Further guidance

Contents

There are no further activities or notes associated with this module.

A4 Harnessing chemicals – Workbook answers

1		• Food products: saccharin, potassium nitrate, sodium chloride, ascorbic acid/vitamin C, acetic acid • Health care products: calcium carbonate, silica, aspirin, magnesium hydroxide • Products for decoration or protection: indigo, titanium dioxide, lead chromate
2	**a**	Diagram correctly labelled (note that the beaker contains sand and salt solution, the filter paper contains sand, and the flask contains the filtrate).
	b	Filtration
	c	Missing words: soluble, insoluble, water
	d	Wash the sand with distilled/pure water.
3	**a**	Pour the filtrate into an evaporating basin. Heat to evaporate the water. Collect the dry salt crystals from the basin.
	b	• Cooled slowly: drawing of large regular-shaped (rhombus) crystals • Cooled fast: drawing of small regular-shaped (rhombus) crystals
	c	…how fast the water evaporates.
4	**a**	• Never-lived sources: air, minerals, ores, rocks, water • Once-lived sources: coal, crude oil, natural gas • Living sources: animal products, cultivated crops, microorganisms, trees
	b	Missing words: organic, methane, inorganic, sodium chloride
5		• Bulk chemical: sulfuric acid • Fine chemicals in this order: ibuprofen, glyphosate, carotene, citral
6		• Labelling packs of chemicals: to warn about hazardous chemicals in containers so people take suitable precautions • Using chemicals at work: to ensure that workers can avoid regular exposure to toxic chemicals • Transporting chemicals: to tell emergency services what to do if there is an accident • Storing chemicals: to ensure that hazardous chemicals do not start a fire or cause an explosion • Getting rid of chemical waste: to avoid pollution of air and water; to avoid harming wildlife
7		• inspection • investigation • guidance • guidance • inspection • investigation

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8		Calcium Ca, hydrogen H, oxygen O, sulfur S, carbon C, magnesium Mg, potassium K, zinc Zn, chlorine Cl, nitrogen N, sodium Na
9	**a**	2 hydrogen atoms, 1 sulfur atom, 4 oxygen atoms
	b	HNO_3
	c	HCl
10		From left to right: corrosive, toxid, highly flammable, irritant, harmful, oxidizing
11	**a**	Acids: vinegar (ethanoic acid), dilute hydrochloric acid Alkalis: dilute sodium hydroxide solution, limewater (calcium hydroxide solution)
	b	Missing words: below, above, salts
	c	• acid + metal → hydrogen • acid + metal carbonate → salt + carbon dioxide + water • acid + metal oxide → salt + water • For example: hydrochloric acid + sodium hydroxide → sodium chloride + water
***12**	**a**	(see table below)

Oxides and hydroxides		**Salts**	
Name	**Formula**	**Name**	**Formula**
calcium oxide	CaO	potassium chloride	KCl
zinc oxide	ZnO	sodium carbonate	Na2CO3
magnesium oxide	MgO	magnesium carbonate	MgCO3
potassium hydroxide	KOH	zinc carbonate	ZnCO3
sodium hydroxide	NaOH	magnesium sulfate	MgSO4
calcium hydroxide	Ca(OH)2	zinc sulfate	ZnSO4
magnesium hydroxide	Mg(OH)2	sodium nitrate	NaNO3
carbon dioxide	CO2	potassium nitrate	KNO3

	b	• $HCl + NaOH \rightarrow NaCl + H_2O$ • $2HCl + CaCO_3 \rightarrow Na_2SO_4 + 2H_2O$ • $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$
	c	• Missing symbols in the word equation: (s), (aq) • $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$

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13	**a**	hydrochloric acid + calcium carbonate → calcium chloride + carbon dioxide + water
	b	Carbon dioxide
	c	• Labelled diagram (left): plug of cotton wool, dilute hydrochloric acid, marble chips • Labelled diagram (right): marble chips reacting with acid Balance and stopwatch also labelled
	d	• Start of curved: reaction fast • Where the curve starts to level out: reaction slow • End of curve: reaction stopped
	e	Correct bold words: larger, faster, faster
	f	The new curve starts and ends at the same points as the existing curve, but rises more steeply and starts to level off before the existing curve.
	g	The higher the temperature, the faster the reaction (i.e. the shorter the time taken for the mixture to become opaque).
	h	Missing words: hotter, more concentrated
14	**a**	Two advantages, for example: • Using catalysts to make reactions faster mean that manufacturers can produce more products in a given time, so making production more cost effective. • Choosing a suitable catalyst can speed up the reaction that gives a chosen product, not those that produce unwanted by-products.
	b	For example: This powder contains biological enzymes, which attack stains faster and work at lower temperatures – making your washing day easier and cheaper!
15	**a**	Step 1: mix two soluble salts to precipitate an insoluble salt. Step 2: filter to collect the product; discard the filtrate. Step 3: wash the residue with water to remove impurities. Step 4: allow the product to dry.
	b	potassium hexacyanoferrate + iron chloride → potassium chloride + iron hexacyanoferrate
	c	A paint pigment
	d	magnesium sulfate + sodium carbonate → magnesium carbonate + sodium sulfate
	e	Antacid
16	**a**	Labels for diagrams in sequential order: • beaker, dilute sulfuric acid • magnesium oxide, stirring rod, add a slight excess of the oxide • thermometer • funnel, excess magnesium oxide • solution of magnesium sulfate, evaporating basin • magnesium sulfate crystals, steam

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	b	magnesium oxide + sulfuric acid → magnesium sulfate + water
	c	To make sure that all the acid is neutralized
	d	One example, e.g. laxative, ingredient of fertilizer, bath salts
17	**a**	Potassium hydroxide
	b	Hydrochloric acid
	c	potassium hydroxide + hydrochloric acid → potassium chloride + water
	d	pH 7
	e	One use, e.g. ingredient in fertilizer, ingredient in low sodium salt
18	**a**	9.9/11.1 x 100 = 89%
	b	72/80 x 100 = 90%
***19**	**a**	$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$
	b	HCl = 36.5, CO_2 = 44, $CaCl_2$ = 111, $CaCO_3$ = 100
	c	Relative formula masses from part b correctly written under equation in part a.
	d	Theoretical yield = 10/100 kg x 111 kg = 11.1 kg
	e	$MgCO_3 \rightarrow MgO + CO_2$ • Relative formula mass $MgCO_3$ = 84 • Relative formula mass of MgO = 40 • Theoretical yield = 1000/84 kg x 40 kg = 476 kg
20	**a**	• Hydrocarbons: methane, propane, C_8H_{18} • Alcohol: methanol, C_2H_5OH, $C_5H_{11}OH$
	b	• Carboxylic acids —COOH • Alcohols —OH
21	**a**	Fruity smell
	b	Two example, e.g. fruit flavourings, solvents
	***c**	ethanol + butanoic acid → ethyl butanoate + water
	***d**	pentanol + ethanoic acid → pentyl ethanoate + water
22	**a**	• A reflux condenser is used to stop vapours escaping while heating the reaction mixture • Water is passed through the condenser jacket to cool the inner tube and condense the vapours • The sulfuric acid acts as a catalyst, speeding up the reaction. • The reaction is heated to speed up the reaction.

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	b	See textbook page 50 bottom diagram.
23		• Aqueous solvent: water • Non-aqueous solvents: ethanol, pentyl ethanoate, methanol, methyl butanoate
24	**a**	Diagrams labelled as follows: **1** sodium carbonate, missing value: 2.5 g **4** missing word: water **5** Make up to the graduation mark with water. **6** Stopper and mix well.
	b	Concentration: 40.0 g/litre 18.0 g/litre 0.05 g/cm3 0.03 g/cm3
	c	Mass of dissolved solute in g: 2.50 0.50 2.5 0.25
	***d**	Concentration in g/litre: 0.001 0.05 0.01
25	**a**	Suspensions: kaolin and morphine mixture (BP), toothpaste Emulsions: milk, sun protection cream*, ice cream, pancake batter, emulsion paint (*Note: sun block is a suspension.)
	b	Emulsifiers: washing up liquid, lecithin (E322) Stabilizers: locust bean gum (E410), pectin (E440), guar gum (E412), carrageenan (E407), starch, agar (E606)
26	**a**	• egg yolk • one of: antioxidant, vinegar
	b	One example, e.g. low sodium salt
	c	Two examples from the mixture in part **b**, e.g. • sodium chloride – tastes salty • potassium chloride – tastes salty, lower sodium content
	d	Three types of chemicals in shampoo, for example: detergent, colour/dye, perfume
27	**a**	Results must be consistent whoever does the test and from day to day.

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<table>
<tr><td></td><td>b</td><td>For example:
Check that all additives have E numbers.
Check the ingredients against the label or specification.
Test concentration of key ingredients to make sure that the recipe has been followed.</td></tr>
<tr><td>28</td><td>a</td><td>Rock salt is scattered on roads – no purification is needed.</td></tr>
<tr><td></td><td>b</td><td>Sodium chloride has to be very pure for medical use, including intravenous drips.</td></tr>
<tr><td>29</td><td></td><td>Analytical grade – very pure, usually further classified to describe exactly what purity standards it meets
Laboratory grade – of medium purity, suitable for many laboratory applications
Technical grade – suitable for general industrial use</td></tr>
<tr><td>30</td><td></td><td>Missing words: exothermic, endothermic</td></tr>
<tr><td>31</td><td>a</td><td>Advantages of acid conversion to starch: high yield, starch is completely broken down to sugars, the acid is cheap
Advantages of enzyme conversion to starch: easy to control, makes a wide range of syrups, makes high quality pure syrups, no waste problems, low temperature process</td></tr>
<tr><td></td><td>b</td><td><table>
<tr><th>Feature</th><th>Acid conversion</th><th>Enzyme conversion</th></tr>
<tr><td>reagents or catalysts needed</td><td>starch, acid</td><td>starch, enzymes</td></tr>
<tr><td>energy requirements</td><td>needs heating to a high temperature</td><td>less energy needed as it is a low temperature process</td></tr>
<tr><td>waste disposal required</td><td>acid waste to be disposed of</td><td>no serious waste</td></tr>
</table></td></tr>
<tr><td>*32</td><td></td><td><table>
<tr><th>Main advantages of the continuous process</th><th>Possible disadvantages of continuous production</th></tr>
<tr><td>smaller reactor and fewer separation stages, so cheaper equipment
cheaper production costs
enzyme lasts longer
purer product</td><td>runs continuously so may be harder to deal with a fluctuating and seasonal demand
may be more difficult to use the equipment for other processes</td></tr>
</table></td></tr>
<tr><td>33</td><td>a</td><td>Animal products, crops, microorganisms, trees</td></tr>
<tr><td></td><td>b</td><td>Minerals, fossil fuels</td></tr>
<tr><td></td><td>c</td><td>Missing word: renewable</td></tr>
</table>

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	d	Use the energy from the exothermic stages to supply the heating for the drying stage.
	e	For example: **1** with a catalyst, reactions are faster at a lower temperature – they use less energy **2** with fewer by-products, there may be less hazardous waste
	f	For example: fewer steps – so less energy is needed; fewer reagents – so less processing needed to prepare the required chemicals; less waste so more efficient – less impact on the environment.