READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

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.
1 Substance X dissolves in water to form a colourless solution. This solution reacts with aqueous lead(II) nitrate in the presence of dilute nitric acid to give a yellow precipitate.

What is substance X?

A  calcium iodide
B  copper(II) chloride
C  iron(II) iodide
D  sodium chloride

2 The diagram shows a diffusion experiment.

Which gas, when present in the beaker over the porous pot, will cause the water level at Y to rise?

A  carbon dioxide, CO₂
B  chlorine, Cl₂
C  methane, CH₄
D  nitrogen dioxide, NO₂
The diagram shows apparatus used to obtain carbon monoxide.

What is the main purpose of Y?

A to dry the gas  
B to prevent water being sucked back on to the hot carbon  
C to remove carbon dioxide from the gas  
D to remove hydrogen chloride from the gas

The boiling points of various gases found in the air are shown below.

<table>
<thead>
<tr>
<th></th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>argon</td>
<td>−186</td>
</tr>
<tr>
<td>carbon dioxide</td>
<td>−78</td>
</tr>
<tr>
<td>nitrogen</td>
<td>−198</td>
</tr>
<tr>
<td>oxygen</td>
<td>−183</td>
</tr>
</tbody>
</table>

If the air is cooled, the first substance to condense is water.

If the temperature is lowered further, what is the next substance to condense?

A argon  
B carbon dioxide  
C nitrogen  
D oxygen
5 The fractional distillation apparatus shown is to be used for separating a mixture of two colourless liquids. A thermometer is missing from the apparatus.

Where should the bulb of the thermometer be placed?

6 Hydrogen can form both $H^+$ ions and $H^-$ ions.

Which one of the statements below is correct?

A An $H^+$ ion has more protons than an $H^-$ ion.
B An $H^+$ ion has no electrons.
C An $H^-$ ion has one more electron than an $H^+$ ion.
D An $H^-$ ion is formed when a hydrogen atom loses an electron.

7 A dark, shiny solid, X, conducts electricity.

Oxygen combines with X to form a gaseous oxide.

What is X?

A graphite
B iodine
C iron
D lead
8 The diagram shows the molecule ethyl propanoate.

\[
\text{CH}_3-\text{CH}_2-\text{C} \quad \text{O} \quad \text{O} \quad \text{CH}_3-\text{CH}_2-\text{CH}_3
\]

How many bonding pairs of electrons are there in the molecule?

A 13  B 16  C 17  D 20

9 The conduction of electricity by metals is carried out by the movement of

A electrons only.
B electrons and positive ions.
C negative ions only.
D negative ions and positive ions.

10 Which substance could be sodium chloride?

<table>
<thead>
<tr>
<th>melting point / °C</th>
<th>conduction of electricity</th>
<th>when liquid</th>
<th>in aqueous solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A -114</td>
<td>nil</td>
<td>nil</td>
<td>good</td>
</tr>
<tr>
<td>B 180</td>
<td>nil</td>
<td>nil</td>
<td>nil (insoluble)</td>
</tr>
<tr>
<td>C 808</td>
<td>good</td>
<td>nil</td>
<td>good</td>
</tr>
<tr>
<td>D 3550</td>
<td>nil</td>
<td>nil</td>
<td>nil (insoluble)</td>
</tr>
</tbody>
</table>

11 What is the concentration of iodine molecules, I\textsubscript{2}, in a solution containing 2.54 g of iodine in 250 cm\textsuperscript{3} of solution?

A 0.01 mol/dm\textsuperscript{3}
B 0.02 mol/dm\textsuperscript{3}
C 0.04 mol/dm\textsuperscript{3}
D 0.08 mol/dm\textsuperscript{3}
12 The diagram shows the results of an electrolysis experiment using inert electrodes.

![Diagram of electrolysis experiment](image)

Which could be liquid X?

A aqueous copper(II) sulfate  
B concentrated aqueous sodium chloride  
C dilute sulfuric acid  
D ethanol

13 The energy profile for the forward direction of a reversible reaction is shown.

![Energy profile for a reversible reaction](image)

Which row correctly shows the sign of both the activation energy and the type of the enthalpy change for the reverse reaction?

<table>
<thead>
<tr>
<th></th>
<th>sign of activation energy</th>
<th>type of enthalpy change</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>negative</td>
<td>endothermic</td>
</tr>
<tr>
<td>B</td>
<td>negative</td>
<td>exothermic</td>
</tr>
<tr>
<td>C</td>
<td>positive</td>
<td>endothermic</td>
</tr>
<tr>
<td>D</td>
<td>positive</td>
<td>exothermic</td>
</tr>
</tbody>
</table>
14 The equation shows the formation of sulfur trioxide in the Contact process.

\[ 2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g) \quad \Delta H = -95 \text{kJ/mol} \]

What would **decrease** the yield of sulfur trioxide in a given time?

A addition of more oxygen  
B an increase in pressure  
C an increase in temperature  
D removal of \( \text{SO}_3(g) \) from the reaction chamber

15 Which graph represents how the rate of reaction varies with time when an excess of calcium carbonate reacts with dilute hydrochloric acid?

![Graphs](image)

16 In which reaction is nitric acid acting as an oxidising agent?

A \( \text{Cu} + 4\text{HNO}_3 \rightarrow \text{Cu(NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NO}_2 \)

B \( \text{CuO} + 2\text{HNO}_3 \rightarrow \text{Cu(NO}_3)_2 + \text{H}_2\text{O} \)

C \( \text{Na}_2\text{CO}_3 + 2\text{HNO}_3 \rightarrow 2\text{NaNO}_3 + \text{H}_2\text{O} + \text{CO}_2 \)

D \( \text{NaOH} + \text{HNO}_3 \rightarrow \text{NaNO}_3 + \text{H}_2\text{O} \)
17 A student mixed together aqueous solutions of Y and Z. A white precipitate formed.

Which could not be solutions Y and Z?

<table>
<thead>
<tr>
<th></th>
<th>solution Y</th>
<th>solution Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>hydrochloric acid</td>
<td>silver nitrate</td>
</tr>
<tr>
<td>B</td>
<td>hydrochloric acid</td>
<td>sodium nitrate</td>
</tr>
<tr>
<td>C</td>
<td>sodium chloride</td>
<td>lead(II) nitrate</td>
</tr>
<tr>
<td>D</td>
<td>sodium chloride</td>
<td>silver nitrate</td>
</tr>
</tbody>
</table>

18 The tests below were carried out on a solution containing ions of the metal X.

<table>
<thead>
<tr>
<th>test</th>
<th>observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>add sodium chloride solution</td>
<td>no change</td>
</tr>
<tr>
<td>add sodium sulfate solution</td>
<td>no change</td>
</tr>
<tr>
<td>add sodium hydroxide solution</td>
<td>a precipitate was formed, soluble in excess of the hydroxide</td>
</tr>
</tbody>
</table>

What is metal X?
A calcium
B iron
C lead
D zinc

19 Which property is common to calcium, potassium and sodium?
A Their atoms all lose two electrons when they form ions.
B They all form carbonates which are insoluble in water.
C They are all less dense than water.
D They are all metallic.

20 Which set of the electronic structures are only found in metals?
A 2, 1 2, 8, 1 2, 8, 8, 1
B 2, 5 2, 6 2, 7
C 2, 7 2, 8, 7 2, 8, 18, 7
D 2, 8, 3 2, 8, 4 2, 8, 5
21 The position of metal M in the reactivity series is shown.

\[
\text{decrease in reactivity} \\
\text{K, Na, M, Al, Zn, Fe, Pb, Cu, Ag}
\]

Which method will be used to extract M from its ore?
A  electrolysis of its aqueous sulfate
B  electrolysis of its molten oxide
C  reduction of its oxide by heating with coke
D  reduction of its oxide by heating with hydrogen

22 When zinc is added to a solution of a metal sulfate, the metal is deposited and zinc ions are produced in solution.

Which metal is deposited?
A  calcium
B  copper
C  magnesium
D  potassium

23 The diagram shows the structure of brass.

Why is brass harder than pure copper?
A  The zinc atoms form strong covalent bonds with copper atoms.
B  The zinc atoms prevent layers of copper atoms from slipping over each other easily.
C  The zinc atoms prevent the ‘sea of electrons’ from moving freely in the solid.
D  Zinc atoms have more electrons than copper atoms.
24 The diagram shows processes that take place in the manufacture of ammonia.

What are substances W and X and catalyst Y?

<table>
<thead>
<tr>
<th></th>
<th>W</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>air</td>
<td>oil</td>
<td>iron</td>
</tr>
<tr>
<td>B</td>
<td>air</td>
<td>oil</td>
<td>vanadium(V) oxide</td>
</tr>
<tr>
<td>C</td>
<td>oil</td>
<td>air</td>
<td>iron</td>
</tr>
<tr>
<td>D</td>
<td>oil</td>
<td>air</td>
<td>vanadium(V) oxide</td>
</tr>
</tbody>
</table>

25 Sulfur is burnt in air.

Which statement about this reaction is correct?

A  Sulfur is oxidised to sulfur trioxide.

B  The gas formed turns aqueous potassium dichromate(VI) from orange to green.

C  The reaction is reversible.

D  The reaction needs a catalyst.
26 Using the apparatus shown, chlorine is passed through the tube.

After a short time, coloured substances are seen at P, Q and R.

What are these coloured substances?

<table>
<thead>
<tr>
<th></th>
<th>at P</th>
<th>at Q</th>
<th>at R</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>green gas</td>
<td>red brown vapour</td>
<td>violet vapour</td>
</tr>
<tr>
<td>B</td>
<td>green gas</td>
<td>violet vapour</td>
<td>black solid</td>
</tr>
<tr>
<td>C</td>
<td>red brown vapour</td>
<td>violet vapour</td>
<td>black solid</td>
</tr>
<tr>
<td>D</td>
<td>violet vapour</td>
<td>red brown vapour</td>
<td>red brown vapour</td>
</tr>
</tbody>
</table>

27 Which equation in the blast furnace extraction of iron is not a redox reaction?

A  CaCO₃ → CaO + CO₂
B  2C + O₂ → 2CO
C  C + CO₂ → 2CO
D  Fe₂O₃ + 3CO → 2Fe + 3CO₂

28 In the electrolysis of molten aluminium oxide for the extraction of aluminium, the following three reactions take place.

1  Al³⁺ + 3e⁻ → Al
2  2O²⁻ → O₂ + 4e⁻
3  C + O₂ → CO₂

Which reactions take place at the anode?

A  1 only  B  2 only  C  1 and 3  D  2 and 3
29 Which statement about the material used for aircraft bodies is correct?

Aircraft bodies are made from

A an aluminium alloy because pure aluminium is too soft.
B pure aluminium because of its high melting point.
C pure aluminium because of its low density.
D pure aluminium because of its resistance to corrosion.

30 A catalytic converter in a car exhaust system speeds up the change of pollutants into less harmful products.

Which change does not occur in a catalytic converter?

A carbon dioxide $\rightarrow$ carbon
B carbon monoxide $\rightarrow$ carbon dioxide
C nitrogen oxides $\rightarrow$ nitrogen
D unburned hydrocarbons $\rightarrow$ carbon dioxide and water

31 Which natural process can cause nitrogen oxides to be formed in the atmosphere?

A bacterial decay of plants
B lightning activity
C photosynthesis
D respiration

32 Which type of water in the left hand column is linked correctly to a statement in the right hand column?

A distilled water
B drinking water
C river water
D sea water

A may contain fertilisers washed off from the fields
B contains no dissolved substances
C contains dissolved sodium chloride
D can be desalinated by treatment with chlorine
33 An organic compound has an empirical formula \( \text{C}_2\text{H}_4\text{O} \).

What is the compound?

A  butanoic acid  
B  butanol  
C  ethanoic acid  
D  ethanol

34 Which formula represents a compound likely to undergo addition polymerisation?

A  

B  

C  

D  

35 The diagrams show two organic compounds.

Which statement about the compounds S and T is correct?

A  Both S and T react with sodium carbonate.  
B  S and T react together to form the ester ethyl propanoate.  
C  T can be changed into S using acidified potassium dichromate(VI).  
D  They are in the same homologous series.
36 Five structures are shown.

Which structures represent identical molecules?

A 1 and 3 only
B 2 and 3 only
C 1, 3 and 4 only
D 1, 3 and 5 only

37 Which statement about ethanol is correct?

A It is an unsaturated compound.
B It is formed by the catalytic addition of steam to ethene.
C It is formed by the oxidation of ethanoic acid.
D It reacts with ethyl ethanoate to form an acid.

38 In which reaction is water produced?

A manufacture of ethanol from ethene
B manufacture of margarine from vegetable oils
C manufacture of poly(ethene) from ethene
D manufacture of Terylene from a carboxylic acid and an alcohol
39 The results of tests on compound Z are shown.

<table>
<thead>
<tr>
<th>test</th>
<th>result</th>
</tr>
</thead>
<tbody>
<tr>
<td>add bromine water</td>
<td>turns colourless</td>
</tr>
<tr>
<td>add aqueous sodium carbonate</td>
<td>carbon dioxide formed</td>
</tr>
</tbody>
</table>

What is compound Z?

A

B

C

D

40 Polymer X has the structure shown.

The list shows four terms that can be applied to polymers.

1 addition polymer
2 condensation polymer
3 polyamide
4 polyester

Which two terms can be applied to polymer X?

A 1 and 3  
B 1 and 4  
C 2 and 3  
D 2 and 4
DATA SHEET
The Periodic Table of the Elements

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>He</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Li</td>
<td>Be</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Na</td>
<td>Mg</td>
<td>Al</td>
<td>Si</td>
<td>P</td>
<td>S</td>
<td>Cl</td>
<td>Ar</td>
</tr>
<tr>
<td>5</td>
<td>K</td>
<td>Ca</td>
<td>Sc</td>
<td>Ti</td>
<td>V</td>
<td>Cr</td>
<td>Mn</td>
<td>Fe</td>
</tr>
<tr>
<td>6</td>
<td>Mg</td>
<td>Si</td>
<td>Ti</td>
<td>V</td>
<td>Cr</td>
<td>Mn</td>
<td>Fe</td>
<td>Ni</td>
</tr>
<tr>
<td>7</td>
<td>Al</td>
<td>P</td>
<td>S</td>
<td>Cl</td>
<td>Ar</td>
<td>K</td>
<td>Ba</td>
<td></td>
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<td>8</td>
<td>Sr</td>
<td>S</td>
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<td>Nb</td>
<td>Mo</td>
<td>Tc</td>
<td>Ru</td>
<td>Rh</td>
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<td>9</td>
<td>Y</td>
<td>Ca</td>
<td>La</td>
<td>Ce</td>
<td>Pr</td>
<td>Nd</td>
<td>Pm</td>
<td>Sm</td>
</tr>
<tr>
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<td>Zr</td>
<td>Xe</td>
<td>Xe</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>11</td>
<td>Ba</td>
<td>La</td>
<td>Ce</td>
<td>Pr</td>
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<td>Pm</td>
<td>Sm</td>
<td>Eu</td>
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<tr>
<td>12</td>
<td>Hf</td>
<td>Ta</td>
<td>W</td>
<td>Re</td>
<td>Os</td>
<td>Ir</td>
<td>Pt</td>
<td>Au</td>
</tr>
<tr>
<td>13</td>
<td>Ra</td>
<td>Th</td>
<td>U</td>
<td>Np</td>
<td>Pu</td>
<td>Am</td>
<td>Cm</td>
<td>Bk</td>
</tr>
<tr>
<td>14</td>
<td>Ra</td>
<td>Th</td>
<td>U</td>
<td>Np</td>
<td>Pu</td>
<td>Am</td>
<td>Cm</td>
<td>Bk</td>
</tr>
<tr>
<td>15</td>
<td>Tl</td>
<td>Pb</td>
<td>Bi</td>
<td>Po</td>
<td>At</td>
<td>Rn</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*58-71 Lanthanoid series
†90-103 Actinoid series

Key

- a = relative atomic mass
- b = proton (atomic) number
- X = atomic symbol

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