Question	Answer	Marks	Guidance
1 a	**X**- temporary **Y**- permanent **Z**- temporary and permanent / both (types of hardness) all **three** correct (2) **but** any **two** correct (1) **then any two from:** **X** is temporary as hardness removed (by boiling) (1) **Y** is permanent as no hardness removed (by boiling) (1) **Z** contains both temporary and permanent as some hardness is removed (by boiling) (1)	4	These marks are dependent on correct identification of **X**, **Y** or **Z** **allow X** is temporary since volume of soap goes down (to that of distilled water) **allow Y** is permanent since the volume of soap does not go down (after boiling) / permanent does not change from 20 cm^3 (1) **allow Z** contains both temporary and permanent as volume does go down but not to volume of distilled water / does not go down to minimum volume of soap
b	reacts with calcium or magnesium ions (to make calcium carbonate or magnesium carbonate) (1) calcium carbonate or magnesium carbonate are insoluble / are formed as a precipitate (1)	2	**allow** reacts with calcium or magnesium salts or compounds **allow** reacts with named soluble calcium or magnesium salt or compound **allow** removes calcium ions or magnesium ions **allow** calcium ions removed by forming insoluble carbonate
	Total	**6**	

Question	Answer	Marks	Guidance
2 a	NO_x (1) greatest (negative) gradient (1)	2	The second marking point is **dependent** on the correct pollutant **allow** greatest (negative) slope / steepest graph **allow** correct comparison of mass change shown by quoting values e.g. 190, 80 and 20 (within ±1 square) has greatest change in mass is not sufficient unless supported by data – one piece of data is sufficient
b i	$\frac{52}{3600} \times 100$ (1) 1.44 (%) (1)	2	**FIRST LOOK AT ANSWER** **IF ANSWER = 1.44 or 1.4 AWARD 2 MARKS** **do not allow** 1 / 1.45
ii	Other countries make more than their share (of ammonia) / Sweden makes less (ammonia) than expected / Sweden makes less (ammonia) per million of population (1)	1	**allow** Sweden has better anti-pollution laws **ignore** values are roughly the same **allow** Sweden makes less than average **allow** ecf from percentage above 1.9% in (b)(i)
iii	**FIRST LOOK AT ANSWER** **IF ANSWER = 25 AWARD 2 MARKS** $\frac{974}{39}$ (1) 25 (1)	2	**allow** 24.974 correctly rounded up for the first mark

Question	Answer	Marks	Guidance
iv	Poland makes more (sulfur dioxide) than expected / Poland makes more (sulfur dioxide) than the average / Poland makes more (sulfur dioxide) per million of population (1)	1	**allow** Poland uses a fuel that makes lots of sulfur dioxide **allow** fewer pollution control laws in Poland / Poland cannot afford (modern) pollution controls **allow** some countries produce less than the average **allow** pollution instead of sulfur dioxide **allow** ecf from (b)(iii) if below 9.1
v	Quotes some evidence that indicates a higher population gives more pollutants / ora e.g. Germany has a higher population than Estonia **and** makes more pollutants (1) Quotes some evidence that indicates a higher population gives less pollutants / ora e.g. UK has a higher population than Poland **and** makes less pollutants (1)	2	**The data quoted must be able to be checked to see if it is correct and not ambiguous** **allow** the higher populated countries like Germany Poland and the UK produces a lot more pollution
	Total	**10**	

Question	Answer	Marks	Guidance
3 a	crust is too thick (to drill through) / need to use seismic waves produced by earthquakes/ need to use seismic waves produced by man-made explosions (1)	1	**allow** mantle is too hot / core is too hot / idea that layers below the crust are too hot (1) **allow** ideas of not being able to dig deep enough (1)
b i	**any two from:** (Wegener) suggested **continental drift theory** (1) idea that **continental drift theory** was not accepted by scientists at the time (1) (later) extra evidence obtained such as sea floor spreading or measurement of continental drift (1)	2	 **allow** evidence such as continents fitting together (1) **ignore** references to subduction / earthquakes & volcanoes
b ii	idea that (most scientists now accept the theory as) subsequent research has supported the theory (1)	1	**allow** there's more evidence to support it (1) **allow** examples of extra evidence that supports theory e.g. similar fossils in South America and Africa (1) **ignore** similar animal breeds
	Total	**4**	

Question	Answer	Marks	Guidance
4 a i	**any one from** less used for in electricity generation (1) less used for other uses (1) less used for farming (1)	1	 **allow** new ways to generate electricity that do not use water **allow** less demand for rather than less used for fewer farmers or less farming is **not** sufficient
ii	percentage = $\frac{\text{volume for public water supply}}{\text{total volume}} \times 100$ (1) **but** $\frac{13000}{42000} \times 100$ (2)	2	**allow** $\frac{13000}{42000}$ = 0.3095 (1) 0.3095 x 100 (1) No mark for 30.95% **allow** ecf from wrong interpretation of bar charts for the first mark **allow** alternative approaches for example showing that 30.95% of 42000 is 13000 i.e. 30.95 divided by 100 (1) and then 0.3095 x 42000 (1)
iii	increase (1)	1	**allow** went to 37.14 (%)
b	prediction made water meters increases (so less water used) (1) population increases so more water used (1) water leakage has not changed so no effect (1)	3	**no marks** for the prediction but without a prediction maximum two marks

Question	Answer	Marks	Guidance
c i	Albania (1)	1	
ii	Niger (1) Idea that the ratio of population to water used or availability is the highest of all the countries (1) This mark is dependent on the correct country	2	 **Allow** high population but very little water A population of 15 million is **not** sufficient Has the most population to share the water is **not** sufficient
	Total	**10**	

Question			Answer	Marks	Guidance
5	(a)		gas — percent **nitrogen** — (78%) **oxygen** — (21%) (carbon dioxide) — **0.035%** **all three correct** (2) **but** **one or two correct** (1)	2	**allow** carbon dioxide between 0.03 and 0.04%
	(b)	(i)	**any two from:** idea that air quality is maintained (1) reduce or prevent harm to living organisms (1) control or reduce smog (1) protect buildings and/or metals (1)	2	**allow** so that air is safe to breathe (1) **allow** reference to reducing asthma (1) **allow** (carbon monoxide) is poisonous or toxic (1) **ignore** just kills people **ignore** damage the environment **allow** reduce damage to ozone layer (1) **allow** greenhouse effect or global warming or acid rain (1) **allow** an effect of damage to ozone layer, global warming or acid rain (1)

Question			Answer	Marks	Guidance
		(ii)	(catalytic converter) changes carbon monoxide into carbon dioxide (1) balanced symbol equation: $2CO + 2NO \rightarrow N_2 + 2CO_2$ formulae (1) balancing (1)	3	**allow** changes nitrogen oxide / NO into nitrogen / N_2 (1) **first marking point can be credited from a symbol equation (even if incorrect)** **allow** any correct multiple, including fractions **allow** = / ⇌ instead of → **not** and / & balancing mark is dependent on the correct formula **but allow** 1 mark for a balanced equation with minor errors of case, subscripts, superscripts, etc eg 2CO + 2NO → N2 + 2CO2
	(c)		as (the concentration of) smoke increased, the number of deaths increased / ora (1) as (the concentration of) sulfur dioxide increased, the number of deaths increased / ora (1)	2	**allow** as concentration increases deaths increase (1) **allow** idea that graphs have the same shape (1) **allow** the higher the (concentrations of) smoke and sulfur dioxide, the more deaths (per day) (2)
			Total	**9**	

Question			Answer	Marks	Guidance
6	(a)		idea that the lithosphere has a lower density than the inner mantle (1)	1	assume unqualified answer refers to the lithosphere e.g. 'it is less dense than the inner mantle' **allow** idea that the crust and outer mantle have a lower density than the inner mantle / ora (1) **ignore** the crust and the outer mantle are lighter than the inner mantle
	(b)		idea that there is a greater range of evidence (1) idea that (more) scientists have discussed or tested the theory (1)	2	**allow** there is better technology (1)
			Total	**3**	

Question			answer	Marks	Guidance
7	(a)	(i)	**LOOK FOR ANSWER FIRST OF ALL** **IF year = 2078 AWARD 2 MARKS** in 2003 it is 8.0 so at 50% it will be 4.0 (1) 2078 (1)	2	look for working out on the graph **ALLOW** ecf from incorrect 50% value
		(ii)	(yes or no) 45 years after the ban still expect lots of CFCs (1)	1	**allow** the graph is not steep enough **allow** takes about 75 years to halve amount
		(iii)	**any two from:** not all countries may have banned CFC / more countries may ban the use / some countries may lift the ban (1) idea that not sufficient data to make firm prediction (1) new research to remove CFCs may be done (1) idea that concentration measurements may not be accurate until new technology introduced (1)	2	**allow** CFCs are still being released into the atmosphere **allow** there is not enough evidence **allow** takes a long time to do research on CFCs **allow** the drop in concentration may not be constant
	(b)		**LOOK FOR ANSWER FIRST OF ALL** **IF age = 43 years AWARD 2 MARKS** 1970 is the year having 2.0 (1) so age is 43 years (1)	2	 **allow** ecf from wrong year from graph ie 2013 – year

Question			answer	Marks	Guidance
	(c)	(i)	2.2% (1)	1	**allow** 2% **allow** 2.22 / 2.23% **allow** 2.3 %
		(ii)	**any two from:** (no because) CFC12 decrease is much later / no apparent decrease (1) initial concentration of CFC12 much lower so more difficult to tell if any effect (1) CFC12 may have a much longer lifetime in the air (1) idea that the ban may not have been a universal one (1) rate of decrease of CFC11 is greater (than CFC12) (1)	2	**allow** CFC11 peaked in 1993 and CFC12 in 2000 **allow** ora **allow** ora
			Total	**10**	