CHEMISTRY · Mark scheme and worked solutions

CHEMISTRY Practice Paper 1

Use this to check your own answers. Self-marking is a great way to learn, but it doesn't update SubjectCover progress: to have your answers marked and your coverage tracked, take the paper in a free account.

Question 1

[7 marks]

ANSWER

(a) A greenhouse gas absorbs infrared radiation and traps heat in the atmosphere. Examples: carbon dioxide, methane, water vapour.

(b) Combustion of fossil fuels releases carbon, which reacts with oxygen to form carbon dioxide.

(c) Rising sea levels, melting polar ice caps, or increased extreme weather.

(d) CuO is the oxidising agent because it provides oxygen to magnesium (Mg) and is itself reduced to copper (Cu).

(e) Because natural processes that remove CO2 (e.g., photosynthesis, dissolving in oceans) are slower than the rate of addition.

Common mistakes: Confusing oxidising and reducing agents; Naming oxygen as a greenhouse gas; Saying global warming is caused only by CO2, without mentioning other effects

MARKING POINTS

B1 (a) · 1 mark · Correct definition of greenhouse gas

B2 (a) · 1 mark · Correct example named (e.g., carbon dioxide)

B3 (b) · 1 mark · Correct explanation of combustion releasing CO2

B4 (c) · 1 mark · One valid environmental impact identified

M1 (d) · 1 mark · Identification of CuO as oxidising agent

M2 (d) · 1 mark · Explanation using oxygen transfer (CuO provides oxygen/magnesium gains oxygen)

B5 (e) · 1 mark · Correct reason for slow removal (natural processes slower than addition)

WORKED SOLUTION

a) A greenhouse gas is a gas that absorbs infrared radiation and helps trap heat in the Earth's atmosphere. An example is carbon dioxide (CO_2).

b) When fossil fuels burn, carbon in the fuel reacts with oxygen in the air to produce carbon dioxide.

c) One impact could be that global temperatures increase, causing glaciers to melt and sea levels to rise. Other effects include extreme weather events such as floods or droughts.

d) In Mg(s) + CuO(s) → MgO(s) + Cu(s), CuO is the oxidising agent because it gives oxygen to magnesium (Mg), causing magnesium to be oxidised to magnesium oxide (MgO). CuO is reduced to copper (Cu) as it loses oxygen.

e) Carbon dioxide is not removed from the atmosphere as quickly as it is added because processes like photosynthesis (by plants) and absorption by oceans are relatively slow compared to the large amount produced by human activities.

Question 2

[5 marks]

ANSWER

(a) Crude oil is a mixture of hydrocarbons.

(b) Example: petrol (used as fuel in cars); diesel (fuel in vehicles); kerosene (aircraft fuel); bitumen (road surfacing); etc.

(c) As molecule size increases, viscosity increases (liquid becomes thicker, flows less easily) and colour becomes darker.

(d) Larger molecules have stronger intermolecular forces, so more energy is needed to separate them, resulting in a higher boiling point.

MARKING POINTS

B1 (a) · 1 mark · States that crude oil is a mixture of hydrocarbons

B1 (b) · 1 mark · Gives a correct product and use from a crude oil fraction (e.g., petrol as car fuel)

B1 (c) · 1 mark · Describes correct viscosity trend with molecule size (e.g., increases)

B1 (c) · 1 mark · Describes correct colour trend with molecule size (e.g., becomes darker)

B1 (d) · 1 mark · Explains higher boiling point of larger hydrocarbons due to stronger intermolecular forces

WORKED SOLUTION

a) Crude oil is a mixture of hydrocarbons.

b) Petrol (used as fuel in cars) is obtained from a fraction of crude oil. (Any correct example and use accepted.)

c) As the size of hydrocarbon molecules increases, the liquids become more viscous (they flow less easily) and also become darker in colour.

d) Larger hydrocarbon molecules have stronger intermolecular forces because they have more atoms, so more energy is needed to separate them, resulting in a higher boiling point.

Question 3

[5 marks]

ANSWER

(a) A is acidic (red litmus, red methyl orange, colourless phenolphthalein); B is alkaline (blue litmus, pink phenolphthalein, yellow methyl orange); C is neutral (purple litmus, colourless phenolphthalein, yellow methyl orange).

(b) B is alkaline, so its pH is likely to be between 8 and 14; pink phenolphthalein suggests pH > 8, yellow methyl orange confirms alkaline.

Common mistakes: swapping neutral and alkaline indicator results; misinterpreting purple litmus

MARKING POINTS

A1 (a) · 1 mark · Correctly identifies A as acidic, B as alkaline, C as neutral.

M1 (a) · 1 mark · Supports answer for acidic with at least one indicator colour (e.g. red litmus or methyl orange).

M2 (a) · 1 mark · Supports answer for alkaline and neutral with correct indicator colour(s).

A2 (b) · 1 mark · States B’s pH is above 7 or in correct alkaline range (8–14).

M3 (b) · 1 mark · Justifies using the indicator colour(s) (e.g., pink phenolphthalein = alkaline).

WORKED SOLUTION

a. Solution A is acidic: litmus is red, methyl orange is red, phenolphthalein is colourless – all are colours in acid.

Solution B is alkaline: litmus is blue, phenolphthalein is pink, methyl orange is yellow – all indicate alkali.

Solution C is neutral: litmus is purple (neutral), phenolphthalein is colourless (neutral or acid), methyl orange is yellow (neutral or alkali), supporting neutrality.

b. Solution B has a pH above 7 (alkaline). The pink colour in phenolphthalein suggests the pH is above 8. Yellow methyl orange also confirms it is alkaline. So the pH is likely to be between 8 and 14.

Question 4

[5 marks]

ANSWER

(a) — · must show Magnesium ion (Mg^{2+}) with 8 electrons in outer shell, Oxygen ion (O^{2-}) with 8 electrons in outer shell, Two electrons shown transferred from Mg to O, Correct charges on ions

(b) Aluminium loses 3 electrons to form an Al^{3+} ion. Nitrogen gains 3 electrons to form an N^{3-} ion. Three electrons are transferred from each aluminium atom to each nitrogen atom. · must show Al loses 3 electrons to form Al^{3+}, N gains 3 electrons to form N^{3-}, Reference to transfer of electrons

Common mistakes: Missing charges on ions; Wrong number of electrons transferred

MARKING POINTS

M1 (a) · 1 mark · Magnesium ion (Mg^{2+}) with correct number of electrons in outer shell (8)

M2 (a) · 1 mark · Oxygen ion (O^{2-}) with 8 electrons in its outer shell (2 crosses, 6 dots or vice versa)

A1 (a) · 1 mark · Correct charges shown on both ions (Mg^{2+} and O^{2-}) and two electrons shown as transferred

B1 (b) · 1 mark · Statement that aluminium loses 3 electrons to form Al^{3+}; nitrogen gains 3 electrons to form N^{3-}

B2 (b) · 1 mark · Describes electron transfer from aluminium to nitrogen (or equivalent description)

WORKED SOLUTION

a) In magnesium oxide (MgO), magnesium loses two electrons to form a Mg^{2+} ion and oxygen gains two electrons to form an O^{2-} ion.

[Mg]^{2+} with 8 electrons [O]^{2-} with 8 el

Dot-and-cross diagram for MgO

b) Aluminium (Al) is in Group 3 so it loses 3 electrons to form an Al^{3+} ion. Nitrogen (N) is in Group 5 so it gains 3 electrons to form an N^{3-} ion. Three electrons are transferred from aluminium to nitrogen.

Question 5

[5 marks]

ANSWER

(a) Hold damp red litmus or universal indicator paper at the mouth of the test tube; ammonia turns the paper blue. · must show use of damp red litmus or universal indicator paper, test paper turns blue with ammonia gas

(b(i)) Add a few drops of dilute nitric acid to the solution, then add a few drops of silver nitrate solution. · must show add dilute nitric acid before silver nitrate, add silver nitrate solution

(b(ii)) A white precipitate of silver chloride forms. · must show name: silver chloride, colour: white

MARKING POINTS

B1 (a) · 1 mark · Correct procedure: use of damp red litmus or universal indicator paper at mouth of test tube with ammonia.

B1 (a) · 1 mark · Correct result: paper turns blue in the presence of ammonia gas.

M1 (b(i)) · 1 mark · Add dilute nitric acid to the solution before testing.

M1 (b(i)) · 1 mark · Then add silver nitrate solution to the mixture.

A1 (b(ii)) · 1 mark · White precipitate of silver chloride forms (name and colour).

WORKED SOLUTION

a) The chemical test for ammonia gas is carried out by holding a piece of damp red litmus paper or universal indicator paper at the mouth of the test-tube. If ammonia gas is present, it turns the paper blue.

b) (i) To test for chloride ions, add a few drops of dilute nitric acid to the solution to remove any interfering ions, then add a few drops of silver nitrate solution.

(ii) If chloride ions are present, a white precipitate of silver chloride forms.

Question 6

[3 marks]

ANSWER

(a) heptane · must show heptane

(b) C7H16 · must show C7H16

(c) — · must show 7 carbon atoms in a single straight chain, each with correct number of hydrogens (ends: 3, middle: 2), all bonds shown

Must show: heptane, C7H16, seven carbons in a straight chain with correct number of hydrogens

Common mistakes: Wrong chain length or name, missing hydrogens

MARKING POINTS

B1 (a) · 1 mark · Correct name: heptane.

B1 (b) · 1 mark · Correct molecular formula: C7H16.

B1 (c) · 1 mark · Displayed formula is correct: seven C in a straight line, each carbon showing correct number of hydrogens.

WORKED SOLUTION

a) The alkane with seven carbon atoms is called heptane.

b) Its molecular formula is $\mathrm{C_7H_{16}}$.

c) Displayed formula:

CH3—CH2—CH2—CH2—CH2—CH2—CH3 (all bonds between carbons and all hydrogens should be drawn out).

Question 7

[3 marks]

ANSWER

0.00323 mol (±0.0001)

Also accept: Accepts working with mean volume 21.7 cm³

Common mistakes: Not using mean volume.; Not converting to dm³.

MARKING POINTS

M1 · 1 mark · Finds mean volume of NaOH: (21.5 + 21.7)/2 = 21.6 cm³ or uses correct method. (Ignoring first titration as rough)

M2 · 1 mark · Converts mean volume to dm³: 21.6 cm³ = 0.0216 dm³ (or correct mean). (follow-through)

A1 · 1 mark · Calculates (0.0216) × 0.150 = 0.00324 mol (accept 0.00323 depending on mean). (follow-through)

WORKED SOLUTION

Mean volume (excluding first – rough): (21.5 + 21.7)/2 = 21.6 cm³

Convert to dm³: 21.6/1000 = 0.0216 dm³

$$n = 0.0216 \times 0.150 = 0.00324\,\mathrm{mol}$$

Question 8

[1 mark]

ANSWER

The reactivity increases as you go down Group 1.

Also accept: Reactivity increases down the group.; Alkali metals become more reactive further down Group 1.; They get more reactive as you go down Group 1.

Common mistakes: Reactivity decreases down the group.; Reactivity stays the same.

MARKING POINTS

B1 · 1 mark · States clearly that reactivity increases down Group 1.

WORKED SOLUTION

As you go down Group 1, the reactivity of the alkali metals increases.

Question 9

[3 marks]

ANSWER

(a) Soft (can be cut with a knife); or low melting point; or shiny (when freshly cut); or good electrical conductor.

(b) Reacts with water to form hydrogen; or forms an alkaline solution with water; or reacts vigorously with water.

(c) Silvery (or grey) and shiny (when freshly cut); solid.

MARKING POINTS

B1 (a) · 1 mark · States any valid physical property of sodium.

B1 (b) · 1 mark · Gives any valid chemical property common to Li, Na, K.

B1 (c) · 1 mark · Describes the appearance of potassium at room temperature.

WORKED SOLUTION

a) One physical property of sodium is that it is soft and can be cut with a knife.
b) A chemical property common to lithium, sodium, and potassium is that they all react with water to produce hydrogen gas.
c) At room temperature, potassium appears as a shiny, silvery solid (when freshly cut).

Question 10

[3 marks]

ANSWER

(a) Lubricating oil

(b) — · must show Fraction with more carbon atoms, Viscosity increases with molecule size

MARKING POINTS

B1 (a) · 1 mark · Correctly identifies lubricating oil as the more viscous fraction.

M1 (b) · 1 mark · Recognises that lubricating oil has larger molecules (more carbon atoms).

A1 (b) · 1 mark · States that viscosity increases as the size (number of carbon atoms) increases.

WORKED SOLUTION

a) Lubricating oil

b) Lubricating oil has a higher number of carbon atoms (20) than fuel gas (3). As the number of carbon atoms in a hydrocarbon increases, the molecules are larger and the liquid becomes more viscous.

Question 11

[2 marks]

ANSWER

Must show: Copper is below carbon: can be reduced, Magnesium is above carbon: cannot be reduced by carbon

Also accept: Copper is less reactive than carbon so can be reduced by it. Magnesium is more reactive than carbon so it cannot.

Common mistakes: Saying carbon is more reactive than all metals

MARKING POINTS

B1 · 1 mark · States copper is below carbon in the reactivity series, so carbon can reduce copper(II) oxide.

B1 · 1 mark · States magnesium is above carbon in the reactivity series, so carbon cannot reduce magnesium oxide.

WORKED SOLUTION

Copper is below carbon in the reactivity series, so carbon can reduce copper(II) oxide to copper. Magnesium is above carbon, so carbon cannot reduce magnesium oxide.

Question 12

[8 marks]

ANSWER

(a) Butane

(b) Used as liquefied petroleum gas (LPG) for heating or cooking.

(c) 2-methylbutane

(d) Fractional distillation. Crude oil is heated and its vapours pass up a column. Hydrocarbons condense at different levels based on their boiling points; smaller molecules with lower boiling points condense higher up, larger molecules condense lower down.

Also accept: 3-methylbutane; 2-methylbutane

Common mistakes: Incorrectly numbering the main carbon chain; Incorrect branch or fraction uses

MARKING POINTS

B1 (a) · 2 marks · Correctly names the 4-carbon straight chain compound as butane.

B2 (b) · 1 mark · Gives a typical use of refinery gases, e.g., LPG for heating/cooking.

B3 (c) · 2 marks · Correctly names branched compound as 2-methylbutane using IUPAC rules.

B4 (d) · 1 mark · Correctly names 'fractional distillation' as the process.

A1 (d) · 1 mark · Mentions compounds separated based on boiling points.

A2 (d) · 1 mark · Describes that smaller/lower-boiling condense near the top, larger/higher-boiling at the bottom.

WORKED SOLUTION

a) The compound shown is butane.
b) Refinery gases are used as LPG for home heating and cooking.
c) The compound with a main chain of 4 carbons and a methyl on the 2nd carbon is called 2-methylbutane.
d) The process is fractional distillation. Crude oil is heated so it vaporises; vapours rise up a fractionating column. Fractions condense at different heights depending on boiling point: lower boiling hydrocarbons condense higher up, and those with higher boiling points condense at lower levels.

Question 13

[8 marks]

ANSWER

(a) — · must show Weigh solvent and solute, Add solute to water at 40°C until saturated, Filter and evaporate water to weigh remaining solid, Calculate solubility from masses

(b) — · must show Melting over a range indicates mixture or impurity

(c) — · must show Pure substances melt at a sharp, constant temperature, Mixtures melt over a range, Example with temperatures (e.g. pure X melts at 100°C, mixture at 85–96°C)

MARKING POINTS

M1 (a) · 1 mark · States the solution is saturated by adding solid until no more dissolves at 40°C.

M2 (a) · 1 mark · Mentions filtering out undissolved solid and weighing solution.

M3 (a) · 1 mark · States water is evaporated and residue (dissolved solid) is weighed.

A1 (b) · 1 mark · Correctly states melting over a range means mixture or impurity.

M4 (b) · 1 mark · Explains that pure substances have a sharp melting point, mixtures do not.

A2 (c) · 1 mark · Describes sharp melting point for pure substances, range for mixtures.

M5 (c) · 1 mark · Gives a data example (e.g. pure melts at 120°C, mixture at 110–116°C).

M6 (c) · 1 mark · Explains usefulness for identifying purity (e.g. in chemical preparation).

WORKED SOLUTION

a. Weigh a clean, dry evaporating basin. Prepare water at 40°C in a boiling tube. Add the solid in small amounts and stir until no more dissolves, forming a saturated solution. Filter the solution to remove any undissolved particles. Measure the mass of the solution plus basin. Then evaporate all water and reweigh to find the mass of solid that was dissolved. Calculate solubility using the known mass of water for the solution.

b. Melting over a range of 76–83°C suggests that the sample is not pure—a pure substance should have a sharp, fixed melting point. This indicates the powder is a mixture or contains impurities.

c. Pure substances melt at a precise temperature, e.g., pure benzoic acid melts at 122°C, while a mixture melts over a wider range, e.g., an impure sample melts from 110°C to 119°C. Therefore, measuring the melting point helps to tell whether a substance is pure or a mixture.

Question 14

[8 marks]

ANSWER

(a) 2K(s) + 2H2O(l) → 2KOH(aq) + H2(g)

(b) Potassium reacts more vigorously; eg, produces a lilac flame or explodes, while lithium does not.

(c) Potassium's outer electron is further from the nucleus, so it is less strongly attracted and lost more easily, making it more reactive than sodium.

(d(i)) Cl2(aq) + 2I^-(aq) → 2Cl^-(aq) + I2(aq)

(d(ii)) The solution turns brown because iodine is formed; chlorine is more reactive than iodine and displaces iodide ions.

MARKING POINTS

A1 (a) · 1 mark · Correct balanced equation for potassium and water.

B1 (b) · 1 mark · One valid observation difference explained (e.g., potassium flame, explosion, faster reaction).

M1 (c) · 1 mark · Correctly refers to atomic structure (electron shells, distance from nucleus).

A2 (c) · 1 mark · Correct explanation relating weaker attraction to increased reactivity.

A3 (d(i)) · 2 marks · Correct ionic equation, mark both species and balancing.

B2 (d(ii)) · 1 mark · Correct visible observation (solution turns brown).

M2 (d(ii)) · 1 mark · Explanation refers to reactivity: chlorine displaces iodide due to being more reactive.

WORKED SOLUTION

a) Potassium and water equation:

$$2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$$

b) Potassium reacts more vigorously: it may produce a lilac flame or explode, and the reaction is faster than with lithium.

c) Potassium's outer electron is in a shell further from the nucleus than sodium's. This means the outer electron is less strongly attracted, so it is lost more easily, making potassium more reactive than sodium.

d)(i) The ionic equation for the reaction is:

$$Cl_2(aq) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(aq)$$

d)(ii) The solution turns brown because iodine is formed. Chlorine is more reactive than iodine and so displaces iodide ions from solution.

Question 15

[6 marks]

ANSWER

(a) 'Discharging an ion' means the ion loses its charge at the electrode, by either gaining or losing electrons to become a neutral atom or molecule. · must show Losing charge, Gaining/ losing electrons, Form neutral atom/molecule

(b) Calcium ions (Ca^{2+}) move to the cathode; chloride ions (Cl^-) move to the anode. · must show Ca^{2+} to cathode, Cl^- to anode

(c) $2Cl^- \rightarrow Cl2 + 2e^-$ · must show balanced half-equation for anode

(d) A calcium ion (Ca^{2+}) gains two electrons at the cathode to become a neutral calcium atom. This is reduction. · must show Ca^{2+} gains electrons, becomes calcium atom, called reduction

Common mistakes: Describing discharge only as forming atoms without mention of charge loss; Confusing anode and cathode; Not mentioning movement of ions

MARKING POINTS

M1 (a) · 1 mark · States that discharging an ion means it loses its charge at the electrode.

C1 (a) · 1 mark · Mentions process involves gain or loss of electrons, becoming a neutral atom or molecule.

B1 (b) · 1 mark · Identifies Ca^{2+} moves to cathode and Cl^- to anode.

A1 (c) · 1 mark · Correctly writes balanced half-equation: $2Cl^- \rightarrow Cl2 + 2e^-$.

M1 (d) · 1 mark · States that Ca^{2+} gains two electrons at the cathode.

C1 (d) · 1 mark · Explains this process is reduction, forming a calcium atom.

WORKED SOLUTION

a) Discharging an ion means the ion loses its charge at the electrode, either by gaining or losing electrons and becoming a neutral atom or molecule.

b) The ions present are calcium ions (Ca^{2+}) and chloride ions (Cl^-). Ca^{2+} move to the cathode and Cl^- to the anode.

c) The half-equation for chloride ions at the anode is:

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

d) At the cathode, each Ca^{2+} gains two electrons to become a neutral calcium atom ($Ca^{2+} + 2e^- \rightarrow Ca$). This is reduction because the ion gains electrons.

Question 16

[6 marks]

ANSWER

(a) A molecule is a group of two or more atoms chemically bonded together.

(b) — · must show Proton: Relative mass 1, Relative charge +1, Position nucleus, Neutron: Relative mass 1, Relative charge 0, Position nucleus, Electron: Relative mass 1/1836, Relative charge -1, Position outside nucleus

(c(i)) 7

(c(ii)) 10

Common mistakes: Confusing mass number with atomic number; Including formula units instead of molecules; Mixing up properties of protons, neutrons and electrons

MARKING POINTS

B1 (a) · 1 mark · Correct definition of molecule.

B2 (b) · 1 mark · Correct properties filled for proton.

B3 (b) · 1 mark · Correct properties filled for neutron.

B4 (b) · 1 mark · Correct properties filled for electron.

M1 (c(i)) · 1 mark · Method for calculating number of neutrons (mass number - atomic number).

A1 (c(ii)) · 1 mark · Correct total number of electrons in $\mathrm{NH_3}$.

WORKED SOLUTION

a) A molecule is a group of two or more atoms chemically bonded together.

b)

	Relative mass	Relative charge	Position in atom
Proton	1	+1	nucleus
Neutron	1	0	nucleus
Electron	1/1836	-1	outside nucleus

c) i) Number of neutrons = mass number - atomic number = 14 - 7 = 7

ii) Ammonia ($\mathrm{NH_3}$) has 1 nitrogen atom and 3 hydrogen atoms.

Number of electrons = (number in N) + (number in 3 H) = 7 + (3 × 1) = 10

Question 17

[4 marks]

ANSWER

(a) 2,5

(b) 2,8,3

(c) 2,8,8,2

(d) Calcium, because it has 4 shells.

Also accept: Accept comma or space as separator in configurations.

Common mistakes: Wrong number of electrons in shells; Not explaining shell count

MARKING POINTS

B1 (a) · 1 mark · Correct configuration for nitrogen (2,5 or 2 5).

B1 (b) · 1 mark · Correct configuration for aluminium (2,8,3 or 2 8 3).

B1 (c) · 1 mark · Correct configuration for calcium (2,8,8,2 or 2 8 8 2).

M1 (d) · 1 mark · Identifies calcium as having the most shells and gives appropriate explanation.

WORKED SOLUTION

a. Nitrogen has atomic number 7: configuration is 2,5.

b. Aluminium has atomic number 13: 2,8,3.

c. Calcium has atomic number 20: 2,8,8,2.

d. Calcium, because it has four shells (2,8,8,2), the greatest number among the three elements.

Question 18

[4 marks]

ANSWER

(a) Aluminium, because it is extracted by electrolysis which is used for the most reactive metals.

(b) Gold, because it is found uncombined in the Earth's crust due to its low reactivity.

(c) Reduction with carbon can only be used for metals less reactive than carbon (like iron); more reactive metals (like aluminium) cannot be reduced by carbon, so other methods are needed.

Common mistakes: Confusing most reactive with least reactive based on extraction method; Incorrect explanation for why carbon cannot be used for all metals

MARKING POINTS

B1 (a) · 1 mark · Names aluminium as most reactive; reason links electrolysis to high reactivity.

B1 (b) · 1 mark · Identifies gold; gives valid reason for being found uncombined.

M1 (c) · 1 mark · States reduction with carbon works only for metals less reactive than carbon.

M1 (c) · 1 mark · Correctly explains that more reactive metals require different extraction (e.g., electrolysis).

WORKED SOLUTION

a) Aluminium is most reactive because electrolysis is used for highly reactive metals.

b) Gold is least likely to be found as an ore, because it is so unreactive it is found as the element.

c) Reduction with carbon works for metals below carbon in the reactivity series (like iron) but not for more reactive metals (like aluminium), so these must be extracted by electrolysis.

Question 19

[4 marks]

ANSWER

(a) Pure solids melt sharply at a fixed temperature; mixtures melt over a range of temperatures. · must show Fixed melting point for pure solid, Range for mixture

(b) The sample is likely to be a mixture or impure because it melts over a range of temperatures. · must show Relates temperature range to impurity/mixture

Common mistakes: Ignoring temperature range as indicator of mixture; Stating melting point depresses without giving reason

MARKING POINTS

M1 (a) · 1 mark · States that pure solids melt at a fixed (sharp) point

A1 (a) · 1 mark · States that mixtures melt over a range of temperatures

M2 (b) · 1 mark · Recognizes melting over a range indicates a mixture

A2 (b) · 1 mark · Describes sample as impure or a mixture due to the range

WORKED SOLUTION

a) Pure solids have a sharp, fixed melting point. Mixtures melt over a range of temperatures as the different substances melt separately.

b) Since the solid melted over a range of 150°C to 163°C, this suggests it is not pure and likely a mixture or contains impurities.

Question 20

[4 marks]

ANSWER

(a) Silver chloride (AgCl), silver bromide (AgBr), silver iodide (AgI) · must show silver chloride, silver bromide, silver iodide

(b) White (AgCl), cream (AgBr), yellow (AgI) · must show white, cream, yellow

Common mistakes: Swapping colours between compounds.; Giving formulae instead of names when asked for names.

MARKING POINTS

A1 (a) · 1 mark · Correctly names silver chloride (AgCl)

A2 (a) · 1 mark · Correctly names silver bromide and silver iodide

C1 (b) · 1 mark · Gives correct colours: white (AgCl), cream (AgBr), yellow (AgI)

C2 (b) · 1 mark · All three correct and in correct order

WORKED SOLUTION

(a) Silver chloride, silver bromide, and silver iodide are formed.

(b) Silver chloride is white; silver bromide is cream; silver iodide is yellow.

Question 21

[4 marks]

ANSWER

(a) Ethanol is made by fermentation of sugars with yeast at 30–40°C and no air (anaerobic conditions), or by hydration of ethene with steam at high temperature and pressure using a catalyst.

(b) High temperature (e.g. about 300°C) or use of a catalyst (phosphoric acid), or high pressure.

(c) Hydration of ethene is fast or produces pure ethanol, or uses available petroleum feedstock.

MARKING POINTS

M1 (a) · 1 mark · Describes fermentation method for ethanol production.

M2 (a) · 1 mark · Describes hydration of ethene method for ethanol production.

B1 (b) · 1 mark · States any correct condition for hydration of ethene (temperature, pressure, catalyst).

B2 (c) · 1 mark · Gives a correct reason why hydration of ethene is used (faster, pure product, uses oil feedstock, etc).

WORKED SOLUTION

a) Ethanol can be made by fermenting sugars with yeast at 30–40°C and without air, or by reacting ethene with steam at 300°C and 60 atmospheres pressure with a catalyst.

b) One condition is high temperature (about 300°C).

c) Hydration of ethene gives pure ethanol quickly, or uses oil-derived ethene where sugar may not be available.

Question 22

[2 marks]

ANSWER

Also accept: Advantage: High-carbon steel is harder/more wear resistant, so nails are less likely to bend or wear down.; Disadvantage: High-carbon steel is more brittle, so nails are more likely to snap, or is less malleable or harder to hammer in.

Common mistakes: Saying 'stronger' without context.; Mixing up brittleness for hardness.

MARKING POINTS

B1 · 1 mark · States a valid advantage of high-carbon steel for nails (e.g. harder or more wear resistant).

B2 · 1 mark · States a valid disadvantage of high-carbon steel for nails (e.g. more brittle or more likely to snap, or harder to shape).

WORKED SOLUTION

Advantage: High-carbon steel is harder and more resistant to wear, so nails made from it are less likely to bend or become blunt.

Disadvantage: High-carbon steel is more brittle than mild steel and is more likely to snap or break when hammered.

Question 23

[3 marks]

ANSWER

Common mistakes: Not referring to proton transfer; confusing which gives/accepts proton.

MARKING POINTS

B1 · 1 mark · States that nitric acid donates a proton (H+) to sodium hydroxide (or OH-).

B2 · 1 mark · States that sodium hydroxide (the base) accepts a proton (H+) from the acid.

B3 · 1 mark · Describes that an acid is a proton donor and a base is a proton acceptor (in context or definition).

WORKED SOLUTION

Nitric acid acts as a proton donor (acid) and gives a proton (H+) to sodium hydroxide's hydroxide ion (OH-). Sodium hydroxide is the base: it accepts the proton. This forms water.

Question 24

[4 marks]

ANSWER

(a) Sodium sulfate and copper(II) sulfate are electrolytes; sugar and ethanol are non-electrolytes. Electrolytes conduct electricity (bulb lights and gas formed); non-electrolytes do not.

(b) Sugar and ethanol are covalent compounds; they do not contain ions and do not conduct electricity.

MARKING POINTS

B1 (a) · 1 mark · Correctly identifies sodium sulfate and copper(II) sulfate as electrolytes.

B2 (a) · 1 mark · Correctly explains that non-electrolytes (sugar, ethanol) do not conduct and bulb does not light.

B3 (b) · 1 mark · States that sugar and ethanol are covalent compounds/non-electrolytes.

B4 (b) · 1 mark · Explains sugar and ethanol do not conduct because they do not form ions in solution.

WORKED SOLUTION

a) Sodium sulfate and copper(II) sulfate are electrolytes because the bulb lights up and oxygen gas is produced at the anode for both—they contain ions that move. Sugar and ethanol are non-electrolytes, since the bulb does not light and no gas is produced; they do not conduct electricity.

b) The experiment shows that sugar and ethanol are covalent compounds, as they do not conduct electricity and therefore do not produce ions in solution.

Question 25

[4 marks]

ANSWER

(a) \ce{C2H5OH(l) + 3O2(g) -> 2CO2(g) + 3H2O(l)} · must show Correct formulae for ethanol, oxygen, carbon dioxide, water; correct balancing

(b) Ethanol can be used as a fuel for cars (or as a petrol additive). It is a biofuel because it is produced from renewable biological sources such as sugar cane or corn. · must show Identifies ethanol as a fuel/additive, Explains biofuel (produced from plants/renewable sources)

MARKING POINTS

M1 (a) · 1 mark · Writes correct reactants and products (ethanol, oxygen, carbon dioxide, water).

A1 (a) · 1 mark · Balances equation correctly: \ce{C2H5OH(l) + 3O2(g) -> 2CO2(g) + 3H2O(l)}

B1 (b) · 1 mark · States use of ethanol as a fuel or as an additive to petrol.

B2 (b) · 1 mark · Explains that ethanol is considered a biofuel as it is made from renewable/bio sources.

WORKED SOLUTION

a) The balanced chemical equation for the complete combustion of ethanol is:

$$\mathrm{C_2H_5OH\,(l) + 3\,O_2\,(g) \longrightarrow 2\,CO_2\,(g) + 3\,H_2O\,(l)}$$

b) Ethanol can be used in car engines, either as a fuel on its own or as an additive to petrol. Ethanol is considered a biofuel because it is produced from biological materials like sugar cane, making it renewable.

Question 26

[8 marks]

ANSWER

(a) Dynamic equilibrium requires a closed system with no substances being added or removed, and the reaction mixture must be at constant temperature and pressure if appropriate. These are necessary so reactants and products cannot escape and forward and reverse reactions can balance. · must show Conditions listed and explained clearly.

(b) When concentrations level off, it means the rate of the forward reaction (E2 + F2 → 2EF) equals the rate of the reverse reaction (2EF → E2 + F2). No net change occurs in concentrations, though both reactions continue. · must show Relationship between rates explained when concentrations constant.

(c) Adding more F2 increases its concentration, so the system shifts right (towards more EF), so E2 decreases and EF increases until a new equilibrium is reached. F2 itself will partially decrease as it reacts to form more EF. · must show Predicted changes for all three substances.

(d) Increasing F2 pushes the equilibrium towards formation of more EF, increasing EF yield. This helps industries make more product without needing to add more E2. · must show Industrial advantage explained with reference to equilibrium shift.

Also accept: Well-reasoned alternatives accepted for industrial or equilibrium explanations.

Common mistakes: Saying 'no reaction' at equilibrium, rather than 'rates are equal'.; Assuming concentrations must be equal at equilibrium.

MARKING POINTS

M1 (a) · 1 mark · States that a closed system and constant conditions are necessary for dynamic equilibrium.

M2 (a) · 1 mark · Explains why these conditions allow equilibrium (no loss of reactants/ products, balance of rates).

M3 (b) · 1 mark · States that forward and reverse reaction rates are equal at equilibrium.

M4 (b) · 1 mark · Notes that concentrations remain constant, but both reactions continue.

M5 (c) · 1 mark · Predicts that increasing F2 will increase EF and decrease E2 as equilibrium shifts right.

M6 (c) · 1 mark · Correctly describes the changes in all three substances, including temporary rise in F2 followed by partial decrease.

M7 (d) · 1 mark · States that increasing F2 increases EF yield industrially via equilibrium shift.

M8 (d) · 1 mark · Explains clearly why yield increases (more product forms through equilibrium movement).

WORKED SOLUTION

a) Dynamic equilibrium requires a closed system (nothing enters or leaves) and constant conditions (temperature and pressure). This ensures that both forward and reverse reactions can occur and reach a balance without loss of substances.

b) When concentrations of all substances become constant, the rate at which EF is produced equals the rate at which it is broken down. Both reactions continue, but there is no net change in amounts.

c) Adding more F2 causes the system to shift right to use up extra F2, so EF increases and E2 decreases until equilibrium is restored.

d) By increasing F2, industries can shift equilibrium towards more EF, maximising the amount of desired product made efficiently.

Question 27

[2 marks]

ANSWER

Alkali metals react rapidly with air to form an oxide coating, so they are stored under oil to prevent contact with air and keep the metals from reacting.

Also accept: They are kept under oil because they react quickly with air (oxygen), forming an oxide layer, and oil keeps them safe from this reaction; Oil prevents them from reacting with oxygen in the air

Common mistakes: Saying only water must be avoided; Not mentioning reaction with air or oxide formation

MARKING POINTS

B1 · 1 mark · Explains that alkali metals react rapidly with air (or oxygen) to form an oxide coating.

B2 · 1 mark · States that storage under oil prevents this reaction by keeping the metal away from air.

WORKED SOLUTION

Alkali metals like lithium, sodium, and potassium react quickly with oxygen in the air to form a layer of oxide on their surfaces.

They are stored under oil to keep them away from air and prevent them from reacting and losing their original shiny surfaces.

Question 28

[2 marks]

ANSWER

(a) An atom is the smallest particle of an element that can exist and still be recognised as that element.

(b) A molecule is a substance made up of two or more atoms chemically bonded together (can be the same or different elements).

Common mistakes: Stating that an atom is the same as a molecule or vice versa.; Saying any small particle is an atom or molecule without mentioning smallest piece or bonded atoms.

MARKING POINTS

B1 (a) · 1 mark · Correctly defines atom as the smallest particle of an element that can exist and still be recognised as that element.

B1 (b) · 1 mark · Correctly defines molecule as two or more atoms chemically bonded together (from same or different elements).

WORKED SOLUTION

a) An atom is the smallest particle of an element that still keeps the properties of that element.

b) A molecule is made up of two or more atoms chemically bonded together. They can be the same or different kinds of atoms.

Question 29

[5 marks]

ANSWER

(a) As relative molecular mass increases, both the melting point and boiling point increase.

(b) At 25°C, substance C is between its melting and boiling points so it is liquid. Substance A's boiling point is much lower (–183°C), so at 25°C it is already a gas. This is because C has stronger intermolecular forces due to higher molecular mass.

(c) Simple molecular substances do not have delocalised electrons or ions that can move to conduct electricity.

MARKING POINTS

A1 (a) · 1 mark · States or clearly describes that melting (or boiling) points increase as relative molecular mass increases.

A2 (a) · 1 mark · Correctly links both melting and boiling points to increasing molecular mass or refers to both properties.

B1 (b) · 1 mark · States substance C's melting and boiling points straddle 25°C (liquid at this temperature), substance A is gas because boiling point is below 25°C.

B2 (b) · 1 mark · Explains that substance C's higher Mr leads to stronger intermolecular forces, so higher boiling/melting points than substance A.

C1 (c) · 1 mark · States that simple molecular substances cannot conduct electricity due to lack of mobile charged particles (no delocalised electrons or ions).

WORKED SOLUTION

(a) As relative molecular mass increases from A to C, both the melting points and boiling points increase. For example, A has lowest melting/boiling points, C has highest.

(b) Substance C is a liquid at 25°C because its melting point is –7°C and its boiling point is 59°C; 25°C lies between them. Substance A boils at –183°C, so at 25°C it has already boiled and is a gas. Substance C, with greater molecular mass, has stronger intermolecular forces so its melting/boiling points are higher.

(c) None of these simple molecular substances conduct electricity because their molecules do not supply delocalised electrons or ions that can move to carry electric current.

Question 30

[5 marks]

ANSWER

(a) 20.4 dm^3

(b) 20,400 cm^3

(c) Any gas with the same number of moles at rtp occupies the same volume because the number of molecules is the same (Avogadro's law/molar volume idea). · must show Reference to Avogadro's law OR equal number of molecules implies equal volume at rtp

Common mistakes: Incorrect use of molar volume (22.4 dm^3, STP instead of rtp); Incorrect conversion between dm^3 and cm^3

MARKING POINTS

M1 (a) · 1 mark · Uses correct formula: volume = moles × 24 (dm³)

A1 (a) · 1 mark · Correct calculation: 0.85 × 24 = 20.4 dm³ (follow-through)

M2 (b) · 1 mark · Converts answer from (a) to cm³ by multiplying by 1000. (follow-through)

B1 (c) · 1 mark · States that any gas with the same number of moles occupies same volume at rtp (reference to Avogadro's law or equal number of molecules).

B2 (c) · 1 mark · Explanation linked specifically to same volume at rtp due to same number of molecules OR clear link to 'molar volume' concept.

WORKED SOLUTION

a) Calculate hydrogen volume in dm³:

$$\text{Volume} = \text{moles} \times \text{molar volume} = 0.85 \text{ mol} \times 24 \text{ dm}^3 \text{ mol}^{-1} = 20.4 \text{ dm}^3$$

b) Convert to cm³: 20.4 dm³ × 1000 = 20,400 cm³

c) Explanation: Any gas with the same number of moles at rtp occupies the same volume because, according to Avogadro's law, equal numbers of gas molecules at the same temperature and pressure occupy equal volumes.

Finished this paper?

Check it yourself with the free mark scheme, or create a free SubjectCover account to take it again for marking, explanations and progress tracking.

subjectcover.com/practice/chemistry/papers/chemistry-practice-paper-1