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. The table gives data about four substances.

Which substance has particles in a disorderly arrangement at room temperature?

<table>
<thead>
<tr>
<th></th>
<th>melting point / °C</th>
<th>boiling point / °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>−114</td>
<td>−80</td>
</tr>
<tr>
<td>B</td>
<td>120</td>
<td>445</td>
</tr>
<tr>
<td>C</td>
<td>750</td>
<td>1407</td>
</tr>
<tr>
<td>D</td>
<td>1610</td>
<td>2230</td>
</tr>
</tbody>
</table>

2. Which gas has the slowest rate of diffusion?
   A. ammonia, NH₃
   B. methane, CH₄
   C. oxygen, O₂
   D. nitrogen, N₂

3. An excess of calcium hydroxide is added to an acidic soil.

What happens to the pH of the soil?

<table>
<thead>
<tr>
<th></th>
<th>change in pH</th>
<th>final pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>increase</td>
<td>7</td>
</tr>
<tr>
<td>B</td>
<td>increase</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>decrease</td>
<td>7</td>
</tr>
<tr>
<td>D</td>
<td>decrease</td>
<td>5</td>
</tr>
</tbody>
</table>

4. Which test could be used to show that a sample of water is pure?
   A. It freezes at exactly 0°C.
   B. It turns anhydrous copper(II) sulphate blue.
   C. It turns cobalt(II) chloride paper pink.
   D. When it evaporates, it leaves no residue.
5 Hydrogen can form both H\(^+\) ions and H\(^-\) ions.

Which statement about these two ions is correct?

A An H\(^+\) ion has no electrons in its first shell.
B An H\(^+\) ion has more protons than an H\(^-\) ion.
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.

6 Which graph shows the number of electrons in the outer shell of an atom, plotted against the proton (atomic) number for the first ten elements in the Periodic Table?

![Graph options A, B, C, D]

7 The symbols and electronic structures for some elements are shown below.

silicon, Si (2,8,4)        oxygen, O (2,6)        hydrogen, H (1)
fluorine, F (2,7)         nitrogen, N (2,5)

Which formula is correct for a compound containing silicon?

A Si\(_4\)F  B SiH\(_4\)  C SiN\(_5\)  D Si\(_2\)O
8 Substance X conducts electricity when in the solid state.

X reacts with hydrochloric acid.

Which substance could X be?
A copper(II) oxide
B silicon(IV) oxide
C sodium chloride
D zinc

9 Rubidium is in Group I and bromine is in Group VII of the Periodic Table.

How is a compound formed between rubidium and bromine?
A Each atom of bromine shares an electron with an atom of rubidium.
B Each atom of bromine shares a pair of electrons with an atom of rubidium.
C Each atom of bromine gives an electron to an atom of rubidium.
D Each atom of bromine receives an electron from an atom of rubidium.

10 2 dm$^3$ of aqueous sodium hydroxide of concentration 5 mol/dm$^3$ were required for an experiment.

How many moles of sodium hydroxide were needed to make up this solution?
A 2.5  B 5  C 7  D 10

11 An 8 g sample of oxygen atoms contains the same number of atoms as 16 g of element X.

What is the relative atomic mass, $A_r$, of X?
A 4  B 8  C 16  D 32
12 The apparatus shown below was set up to copper plate the metal spoon.

The experiment did not work.

What was the mistake in the apparatus?

A A variable resistor should be included in the electrical circuit.
B Dilute sulphuric acid should be used as the electrolyte.
C The copper electrode should all be in the solution.
D The spoon should be the negative electrode.

13 Which pair of substances act as reducing agents in the blast furnace?

A carbon and oxygen
B carbon monoxide and carbon dioxide
C carbon and carbon monoxide
D carbon dioxide and oxygen
14 Two cells were set up as shown in the diagram. The arrows show the direction of electron flow in the external circuits.

Which set of metals would give the electron flows in the directions shown?

<table>
<thead>
<tr>
<th></th>
<th>metal X</th>
<th>metal Y</th>
<th>metal Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Ag</td>
<td>Cu</td>
<td>Zn</td>
</tr>
<tr>
<td>B</td>
<td>Ag</td>
<td>Zn</td>
<td>Cu</td>
</tr>
<tr>
<td>C</td>
<td>Cu</td>
<td>Zn</td>
<td>Ag</td>
</tr>
<tr>
<td>D</td>
<td>Zn</td>
<td>Cu</td>
<td>Ag</td>
</tr>
</tbody>
</table>

15 The equation below shows an exothermic reaction.

\[ \text{Mg(s) + 2HCl(aq) → MgCl}_2\text{(aq) + H}_2\text{(g)} \]

Which statement about this exothermic reaction is **not** correct?

A  Magnesium chloride is soluble in water.
B  Magnesium is above hydrogen in the reactivity series.
C  One mole of magnesium produces one mole of hydrogen gas.
D  The total energy of the products is greater than that of the reactants.
16. The diagram shows the energy profile for a chemical reaction.

What is the correct description of the reaction?

<table>
<thead>
<tr>
<th></th>
<th>sign of $\Delta H$</th>
<th>overall energy change</th>
<th>sign of $E_A$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$-$</td>
<td>exothermic</td>
<td>$-$</td>
</tr>
<tr>
<td>B</td>
<td>$+$</td>
<td>endothermic</td>
<td>$+$</td>
</tr>
<tr>
<td>C</td>
<td>$+$</td>
<td>endothermic</td>
<td>$-$</td>
</tr>
<tr>
<td>D</td>
<td>$+$</td>
<td>exothermic</td>
<td>$+$</td>
</tr>
</tbody>
</table>

17. In the Contact process for making sulphuric acid, one step involves the oxidation of sulphur dioxide as shown below.

$$2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g)$$

The forward reaction is exothermic.

Which change would increase the amount of sulphur trioxide produced at equilibrium?

A. increasing the temperature
B. decreasing the temperature
C. decreasing the pressure
D. adding a catalyst

18. Which statement about conduction of electricity is correct?

A. Electricity is conducted in aqueous solution by electrons.
B. Electricity is conducted in a metal wire by ions.
C. Electricity is conducted in a molten electrolyte by electrons.
D. Electricity is conducted in an acid solution by ions.
19 Which change is an example of oxidation?
A chloride ions to chlorine atoms
B copper(II) ions to copper atoms
C iron(III) ions to iron(II) ions
D oxygen atoms to oxide ions

20 Which cation, on reaction with aqueous sodium hydroxide, forms a precipitate that dissolves in excess sodium hydroxide?
A Ca$^{2+}$
B Cu$^{2+}$
C Fe$^{3+}$
D Zn$^{2+}$

21 Which of the following is a reaction of dilute sodium hydroxide?
A It reacts with ammonium chloride to produce ammonia.
B It reacts with calcium carbonate to produce carbon dioxide.
C It reacts with copper(II) oxide to produce water.
D It reacts with Universal Indicator solution turning it red.

22 The equation for one method of making copper carbonate is shown below.
\[ \text{CuSO}_4 + \text{Na}_2\text{CO}_3 \rightarrow \text{CuCO}_3 + \text{Na}_2\text{SO}_4 \]
The reaction is an example of
A neutralisation.
B oxidation and reduction.
C precipitation.
D synthesis.

23 A lump of element X can be cut by a knife.
During its reaction with water X floats and melts.
What is X?
A calcium
B copper
C magnesium
D potassium
24 Which deduction about the element astatine, At, can be made from its position in Group VII?

A It forms covalent compounds with sodium.
B It is displaced from aqueous potassium astatide, KAt, by chlorine.
C It is a gas.
D It is more reactive than iodine.

25 Which atom has the same electronic configuration as the strontium ion?

A calcium
B krypton
C rubidium
D selenium

26 Rubidium is in Group I of the Periodic Table.

What are properties of rubidium chloride?

<table>
<thead>
<tr>
<th></th>
<th>formula</th>
<th>approximate melting point/°C</th>
<th>solubility in water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>RbCl</td>
<td>70</td>
<td>insoluble</td>
</tr>
<tr>
<td>B</td>
<td>RbCl₂</td>
<td>700</td>
<td>soluble</td>
</tr>
<tr>
<td>C</td>
<td>RbCl₂</td>
<td>70</td>
<td>soluble</td>
</tr>
<tr>
<td>D</td>
<td>RbCl₂</td>
<td>700</td>
<td>insoluble</td>
</tr>
</tbody>
</table>

27 Iron pipes corrode rapidly when exposed to sea water.

Which metal, when attached to the iron, would not offer protection against corrosion?

A aluminium
B copper
C magnesium
D zinc

28 Metal carbonates decompose when heated.

Which carbonate is most stable to heat?

A calcium carbonate
B copper(II) carbonate
C lead(II) carbonate
D zinc carbonate
The apparatus shown was set up with 100 cm³ volume of air in the tube. The volume of gas in the tube was measured at intervals for six days. Which graph best represents how the volume of gas changes with time?
30 From your knowledge of the manufacture of both aluminium and iron, what is the order of chemical reactivity of aluminium, carbon and iron towards oxygen?

<table>
<thead>
<tr>
<th></th>
<th>most reactive</th>
<th>least reactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>aluminium</td>
<td>carbon</td>
</tr>
<tr>
<td>B</td>
<td>aluminium</td>
<td>iron</td>
</tr>
<tr>
<td>C</td>
<td>carbon</td>
<td>aluminium</td>
</tr>
<tr>
<td>D</td>
<td>carbon</td>
<td>iron</td>
</tr>
</tbody>
</table>

31 The molar heat of combustion, i.e. the heat given out when one mole of the alcohol is completely burned in oxygen, of a number of alcohols is given below.

<table>
<thead>
<tr>
<th>alcohol</th>
<th>formula</th>
<th>heat of combustion kJ/mol</th>
</tr>
</thead>
<tbody>
<tr>
<td>methanol</td>
<td>CH₃OH</td>
<td>750</td>
</tr>
<tr>
<td>ethanol</td>
<td>C₂H₅OH</td>
<td>1380</td>
</tr>
<tr>
<td>propanol</td>
<td>C₃H₇OH</td>
<td>2010</td>
</tr>
<tr>
<td>butanol</td>
<td>C₄H₉OH</td>
<td>2640</td>
</tr>
</tbody>
</table>

How many carbon and hydrogen atoms would there be in an alcohol that has a molar heat of combustion of 3900 kJ/mol?

<table>
<thead>
<tr>
<th></th>
<th>number of carbon atoms</th>
<th>number of hydrogen atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>14</td>
</tr>
</tbody>
</table>
32 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>

33 Element R reacts with oxygen to form a gas, T.

T changes the colour of damp litmus paper from blue to red.

T is used to kill bacteria in the preservation of dried fruit.

What is R?

A carbon  
B chlorine  
C nitrogen  
D sulphur

34 The gases coming from a car’s exhaust contain oxides of nitrogen.

How are these oxides formed?

A Nitrogen reacts with carbon dioxide.  
B Nitrogen reacts with carbon monoxide.  
C Nitrogen reacts with oxygen.  
D Nitrogen reacts with petrol.
35 The table shows pollutants and their possible effects.

Which line is not correct?

<table>
<thead>
<tr>
<th>pollutant</th>
<th>effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>CFCs cause destruction of the ozone layer</td>
</tr>
<tr>
<td>B</td>
<td>CH₄ forms photochemical smog</td>
</tr>
<tr>
<td>C</td>
<td>CO is poisonous to humans</td>
</tr>
<tr>
<td>D</td>
<td>NO₂ forms acid rain</td>
</tr>
</tbody>
</table>

36 A student investigated the reaction of different vegetable oils with hydrogen. 100 cm³ of hydrogen was passed through 1 g samples of vegetable oils containing a suitable catalyst.

The volume of hydrogen remaining after each reaction was recorded.

<table>
<thead>
<tr>
<th>vegetable oil</th>
<th>volume of hydrogen remaining/cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>100</td>
</tr>
<tr>
<td>Q</td>
<td>87</td>
</tr>
<tr>
<td>R</td>
<td>63</td>
</tr>
<tr>
<td>S</td>
<td>0</td>
</tr>
</tbody>
</table>

Which vegetable oils are unsaturated?

A P only
B Q and R only
C Q, R and S only
D S only

37 In the polymerisation of ethene to form poly(ethene), which of the following does not change?

A boiling point
B density
C empirical formula
D molecular mass
38 In which pair of macromolecules are the linkages the same?
   A fats and proteins
   B nylon and fats
   C nylon and proteins
   D proteins and Terylene

39 The structures of four organic compounds are shown.

Which compounds decolourise bromine water?
   A 1 and 2
   B 2 and 4
   C 3 only
   D 3 and 4

40 Which polymer would hydrolyse to amino acids?
   A
   B
   C
   D
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>I</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Li</td>
<td>3</td>
<td>Be</td>
<td>4</td>
<td>Na</td>
<td>11</td>
<td>Mg</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>23</td>
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<td>708</td>
<td>709</td>
<td>710</td>
<td>711</td>
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<td>713</td>
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<tr>
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<td>785</td>
<td>786</td>
<td>787</td>
<td>788</td>
<td>789</td>
<td>790</td>
<td>Br</td>
</tr>
<tr>
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<td>865</td>
<td>866</td>
<td>867</td>
<td>868</td>
<td>869</td>
<td>870</td>
<td>871</td>
<td>Kr</td>
</tr>
<tr>
<td>941</td>
<td>942</td>
<td>943</td>
<td>944</td>
<td>945</td>
<td>946</td>
<td>947</td>
<td>948</td>
<td>Xe</td>
</tr>
</tbody>
</table>

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

Key

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

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