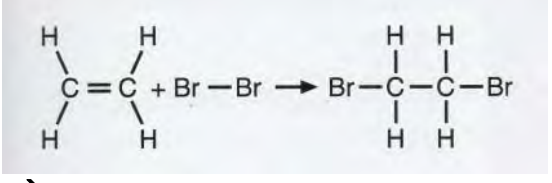
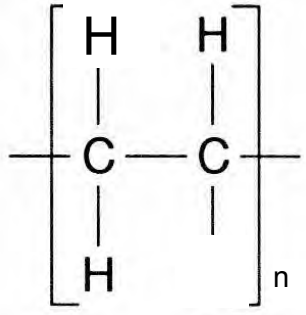
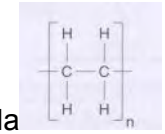
Question			answer	Marks	Guidance
1	(a)		contains single (covalent) bonds **only** / AW (1)	1	**allow** does not have a double bond **allow** fits the general formula C_nH_{2n+2} **ignore** reference to saturation
	(b)		ethene		**allow** C_2H_4 / correct displayed formula / ethylene
	(c)		$C_2H_4O_2$	1	**allow** symbols in any order **ignore** CH_3COOH **not** C2H4O2 / $C_2H^4O_2$/ $C^2H^4O^2$
	(d)		$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$	1	**allow** correct equation using displayed formulae or mixture of molecular, correct structural and correct displayed formulae  **allow = for →** **not and & for +**
			Total	**4**	

Question			answer	Marks	Guidance
2	(a)			1	**allow** formula with or without 'n' after bracket **allow** formula without brackets **allow** a section of the polymer drawn eg with at least two repeat units answer must have **free bonds** at either end but bonds do not have to cross the bracket
	(b)		**any two from:** insoluble in water / does not dissolve in water / water-proof / leak-proof / not porous (1) does not corrode / does not react with water (and air) / non-biodegradable (1) non-toxic (1)	2	 **ignore** does not rust **allow** strong **ignore** hard / hard wearing / tough / low density / lightweight
	(c)	(i)	weak intermolecular forces / forces or bonds between polymer chains are weak (1) so polymer molecules can slide over one another / intermolecular forces are easy to break / AW (1)	2	**allow** polymer chains are not connected together **allow** it has no cross-linking **allow** no bonds between polymer chains any reference to bonds **within** the molecule are weak or weak **covalent** bonds scores 0 marks **allow** molecules are easy to separate (from one another)
		(ii)	cross links (between the polymer molecules) / strong bonds between the polymer molecules (1)	1	**allow** strong intermolecular bonds **allow** covalent bonds between polymer molecules **ignore** strong intermolecular forces **ignore** polymer has strong bonds – must have idea of bonds between polymer molecules
			Total	**6**	

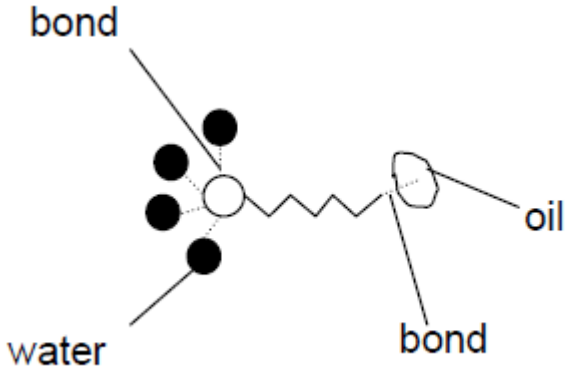
Question			Answer	Marks	Guidance
3	(a)		because they contain carbon and hydrogen (atoms) (1) only (1)	2	**allow** are compounds containing carbon and hydrogen (1) only (1) second mark is dependent on the first **allow** contains carbon and hydrogen molecules **only** (1) **but** contains carbon and hydrogen molecules (0) **allow** contains C and H **only** (1) **allow** contains a mixture of carbon and hydrogen **only** (1) **but** contains a mixture of carbon and hydrogen (0)
	(b)		C_4H_{10} (1)	1	**allow** $H_{10}C_4$ **not** C4H10 / C^4H^{10}
	(c)		contains a double bond (between the carbon atoms)	1	

Question			answer	Marks	Guidance
3	(d)		**[Level 3]** Describe polymerisation of ethene and apply their knowledge of polymerisation to draw the displayed formula of poly(ethene). Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **[Level 2]** Applies knowledge of polymerisation to draw the displayed formula of poly(ethene) **or** describes polymerisation to make a polymer or poly(ethene) **and** gives one of the conditions needed. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **[Level 1]** Partially describes polymerisation in terms of the reaction of monomers **or** gives one of the conditions needed for polymerisation. Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to A/A*** **At Level 3 answer must include:** • a correctly drawn displayed formula  **Indicative scientific points may include:** • an attempt to show an equation showing the formation of a polymer • monomer is unsaturated or contains a double bond • idea that ethene is the monomer • idea that **many** monomers are used • idea that polymer is saturated • idea that monomers are alkenes • idea that the double bond breaks (in the monomer) • attempt to draw the displayed formula of the polymer, e.g. structure showing a double bond or omitting the n • conditions are high pressure and a catalyst but **ignore** references to temperature
			Total	**10**	

Question			answer	Marks	Guidance
4	(a)		**any one from – arguments for** UK dependent on oil from other countries (1) reserves of oil in the UK are fast running out (1) the UK does not produce enough oil of its own (1) **any one from – arguments against** countries could block pipeline / cut us off (1) countries can charge what they like for the oil (1) transportation can lead to pollution or environmental damage (1)	2	**ignore** any reference to oil being cheaper **ignore** oil is needed for transport **allow** paying unstable countries for oil will help them **allow** alliances / beneficial relationships will be formed **allow** money they get from oil can be spent on weapons / money could be used to bolster the corrupt government
	(b)		**any two from** because LPG is a smaller molecule than petrol (1) LPG has weaker intermolecular forces than petrol / LPG has fewer intermolecular bonds (1) less energy is required to break the forces **between** the molecules in LPG (1)	2	**assume** answer refers to LPG if no reference **allow** LPG has smaller chains **ignore** all references to few carbon atoms in LPG / is a short chain hydrocarbon unless there is a direct comparison with petrol **allow** weaker forces or weaker bonds **between** LPG molecules
	(c)		correct identification of one fraction in low demand (1) a fraction in low demand is converted / broken down into petrol (1)	2	**allow** heating oil or paraffin or fuel oil or bitumen **allow** 12% of fuel oil and bitumen not required / 4% of heating oil not required / 5% of paraffin not required **allow** cracking is the breaking down of large hydrocarbon molecules into smaller more useful ones if no the mark has been given **ignore** conditions for cracking
	(d)		**either** (hydrogen) most energy produced / more energy than petrol (1) only water produced / no greenhouse gases (1) **or** (LPG) is (readily) available (1) more energy than petrol (1)	2	no mark is given for fuel on its own

Question			answer	Marks	Guidance
4	(e)		$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$ (2) formulae (1) balancing (1)	2	balancing mark is conditional on correct formulae **allow** = instead of → **not** 'and' or '&' instead of + **allow** correct multiples **allow** one mark for correct balanced equation with minor errors of case and subscript eg $C_2H4 + 3O_2 \rightarrow 2CO2 + 2H_2O$
			Total	**10**	

Question			answer	Marks	Guidance
5	(a)		energy released = 100 × 4.2 × 20 **or** 8400 (1) energy per gram = 16800 (1)	2	**allow** 8400 on answer line (1) 16800 on its own scores **two** marks **allow** ecf from wrong energy released i.e. energy released ÷ 0.5 (e.g. 0.5 X 4.2 X 20 / 0.5 or 84 on answer line (1)
	(b)		Yes, because as the molecular size increases the temperature change increases (1) and result for decane is anomalous (1) **or** no, because although as the molecular size increases the temperature change increases (1) but result for decane does not fit the pattern / there is a bigger change in temperature for nonane than for decane / there is a bigger energy change for nonane than for decane (1)	2	no mark for yes or no, it is for the explanation answer must refer to the temperature change and not temperature at the end
			Total	**4**	

Question	Answer	Marks	Guidance
6 a	**C** (1) it removes blood / food stains (1)	2	 **allow** it removes organic materials **not** any reference to removing paint **ignore** reference to grease
b	**any three from** detergent has a hydrophilic (head) (1) idea that detergent is bonded to water molecules (1) hydrophobic end bonds with grease (1) idea that hydrophobic or tail lifts off grease (1)	3	**USE TICKS FOR THIS QUESTION** **marks may be awarded for a labelled diagram** **allow** idea of hydrophilic end or hydrophilic part (1) **allow** hydrophilic (end) is bonded to water / hydrophilic (end) is attracted to water (molecules) (2) water surrounds the hydrophilic end is **not** sufficient **allow** hydrophobic (end) is attracted to grease (molecules) grease surrounds the hydrophobic end is **not** sufficient for MP2 and MP3 **allow** attached to, clings to, connected, stick on or stick to instead of bonded, but **do not allow** stick into or stick out 

Question	Answer	Marks	Guidance
c	test - add bromine (water) (1) result - idea that bromine water loses its colour (1) – this mark is dependent on the correct reagent or a near miss e.g. bromide	2	**allow** Br_2 (1) **allow** decolourised / loses its colour / goes colourless (1) **not** goes clear / discoloured **ignore** initial colour of bromine
	Total	**7**	

Question			answer	Marks	Guidance
7	(a)		**Level 3 (5–6 marks)** **Comprehensively explains the process of fractional distillation in terms of molecular size, intermolecular forces and boiling points** **AND** **Applies knowledge of temperature gradient in fractionating tower to correctly list the fractions in the order they 'exit' the tower.** Quality of written communication does not impede communication of the science at this level. **Level 2 (3–4 marks)** **Attempts to explain the process of fractional distillation in terms of molecular size and/or intermolecular forces and boiling points** **AND** **Applies knowledge of temperature gradient in fractionating tower to list the fractions in the order they 'exit' the tower.** Quality of written communication partly impedes communication of the science at this level. **Level 1 (1–2 marks)** **Describes the process of fractional distillation, but answer may be simplistic and lacking in detail** **OR** **lists the fractions in the correct order.** Quality of written communication impedes communication of the science at this level. **Level 0 (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.	6	**This question is targeted at grades up to A*.** **Indicative scientific points at levels 2 and 3 may include:** • smaller molecules, eg LPG / petrol / paraffin, have weaker or fewer intermolecular forces / ora • smaller molecules have lower boiling points with weaker or fewer intermolecular forces / ora • during boiling the weak intermolecular forces break but covalent bonds within the molecule do not. **Indicative scientific points at Level 1 may include:** • crude oil is heated • fractionating column has temperature gradient (cold at top and hot at bottom) • order of fractions, from top, is: LPG petrol paraffin heating oil fuel oils bitumen **Use the L1, L2, L3 annotations in scoris; do not use ticks.**

Question			Answer	Marks	Guidance
	(b)		$C_3H_8 + 3½O_2 \rightarrow 3CO + 4H_2O$ formulae (1) balancing (1)	2	**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 $C_3H_8 + 3½O2 \rightarrow 3CO + 4H2O$
			Total	**8**	

Question			answer	Marks	Guidance
8	(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**	