Uub unbium —	619 Uut untrium —	620 Uub unbium —	621 Uut untrium —	622 Uub unbium —	623 Uut untrium —	624 Uub unbium —	625 Uut untrium —	626 Uub unbium —	627 Uut untrium —	628 Uub unbium —	629 Uut untrium —	630 Uub unbium —	631 Uut untrium —	632 Uub unbium —	633 Uut untrium —	634 Uub unbium —	635 Uut untrium —	636 Uub unbium —	637 Uut untrium —	638 Uub unbium —	639 Uut untrium —	640 Uub unbium —	641 Uut untrium —	642 Uub unbium —	643 Uut untrium —	644 Uub unbium —	645 Uut untrium —	646 Uub unbium —	647 Uut untrium —	648 Uub unbium —	649 Uut untrium —	650 Uub unbium —	651 Uut untrium —	652 Uub unbium —	653 Uut untrium —	654 Uub unbium —	655 Uut untrium —	656 Uub unbium —	657 Uut untrium —	658 Uub unbium —	659 Uut untrium —	660 Uub unbium —	661 Uut untrium —	662 Uub unbium —	663 Uut untrium —	664 Uub

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.).