READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, 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.
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 A bottle of aqueous ammonia is placed on a table in a corner of the laboratory.

The stopper is removed and after a few minutes all the students in the room can smell the ammonia.

Which process occurs?

A Brownian motion
B diffusion
C dissolving
D distillation

2 A student is investigating a coloured mixture using chromatography.

Where should the student place the coloured mixture?

A in the solvent
B just above the pencil line
C just below the pencil line
D on the pencil line
The diagrams show liquids in a burette and a measuring cylinder.

Which row shows the correct readings for the burette and the measuring cylinder?

<table>
<thead>
<tr>
<th></th>
<th>burette</th>
<th>measuring cylinder</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>27.8</td>
<td>42</td>
</tr>
<tr>
<td>B</td>
<td>27.8</td>
<td>44</td>
</tr>
<tr>
<td>C</td>
<td>28.2</td>
<td>42</td>
</tr>
<tr>
<td>D</td>
<td>28.2</td>
<td>44</td>
</tr>
</tbody>
</table>

The diagram shows how muddy water can be purified.

Which process for purifying the muddy water is shown?

A crystallisation
B distillation
C filtration
D solvent extraction
5 The aluminium ion, $\text{Al}^{3+}$, has the same electronic structure as an atom of which noble gas?

A argon  
B helium  
C krypton  
D neon

6 A covalent molecule $M$ contains a total of four shared electrons. 

What is $M$?

A ammonia, $\text{NH}_3$  
B hydrogen chloride, $\text{HCl}$  
C methane, $\text{CH}_4$  
D water, $\text{H}_2\text{O}$

7 Three substances have the properties shown.

- X conducts electricity when solid and when molten.
- Y is soluble in water and the solution conducts electricity.
- Z only conducts electricity when molten.

What are X, Y and Z?

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Ca</td>
<td>MgO</td>
<td>NaOH</td>
</tr>
<tr>
<td>B</td>
<td>Ca</td>
<td>NaOH</td>
<td>MgO</td>
</tr>
<tr>
<td>C</td>
<td>MgO</td>
<td>Ca</td>
<td>NaOH</td>
</tr>
<tr>
<td>D</td>
<td>MgO</td>
<td>NaOH</td>
<td>Ca</td>
</tr>
</tbody>
</table>
8 Caffeine is a stimulant found in coffee.

\[
\begin{align*}
\text{caffeine} \\
\text{H}_3\text{C} & \text{N} \text{C} \text{C} \text{N} \text{C} \text{C} \text{N} \text{C} \text{H} \\
\text{O} & \text{CH}_3 \text{O}
\end{align*}
\]

Which formula represents caffeine?

A \( \text{C}_7\text{H}_{10}\text{N}_4\text{O}_2 \)  
B \( \text{C}_8\text{H}_{10}\text{N}_3\text{O}_2 \)  
C \( \text{C}_8\text{H}_{10}\text{N}_4\text{O}_2 \)  
D \( \text{C}_8\text{H}_{11}\text{N}_4\text{O}_2 \)

9 Four substances are electrolysed.

The substances are concentrated aqueous sodium chloride, concentrated hydrochloric acid, molten lead(II) bromide and molten sodium oxide.

Which statement about these electrolysis reactions is correct?

A A colourless gas is formed at the anode when molten sodium oxide is electrolysed.
B A green gas is formed at the cathode when concentrated hydrochloric acid is electrolysed.
C A metal is formed at the anode when molten lead(II) bromide is electrolysed.
D A metal is formed at the cathode when concentrated aqueous sodium chloride is electrolysed.

10 Ammonium chloride is added to 100 cm\(^3\) of water. The temperature changes from 25 °C to 20 °C.

Which type of reaction occurs?

A endothermic  
B exothermic  
C freezing  
D neutralisation
11 A diagram for the energy change during an exothermic reaction is shown.

![Diagram showing energy change during exothermic reaction]

For which reactions would this be an appropriate diagram?

1. \( \text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \)
2. \( 2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} \)
3. \( \text{C} + \text{O}_2 \rightarrow \text{CO}_2 \)

A none of them  
B 1 and 2 only  
C 2 and 3 only  
D all of them

12 The diagram shows the apparatus used to measure the rate of a chemical reaction.

![Apparatus for measuring reaction rate]

For which reaction can the rate be measured using this apparatus?

A \( 2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl} \)  
B \( \text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} \)  
C \( \text{Na}_2\text{O} + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} \)  
D \( \text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2 \)
13 Copper(II) carbonate reacts with dilute sulfuric acid.

\[ \text{CuCO}_3(s) + \text{H}_2\text{SO}_4(aq) \rightarrow \text{CuSO}_4(aq) + \text{CO}_2(g) + \text{H}_2\text{O}(l) \]

The rate of the reaction can be changed by varying the conditions.

Which changes always increase the rate of this chemical reaction?

1. increasing the concentration of sulfuric acid
2. increasing the size of the pieces of copper(II) carbonate
3. increasing the temperature
4. increasing the volume of sulfuric acid

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

14 In which reaction is the first substance in the equation oxidised?

A \( \text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 \)
B \( 4\text{FeO} + \text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 \)
C \( \text{SnO}_2 + 2\text{H}_2 \rightarrow \text{Sn} + 2\text{H}_2\text{O} \)
D \( \text{ZnCO}_3 \rightarrow \text{ZnO} + \text{CO}_2 \)

15 The equation for the effect of heat on hydrated sodium carbonate is as shown.

\[ \text{Na}_2\text{CO}_3\cdot10\text{H}_2\text{O(s)} \rightleftharpoons \text{Na}_2\text{CO}_3(s) + 10\text{H}_2\text{O(g)} \]

Statements made by four students about the reaction are given.

P Anhydrous sodium carbonate is formed.
Q Steam is formed.
R There is a colour change from blue to white.
S The reaction is reversible.

Which students’ statements are correct?

A P, Q and R only
B P, Q and S only
C Q, R and S only
D P, Q, R and S
16 Which reaction is a neutralisation reaction?

A \[ \text{AgNO}_3 + \text{HCl} \rightarrow \text{AgCl} + \text{HNO}_3 \]  
B \[ \text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2 \]  
C \[ 4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O} \]  
D \[ 2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O} \]

17 Elements W and X are metals.

Elements Y and Z are non-metals.

The oxides of W, X, Y and Z all form solutions when added to water.

Which statement is correct?

A The solution of the oxide of element W turns blue litmus red.
B The solution of the oxide of element X fizzes when sodium carbonate is added.
C The solution of the oxide of element Y has a pH greater than pH 7.
D The solution of the oxide of element Z fizzes when powdered magnesium is added.

18 A student is given an unknown solution.

Which two tests provide evidence that the solution is copper(II) sulfate?

1 adding dilute hydrochloric acid
2 adding aqueous sodium hydroxide
3 adding dilute nitric acid, then silver nitrate solution
4 adding dilute nitric acid, then barium nitrate solution

A 1 and 3  
B 1 and 4  
C 2 and 3  
D 2 and 4
19. The diagram shows the steps in the preparation of a salt.

Which salt is prepared by this method?
A. barium sulfate  
B. copper(II) sulfate  
C. potassium sulfate  
D. sodium sulfate

20. Which property of elements increases across a period of the Periodic Table?
A. metallic character  
B. number of electron shells  
C. number of outer shell electrons  
D. tendency to form positive ions

21. The noble gases are in Group VIII of the Periodic Table.

Which statement explains why noble gases are unreactive?
A. They all have eight electrons in their outer shells.  
B. They all have full outer shells.  
C. They are all gases.  
D. They are all monoatomic.

22. Which compound is made from elements which are all in the same period?
A. Al_2(SO_4)_3  
B. C_2H_5OH  
C. LiNO_3  
D. Na_3AlF_6
23 Part of the Periodic Table is shown.

Which element is used as a catalyst?

A

B

C

D

24 Which statement about all metals is correct?

A They are attracted to a magnet.
B They are weak and brittle.
C They may be used to form alloys.
D They react with water.

25 Two experiments are carried out.

In experiment 1, copper is heated with steam.

In experiment 2, copper(II) oxide is heated with carbon.

Which row describes what happens in experiments 1 and 2?

<table>
<thead>
<tr>
<th></th>
<th>experiment 1</th>
<th>experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>no reaction</td>
<td>no reaction</td>
</tr>
<tr>
<td>B</td>
<td>no reaction</td>
<td>reaction</td>
</tr>
<tr>
<td>C</td>
<td>reaction</td>
<td>no reaction</td>
</tr>
<tr>
<td>D</td>
<td>reaction</td>
<td>reaction</td>
</tr>
</tbody>
</table>
26 Which metal is commonly used to form alloys with a non-metallic element?

A copper  
B iron  
C magnesium  
D zinc

27 Steel is made by adding ........ 1 ........ to molten iron to remove ........ 2 ........ from the iron.  
Stainless steel is ........ 3 ........ resistant to corrosion than mild steel.  
Which words complete the gaps 1, 2 and 3?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>basic oxides</td>
<td>acidic impurities</td>
<td>less</td>
</tr>
<tr>
<td>B</td>
<td>basic oxides</td>
<td>carbon</td>
<td>more</td>
</tr>
<tr>
<td>C</td>
<td>oxygen</td>
<td>acidic impurities</td>
<td>less</td>
</tr>
<tr>
<td>D</td>
<td>oxygen</td>
<td>carbon</td>
<td>more</td>
</tr>
</tbody>
</table>

28 Water is added to hydrated copper(II) sulfate.  
Which colour change takes place?

A blue to pink  
B blue to white  
C no change  
D white to blue
29 Two reactions, \( X \) and \( Y \), produce carbon dioxide.

\[
\begin{align*}
\text{CH}_4 & \xrightarrow{X} \text{CO}_2 & \text{Y} & \xrightarrow{} \text{CaCO}_3 \\
& & & \\
\end{align*}
\]

Which types of reaction are \( X \) and \( Y \)?

<table>
<thead>
<tr>
<th></th>
<th>( X )</th>
<th>( Y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>combustion</td>
<td>combustion</td>
</tr>
<tr>
<td>B</td>
<td>combustion</td>
<td>thermal decomposition</td>
</tr>
<tr>
<td>C</td>
<td>thermal decomposition</td>
<td>combustion</td>
</tr>
<tr>
<td>D</td>
<td>thermal decomposition</td>
<td>thermal decomposition</td>
</tr>
</tbody>
</table>

30 An experiment to find the percentage of oxygen in \( 150 \, \text{cm}^3 \) of polluted air is shown.

[Diagram of the experiment]

The apparatus is left for one week.

After this time, the volume of gas in the measuring cylinder is \( 122 \, \text{cm}^3 \).

What is the percentage of oxygen, to the nearest whole number, in the polluted air?

A 19%  B 21%  C 28%  D 81%

31 Ammonia is produced when a mixture of ammonium chloride and substance \( X \) is heated.

What is substance \( X \)?

A ammonium sulfate
B barium chloride
C calcium hydroxide
D silver nitrate
32 Which row is correct for both carbon dioxide and methane?

<table>
<thead>
<tr>
<th></th>
<th>causes climate change</th>
<th>produced by burning fuels</th>
<th>produced by living organisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>C</td>
<td>✓</td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

33 Which statements about sulfur dioxide are correct?

1. It dissolves in water to produce a solution with a pH less than pH 7.
2. It is used as a food preservative.
3. It changes potassium manganate(VII) from colourless to purple.
4. It is produced by the combustion of sulfur-containing fossil fuels.

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

34 A student carried out two experiments.

experiment 1 The student heated a sample of limestone very strongly. A white powder formed.

experiment 2 The white powder from experiment 1 was cooled. The student then added a small quantity of cold water to the powder. Large quantities of steam were produced.

Which statement is not correct?

A An endothermic reaction occurred in experiment 1.
B An exothermic reaction occurred in experiment 2.
C Thermal decomposition occurred in experiment 1.
D Thermal decomposition occurred in experiment 2.

35 Which substance has a main constituent that contains only one carbon atom per molecule?

A bitumen
B gasoline
C natural gas
D petroleum
36 The table shows the composition of four different types of petroleum.

<table>
<thead>
<tr>
<th>fraction</th>
<th>Arabian Heavy /%</th>
<th>Arabian Light /%</th>
<th>Iranian Heavy /%</th>
<th>North Sea /%</th>
</tr>
</thead>
<tbody>
<tr>
<td>gasoline</td>
<td>18</td>
<td>21</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>kerosene</td>
<td>11</td>
<td>15</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>diesel oil</td>
<td>18</td>
<td>21</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>fuel oil</td>
<td>53</td>
<td>43</td>
<td>46</td>
<td>38</td>
</tr>
</tbody>
</table>

Which type of petroleum is best for the motor vehicle industry?

A Arabian Heavy
B Arabian Light
C Iranian Heavy
D North Sea

37 Ethanol is a fuel used in cars. It can be made from petroleum.

\[
\begin{align*}
C_4H_{10} & \rightarrow C_2H_4 + C_2H_6 & \text{cracking} \\
C_2H_4 + H_2O & \rightarrow C_2H_5OH & \text{producing ethanol} \\
C_2H_5OH + 3O_2 & \rightarrow 2CO_2 + 3H_2O & \text{burning}
\end{align*}
\]

Compounds of how many homologous series appear in these equations?

A 1  B 2  C 3  D 4

38 Ethanol is produced from either ethene or sugar.

Which type of chemical reaction is used in each case?

<table>
<thead>
<tr>
<th>ethene → ethanol</th>
<th>sugar → ethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>A addition</td>
<td>fermentation</td>
</tr>
<tr>
<td>B addition</td>
<td>fractional distillation</td>
</tr>
<tr>
<td>C distillation</td>
<td>fermentation</td>
</tr>
<tr>
<td>D distillation</td>
<td>fractional distillation</td>
</tr>
</tbody>
</table>
39 Which type of hydrocarbon reacts rapidly with aqueous bromine and what is the colour change of the aqueous bromine?

<table>
<thead>
<tr>
<th>type of hydrocarbon</th>
<th>colour change of the aqueous bromine</th>
</tr>
</thead>
<tbody>
<tr>
<td>A alkane</td>
<td>brown to colourless</td>
</tr>
<tr>
<td>B alkane</td>
<td>colourless to brown</td>
</tr>
<tr>
<td>C alkene</td>
<td>brown to colourless</td>
</tr>
<tr>
<td>D alkene</td>
<td>colourless to brown</td>
</tr>
</tbody>
</table>

40 The diagram shows the structure of an important product.

\[
\begin{array}{cccccccc}
H & H & H & H & C & C & C & C & C \\
H & H & H & H & H & H & H & H & H \\
\end{array}
\]

This product is formed by …..1…… of an …..2…… .

Which words complete gaps 1 and 2?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>addition polymerisation</td>
<td>alkane</td>
</tr>
<tr>
<td>B</td>
<td>addition polymerisation</td>
<td>alkene</td>
</tr>
<tr>
<td>C</td>
<td>cracking</td>
<td>alkane</td>
</tr>
<tr>
<td>D</td>
<td>cracking</td>
<td>alkene</td>
</tr>
</tbody>
</table>
The Periodic Table of 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>VIII</th>
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<tr>
<td></td>
<td>3</td>
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<td>Be</td>
<td>B</td>
<td>C</td>
<td>N</td>
<td>O</td>
<td>F</td>
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<td>Zr</td>
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<td>Ru</td>
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<td></td>
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<td>Ru</td>
<td>Rh</td>
</tr>
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<td>43</td>
<td>44</td>
<td>Nb</td>
<td>Mo</td>
<td>Tc</td>
<td>Ru</td>
<td>Rh</td>
<td>Pd</td>
</tr>
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<td></td>
<td>45</td>
<td>46</td>
<td>Mo</td>
<td>Tc</td>
<td>Ru</td>
<td>Rh</td>
<td>Pd</td>
<td>Ag</td>
</tr>
<tr>
<td></td>
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<td>48</td>
<td>Tc</td>
<td>Ru</td>
<td>Rh</td>
<td>Pd</td>
<td>Ag</td>
<td>Cd</td>
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<td>50</td>
<td>Ru</td>
<td>Rh</td>
<td>Pd</td>
<td>Ag</td>
<td>Cd</td>
<td>In</td>
</tr>
<tr>
<td></td>
<td>51</td>
<td>52</td>
<td>Rh</td>
<td>Pd</td>
<td>Ag</td>
<td>Cd</td>
<td>In</td>
<td>Sn</td>
</tr>
<tr>
<td></td>
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<td>54</td>
<td>Pd</td>
<td>Ag</td>
<td>Cd</td>
<td>In</td>
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The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).