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 A drop of liquid bromine is placed in the bottom of a gas jar. Brown fumes of bromine vapour slowly spread through the covered gas jar.

Why does this happen?

A Bromine vapour is less dense than air.
B Bromine molecules and the molecules in air are always moving around.
C Bromine molecules are smaller than the molecules in air.
D Bromine molecules move faster than the molecules in air.

2 Copper(II) sulfate crystals are separated from sand using the four processes listed below.

In which order are these processes used?

<table>
<thead>
<tr>
<th></th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>filtering</td>
<td>dissolving</td>
<td>crystallising</td>
<td>evaporating</td>
</tr>
<tr>
<td>B</td>
<td>filtering</td>
<td>dissolving</td>
<td>evaporating</td>
<td>crystallising</td>
</tr>
<tr>
<td>C</td>
<td>dissolving</td>
<td>evaporating</td>
<td>filtering</td>
<td>crystallising</td>
</tr>
<tr>
<td>D</td>
<td>dissolving</td>
<td>filtering</td>
<td>evaporating</td>
<td>crystallising</td>
</tr>
</tbody>
</table>

3 The diagrams show an experiment with aqueous ammonium chloride.

A gas, \( Y \), is produced and the litmus paper changes colour.

What are solution \( X \) and gas \( Y \)?

<table>
<thead>
<tr>
<th></th>
<th>solution ( X )</th>
<th>gas ( Y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>aqueous sodium hydroxide</td>
<td>ammonia</td>
</tr>
<tr>
<td>B</td>
<td>aqueous sodium hydroxide</td>
<td>chlorine</td>
</tr>
<tr>
<td>C</td>
<td>dilute sulfuric acid</td>
<td>ammonia</td>
</tr>
<tr>
<td>D</td>
<td>dilute sulfuric acid</td>
<td>chlorine</td>
</tr>
</tbody>
</table>
A student tested a solution by adding aqueous sodium hydroxide. A precipitate was not seen because the reagent was added too quickly.

What could not have been present in the solution?

A  Al$^{3+}$    B  Ca$^{2+}$    C  NH$_4^+$    D  Zn$^{2+}$

In which of the following is there a lattice of positive ions in a ‘sea of electrons’?

A  liquid potassium chloride
B  sand
C  solid graphite
D  solid magnesium

What is the mass of oxygen contained in 72 g of pure water?

[Relative atomic masses: H = 1; O = 16]

A  16 g    B  32 g    C  64 g    D  70 g

A covalent bond is formed by

A  electron sharing between metals and non-metals.
B  electron sharing between non-metals.
C  electron transfer between non-metals.
D  electron transfer from metals to non-metals.

Which molecule has the largest number of electrons involved in covalent bonds?

A  C$_2$H$_4$    B  CO$_2$    C  CH$_3$OH    D  N$_2$

The equation for the reaction between calcium carbonate and hydrochloric acid is shown.

\[
\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})
\]

How many moles of calcium carbonate will give 24 cm$^3$ of carbon dioxide when reacted with an excess of the acid?

(Assume one mole of carbon dioxide occupies 24 dm$^3$.)

A  1 mol    B  0.1 mol    C  0.01 mol    D  0.001 mol

Element X has the electronic structure 2,8,5. Element Y has the electronic structure 2,8,7.

What is the likely formula of a compound containing only X and Y?

A  X$Y_3$    B  X$_2$Y$_3$    C  X$_3$Y    D  X$_3$Y$_2$
11 The empirical formula of a liquid compound is $C_2H_4O$.

To find the empirical formula, it is necessary to know the

A density of the compound.
B percentage composition of the compound.
C relative molecular mass of the compound.
D volume occupied by 1 mole of the compound.

12 Which statement about both chlorine atoms and chloride ions is correct?

A They are chemically identical.
B They are isotopes of chlorine.
C They have the same number of protons.
D They have the same physical properties.

13 The diagram shows the electrolysis of molten lead(II) bromide using inert electrodes.

What happens during this electrolysis?

A Atoms change to ions.
B Covalent bonds are broken.
C Ions change to atoms.
D New compounds are formed.
14 The energy profile diagram for the reaction between hydrogen and chlorine is shown.

What information about this reaction does the diagram show?

<table>
<thead>
<tr>
<th>type of reaction</th>
<th>sign of enthalpy change, $\Delta H$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A endothermic</td>
<td>negative</td>
</tr>
<tr>
<td>B endothermic</td>
<td>positive</td>
</tr>
<tr>
<td>C exothermic</td>
<td>negative</td>
</tr>
<tr>
<td>D exothermic</td>
<td>positive</td>
</tr>
</tbody>
</table>

15 Which pair of metals X and Y will produce the highest voltage when used as electrodes in a simple cell?
16 The equation shows what happens in a redox reaction between iron(II) chloride and chlorine gas.

\[ 2\text{FeCl}_2 + \text{Cl}_2 \rightarrow 2\text{FeCl}_3 \]

Which equation describes the reduction process in this reaction?

A \[ 2\text{Cl}^- \rightarrow \text{Cl}_2 + 2e^- \]
B \[ \text{Cl}_2 + 2e^- \rightarrow 2\text{Cl}^- \]
C \[ \text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + e^- \]
D \[ \text{Fe}^{3+} + e^- \rightarrow \text{Fe}^{2+} \]

17 Which acid and base react together to produce an **insoluble** salt?

A hydrochloric acid and sodium hydroxide
B nitric acid and calcium oxide
C sulfuric acid and barium hydroxide
D sulfuric acid and zinc oxide

18 Carbon and silicon are both in Group IV of the Periodic Table.

Which statement is correct for both carbon dioxide and silicon dioxide?

A They are acidic oxides.
B They are readily soluble in water.
C They contain ionic bonds.
D They have giant molecular structures.

19 The following changes could be made to the conditions in the reaction between zinc and hydrochloric acid.

1 increase in concentration of the acid
2 increase in particle size of the zinc
3 increase in pressure on the system
4 increase in temperature of the system

Which pair of changes will increase the rate of reaction?

A 1 and 2  B 1 and 4  C 2 and 3  D 3 and 4
20  Which calcium compound does **not** increase the pH of acidic soils?

A  calcium carbonate  
B  calcium hydroxide  
C  calcium oxide  
D  calcium sulfate

21  A solution of fertiliser was tested as shown.

Which ions must be present in the fertiliser?

A  Fe$^{2+}$ and SO$_{4}^{2-}$  
B  Fe$^{3+}$ and NO$_{3}^{-}$  
C  NH$_{4}^{+}$ and Fe$^{2+}$  
D  NH$_{4}^{+}$ and NO$_{3}^{-}$

22  Which pair of properties are **both** correct for a typical transition element?

<table>
<thead>
<tr>
<th></th>
<th>property 1</th>
<th>property 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>forms coloured compounds</td>
<td>soluble in water</td>
</tr>
<tr>
<td>B</td>
<td>high density</td>
<td>has variable oxidation states</td>
</tr>
<tr>
<td>C</td>
<td>low density</td>
<td>high melting point</td>
</tr>
<tr>
<td>D</td>
<td>low melting point</td>
<td>can act as a catalyst</td>
</tr>
</tbody>
</table>
23 What happens when zinc foil is placed in an aqueous solution of copper(II) sulfate?

   A  Copper(II) ions are oxidised.
   B  There is no reaction.
   C  Zinc atoms are oxidised.
   D  Zinc sulfate is precipitated.

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 a gas.
   C  It is displaced from aqueous potassium astatide, KAt, by chlorine.
   D  It is more reactive than iodine.

25 In the apparatus shown, gas $P$ is passed over solid $Q$.

   $P \rightarrow Q$

No reaction occurs if $P$ and $Q$ are

<table>
<thead>
<tr>
<th></th>
<th>$P$</th>
<th>$Q$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>hydrogen</td>
<td>lead(II) oxide</td>
</tr>
<tr>
<td>B</td>
<td>hydrogen</td>
<td>magnesium oxide</td>
</tr>
<tr>
<td>C</td>
<td>oxygen</td>
<td>carbon</td>
</tr>
<tr>
<td>D</td>
<td>oxygen</td>
<td>sulfur</td>
</tr>
</tbody>
</table>

26 The diagram represents the manufacture of sulfuric acid by the Contact process.

$sulfur \rightarrow sulfur dioxide \rightarrow sulfur trioxide \rightarrow R \rightarrow sulfurous acid$

What is used in step $R$?

   A  concentrated sulfuric acid followed by water
   B  vanadium(V) oxide
   C  water followed by concentrated sulfuric acid
   D  water only
27 Aluminium is higher than copper in the reactivity series so the following displacement reaction should be feasible.

\[ 2\text{Al}(s) + 3\text{CuSO}_4(aq) \rightarrow \text{Al}_2\text{(SO}_4)_3(aq) + 3\text{Cu}(s) \]

The reaction does not take place at room temperature.

What is the reason for this?

A Aluminium has an inert coating all over it.
B The compound aluminium sulfate does not exist.
C The reaction is exothermic.
D The reaction needs to be warmed to take place.

28 Scrap iron is often recycled.

Which reason for recycling is not correct?

A It reduces the amount of pollution at the site of the ore extraction.
B It reduces the amount of waste taken to landfill sites.
C It reduces the need to collect the scrap iron.
D It saves natural resources.

29 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.

30 Which element can only be extracted from its ore using electrolysis?

A calcium
B copper
C lead
D silver
31 Which diagram represents the structure of an alloy?

![Diagram A]

![Diagram B]

![Diagram C]

![Diagram D]

32 When a volcano erupts, which gas is produced in significant amounts?

A carbon monoxide
B chlorofluorocarbons
C methane
D sulfur dioxide

33 Useful fractions are obtained by the fractional distillation of petroleum.

Which fraction is matched by its use?

<table>
<thead>
<tr>
<th>fraction</th>
<th>use</th>
</tr>
</thead>
<tbody>
<tr>
<td>A bitumen</td>
<td>fuel in cars</td>
</tr>
<tr>
<td>B lubricating oils</td>
<td>for making waxes and polishes</td>
</tr>
<tr>
<td>C paraffin (kerosene)</td>
<td>for making roads</td>
</tr>
<tr>
<td>D petrol (gasolene)</td>
<td>aircraft fuel</td>
</tr>
</tbody>
</table>

34 Compounds X and Y are both alkanes. Compound X has a higher boiling point than compound Y.

What could be the formulae of compounds X and Y?

<table>
<thead>
<tr>
<th>compound X</th>
<th>compound Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A C₈H₁₆</td>
<td>C₉H₁₅</td>
</tr>
<tr>
<td>B C₈H₁₈</td>
<td>C₈H₂₀</td>
</tr>
<tr>
<td>C C₉H₁₈</td>
<td>C₈H₁₆</td>
</tr>
<tr>
<td>D C₈H₂₀</td>
<td>C₈H₁₈</td>
</tr>
</tbody>
</table>
35 Compound X is a hydrocarbon. It reacts with steam to form an alcohol.

Which type of compound is X and what would be its effect on bromine water?

<table>
<thead>
<tr>
<th>type of compound</th>
<th>effect on bromine water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A alkane</td>
<td>turns from brown to colourless</td>
</tr>
<tr>
<td>B alkane</td>
<td>turns from colourless to brown</td>
</tr>
<tr>
<td>C alkene</td>
<td>turns from brown to colourless</td>
</tr>
<tr>
<td>D alkene</td>
<td>turns from colourless to brown</td>
</tr>
</tbody>
</table>

36 Which bond is present in both nylon and Terylene?

A C – O  B C = O  C N – C  D N – H

37 With which substance will ethene react to form more than one product?

A bromine
B hydrogen
C oxygen
D steam
38 Four hydrocarbon structures are shown.

Which hydrocarbons are isomers of each other?

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

39 When a compound X is reacted with sodium carbonate, carbon dioxide gas is evolved.

What could be the formula of compound X?

A $\text{C}_2\text{H}_5\text{CO}_2\text{CH}_3$ B $\text{C}_3\text{H}_7\text{CO}_2\text{H}$ C $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$ D $\text{C}_4\text{H}_9\text{OH}$

40 Which statement about ethanoic acid is correct?

A It contains three carbon atoms per molecule.
B It contains five hydrogen atoms per molecule.
C It is insoluble in water.
D It reacts with ethanol to form a sweet-smelling compound.
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>
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<tbody>
<tr>
<td></td>
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<td>B</td>
<td>C</td>
<td>N</td>
<td>O</td>
<td>F</td>
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<tr>
<td>Li</td>
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<td>Be</td>
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<td>S</td>
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<tr>
<td>Na</td>
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<td>Mn</td>
<td>Fe</td>
<td>Co</td>
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<td></td>
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<td></td>
<td>Li</td>
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</tbody>
</table>

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

The volume of one mole of any gas is 24 dm$^3$ at room temperature and pressure (r.t.p.).