| Question | | Answers | Notes | Total | Criterion |
|---|---|---|---|---|---|
| **1** | a | 9 | | **1** | A |
| | b | Aluminium: 3 3<br>Silicon: 4 3<br>Aluminium: group 3 ***and*** period 3<br>Silicon: group 4 ***and*** period 3 | | **2** | A |
| | c | A.  B.  C.  D. <br>B | | **1** | A |

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| **2** | a | alloy | | **1** | A |
| | b | ***Low carbon steel:***<br>Would not be strong ***or*** too malleable ***or*** would not hold its shape<br><br>***Very high carbon steel:***<br>Brittle ***or*** not malleable ***or*** not easy to shape | *WTTE* | **2** | A |
| | c | kg converted to g<br><br>*n* = m/ram **or** *n* = 405/56<br><br>7.23 (moles)<br><br>7.2 (moles) | <br><br>*Seen or implied. Accept correct answers using 98.15% high carbon steel*<br><br>*Award 3 marks if only this answer is seen*<br><br>*Correct answer expressed to 2 sig figs* | **4** | A<br><br>D |
| | d | Solid | | **1** | A |

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| | e | ***Point A (liquid)***<br>Irregular arrangement of at least 6 particles with at least 4 in contact arranged towards the base of the container<br><br>***Point B (solid)***<br>Regular arrangement of at least 6 particles at the base of the container | *Do **not** accept completely dispersed particles or pairs of particles implying gas molecules* | **2** | A |
| | f | 327 ± 1 (ºC) | | **1** | A |

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| **3** | a | Strontium carbonate + nitric acid → strontium nitrate +<br><br>Carbon dioxide<br><br>Water | *Accept correct formulae* | **2** | A |
| | b | **$SrCO_3 + 2HNO_3 \rightarrow Sr(NO_3)_2 + CO_2 + H_2O$**<br><br>Correct reactants with correct coefficients<br><br>Correct formula for $Sr(NO_3)_2$<br><br>Equation correctly balanced | *Ignore one subscript error, accept = sign*<br><br>*no ECF* | **3** | A |
| | c | Radium is <u>radioactive</u> ***or*** zinc sulphide is not <u>radioactive</u><br><br>Radioactivity causes damage to the body | <br><br>*WTTE*<br>*accept negative effect on health* | **2** | A |

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| | d | Text Object<br>$^{210}_{84}Po$ $^{210}_{82}Pb$<br>Text/MCQ/Mini-Cloze Object<br>Protons: 84 82<br>Neutrons: 126 128<br>Electrons: 84 82<br>***One mark for each correct column***<br>$^{210}_{84}Po$: *p* = 84 ***and*** *n* = 126 ***and*** *e* = 84<br>$^{210}_{82}Pb$ *p* = 82 ***and*** *n* = 128 ***and*** *e* = 82 | | **2** | A |
| | e | C | | **1** | A |

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| **4** | a | IV: (type of) hydrogel<br><br>DV: volume of water (not absorbed)<br><br>***Any two reasonable CV, for example [max 2]***<br>• mass of hydrogel<br>• temperature<br>• initial volume of water or 400 $cm^3$<br>• time (for absorption)<br>• number of times mixed | | **4** | B |
| | b | Two columns ***or*** rows for IV and DV<br><br>Labels: hydrogel ***and*** volume (of water)<br><br>(volume of water) not absorbed<br><br>Unit of $cm^3$ in label only | *Ignore order of hydrogels*<br><br>*Accept "sample"* | **4** | C |
| | c | Title correctly linking hydrogels with water (not) absorbed<br><br>y axis scale starts at zero with even intervals<br><br>***Axis labelling:*** *x* = type of hydrogel ***or*** sample ***and*** *y* = volume/$cm^3$<br><br>Data for at least three hydrogels correctly plotted as a bar chart | *Accept labels from part b, ECF*<br><br>*Accept volume of water absorbed if processed data is plotted* | **4** | C |
| | d | ***Any justification from the list [max 1]***<br>• no ***and*** the raw data measured water not absorbed<br>• yes ***and*** need to process raw data to calculate water absorbed<br>• no ***and*** there were not sufficient trials | | **1** | C |
| | e | Hydrogel 1<br><br>(experimental data shows water absorbed) 400 – 340 = 60 $cm^3$<br>***or***<br>400 – 60 = 340 $cm^3$<br><br>An explanation that only hydrogel 1 can absorb this volume of water ***or*** more than this volume | *Accept 400 – 350 or 400 - 50* | **3** | C |

<table>
<tr>
<td>5</td>
<td>a</td>
<td>Any two environmental impacts correctly linked to a specific nappy type, for example [max 2]<br>• waste water<br>• pesticides<br>• energy use<br>• detergent use<br><br>Advantages and disadvantages correctly linked to a specific nappy type, for example [max 2]<br>• time needed to wash<br>• need to buy new nappies each time<br>• hygiene considerations about washing nappies<br>• cost of energy to wash<br><br>A concluding appraisal linked to earlier arguments</td>
<td>Do not credit the same idea in both categories</td>
<td>5</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>
<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Variables</td><td>some variables implied</td><td>IV (type of nappy) or DV (volume of water) and one CV identified</td><td>IV and DV and one CV identified</td><td>IV and DV and two CV identified</td></tr>
<tr><td>Equipment</td><td>equipment suggested but not relevant</td><td>equipment to measure DV or to control one CV</td><td>equipment to measure DV and to control two CV</td><td></td></tr>
<tr><td>Sufficient data</td><td>reference to different brands or trials</td><td>all five brands or three trials</td><td>all five brands and three trials</td><td>all five brands, three trials and calculates mean</td></tr>
<tr><td>Method</td><td>attempt at method but may be not relevant</td><td>attempt at method, insufficient detail and not likely to give relevant data</td><td>method described, could be followed, will produce relevant data</td><td>complete method fully explained and could be replicated</td></tr>
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<td>15</td>
<td>B</td>
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| **6** | a | ***Any three reasonable statements correctly linked to the <u>data</u>, for example [max 3]***<br>• not supported ***and*** the most absorbent nappy is Pugs<br>• not supported ***and*** Pugs has the least amount of hydrogel<br>• the fluff pulp also affects volume of water absorbed<br>• volume absorbed depends on the composition of fluff pulp and hydrogel | | **3** | C |
| | b | ***If:*** the total mass of absorbent material increases<br>***then:*** the mass of water absorbed increases<br>***because:*** fluff pulp and hydrogel both absorb water **or** hydrogel absorbs more than fluff pulp<br><br>***or***<br>***If:*** the mass of hydrogel increases<br>***then:*** the mass of water <u>absorbed by the hydrogel</u> increases<br>***because****:* hydrogel absorbs a larger proportion of the total water absorbed (compared to FP)<br><br>**or**<br>***If:*** the mass of fluff pulp is greater<br>***then:*** the mass of water <u>absorbed by the fluff pulp</u> increases<br>***because:*** fluff pulp absorbs water | | **3** | B |
| | c | Fluff pulp removes ions ***or*** impurities ***or*** minerals from the urine<br><br>(so) the hydrogel absorbs the water | *WTTE* | **2** | B |

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| **7** | a | Dye C<br><br>Because it has the same spot pattern ***or*** it is an irritant | *WTTE* | **2** | C |
| | b | The other dyes do not have the same components<br><br>Dye B only has two pigments in common<br><br>Dye D has an additional pigment which is not present in the sample | *WTTE* | **3** | C |
| | c | ***Appropriate measurements:***<br>Yellow spot 1.5-1.9 (cm) ***and*** solvent front 3.7 (cm)<br><br>Any Rf value calculated correctly<br><br>Rf value links to yellow spot in Dye C 0.48 ± 0.05 | *Accept correct measurements for other spots for this first mark. Examiners will need to measure incorrect spots*<br><br>*Can award first two marks for any spot* | **3** | C |

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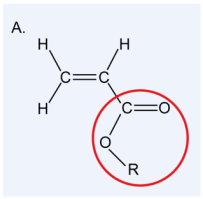
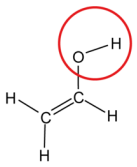
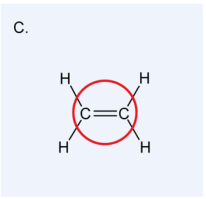
| **8** | a | A.  Ester<br>B.  Alcohol<br>C.  Alkene | | **3** | A |

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| | b | ***Any two properties, for example [max 2]***<br>• heat resistant ***or*** appropriate melting temperature<br>• cheap<br>• waterproof<br>• strong<br>• rigid<br><br>***Any advantage, for example [max 1]***<br>• PLA can biodegrade<br>• made from renewable material<br>• does not release harmful toxins<br>• saves greenhouse gases during production<br>• higher heat capacity<br>• can be reused<br>• uses less oil during production<br><br>***Any disadvantage, for example [max 1]***<br>• limited production capacity<br>• more expensive<br><br>***Any two further advantages or disadvantages [max 2]***<br><br>***A conclusion linking all arguments*** | | **7** | D |

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| **9** | | | | | | | 13 | D |

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| **Sustainability (including costs of a one-use product)** | oil-based plastics are unsustainable ***or*** algae-based plastics are sustainable is implied | a clear statement that oil-based plastics are unsustainable ***or*** algae is sustainable | a clear statement that oil-based plastics are unsustainable ***and*** algae-based are sustainable | a clear statement that oil-based plastics are unsustainable ***and*** algae-based are sustainable supported with scientific reasoning |
| **Environmental** | an environmental impact of oil-based plastics ***or*** algae-based plastics is implied | a clear statement of an environmental impact of oil-based plastics ***or*** algae-based plastics | a clear statement of an environmental impact of oil-based plastics ***and*** algae-based plastics | a clear statement of an environmental impact of oil-based plastics ***and*** algae-based plastics ***and*** an additional environmental impact of either plastic (at any stage) |
| **Social impacts (jobs and production time, social or health effects of environmental damage)** | one social impact is implied | a clear statement of one social impact | clear statements of two social impacts (at any stage) | clear statements of social impact of production ***and*** use ***and*** end of use |
| **Appraisal** | a concluding statement | | | |