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C2 Material choices – Foundation Workbook answers

1		<p>(Note that in this exercise there are often alternative answers that are acceptable.)</p> <p>Difficult to melt – e.g. plastic electric plugs and switches, melamine crockery</p> <p>Strong in tension – e.g. polythene water tank, nylon carpet</p> <p>Strong in compression – e.g. plastic building brick</p> <p>Stiff – e.g. plastic door handles</p> <p>Hard – e.g. plastic building bricks</p> <p>Tough – e.g. PVC pipes and guttering</p> <p>Heavy for its size (high density) – e.g. melamine crockery</p> <p>Easy to melt – all except electric plugs and melamine crockery</p> <p>Weak in tension – e.g. polystyrene egg box and foam cavity insulation</p> <p>Weak in compression – e.g. polystyrene egg box</p> <p>Flexible – e.g. e.g. flexible PVC toy, PCV washing-up liquid bottle</p> <p>Soft – e.g. polyester sheets, acrylic upholstery</p> <p>Brittle – e.g. melamine crockery</p> <p>Light for its size (low density) – e.g. foam cavity wall insulation</p>
2	a	<p>Strength in tension – how much stretching force is needed to break the material</p> <p>Strength in compression – how much squashing force is needed to break the material</p> <p>Stiffness – how hard it is to bend the material</p> <p>Hardness – how easy it is to scratch or dent the material</p> <p>Melting point – how hot the material has to be before it turns liquid</p> <p>Density – how heavy the material is for its size</p>
	b	<p>a – flexible, light for its size – also holds water</p> <p>b – strong in tension, flexible – also hard wearing</p> <p>c – flexible, light for its size – also non-toxic</p> <p>d – flexible, light for its size – also non-toxic and holds water</p> <p>e – strong, flexible – also elastic</p>
3	a	A – It has the highest stiffness measurement, and is also strong (second strongest).
	b	C – It has the lowest stiffness measurement so can bend/stretch.
	c	B – It is the only material to withstand temperatures >100°C (boiling water).
	d	B – It is flexible (low stiffness measurement) but is the strongest material, so won't break easily when a fish is caught. It is also denser than water (>1 g/cm ³) so won't float.
	e	A – It is the stiffest and is also strong, so it won't collapse. It is also the densest, so won't blow away easily!
	f	C – It is the most flexible (lowest stiffness) and can be torn off a roll easily (least strong).
4	a	A

Comment [A1]: Changes here but track changes not working at first. I started at home last night and then found that I did not have the Foundation book.

Further guidance

	b	C
	c	There might be variation between screwdrivers of the same type. Taking a mean from several results gives the best estimate of the true value.
	d	For example: <ul style="list-style-type: none"> • use the same equipment and follow the same procedure each time • use a machine that can give measured hammer blows in a consistent way
	e	<ul style="list-style-type: none"> • Different plastics can have different strengths, hardness, etc. • The shape and size of the handle can affect the results.
	f	No – the strength of plastic handles can be significantly better than wooden ones but they can also be significantly weaker. Screwdrivers with plastic handles are more variable.
	g	C – it is the strongest, withstands the hammer best, but is not the most expensive. (It is best value for money.)
5	a	Different bags, to give a representative sample of bags from that supermarket.
	b	The strips may have varied slightly in size (cut by hand), and in the length of the small cut made in each strip. Also the strips may have come from different batches of bags made from plastic film with slight variations in thickness or other properties.
	c	The best estimate of a value of a quantity is the average of several repeated measurements. The larger the sample, the closer the average will be to the true value.
	d	$360 + 380 + 360 \dots = 3580 \div 10 = 358\text{g}$
	e	340g to 380g
	f	Results plotted on number line, with 860 circled as an outlier. <ul style="list-style-type: none"> • The bag that measured 860g might have been different to the others (e.g. a different batch or design). • The small cut in this strip could have been shorter than for the other strips, making the bag harder to rip.
	g	$760 + 720 + 780 \dots = 6760 \div 9 = 751\text{g}$
	h	720g to 780g
	i	Type A = 358g, type B = 751g. The ranges do not overlap, so the results are significantly different.
	j	The plastic film used to make the type B bags are more than twice as strong as that used to make type A bags.
6	a	2
	b	4
	c	Because it contains just hydrogen and carbon atoms
	d	5000
	e	Polymerization
7		Missing words: long, polymers, chains, poly, polymer, blocks, monomers, joined, polymerization

Comment [A2]: I have gone for wordings in the course specification where possible.

Further guidance

8		Octane – top diagram – liquid – Longer molecules... Methane – bottom diagram – gas – Very small molecules... Polythene – middle diagram – solid – Very long chains...
9		Missing words for diagram A: gas, hydrocarbon, molecules, weak, little Missing words for diagram B: (hydrocarbon), chain polymer, stronger, more
10	a	Wax, polythene
	b	...it is made up of shorter molecules, so they do not stick together as strongly as in polythene.
	c	Vulcanized, natural
	d	...there are no cross-links between the chains
	e	Unplasticized, plasticized
	f	...more flexible (because the plasticizer holds the chains apart, weakening the forces between them)
11	a	From plants: cotton, paper, wood From animals: leather, silk, wool Synthetic: acrylic, nylon, polyester, polythene, PVC
	b	Might be made from synthetic polymers today: bucket, dustpan and brush, bread bin, cutting board, jug, cup and saucer, colander, etc. Could not be made from synthetic polymers: frying pan, saucepans, knife, mincer, etc.
12		Crude oil found in the Earth's crust is... a dark, tarry liquid. Crude oil consists mainly of chemicals called... hydrocarbons. Hydrocarbons are chemicals made from... carbon and hydrogen atoms. Petrochemical refineries produce... fuels, lubricants, and chemicals. A polymer made of chemicals from oil is... a synthetic material.
13	a	Missing words: raw materials, manufacture, petrol, cleaning, maintain, dispose, space
	b	(Based on diagram Textbook page 124) Labels from top left: crude oil, oil well, chemicals, plastic bottles, refinery, petrol, electricity, use, recycling, incineration, landfill
14	a	Reuse, landfill
	b	Crude oil
	c	Arrow from reuse (bottom left) to transport bottles
	d	For example: refining – fuel to heat crude oil; mould bottles – energy to run machines and melt plastics
	e	For example: the transport and refining of oil uses energy and can cause pollution;
	f	For example: they are cheaper than other materials, they are lighter and so the cost of transport is less, they can be burnt after use to recover the energy, or they can be recycled.

Further guidance

	g	Littering: polythene waste persists, is unsightly and can harm wildlife Landfill – they do not rot (so energy is trapped).
15	a	Nylon: synthetic, non-renewable Cotton: natural, renewable Viscose: synthetic, renewable
	b	Energy is needed, for example: to harvest crops or to extract oil, also to transport and process raw materials, then to operate the machinery to make fibres and spin them Water is needed, for example: to grow crops, to process oil, to treat fibres, to clean products
	c	Darker colours can cause more pollution because they need more dye. Some times only a little of the dye sticks to the fabric and the rest goes to waste. Some methods of printing the design on a T-shirt involve chemicals that may be harmful.
	d	Water and energy are needed to wash the T-shirt. Energy is used to iron the shirt.
	e	Wash in a modern machine that uses minimal water. Dry in air and not in a tumbler drier. Wash and iron at a lower temperature.
	f	It can be passed on for other people to wear.
	g	Reuse requires no new raw materials and avoids the energy water needed during the processing of materials and manufacture of the T-shirt.
	h	Clothes can be recycled through a local clothes bank or via a charity shop.
	i	Recycling gives a longer life to materials made from precious raw materials.
	j	This is a matter of opinion. There comes a point at which a T-shirt is so worn that it cannot be reused and then recycling becomes the better option.
	k	Throwing away old T-shirts: - stops reuse which limits the useful life of the T-shirts - wastes valuable materials which could be recycled - prevents recovery of energy which is possible if the waste is burnt
	l	Much of environmental impact depends on how the wearer uses, washes and irons the T-shirt. It is difficult to keep track of the water and energy use over the whole life cycle of the T-shirt. There are uncertainties about some of the impacts – not all the science is known.
16		(Speech bubbles numbered from bottom left) A scientific approach can investigate: speech bubbles 1, 3 and 4 Science alone cannot deal with this: speech bubbles 2, 5 and 6
17		Sustainable – Can be done without harming... Development – Changes in our world... Sustainable development – Changes that...

C2 Material choices – Higher Workbook answers

1		<p>(Note that in this exercise there are often alternative answers that are acceptable.)</p> <p>Difficult to melt – e.g. plastic electric plugs and switches, melamine crockery</p> <p>Strong in tension – e.g. polythene water tank, nylon carpet</p> <p>Strong in compression – e.g. plastic building brick</p> <p>Stiff – e.g. plastic door handles</p> <p>Hard – e.g. plastic building bricks</p> <p>Tough – e.g. PVC pipes and guttering</p> <p>Heavy for its size (high density) – e.g. melamine crockery</p> <p>Easy to melt – all except electric plugs and melamine crockery</p> <p>Weak in tension – e.g. polystyrene egg box and foam cavity insulation</p> <p>Weak in compression – e.g. polystyrene egg box</p> <p>Flexible – e.g. e.g. flexible PVC toy, PCV washing-up liquid bottle</p> <p>Soft – e.g. polyester sheets, acrylic upholstery</p> <p>Brittle – e.g. melamine crockery</p> <p>Light for its size (low density) – e.g. foam cavity wall insulation</p>
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	c	B – It is the only material to withstand temperatures >100°C (boiling water).
	d	B – It is flexible (low stiffness measurement) but is the strongest material, so won't break easily when a fish is caught. It is also denser than water (>1 g/cm ³) so won't float.
	e	A – It is the stiffest and is also strong, so it won't collapse. It is also the densest, so won't blow away easily!
	f	C – It is the most flexible (lowest stiffness) and can be torn off a roll easily (least strong).
4	a	Different bags, to give a representative sample of bags from that supermarket.
	b	The strips may have varied slightly in size (cut by hand), and in the length of the small cut made in each strip. Also the strips may have come from different batches of bags made from plastic film with slight variations in thickness or other properties.
	c	The best estimate of a value of a quantity is the average of several repeated measurements. The larger the sample, the closer the average will be to the true value.
	d	$360 + 380 + 360 \dots = 3580 \div 10 = 358\text{g}$

Comment [A3]: I have gone for wordings in the course specification where possible.

Further guidance

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	f	Results plotted on number line, with 860 circled as an outlier. <ul style="list-style-type: none"> The bag that measured 860g might have been different to the others (e.g. a different batch or design). The small cut in this strip could have been shorter than for the other strips, making the bag harder to rip.
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	h	720g to 780g
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	b	C
	c	There might be variation between screwdrivers of the same type. Taking a mean from several results gives the best estimate of the true value.
	d	For example: <ul style="list-style-type: none"> use the same equipment and follow the same procedure each time use a machine that can give measured hammer blows in a consistent way
	e	<ul style="list-style-type: none"> Different plastics can have different strengths, hardness, etc. The shape and size of the handle can affect the results.
	f	No – the strength of plastic handles can be significantly better than wooden ones but they can also be significantly weaker. Screwdrivers with plastic handles are more variable.
	g	C – it is the strongest, withstands the hammer best, but is not the most expensive. (It is best value for money.)
6	a	Missing words: long, polymers, chains, poly, polymer, blocks, monomers, joined, polymerization
	b	Monomers (ethane molecules), the process of polymerisation, the polymer called polythene
7		Missing words for diagram A: gas, hydrocarbon, molecules, weak, little Missing words for diagram B: (hydrocarbon), chain polymer, stronger, more
8	a	Missing words: low, high The diagram on the left shows crystalline structure.
	b	...without cross-links the chains/molecules line up closer together.
	c	Vulcanized, natural
	d	...there are no cross-links between the chains
	e	Unplasticized, plasticized

Further guidance

	f	...more flexible (because the plasticizer holds the chains apart, weakening the forces between them)
9	a	From plants: cotton, paper, wood From animals: leather, silk, wool Synthetic: acrylic, nylon, polyester, polythene, PVC
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	g	Littering: polythene waste persists, is unsightly and can harm wildlife Landfill – they do not rot (so energy is trapped).
13	a	In manufacture – burning fuel to refine and process oil to produce chemicals In fabrication – burning fuel to power the machinery that melts and extrudes the plastic In transportation – burning fuel to transport the pipes to where they are used
	b	It builds up in the atmosphere and enhances the greenhouse effect. This causes global warming.
	c	Polythene uses up the most energy in its lifetime. Cast iron is the most polluting, in terms of carbon dioxide. Overall, PVC has the least environmental impact of the three

Further guidance

	d	Other factors to consider might include: total costs availability of raw materials length of useful life as a result of resistance to corrosion and other factors likely extent of water leaks in the years the pipes are in use extent to which the material contaminates the water
14	a	Landfill
	b	In the UK, almost all waste went to landfill. In the Netherlands, most was recycled or used for energy recovery. For example: the government in the Netherlands had better planning and invested more in alternatives to landfill; there is less land available for landfill in the Netherlands.
	c	Denmark – the least landfill, the most energy recovery and a significant level of recycling.
	d	For example: Reduce the quantities of materials used to make products by better design. Design goods so that the materials are easier to separate and recycle. Reduce the amount of packaging. Use materials that can be composted and recycled more easily, or used for energy recovery.
15	a	Sustainable – Can be done without harming... Development – Changes in our world... Sustainable development – Changes that...
	b	
	c	C F
	d	A E H I L
	e	B D G J K
16		(Speech bubbles numbered from bottom left) A scientific approach can investigate: speech bubbles 1, 3 and 4 Science alone cannot deal with this: speech bubbles 2, 5 and 6

Further guidance

17		Who wins?	Who loses?
	Refinery and chemical plant	Those with a financial interest – owners, shareholders, employees, associated businesses	Environment and community – pollution by chemicals (air, water, soil, noise), eyesore, pressure on land-use for housing
	Fruit in plastic packaging	Supermarkets – easier to handle, distribute and at point of sale. Customers who welcome undamaged fruit which is easy to take home without harm	Environment – plastic waste for disposal
	Waste incinerator	Local authority and businesses – takes up less space than landfill, relatively cheap way to get rid of rubbish. Reduced costs for council tax payers.	Environment and community – air pollution if incinerator is not operated correctly.

Further guidance

18	Action	Could it be done?	Should it be done?	Action to make it more likely to happen
	Increased use of renewable resources	Yes – but life cycle analysis can throw up unexpected results with some products	Yes – where it really is more efficient in terms of energy and resources to do so	Changing the way that government subsidies for farming and electricity generation are distributed
	Increased use of recycled plastics	Yes – but recycled plastics cannot always be used, for example in food and medical products	Yes – when possible but plastic waste is so varied and mixed with pigments and fillers that sometimes the best option is to treat it as a fuel	A rising cost of raw crude oil so that energy and chemicals become more expensive
	Design products to last longer	Yes – but it would change of attitudes in industrialized countries where the economies favour a high turnover of goods	This is a matter of opinion – and already some products are designed to last longer than they once did (such as cars)	A change in the cultural and economic value places on durable products.
	Design products to be easier to reuse or recycle	Yes – it is being done and is feasible for many products including vehicles	Yes – and this is a way that an economy with a skilled workforce can add value to what it manufactures	This is required by law of some manufacturers in some countries
	Design products to cut running costs and maintenance costs	Yes – this is being done for many domestic white goods such as refrigerators and washing machines	Yes – the only argument against is that it may put up the initial cost of goods, which penalises those on low incomes	A change of attitude by people, which can be encouraged by higher energy costs and water bills
	Increase household recycling rates	Yes – some parts of the UK and other countries have managed to do this	Yes – essential not to waste valuable resources	Charging householders for rubbish collection; collecting waste for recycling from homes