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C4 Chemical patterns – Foundation Workbook answers

1		Missing words: atomic mass, periodic table, left, non-metals. groups, proton Missing letters: the ROU of group and the ERIO of period
2	a	Correctly coloured periodic table: <ul style="list-style-type: none"> • group 1 (alkali metals) – first column on the left • group 7 (halogens) – column headed 7 on the right • non-metals – H and elements in the top right corner (He, B, C, N, O, F, Ne, Si, P, S, Cl, Ar, As, Se, Br, Kr, Te, I, Xe, At, Rn) • transition metals – all elements in the block between groups 2 and 3
	b	Metals are all the elements that were not shown as non-metals above.
3	a	Missing symbols from left to right: Li, C, O, Mg, Ar Missing proton numbers from left to right: 5, 7, 11, 14, 17
	b	Carbon and silicon, group 4
	c	Melting points increase over the first four elements (proton numbers 3–6) then drop off suddenly for the next four elements (7–10). This pattern repeats itself for the next eight elements.
	d	Missing proton numbers: 9, 35 Missing symbols: Cl, I
	e	Halogens
	f	Melting points increase down the group.
4	a	<ul style="list-style-type: none"> • Missing words: soft, shiny, tarnish, density, hydrogen, alkaline, hydroxide • lithium + water → lithium hydroxide + hydrogen • potassium + chlorine → potassium chloride
	b	<ul style="list-style-type: none"> • Alkali metals: store group 1 metals under oil, do not touch but handle with forceps, wear eye protection when handling. Dispose of metal residues by reacting with an alcohol. • Alkalis: wear eye protection and wash off any splashes and spills with excess water.
	c	<ul style="list-style-type: none"> • Melting point decreases down the group • Boiling point decreases down the group
	d	Least reactive – lithium, most reactive – potassium <ul style="list-style-type: none"> • Lithium floats on water and fizzes gently. It gives off hydrogen. • Sodium melts when placed in water, giving off hydrogen gas and moving around on the water. It sometimes makes sparks and the gas catches fire. • Potassium has a very violent reaction with water. The hydrogen given off catches fire at once and molten metal may be thrown off the surface of the water.

Further guidance

5		hydrogen	H	H ₂
		water	H, O	H ₂ O
		lithium fluoride	Li, F	LiF
		sodium chloride	Na, Cl	NaCl
		potassium bromide	K, Br	KBr
		lithium hydroxide	Li, O, H	LiOH
6	a	Missing words: <ul style="list-style-type: none"> • reaction • left, products • word equation, s, liquid, gas, aq 		
	b	<ul style="list-style-type: none"> • lithium (s) + chlorine (g) → lithium chloride (s) • sodium (s) + chlorine (g) → sodium chloride (s) • potassium (s) + chlorine (g) → potassium chloride (s) 		
	c	<ul style="list-style-type: none"> • lithium (s) + water (l) → lithium hydroxide (aq) + hydrogen (g) • sodium (s) + water (l) → sodium hydroxide (aq) + hydrogen (g) • potassium (s) + water (l) → potassium hydroxide (aq) + hydrogen (g) 		
7	a	<ul style="list-style-type: none"> • Chlorine is a dense, pale green gas. It is smelly and poisonous. • Bromine is a deep red liquid with a red-brown vapour. It is smelly, poisonous and corrosive. • Iodine is a grey solid with purple vapours. It is smelly and harmful. 		
	b	Correct bold words: <ul style="list-style-type: none"> • non-metals, coloured • bleach • toxic • two, diatomic • metal • colourless, potassium bromide • MX 		
	c	<ul style="list-style-type: none"> • Reaction with chlorine: As the chlorine gas passes over the hot iron, the iron glows brightly and changes to a rust-brown solid (iron chloride). • Reaction with bromine: The hot iron glows, but less brightly, as the bromine gas passes over it. It reacts to produce iron bromide. • Reaction with iodine: There is hardly any sign of reaction when iodine vapour is passed over hot iron. It reacts to make iron iodide. 		
8	a	Flames coloured: lithium – red, sodium chloride – bright yellow, potassium chloride – lilac		
	b	Spectrum of helium coloured as instructed.		

Further guidance

	c	The spectrum of sunlight shows the full range of colours in the EM spectrum. It is a continuous range of colours. The spectrum of helium consists of a number of separate coloured lines.																
	d	The spectrum for each element is unique.																
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	b	<table border="1"> <thead> <tr> <th>Part of atom</th> <th>Relative mass</th> <th>Charge</th> <th>Position</th> </tr> </thead> <tbody> <tr> <td>proton</td> <td>1</td> <td>+1</td> <td>in a very small central nucleus</td> </tr> <tr> <td>neutron</td> <td>1</td> <td>0</td> <td>in a very small central nucleus</td> </tr> <tr> <td>electron</td> <td>Insignificantly small</td> <td>-1</td> <td>in shells around the atom's nucleus</td> </tr> </tbody> </table>	Part of atom	Relative mass	Charge	Position	proton	1	+1	in a very small central nucleus	neutron	1	0	in a very small central nucleus	electron	Insignificantly small	-1	in shells around the atom's nucleus
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10	a	Missing words: shells, energy, inner, 2, 8, 18, left, right, periods, hydrogen, neon, electrons, proton, 11, electrons, 2.8.1																
	b	Correctly drawn arrangements of electrons: H 1, He 2, Li 2.1, Be 2.2, B 2.3, C 2.4, N 2.5, O 2.6, F 2.7, Ne 2.8, Na 2.8.1, Mg 2.8.2																
	c	<ul style="list-style-type: none"> • Alkali metals 2.1, 2.8.1, 2.8.18.1 • Halogens 2.7, 2.8.7, 2.8.18.7 																
	d	Missing numbers/words: 1, similar, 7																
11	a	Missing words: (diagram top left) carbon, (diagram bottom left) molten, (diagram top right) electrode, (text) not, conduct, electrodes, salt, ions																
	b	<ul style="list-style-type: none"> • Any salt (metal and one or more non-metals) • Any crystalline salt, e.g. NaCl, CaF, CuSO₄ • Salts are solids at room temperature. Small molecules are usually liquids or gases. • Any soluble salt, e.g. NaCl dissolved in water forms brine • Any insoluble salt, e.g. minerals such as lead sulfide and iron sulfide found in ores • Solid sodium chloride crystals do not conduct electricity, but do so when molten. (Sodium is produced at the -ve electrode and Cl₂ gas at the +ve electrode.) • Sodium chloride solution (brine) conducts electricity. (Hydrogen gas is given off at the -ve electrode and chlorine gas at the +ve electrode.) 																
12	a	<ul style="list-style-type: none"> • Correctly coloured diagram • The ions are closely packed together into a regular cube shape. They cannot move around, so the crystal keeps this shape whatever its size. 																

Further guidance

	b	<ul style="list-style-type: none"> • All the crystals of each solid ionic compound... – The ions in the giant ionic... • The solution of an ionic compound... – In a solution of an ionic compound... • Ionic compounds have relatively high melting points – The giant ionic structure... • When an ionic compound is heated... – In a molten ionic compound...
13	a	Missing words: (for sodium) loses, positive, (for chlorine) gains, negative
	b	<ul style="list-style-type: none"> • Li 2.1, Li^+ 2 • Mg 2.8.2, Mg^{2+} 2.8 • F 2.7, F^- 2.8 • O 2.6, O^{2-} 2.8
14		<ul style="list-style-type: none"> • Missing words in Hazard column: swallowed, death, corrosive, skin or eyes, fire, fire • Examples: • Harmful: iodine, potassium nitrate • Toxic: chlorine, bromine • Irritant: sodium carbonate, dilute hydrochloric acid • Corrosive: sodium, bromine, sodium hydroxide • Highly flammable: sodium • Oxidizing: potassium nitrate

C4 Chemical patterns – Higher Workbook answers

1		Missing words: atomic mass, periodic table, left, non-metals. groups, proton Missing letters: the ROU of group and the ERIO of period
2	a	Correctly coloured periodic table: <ul style="list-style-type: none"> • group 1 (alkali metals) – first column on the left • group 7 (halogens) – column headed 7 on the right • non-metals – H and elements in the top right corner (He, B, C, N, O, F, Ne, Si, P, S, Cl, Ar, As, Se, Br, Kr, Te, I, Xe, At, Rn) • transition metals – all elements in the block between groups 2 and 3
	b	Metals are all the elements that were not shown as non-metals above. (Some students may know that a few 'in between' elements are classified as metalloids: boron, silicon, germanium, arsenic, antimony, tellurium and polonium).
3	a	Missing symbols from left to right: Li, C, O, Mg, Ar Missing proton numbers from left to right: 5, 7, 11, 14, 17
	b	Carbon and silicon, group 4
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4	a	<ul style="list-style-type: none"> • Missing words: soft, shiny, tarnish, density, hydrogen, alkaline, hydroxide • lithium + water → lithium hydroxide + hydrogen • potassium + chlorine → potassium chloride
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	c	<ul style="list-style-type: none"> • Melting point decreases down the group • Boiling point decreases down the group • The densities of the other elements in group 1 (Rb, Cs, Fr)
	d	Least reactive – lithium, most reactive – potassium <ul style="list-style-type: none"> • Lithium floats on water and fizzes gently. It gives off hydrogen. • Sodium melts when placed in water, giving off hydrogen gas and moving around on the water. It sometimes makes sparks and the gas catches fire. • Potassium has a very violent reaction with water. The hydrogen given off catches fire at once and molten metal may be thrown off the surface of the water.

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		water	H, O	H ₂ O																
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6	a	Missing words: atoms, arrow, balanced, s, l, g, aq																		
	b	potassium + water → potassium hydroxide + hydrogen $K + H_2O \rightarrow KOH + H_2$ $2K + H_2O \rightarrow 2KOH + H_2$ $2K(s) + H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$																		
	c	lithium + chlorine → lithium chloride $Li + Cl_2 \rightarrow LiCl$ $2Li + Cl_2 \rightarrow 2LiCl$ $2Li(s) + Cl_2(g) \rightarrow 2LiCl(s)$																		
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	d	Missing numbers/words: 1, similar, 7																
	e	<ul style="list-style-type: none"> Elements in the same group have the same number of electrons in their outer shells. This is why they have similar chemical properties. For example, group 1 metals have 1 electron in their outer shells, so when they react with non-metals they lose this electron and always form ions with 1 positive charge. Likewise, elements in group 7 all have 7 electrons in their outer shell. They need to gain 1 electron when they react with other elements, so always form ions with 1 negative charge. The electrons in the outer shell of small atoms are closer to the nucleus (positive charge) so require lots of energy to remove them. Larger atoms have more shells, so the outer electrons are not held so tightly. So for group 1 elements, potassium (2,8,18,1) will lose its outer electron more easily than lithium (2,1) – it is more reactive. On the other hand, group 7 elements gain 1 electron when they react. It is easier for a smaller atom to gain an electron because the attracting positive charge of the nucleus is stronger than for a larger atom, where the electron has to join an outer shell. So fluorine (2,7) is more reactive than bromine (2,8,18,7). 																

Further guidance

11	a	<ul style="list-style-type: none"> Any salt (metal and one or more non-metals). Salts made from a metal with one non-metal: potassium chloride, magnesium bromide. Salts from a metal with two non-metals: sodium sulphate, potassium nitrate. Any crystalline salt, e.g. NaCl, CaF, CuSO₄. Crystals have a regular shape with smooth faces and sharp edges. Salts such as sodium chloride are solids at room temperature. This is because of the strong attractions between ions. Small molecules are liquids such as water or gases such as oxygen. The attractions between uncharged molecules are weak. Any soluble salt, e.g. NaCl dissolved in water forms brine Any insoluble salt, e.g. minerals such as lead sulfide and iron sulfide found in ores Solid sodium chloride crystals do not conduct electricity, but do so when molten. (Sodium is produced at the -ve electrode and Cl₂ gas at the +ve electrode.) Sodium chloride solution (brine) conducts electricity. (Hydrogen gas is given off at the -ve electrode and chlorine gas at the +ve electrode.) 																
12	a	<ul style="list-style-type: none"> Correctly coloured diagram The ions are closely packed together into a regular cube shape. They can vibrate but they cannot move around, so the crystal keeps this shape whatever its size. 																
	b	<ul style="list-style-type: none"> The ions in the giant ionic structure of an ionic compound are always arranged in the same regular way. Ionic compounds have relatively high melting points. When an ionic compound is heated above its melting point, the molten compound is a good conductor of electricity. In a solution of an ionic compound, the positive metal ions and the negative non-metal ions can move around independently. 																
13	a	Missing words: (for sodium) loses, positive, (for chlorine) gains, negative																
	b	<ul style="list-style-type: none"> Li 2.1, Li⁺ 2 Mg 2.8.2, Mg²⁺ 2.8 F 2.7, F⁻ 2.8 O 2.6, O²⁻ 2.8 																
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lithium bromide	Li ⁺	Br ⁻	LiBr															
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aluminium bromide	Al ³⁺	Br ⁻ Br ⁻ Br ⁻	AlBr ₃															
sodium oxide	Na ⁺ Na ⁺	O ²⁻	Na ₂ O															

Further guidance

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Missing words in Hazard column: swallowed, death, corrosive, skin or eyes, fire, fire

Examples:

- Harmful: iodine, potassium nitrate
- Toxic: chlorine, bromine
- Irritant: sodium carbonate, dilute hydrochloric acid
- Corrosive: sodium, bromine, sodium hydroxide
- Highly flammable: sodium
- Oxidizing: potassium nitrate