

Alkali metals, halogens and noble gases

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet answers

Each answer shows the method and the result in bold. Check every equation for the same number of atoms of each element on both sides, and check that your predicted trends follow the position of the outer shell.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE C1, IGCSE 9

Problem 1 Storing alkali metals

1. Sodium is soft (cut with a knife) and has a low melting point and low density.
2. It reacts quickly with oxygen and water vapour in air, so the oil keeps air and moisture away.

Soft, low melting point; stored under oil to stop reaction with air and water.

Problem 2 Lithium and water

1. Lithium hydroxide and hydrogen.
2. The solution is alkaline, so the indicator turns purple (blue-purple).
3. A lit splint held at the mouth of the tube gives a squeaky pop.

Lithium hydroxide and hydrogen; purple; squeaky pop.

Problem 3 Halogens at room temperature

Halogen	Colour	State
Chlorine	Pale green	Gas
Bromine	Red-brown	Liquid
Iodine	Grey (purple vapour)	Solid

The colours get darker and the state changes gas, liquid, solid down the group.

Problem 4 Uses of noble gases

1. Helium is less dense than air and does not burn.
2. Neon glows red-orange when electricity passes through it.
3. Argon is unreactive, so it protects the hot filament from oxygen.

Unreactive and low-density gases give these uses.

Problem 5 Melting points of alkali metals

1. Sodium melts at 98 °C.
2. The melting point decreases down the group.
3. Caesium is below rubidium in the group, so it melts at a lower temperature than 39 °C (the actual value is about 29 °C).

98 °C; decreases down; caesium below 39 °C.

Problem 6 Word equations

1. Sodium + water → sodium hydroxide + hydrogen.
2. Chlorine + potassium iodide → potassium chloride + iodine.
3. Lithium + chlorine → lithium chloride.

Three word equations as shown.

Problem 7 Balance the equations

Balance atoms one element at a time.

1. $2\text{Li} + 2\text{H}_2\text{O} \rightarrow 2\text{LiOH} + \text{H}_2$.
2. $2\text{K} + \text{Cl}_2 \rightarrow 2\text{KCl}$.
3. $2\text{Na} + \text{Br}_2 \rightarrow 2\text{NaBr}$.
4. $2\text{Rb} + 2\text{H}_2\text{O} \rightarrow 2\text{RbOH} + \text{H}_2$.

Each has two metal atoms in the equation.

Problem 8 Potassium versus sodium

1. Both have 1 outer electron.
2. Potassium has four shells, so its outer electron is further from the nucleus and more shielded by inner shells. It is held more weakly and lost more easily.

Potassium loses its outer electron more easily, so it is more reactive.

Problem 9 Fluorine and iodine

1. A halogen reacts by gaining one electron. In fluorine the outer shell is close to the nucleus and unshielded, so the electron is strongly attracted. In iodine the shell is further away, with more shielding, so the attraction is weaker.
2. The colour gets darker.

Closer shell means stronger attraction and higher reactivity.

Problem 10 Interpreting displacement tests

1. X_2 displaces Y ($\text{X}_2 + \text{NaY}$ reacts), and Y_2 displaces Z. So X is more reactive than Y, which is more reactive than Z. X is most reactive; Z is least.
2. Reactivity falls from X_2 through Y_2 to Z_2 .
3. X is more reactive than Z, so X_2 displaces Z from NaZ: a reaction happens.

Order X, Y, Z; $X_2 + NaZ$ reacts.

Problem 11 Will it react?

1. Yes: $Cl_2 + 2NaI \rightarrow 2NaCl + I_2$.
2. No: iodine is less reactive than chlorine.
3. Yes: $Br_2 + 2KI \rightarrow 2KBr + I_2$.
4. Yes: $Cl_2 + 2KBr \rightarrow 2KCl + Br_2$.

1, 3 and 4 react; 2 does not.

Problem 12 States of the halogens

1. A substance is a gas above its boiling point, a liquid between melting and boiling points, and a solid below its melting point.

Fluorine: boiling point $-188\text{ }^{\circ}\text{C}$, so gas. Chlorine: gas. Bromine: $-7\text{ }^{\circ}\text{C} < 25\text{ }^{\circ}\text{C} < 59\text{ }^{\circ}\text{C}$, so liquid. Iodine: $25\text{ }^{\circ}\text{C}$ is below its melting point of $114\text{ }^{\circ}\text{C}$, so solid.

2. The trend is gas, gas, liquid, solid, so astatine is a solid.

F_2 and Cl_2 gases, Br_2 liquid, I_2 solid; astatine solid.

Problem 13 Hydrogen from sodium

1. $n(Na) = 0.69 \div 23 = 0.030\text{ mol}$.
2. The ratio is $2 Na : 1 H_2$, so $n(H_2) = 0.030 \div 2 = 0.015\text{ mol}$.
3. Volume = $0.015 \times 24 = 0.36\text{ dm}^3 = 360\text{ cm}^3$.

360 cm^3 of hydrogen.

Problem 14 Spot the errors

1. They get more reactive down the group.
2. Chlorine is a pale green gas. Bromine is the red-brown liquid.
3. 8 outer electrons is a full shell, so noble gases are unreactive.

More reactive down; chlorine is a gas; full shells are stable.

Problem 15 Radon boiling point

1. Argon is third; its boiling point is about $-186\text{ }^{\circ}\text{C}$.
2. The boiling point rises down the group.
3. The differences between the last values are $33\text{ }^{\circ}\text{C}$ (Ar to Kr) and $45\text{ }^{\circ}\text{C}$ (Kr to Xe), so the next rise is probably $50\text{ }^{\circ}\text{C}$ or more. Radon would be near $-108 + 46 = -62\text{ }^{\circ}\text{C}$; accept $-70\text{ }^{\circ}\text{C}$ to $-55\text{ }^{\circ}\text{C}$.

Argon $-186\text{ }^{\circ}\text{C}$; radon about $-60\text{ }^{\circ}\text{C}$.

Problem 16 Making iodine

1. $n(KI) = 3.32 \div 166 = 0.0200\text{ mol}$.

2. From $2 \text{KI} : 1 \text{I}_2$, $n(\text{I}_2) = 0.0100 \text{ mol}$. $M_r(\text{I}_2) = 254$, so mass = $0.0100 \times 254 = 2.54 \text{ g}$.
3. $n(\text{Cl}_2) = 0.0100 \text{ mol}$. $M_r(\text{Cl}_2) = 71$, so mass = 0.710 g .

2.54 g iodine; 0.710 g chlorine.

Problem 17 Half equations

1. $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$.
2. $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}^-$.
3. Bromide loses electrons, so it is oxidised. Chlorine gains electrons, so it is reduced.

Bromide is oxidised; chlorine is reduced.

Problem 18 Predict the unknowns

1. Astatine is a dark (black) solid. It is less reactive than iodine, so it would not displace iodine.
2. Francium would react even more violently than caesium.
3. Halogen colours darken and reactivity falls down the group. For alkali metals the outer electron is furthest from the nucleus in francium, so it is lost most easily.

Astatine: dark solid, no displacement; francium: more reactive than caesium.

Problem 19 Helium airship

1. Lift per $\text{m}^3 = 1.20 - 0.17 = 1.03 \text{ kg}$.
2. Total lift = $1.03 \times 2000 = 2060 \text{ kg}$.
3. Helium is a noble gas, so it does not burn. Hydrogen is flammable and can explode in air.

2060 kg of lift; helium does not burn.

Problem 20 Design an investigation

1. Solutions of the halogens (chlorine water, bromine water, iodine solution) and solutions of potassium chloride, bromide and iodide.
2. Same volume of each solution, same concentration, same temperature (any three).
3. Chlorine changes potassium bromide and potassium iodide; bromine changes potassium iodide only; iodine changes neither. So the order is chlorine, bromine, iodine.
4. Use dilute solutions, wear goggles and keep the room ventilated.

Order of reactivity: chlorine > bromine > iodine.