Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY (US) **0439/23**

Paper 2 Multiple Choice (Extended) **May/June 2017**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Center number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

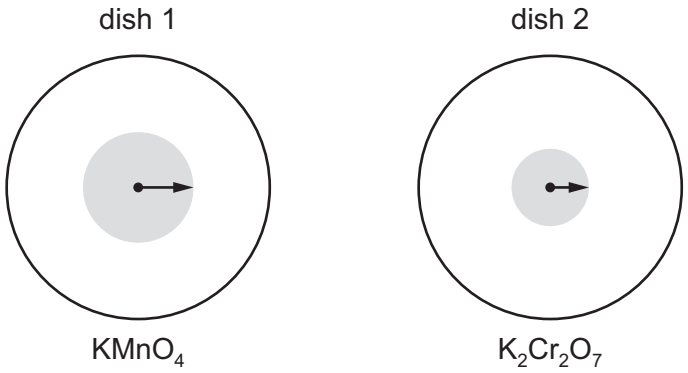
There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

1 Small crystals of purple $KMnO_4$ (M_r = 158) and orange $K_2Cr_2O_7$ (M_r = 294) were placed at the centers of separate petri dishes filled with agar jelly. They were left to stand under the same physical conditions.

After some time, the color of each substance had spread out as shown.



The lengths of the arrows indicate the relative distances traveled by particles of each substance.

Which statement is correct?

A Diffusion is faster in dish 1 because the mass of the particles is greater.

B Diffusion is faster in dish 2 because the mass of the particles is greater.

C Diffusion is slower in dish 1 because the mass of the particles is smaller.

D Diffusion is slower in dish 2 because the mass of the particles is greater.

2 A compound, X, has a melting point of 71 °C and a boiling point of 375 °C.

Which statement about X is correct?

A It is a liquid at 52 °C and a gas at 175 °C.

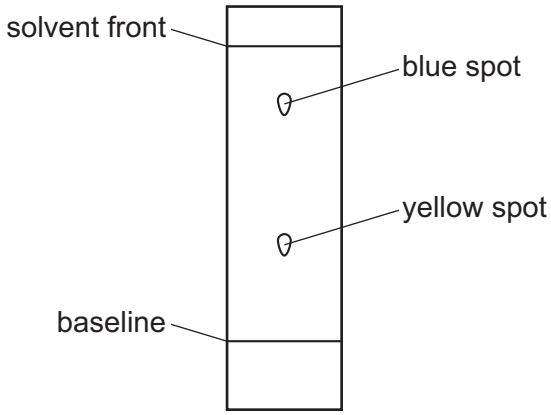
B It is a liquid at 69 °C and a gas at 380 °C.

C It is a liquid at 75 °C and a gas at 350 °C.

D It is a liquid at 80 °C and a gas at 400 °C.

3 A student used chromatography to analyze a green food coloring.

The chromatogram obtained is shown.

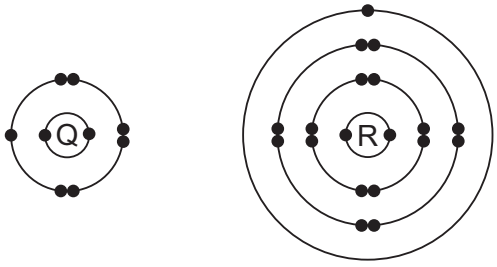


The table lists some yellow food dyes and their R_f values.

Which yellow food dye does the green food coloring contain?

	yellow food dye	R_f value
A	Quinolene Yellow	0.48
B	Sunset Yellow	0.32
C	tartrazine	0.69
D	Yellow 2G	0.82

4 The electronic structures of atoms Q and R are shown.



Q and R form an ionic compound.

What is the formula of the compound?

A QR_7 **B** Q_2R_4 **C** QR **D** Q_7R

5 Which substance is a macromolecule?

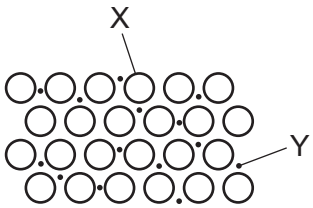
A ammonia

B carbon dioxide

C diamond

D water

6 The diagram shows metallic bonding.



Which labels are correct?

	X	Y
A	atomic nucleus	outer electron
B	metal atom	mobile electron
C	metal ion	mobile electron
D	positive ion	negative ion

7 Aqueous iron(III) sulfate and aqueous sodium hydroxide react to give a precipitate of iron(III) hydroxide and a solution of sodium sulfate.

What is the balanced equation for this reaction?

A $Fe_2(SO_4)_3(aq) + 2NaOH(aq) \rightarrow Fe(OH)_3(s) + Na_2SO_4(aq)$

B $Fe_2(SO_4)_3(aq) + 3NaOH(aq) \rightarrow Fe(OH)_3(s) + 3Na_2SO_4(aq)$

C $Fe_2(SO_4)_3(aq) + 6NaOH(aq) \rightarrow 2Fe(OH)_3(s) + 3Na_2SO_4(aq)$

D $2Fe_2(SO_4)_3(aq) + 6NaOH(aq) \rightarrow 4Fe(OH)_3(s) + 6Na_2SO_4(aq)$

8 The equation for the reaction between sodium carbonate and dilute hydrochloric acid is shown.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

What is the maximum volume of carbon dioxide produced when 26.5 g of sodium carbonate react with dilute hydrochloric acid?

A $6\,dm^3$ **B** $12\,dm^3$ **C** $18\,dm^3$ **D** $24\,dm^3$

9 Which statement about electrolysis is correct?

A Electrons move through the electrolyte from the cathode to the anode.

B Electrons move towards the cathode in the external circuit.

C Negative ions move towards the anode in the external circuit.

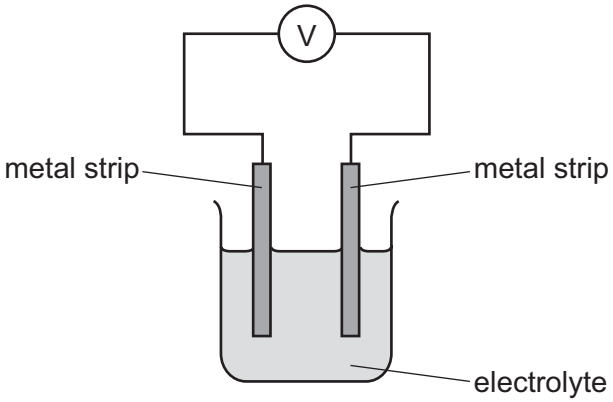
D Positive ions move through the electrolyte towards the anode during electrolysis.

10 The reactivity series for a number of different metals is shown.

most reactive → least reactive

magnesium	zinc	iron	copper	silver	platinum

The diagram shows different metal strips dipped into an electrolyte.



Which pair of metals produces the highest voltage?

A copper and magnesium

B magnesium and platinum

C magnesium and zinc

D silver and platinum

11 Heat energy is produced when hydrocarbons burn in air.

Which equations represent this statement?

1 $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

2 $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

3 $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

12 Which statements about exothermic and endothermic reactions are correct?

1 During an exothermic reaction, heat is given out.

2 The temperature of an endothermic reaction goes up because heat is taken in.

3 Burning methane in the air is an exothermic reaction.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

13 Hydrogen and chlorine react to form hydrogen chloride.

The reaction is exothermic.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

The overall energy change for this reaction is –184 kJ / mol.

The table gives some of the bond energies involved.

bond	bond energy in kJ / mol
H–Cl	+430
H–H	+436

What is the energy of the Cl–Cl bond?

A –240 kJ / mol

B –190 kJ / mol

C +190 kJ / mol

D +240 kJ / mol

14 Which changes are physical changes?

1 melting ice to form water

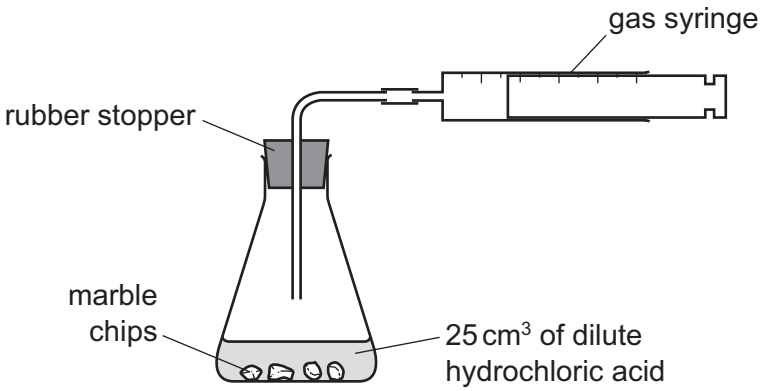
2 burning hydrogen to form water

3 adding sodium to water

4 boiling water to form steam

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

15 A student was investigating the reaction between marble chips and dilute hydrochloric acid.



Which changes slow down the rate of reaction?

	temperature of acid	concentration of acid	surface area of marble chips
A	decrease	decrease	decrease
B	decrease	decrease	increase
C	increase	decrease	decrease
D	increase	increase	increase

16 Hydrogen is produced when methane reacts with steam.

The equation for the reaction is shown.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

The forward reaction is endothermic.

Which conditions produce the highest yield of hydrogen?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

[Turn over

17 An example of a redox reaction is shown.

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

Which statement about the reaction is correct?

A Zn is the oxidizing agent and it oxidizes Cu^{2+}.

B Zn is the oxidizing agent and it reduces Cu^{2+}.

C Zn is the reducing agent and it oxidizes Cu^{2+}.

D Zn is the reducing agent and it reduces Cu^{2+}.

18 Which oxide is amphoteric?

A Al_2O_3 **B** CaO **C** Na_2O **D** SO_2

19 Chloric(I) acid, HClO, is formed when chlorine dissolves in water. It is a weak acid.

What is meant by the term *weak acid*?

A It contains fewer hydrogen atoms than a strong acid.

B It is easily neutralized by a strong alkali.

C It is less concentrated than a strong acid.

D It is only partially ionized in solution.

20 Silver nitrate reacts with sodium chloride to produce silver chloride and sodium nitrate. The equation for the reaction is shown.

$$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

How is silver chloride separated from the reaction mixture?

A crystallization

B distillation

C evaporation

D filtration

21 Aqueous sodium hydroxide reacts with an aqueous solution of compound Y to give a green precipitate.

Aqueous ammonia also reacts with an aqueous solution of compound Y to give a green precipitate.

In each case the precipitate is insoluble when an excess of reagent is added.

Which ion is present in Y?

A chromium(III)

B copper(II)

C iron(II)

D iron(III)

22 Which element is less reactive than the other members of its group in the Periodic Table?

A astatine

B cesium

C fluorine

D rubidium

23 Ununseptium (atomic number 117) is a man-made element that is below astatine in Group VII of the Periodic Table.

What is the expected state of ununseptium at room temperature?

A a diatomic gas

B a liquid

C a monatomic gas

D a solid

24 Why are weather balloons sometimes filled with helium rather than hydrogen?

A Helium is found in air.

B Helium is less dense than hydrogen.

C Helium is more dense than hydrogen.

D Helium is unreactive.

25 Which equation from the zinc extraction process shows the metal being produced by reduction?

A $ZnO + C \rightarrow Zn + CO$

B $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

C $Zn(g) \rightarrow Zn(l)$

D $Zn(l) \rightarrow Zn(s)$

26 Element E:

- forms an alloy
- has a basic oxide
- is below hydrogen in the reactivity series.

What is E?

A carbon

B copper

C sulfur

D zinc

27 The section of the reactivity series shown includes a newly discovered element, symbol X.

The only oxide of X has the formula XO.

Ca

Mg

Fe

X

H

Cu

Which equation shows a reaction which occurs?

A $Cu(s) + X^{2+}(aq) \rightarrow Cu^{2+}(aq) + X(s)$

B $2X(s) + Cu^{2+}(aq) \rightarrow 2X^{+}(aq) + Cu(s)$

C $X(s) + Fe_2O_3(s) \rightarrow 2Fe(s) + 3XO(s)$

D $X(s) + 2HCl(aq) \rightarrow XCl_2(aq) + H_2(g)$

28 Stainless steel is an alloy of iron and other metals. It is strong and does not rust but it costs much more than normal steel.

What is **not** made from stainless steel?

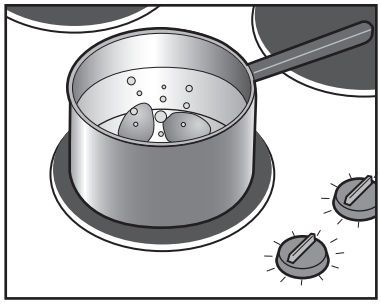
A cutlery

B pipes in a chemical factory

C railway lines

D saucepans

29 The diagram shows some uses of water in the home.



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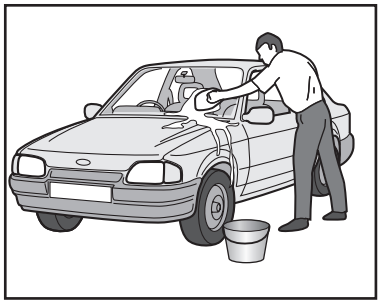

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3

For which uses is it important for the water to have been treated?

A 1 only **B** 2 only **C** 3 only **D** 1, 2 and 3

30 The carbon cycle describes how carbon dioxide gas is added to or removed from the atmosphere.

Which row describes the movement of carbon dioxide during each process?

	photosynthesis	combustion	respiration
A	added to the atmosphere	added to the atmosphere	removed from the atmosphere
B	added to the atmosphere	removed from the atmosphere	added to the atmosphere
C	removed from the atmosphere	added to the atmosphere	added to the atmosphere
D	removed from the atmosphere	added to the atmosphere	removed from the atmosphere

31 Which row gives the catalyst for the Haber process and the sources of the raw materials?

	catalyst	source of hydrogen	source of nitrogen
A	iron	electrolysis	fertilizer
B	iron	methane	air
C	vanadium pentoxide	methane	air
D	vanadium pentoxide	methane	fertilizer

32 Gasoline burns in a car engine to produce waste gases which leave through the car exhaust.

One of these waste gases is an oxide of nitrogen.

Which statement describes how this oxide of nitrogen is formed?

A Carbon dioxide reacts with nitrogen in the catalytic converter.

B Nitrogen reacts with oxygen in the car engine.

C Nitrogen reacts with oxygen in the catalytic converter.

D Gasoline combines with nitrogen in the car engine.

33 Which statement about sulfuric acid is correct?

A It is made by the Haber process.

B It is made in the atmosphere by the action of lightning.

C It reacts with ammonia to produce a fertilizer.

D It reacts with copper metal to produce hydrogen gas.

34 Two equations are shown.

reaction 1 $CaCO_3 \rightarrow CaO + CO_2$

reaction 2 $CaO + H_2O \rightarrow Ca(OH)_2$

Which terms describe reactions 1 and 2?

	reaction 1	reaction 2
A	reduction	hydration
B	reduction	hydrolysis
C	thermal decomposition	hydration
D	thermal decomposition	hydrolysis

35 Fuel oil, gasoline, kerosene and naphtha are four fractions obtained from the fractional distillation of petroleum.

What is the order of the boiling points of these fractions?

	highest boiling point → lowest boiling point
A	fuel oil → kerosene → gasoline → naphtha
B	fuel oil → kerosene → naphtha → gasoline
C	gasoline → naphtha → kerosene → fuel oil
D	naphtha → gasoline → kerosene → fuel oil

36 Butane and methylpropane are isomers with molecular formula C_4H_{10}.

Which statements are correct?

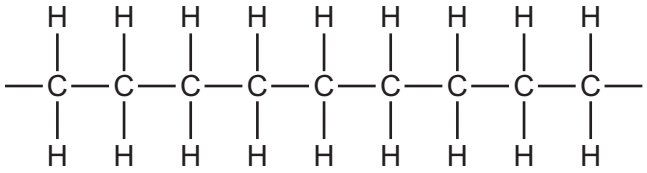
1 They have similar chemical properties.

2 They have the same general formula.

3 They have the same structural formula.

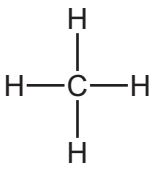
A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

37 The diagram shows part of the molecule of a polymer.

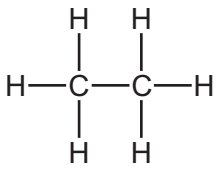


Which diagram shows the monomer from which this polymer could be manufactured?

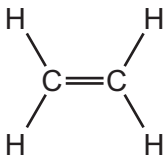
A



B



C



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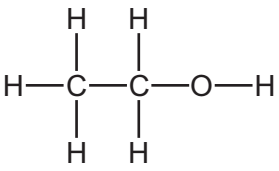
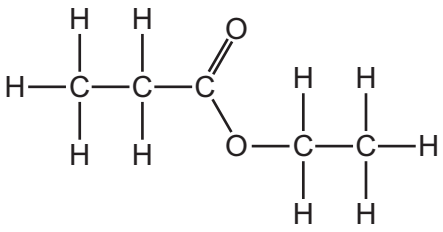


38 Ethanol can be produced by fermentation or by the catalytic addition of steam to ethene.

Which row shows an advantage and a disadvantage for each process?

	fermentation		catalytic addition of steam to ethene	
	advantage	disadvantage	advantage	disadvantage
A	batch process	slow reaction	continuous process	fast reaction
B	fast reaction	continuous process	pure ethanol formed	renewable raw material
C	renewable raw material	batch process	pure ethanol formed	slow reaction
D	renewable raw material	impure ethanol formed	fast reaction	finite raw material

39 The structure of an ester is shown.



Which alcohol and carboxylic acid produce this ester?

	alcohol	carboxylic acid
A	ethanol	ethanoic acid
B	ethanol	propanoic acid
C	propanol	ethanoic acid
D	propanol	propanoic acid

40 How can the amino acids in a protein be separated and identified?

A Add a locating agent to the protein.

B Hydrolyze the protein and then use chromatography.

C Polymerize the protein and then add a locating agent.

D Use chromatography on a solution of the protein.

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminum 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 cesium 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 –		114 Fl flerovium –		116 Lv livermorium –		

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 dm^3 at room temperature and pressure (r.t.p.)