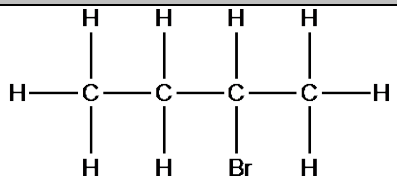
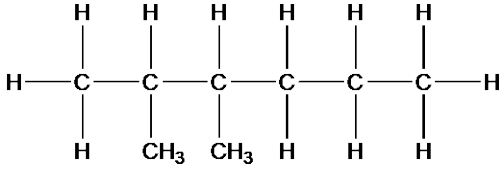
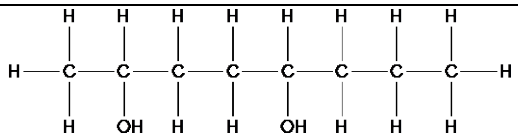
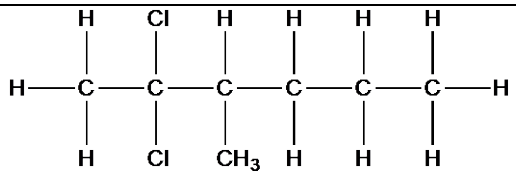
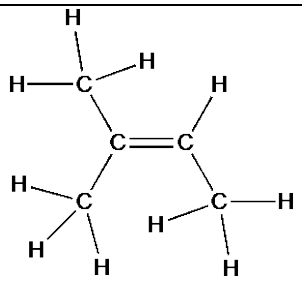
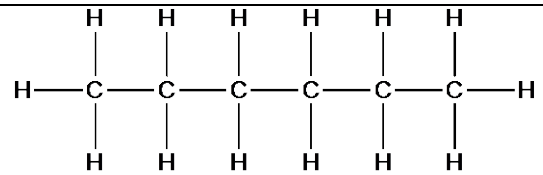
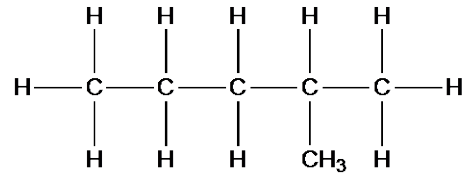
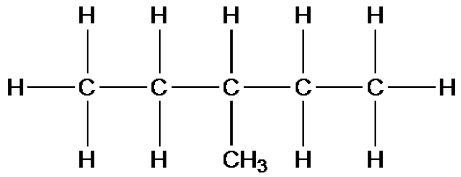
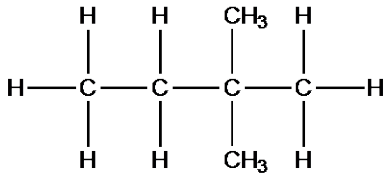
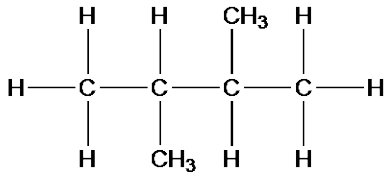
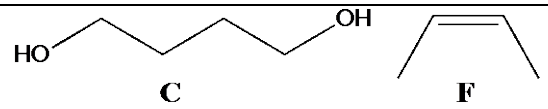
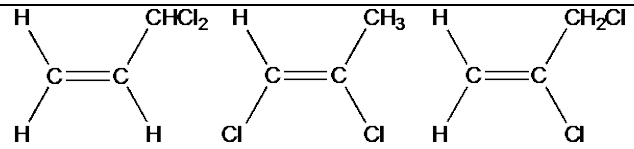
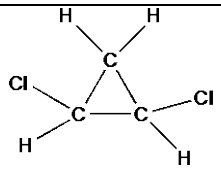
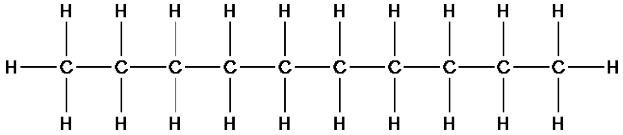
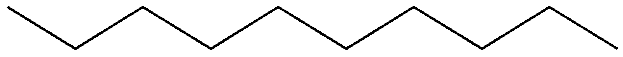
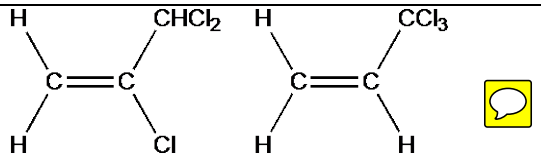
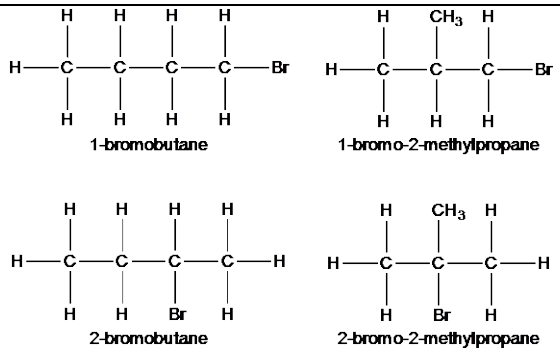
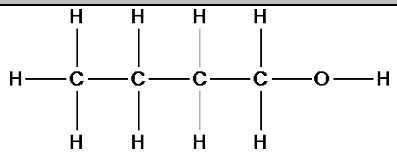
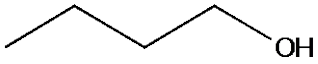
| Question number | Answer | Marks | Guidance |
|---|---|---|---|
| 1 (a) |  | B1 | |
| 1 (b) |  | B1 | |
| 1 (c) |  | B1 | |
| 1 (d) |  | B1 | |
| 1 (e) |  | B1 | |
| 2 (a) | 1-chlorobutane | B1 | |
| 2 (b) | Pentan-3-ol | B1 | |
| 2 (c) | 2-methylpropan-1-ol | B1 | |
| 2 (d) | 1,1,2,2-tetrachloroethane | B1 | |
| 3 (a) | A hydrocarbon is a compound containing carbon and hydrogen only | B1 | |
| 3 (b) | A functional group is the part of the organic molecule that is largely responsible for the molecule's chemical properties | B1 | |
| 3 (c) | A homologous series is a family of compounds with the same functional group and similar chemical properties<br><br>whose successive members differ by the addition of a $–CH_2–$ group | B1<br><br>B1 | |

| Question number | Answer | Marks | Guidance |
|---|---|---|---|
| | | | |
| 4 |  <br>  <br>  <br>  <br>  <br>1 mark for each structure | B1 x 5 | |
| 5 (a) | Butane | B1 | |
| 5 (b) | propan-1-ol | B1 | |
| 5 (c) | butan-2-ol | B1 | |
| 5 (d) | but-1-ene | B1 | |
| 5 (e) | pent-2-ene | B1 | |
| 5 (f) | 2-chlorobutan-1-ol | B1 | |
| 6 (a) | $CH_4$ | B1 | |
| 6 (b) | $C_6H_{12}$ | B1 | |

| Question number | Answer | Marks | Guidance |
|---|---|---|---|
| 6 (c) | $C_2H_6$ | B1 | |
| 6 (d) | $C_7H_{16}O$ | B1 | |
| 7 | In homolytic fission, a covalent bond is breaks with each bonded atoms takes one of the shared pair of electrons from the bond.<br><br>e.g. $H_3C–CH_3 \rightarrow H_3C\bullet + \bullet CH_3$<br><br>In heterolytic fission, a covalent bond is breaks with one of the bonded atoms taking both of the electrons from the bond.<br><br>e.g. $H_3C–Cl \rightarrow H_3C^+ + Cl^-$ | B1<br><br>B1<br><br>B1<br><br>B1 | |
| 8 (a) | $C_9H_{20}$ | B1 | |
| 8 (b) | $C_8H_{18}O$ | B1 | |
| 8 (c) | $C_7H_{16}O$ | B1 | |
| 9 (a) (i) | $C_4H_{10}$ | B1 | |
| 9 (a) (ii) | $C_2H_5O$ | B1 | |
| 9 (a) (iii) | butan-2-ol | B1 | |
| 9 (a) (iv) | **B** and **E** | B1 | |
| 9 (a) (v) |  | B1 | |
| 10 (a) (i) | A homologous series is a family of compounds with the same functional group and similar chemical properties<br><br>whose successive members differ by the addition of a $–CH_2–$ group. | B1<br><br>B1 | **IGNORE** references to physical properties<br>**IGNORE** has same general formula (in question)<br>**DO NOT ALLOW** have the same empirical formula **OR** have the same molecular formula |
| 10 (a) (ii) | $C_nH_{2n}$ | B1 | |
| 11 (a) (i) | Structural isomers are compounds with the same molecular formula but different structural formulae | B1 | |
| 11 (a) (ii) |  <br><br>1 mark for each structure | B1 x 3 | |

| Question number | Answer | Marks | Guidance |
|---|---|---|---|
| 11 (a) (iii) | 1,1-dichloropropene | B1 | |
| 11 (a) (iv) |  | B1 | |
| 12 (a) (i) | C : H = 85.7/12.0 : 14.4/1 = 7.14 : 14.4<br><br>Empirical formula = $CH_2$ | B1<br><br>B1 | |
| 12 (a) (ii) | Molecular formula = $CH_2 \times 56/14 = C_4H_8$ | B1 | |
| 13 (a) | The empirical formula is the simplest whole-number ratio of the atoms of each element present in a compound.<br><br>For decane, empirical formula = $C_5H_{11}$ | B1<br><br>B1 | |
| 13 (b) | The general formula is the simplest algebraic formula for any member of a homologous series<br><br>For decane, general formula is one for the alkanes = $C_nH_{2n+2}$ | B1<br><br>B1 | |
| 13 (c) | A displayed formula shows the relative positioning of all of the atoms in a molecule and the bonds between them.<br><br>For decane, displayed formula is shown below<br>  | B1<br><br>B1 | |
| 13 (d) | The skeletal formula is the simplified organic formula, shown by removing hydrogen atoms from alkyl chains, leaving just a carbon skeleton and associated functional groups<br><br>For decane, skeletal formula is shown below<br>  | B1<br><br>B1 | |
| 14 (a) (i) | C : H : Cl = 24.7/12.0 : 2.1/1 : 73.2/35.5<br>= 2.06 : 2.1 : 2.06<br><br>Empirical formula = CHCl | B1<br><br>B1 | |
| 14 (a) (ii) | Molecular formula = CHCl $\times$ 145.5/48.5<br>= CHCl $\times$ 3 = $C_3H_3Cl$ | B1 | |

| Question number | Answer | Marks | Guidance |
|---|---|---|---|
| | | | |
| 14 (b) (i) |  <br>1 mark for each structure | B1 x 3 | |
| 14 (b) (ii) | 1,2,3-trichloropropene | B1 | |
| 15 (a) (i) | An electrophile is an electron pair acceptor, e.g. $Br_2$ | B1 | |
| 15 (a) (ii) | A nucleophile is an electron pair donor, e.g. $OH^-$ | B1 | |
| 15 (a) (iii) | A radical is an atom or groups of atoms with an unpaired electron, e.g. Cl• | B1 | |
| 15 (b) (i) | $C_3H_6 + Br_2 \rightarrow C_3H_6Br_2$ | B1 | |
| 15 (b) (ii) | $C_3H_7Br + OH^- \rightarrow C_3H_7Br + Br^-$ | B1 | |
| 15 (b) (iii) | $C_3H_7OH \rightarrow C_3H_6 + H_2O$ | B1 | |
| 15 (b) (iv) | $Br_2 \rightarrow 2Br$• | B1 | |
| 16 (a) | C : H : Br = 35.0/12.0 : 6.60/1.0 : 58.4/79.9<br>= 2.92 : 6.60 : 0.731<br><br>Empirical formula = $C_4H_9Br$ | B1<br><br>B1 | |
| 16 (b) | $M(C_4H_9Br)$ = 136.9 which is same as molecular mass.<br>∴ Molecular formula = $C_4H_9Br$ | B1 | |
| 16 (c) |  <br>1 mark for each structure | B1 x 4 | |
| 17 (a) | $C_4H_{10}O$ | B1 | |
| 17 (b) | $C_nH_{2n+1}OH$ | B1 | |

| Question number | Answer | Marks | Guidance |
|---|---|---|---|
| 17 (c) |  | B1 | |
| 17 (d) |  | B1 | |
| 18 | C : H = 82.8/12.0 : 17.2/1 = 6.9 : 17.2<br><br>Empirical formula = $C_2H_5$<br><br>Molecular formula = $C_2H_5 \times 58/29$<br>= $C_2H_5 \times 2 = C_4H_{10}$ | B1<br><br>B1<br><br>B1 | |
| 19 (a) (i) | $C_nH_{2n+2}$ | B1 | |
| 19 (a) (ii) | **F** | B1 | |
| 19 (a) (iii) | $C_{16}H_{34}$ | B1 | |
| 19 (b) (i) | Compounds with eth same molecular formula but different structural formulae | B1 | |
| 19 (b) (ii) | **C**, **D** and **E** | B1 | |
| 20 (a) | A compound with a carbon to carbon multiple bond (double or triple bond) | B1 | |
| 20 (b) | **A**: $C_{10}H_{18}O$;<br><br>**B**: $C_{10}H_{20}O$ | B1<br><br>B1 | |