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.
You may use a calculator.
1. Which diagram shows the process of diffusion?

   A
   B
   C
   D

2. Which method would be most suitable for the separation of a mixture of sand and water to obtain the sand?

   A chromatography
   B crystallisation
   C distillation
   D filtration

3. A student investigates how the concentration of an acid affects the speed of reaction with a 0.5 g mass of magnesium at 30°C.

   The student has a beaker, concentrated acid, water and the apparatus below.

   P a balance
   Q a clock
   R a measuring cylinder
   S a thermometer

   Which pieces of apparatus does the student use?

   A P, Q and R only
   B P, Q and S only
   C Q, R and S only
   D P, Q, R and S
4 An element Y has the proton number 18.

The next element in the Periodic Table is an element Z.

Which statement is correct?
A Element Z has one more electron in its outer shell than element Y.
B Element Z has one more electron shell than element Y.
C Element Z is in the same group of the Periodic Table as element Y.
D Element Z is in the same period of the Periodic Table as element Y.

5 Which atom has twice as many neutrons as protons?
A $\text{H}^1$
B $\text{H}^2$
C $\text{H}^3$
D $\text{He}^4$

6 The table contains information about four substances.

Which substance is potassium chloride?

<table>
<thead>
<tr>
<th></th>
<th>melting point / °C</th>
<th>conduction of electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>11</td>
<td>no</td>
</tr>
<tr>
<td>B</td>
<td>98</td>
<td>yes</td>
</tr>
<tr>
<td>C</td>
<td>772</td>
<td>yes</td>
</tr>
<tr>
<td>D</td>
<td>1410</td>
<td>no</td>
</tr>
</tbody>
</table>

7 The electronic structures of atoms P and Q are shown.

![atomic structures]

P and Q react to form an ionic compound.

What is the formula of this compound?
A $\text{PQ}_2$
B $\text{P}_2\text{Q}$
C $\text{P}_2\text{Q}_6$
D $\text{P}_6\text{Q}_2$
8 The diagrams show the structures of two forms, P and Q, of a solid element.

![P and Q diagrams]

What are suitable uses of P and Q, based on their structures?

<table>
<thead>
<tr>
<th></th>
<th>use of solid P</th>
<th>use of solid Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>drilling</td>
<td>drilling</td>
</tr>
<tr>
<td>B</td>
<td>lubricating</td>
<td>drilling</td>
</tr>
<tr>
<td>C</td>
<td>drilling</td>
<td>lubricating</td>
</tr>
<tr>
<td>D</td>
<td>lubricating</td>
<td>lubricating</td>
</tr>
</tbody>
</table>

9 Methane, CH₄, burns in the air to form carbon dioxide and water.

What is the balanced equation for this reaction?

A CH₄(g) + O₂(g) → CO₂(g) + 2H₂O(g)
B CH₄(g) + 2O₂(g) → CO₂(g) + 2H₂O(g)
C CH₄(g) + 2O₂(g) → CO₂(g) + H₂O(g)
D CH₄(g) + 3O₂(g) → CO₂(g) + 2H₂O(g)

10 In which reaction is lead(II) oxide, PbO, oxidised?

A PbO + C → Pb + CO
B PbO + CO → Pb + CO₂
C PbO + H₂ → Pb + H₂O
D 2PbO + O₂ → 2PbO₂
11 The diagram shows an unsuccessful experiment to nickel plate a pan.

Which change is necessary to plate the pan with nickel?

A  Add more nickel sulfate to the solution.
B  Heat the solution to 100°C.
C  Increase the current in the circuit.
D  Make the pan the negative electrode.

12 The rates of some chemical reactions can be measured by using the apparatus shown.

For which reaction is this apparatus suitable?

A  MgCO₃ + 2HCl → MgCl₂ + CO₂ + H₂O
B  Mg + ZnCl₂ → MgCl₂ + Zn
C  MgCl₂ + 2NaOH → Mg(OH)₂ + 2NaCl
D  MgO + 2HCl → MgCl₂ + H₂O
13 The diagram shows that two gases are formed when concentrated hydrochloric acid is electrolysed using inert electrodes.

Which row correctly describes the colours of the gases at the electrodes?

<table>
<thead>
<tr>
<th></th>
<th>anode (+ve)</th>
<th>cathode (–ve)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>colourless</td>
<td>colourless</td>
</tr>
<tr>
<td>B</td>
<td>colourless</td>
<td>yellow-green</td>
</tr>
<tr>
<td>C</td>
<td>yellow-green</td>
<td>colourless</td>
</tr>
<tr>
<td>D</td>
<td>yellow-green</td>
<td>yellow-green</td>
</tr>
</tbody>
</table>

14 The diagram shows the reaction between zinc oxide and dilute hydrochloric acid.

Which terms describe the reaction?

<table>
<thead>
<tr>
<th></th>
<th>endothermic</th>
<th>neutralisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>C</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>
15. Four different gases are passed through the apparatus shown.

![Diagram of gas flow through apparatus]

damp red litmus paper
damp blue litmus paper

gas in → gas out

Which gas has no effect on either piece of litmus paper?

A. ammonia
B. carbon dioxide
C. chlorine
D. hydrogen

16. An aqueous solution of copper(II) sulfate was made by adding excess copper(II) oxide to dilute sulfuric acid. The mixture was heated, stirred and then filtered.

![Diagram of reaction and solution]

dilute sulfuric acid
copper(II) oxide

copper(II) sulfate solution

What was the pH of the acid before adding the copper(II) oxide and of the solution after filtration?

<table>
<thead>
<tr>
<th>pH of acid before adding copper(II) oxide</th>
<th>pH of solution after filtration</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. greater than 7</td>
<td>B. less than 7</td>
</tr>
<tr>
<td>B. greater than 7</td>
<td>C. 7</td>
</tr>
<tr>
<td>C. less than 7</td>
<td>D. greater than 7</td>
</tr>
<tr>
<td>D. less than 7</td>
<td></td>
</tr>
</tbody>
</table>
17 Aqueous potassium iodide is added to aqueous silver nitrate.

What are the colours of the final precipitate and solution?

<table>
<thead>
<tr>
<th></th>
<th>precipitate</th>
<th>solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>brown</td>
<td>colourless</td>
</tr>
<tr>
<td>B</td>
<td>white</td>
<td>yellow</td>
</tr>
<tr>
<td>C</td>
<td>yellow</td>
<td>colourless</td>
</tr>
<tr>
<td>D</td>
<td>yellow</td>
<td>white</td>
</tr>
</tbody>
</table>

18 Three gas jars contain carbon dioxide, hydrogen and oxygen, as shown.

Which one of the following tests could be used to discover which gas is in each jar?

A a glowing splint
B a lighted splint
C damp blue litmus paper
D limewater

19 The diagram shows an outline of part of the Periodic Table.

Which statement about elements X, Y and Z is not correct?

A All are metals.
B All conduct electricity.
C All form coloured compounds.
D All react with oxygen.
20 Elements X, Y and Z are in Group VII of the Periodic Table.

X is a gas.

Y is less reactive than Z

Z is a red liquid.

When X, Y and Z are put in order of increasing proton number, which order is correct?

A  X → Y → Z  B  X → Z → Y  C  Y → X → Z  D  Y → Z → X

21 Which properties of the element titanium, Ti, can be predicted from its position in the Periodic Table?

<table>
<thead>
<tr>
<th></th>
<th>can be used as a catalyst</th>
<th>conducts electricity when solid</th>
<th>has low density</th>
<th>forms coloured compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>C</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

22 Five elements have proton numbers 10, 12, 14, 16 and 18.

What are the proton numbers of the three elements that form oxides?

A  10, 12 and 14  
B  10, 14 and 18  
C  12, 14 and 16  
D  14, 16 and 18

23 Which statement about aluminium is not correct?

A  It is resistant to corrosion.  
B  It is strong and has a high density.  
C  It is used in food containers.  
D  It is used in the manufacture of aircraft.
24 Many metals are extracted from their ores by heating the metal oxide with carbon.

Which metal cannot be extracted using this method?

A aluminium  
B copper  
C iron  
D zinc

25 A metal has the following properties.

- It does not react with cold water.
- It reacts with dilute hydrochloric acid.
- It cannot be extracted from its oxide using carbon.

Between which two metals in the reactivity series should it be placed?

A calcium and magnesium  
B iron and copper  
C magnesium and zinc  
D zinc and iron

26 Which statements about the general properties of metals are correct?

1 conduct electricity when solid
2 form acidic oxides
3 high melting point

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

27 Water for human use is treated by filtration then chlorination.

Which uses do not need water of this quality?

1 water for cooling in industry
2 water for flushing toilets in the home
3 water for drinking

A 1, 2 and 3  
B 1 and 2 only  
C 1 and 3 only  
D 2 and 3 only
28 Carbon monoxide is an air pollutant produced when petrol is burned in a car engine.

Why is carbon monoxide considered to be an air pollutant?
A It causes global warming.
B It causes the corrosion of buildings.
C It is a greenhouse gas.
D It is poisonous.

29 A new planet has been discovered and its atmosphere has been analysed.

The table shows the composition of the atmosphere.

<table>
<thead>
<tr>
<th>gas</th>
<th>percentage by volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbon dioxide</td>
<td>4</td>
</tr>
<tr>
<td>nitrogen</td>
<td>72</td>
</tr>
<tr>
<td>oxygen</td>
<td>24</td>
</tr>
</tbody>
</table>

Which gases are present in the atmosphere of the planet in a higher percentage than they are in the Earth’s atmosphere?
A carbon dioxide and oxygen
B carbon dioxide only
C nitrogen and oxygen
D nitrogen only

30 Acetylene, C₂H₂, is a hydrocarbon. When acetylene and oxygen react, the hot flame produced can be used to weld steel.

Which statement is correct?
A Acetylene and oxygen react exothermically.
B Acetylene is saturated.
C Oxygen and steel react endothermically.
D Oxygen is a gaseous fuel.
31 Fertilisers are used to provide three elements needed to increase the yield of crops.

Which two compounds, when used together, would provide all three of these elements?

A ammonium nitrate and calcium phosphate
B ammonium nitrate and potassium sulfate
C potassium nitrate and calcium phosphate
D potassium nitrate and potassium sulfate

32 Carbon dioxide and methane are ‘greenhouse gases’ which contribute to global warming.

Which process does **not** increase global warming?

A burning fossil fuels
B decay of organic waste
C farming cattle for beef
D growing crops such as sugar cane

33 When coal and oil burn in power stations, the acidic gas sulfur dioxide is formed. Sulfur dioxide is removed by absorbing it in a liquid sprayed down a tower.

What is liquid X?

A calcium hydroxide solution
B sodium chloride solution
C dilute hydrochloric acid
D water
34 The table shows bonds that are present and bonds that are not present in compound X.

<table>
<thead>
<tr>
<th>bond</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C–C</td>
<td>✓</td>
</tr>
<tr>
<td>C=C</td>
<td>x</td>
</tr>
<tr>
<td>C–H</td>
<td>✓</td>
</tr>
<tr>
<td>C–O</td>
<td>✓</td>
</tr>
<tr>
<td>C=O</td>
<td>✓</td>
</tr>
<tr>
<td>O–H</td>
<td>✓</td>
</tr>
</tbody>
</table>

What type of compound is X?

A a carboxylic acid
B an alcohol
C an alkane
D an alkene

35 The diagram shows different fuels from which electricity can be generated.

Which box completes the diagram?

A ammonia
B bitumen
C natural gas
D steam
36 The diagram shows apparatus used to separate petroleum into four fractions.

![Diagram showing apparatus for separating petroleum into fractions]

Which fraction contains the smallest hydrocarbon molecules?

<table>
<thead>
<tr>
<th>fraction</th>
<th>boiling point range / °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>up to 70</td>
</tr>
<tr>
<td>B</td>
<td>70 to 120</td>
</tr>
<tr>
<td>C</td>
<td>120 to 170</td>
</tr>
<tr>
<td>D</td>
<td>over 170</td>
</tr>
</tbody>
</table>

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  Butene is an alkene which is manufactured by cracking hydrocarbons.

Which hydrocarbon can be cracked to make butene?
A  ethane, C\(_2\)H\(_6\)
B  decane, C\(_{10}\)H\(_{22}\)
C  methane, CH\(_4\)
D  propane, C\(_3\)H\(_8\)

39  Which substance does not produce carbon dioxide when it burns in oxygen?
A  butane
B  ethanol
C  ethene
D  hydrogen

40  Ethanol is an important chemical produced by the \……1\…… of \……2\…… .

Which words correctly complete gaps 1 and 2?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>combustion</td>
<td>ethane</td>
</tr>
<tr>
<td>B</td>
<td>combustion</td>
<td>glucose</td>
</tr>
<tr>
<td>C</td>
<td>fermentation</td>
<td>ethane</td>
</tr>
<tr>
<td>D</td>
<td>fermentation</td>
<td>glucose</td>
</tr>
</tbody>
</table>
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>Li</td>
<td>Be</td>
<td>B</td>
<td>C</td>
<td>N</td>
<td>O</td>
<td>F</td>
<td>Ne</td>
</tr>
<tr>
<td>II</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>III</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>IV</td>
<td>Rb</td>
<td>Sr</td>
<td>Y</td>
<td>Zr</td>
<td>Nb</td>
<td>Mo</td>
<td>Tc</td>
<td>Ru</td>
</tr>
<tr>
<td>V</td>
<td>Cs</td>
<td>Ba</td>
<td>La</td>
<td>Hf</td>
<td>Ta</td>
<td>W</td>
<td>Re</td>
<td>Os</td>
</tr>
<tr>
<td>VI</td>
<td>Fr</td>
<td>Ra</td>
<td>Ac</td>
<td>Th</td>
<td>Pa</td>
<td>U</td>
<td>Np</td>
<td>Pu</td>
</tr>
<tr>
<td>VII</td>
<td>Th</td>
<td>Pa</td>
<td>Np</td>
<td>U</td>
<td>Pu</td>
<td>Am</td>
<td>Cm</td>
<td>Bk</td>
</tr>
<tr>
<td>0</td>
<td>Xe</td>
<td>Xe</td>
<td>Xe</td>
<td>Xe</td>
<td>Xe</td>
<td>Xe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

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