<table>
<tr><th colspan="2">Question</th><th>Answers</th><th>Notes</th><th>Total</th><th>Criterion</th></tr>
<tr><td rowspan="7">1</td><td>a</td><td>group 4

period 6</td><td>Accept group 14</td><td>2</td><td>A</td></tr>
<tr><td>b</td><td>2PbS + 3O₂ →2PbO + 2SO₂
Reactants correct
Products correct

2PbO + C → 2Pb + CO₂
Reactants correct
Products correct</td><td>Do not accept ? in place of a blank coefficient</td><td>4</td><td>A</td></tr>
<tr><td>c</td><td>SO_2 is formed

(which) contributes to the formation of acid rain

or

CO_2 is formed

(which) contributes to climate change</td><td>Do not accept “toxic” fumes as this is not specific enough</td><td>2</td><td>A</td></tr>
<tr><td>d</td><td>Any two from,
• electrical conductivity
• thermal conductivity
• malleability
• appearance</td><td>Any two

Do not accept high melting point for lead</td><td>2</td><td>A</td></tr>
<tr><td>e</td><td>(arsenic is a metalloid/semi-metal so) it would have different structure

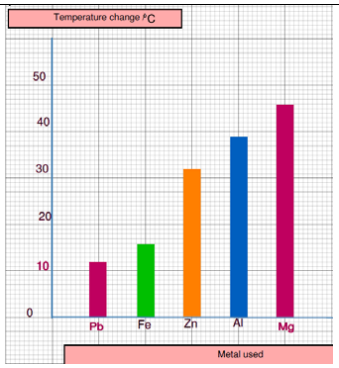
different structure gives rise to different properties</td><td></td><td>2</td><td>A</td></tr>
<tr><td>f</td><td><table><tr><th>Isotope</th><th>Atomic Number</th><th>Atomic Mass</th><th>Protons</th><th>Electrons</th><th>Neutrons</th></tr><tr><td>^{65}As</td><td>33</td><td>65</td><td>33</td><td>33</td><td>32</td></tr><tr><td>^{70}As</td><td>33</td><td>70</td><td>33</td><td>33</td><td>37</td></tr></table></td><td></td><td>2</td><td>A</td></tr>
<tr><td>g</td><td>Same electron configuration

(So) the different isotopes will react in the same way</td><td>WTTE
only award the second mark if the first is given</td><td>2</td><td>A</td></tr>
</table>

2	**a**	How does the volatility of esters depend on the length of their hydrocarbon chain?	*WTTE – must relate to volatility of esters*	**1**	B
	b	If the length of the carbon chain increases (then) the volatility of the ester will reduce (because) the intermolecular forces are stronger	*WTTE* *ECF from part (a), accept a link between chain length and volatility* *Accept "bonds are stronger"*	**3**	B
	c	***Independent variable:*** ester ***or*** length of the carbon chain ***Dependent variable:*** time ***Control variables, any three reasonable variables (2 max) for example,*** • temperature • surface area • container size ***or*** shape • volume ***or*** mass • wind		**4**	B
	d	***low temperature:*** no heat added so avoids breakdown of the ester ***or*** position of equilibrium remains towards the right-hand side/shifts right ***dry:*** avoids adding water to the equilibrium mixture /no change in the concentration of water so avoids breakdown of the ester ***or*** so position of equilibrium remains towards the right hand side/shifts right (ORA)	*ORA* *Accept correct answers relating to intermolecular forces for the first two marking points*	**4**	A
	e	**A** ethanoic acid butanol		**3**	A

<table>
<tr><td>3</td><td>a</td><td colspan="2">C</td><td></td><td>1</td><td>C</td></tr>
<tr><td></td><td>b</td><td colspan="2">Thermometer or temperature probe</td><td></td><td>1</td><td>B</td></tr>
<tr><td></td><td>c</td><td colspan="2"><table>
<tr><th></th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Equipment</td><td>some equipment is listed</td><td>some equipment including a thermometer is listed</td><td>appropriate and complete equipment is listed: suitable solutions, thermometer or temperature probe, test tube, measuring cylinder</td></tr>
<tr><td>Variables</td><td>one control variable is stated</td><td>two control variables are stated</td><td></td></tr>
<tr><td>Method</td><td>attempt at a method</td><td>temperature is measured</td><td>some fine details of technique are included eg recording temperature only when stable, description of how to minimise heat loss</td></tr>
<tr><td>Measurements</td><td>one metal is investigated</td><td>more than two metals are investigated</td><td>all five metals are investigated</td></tr>
<tr><td>Sufficient data</td><td>appropriate number of trials</td><td>appropriate number of trials and plans to calculate averages</td><td></td></tr>
<tr><td>Safety</td><td>a safety precaution is stated</td><td>a safety precaution is stated and linked to hazard</td><td></td></tr>
</table></td><td></td><td>15</td><td>B</td></tr>
<tr><td></td><td>d</td><td colspan="2">Order: Lead – Iron – Zinc – Aluminium – Magnesium</td><td>all correct</td><td>1</td><td>C</td></tr>
</table>

<table>
<tr><td></td><td>e</td><td>the order of reactivity is based on the temperature rise

the larger the <u>temperature change/rise</u> the more reactive the metal is</td><td>WTTE</td><td>2</td><td>C</td></tr>
<tr><td></td><td>f</td><td>bar graph</td><td></td><td>1</td><td>C</td></tr>
<tr><td></td><td>g</td><td>
<table>
<tr><th>Metal added</th><th>Temperature change for the reaction / ºC</th></tr>
<tr><td>Aluminium</td><td>39</td></tr>
<tr><td>Iron</td><td>16</td></tr>
<tr><td>Lead</td><td>12</td></tr>
<tr><td>Magnesium</td><td>46</td></tr>
<tr><td>Zinc</td><td>32</td></tr>
</table>


labels for metal on the x axis

title linking temperature change to different metals

data for one metal correctly plotted

data for all metals plotted correctly

ºC</td><td></td><td>5</td><td>C</td></tr>
<tr><td></td><td>h</td><td>limited validity as results that produced once only are not reliable as errors may occur

more than one trial should be carried out to produce an average</td><td>WTTE</td><td>2</td><td>C</td></tr>
</table>

4	**A**	test with Lit splint/spill/stick gas burns with a (squeaky) pop (so it is hydrogen)	*Accept any reasonable alternative of splint*	**2**	A
	b	if the coin is 100 % copper (then) it will react the slowest (because) copper is the least reactive of these metals	*Accept "newer coins will react the fastest"*	**3**	B
	c	***Independent variable:*** the composition of the coin ***or*** date of coin ***Dependent variable:*** the volume of gas produced in a fixed time ***or*** the time taken to produce a fixed volume of gas ***Any two reasonable control variables (max 2), for example*** • temperature • concentration of acid • type of acid	*Do **not** award this mark for volume or time alone* *Do **not** accept pressure*	**4**	B
	d	***80s:*** date 1857-1864 ***100s:*** date 1857-1864 ***70s:*** date 1962-1982		**3**	C
	e	***Any three reasonable points, for example*** • the coins may not be the exact percentages as indicated in the chart • the results in the calibration graph were for averages and not specific coins • no repeats were possible so there may have been experimental errors • the collection of the gas was inaccurate		**3**	C
	f	destructive method so cannot keep the coin ***or*** cannot repeat results	*WTTE*	**2**	C

5	**a**	2.32183 x 10^4 g	*accept 2.32 x 10^4, 2.322 x 10^4, 2.3218 x 10^4*	**2**	D
	b	***Any three comments about the method, for example*** • method is destructive • the method is able to prove the metal is gold • no details of how the solution was measured • no safety precaution given • no repeats possible, method is not reproducible ***Comment about the validity of the result*** result is inconclusive ***or*** gold could be less than 24 k	*WTTE*	**4**	C
	c	***Any two evaluative points from the list below*** • react should be used rather than dissolve ***and*** concentrated should be used rather than strong • the hypothesis is invalid because gold is slow to react/unreactive • the relationship between the independent variable / purity of gold / number of Karat and dependent variable (concentration) is correct	*Allow use of concentration or strength for this last marking point*	**2**	C
	d	7.32 g		**2**	D
	e	7.32/7.89 X100 = 92.8% (to 3 significant figures)		**1**	C

<table>
<tr><td>6</td><td>a</td><td>Grey arrow = fuel + oxygen → carbon dioxide + water
Red arrow = glucose + oxygen → carbon dioxide + water
Green arrow = carbon dioxide + water → glucose + oxygen

one correct label

all labels correct</td><td></td><td>2</td><td>A</td></tr>
<tr><td></td><td>b</td><td>correct answer 0.44

correct unit ºC</td><td></td><td>2</td><td>C</td></tr>
<tr><td></td><td>c</td><td colspan="2"><table>
<tr><th></th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Activity that increases the carbon footprint</td><td>An activity that increases the carbon footprint or production of emissions</td><td>A relevant activity that increases the emissions or increases carbon footprint</td><td>More than one relevant activity that increases the emission of gases or carbon footprint</td></tr>
<tr><td>Activity that decreases the carbon footprint</td><td>An activity that decreases the carbon footprint</td><td>A relevant activity that decreases the carbon footprint</td><td>More than one relevant activity that decreases carbon footprint</td></tr>
<tr><td>Impact on individual/ society</td><td>a general reference to the result of an activity of either an individual or society on the carbon footprint</td><td>a specific reference to the result of an activity of either an individual or society on the carbon footprint</td><td>a specific reference to the result of an activity of either an individual and society on the carbon footprint and justification</td></tr>
<tr><td>Explanations</td><td>incomplete scientific explanation</td><td>complete scientific explanations of impact on carbon footprint for activities that either increase or decrease the carbon footprint</td><td>complete scientific explanations of impact on carbon footprint for all activities that increase and decrease the carbon footprint</td></tr>
</table></td><td></td><td>12</td><td>D</td></tr>
</table>

7							**17**	D

	1	**2**	**3**	**4**
Environmental impact	an environmental impact	an environmental impact for both cars	an environmental impact for both cars with supporting data	
Running costs/ economic impact	an economic impact	an economic impact for both cars	an economic impact for both cars with explicit supporting data	
Fuel sustainability	a relevant comment about sustainability for a fuel	a relevant comment about sustainability one fuel with justification ***or*** a relevant comment about sustainability for both fuels	a relevant comment about sustainability for both fuels with justification for one	a relevant comment about sustainability for both fuels with justification for both
Usefulness of cars - range and refuelling	a relevant comment about usefulness	a relevant comment about usefulness for both cars referring to data	more than one relevant comment about usefulness for both cars with supporting data	more than one relevant comment about usefulness for both cars with explicit supporting data
Appraisal	a concluding appraisal linked to previous arguments	a concluding appraisal with some scientific justification	a concluding appraisal with complete and detailed scientific justification	