## Mark Scheme

Q1.

| Question number | Answer | Mark |
|---|---|---|
| | **The only correct answer is D** (16σ bonds and 1π bond)<br>***A*** *is incorrect because there are 10 σ C-H bonds, 6 C-C σ bonds and 1 C-C π bond*<br>***B*** *is incorrect because there are 10 σ C-H bonds, 6 C-C σ bonds and 1 C-C π bond*<br>***C*** *is incorrect because there are 10 σ C-H bonds, 6 C-C σ bonds and 1 C-C π bond* | (1) |

**Q2.**

| Question Number | Acceptable Answer | Mark |
|---|---|---|
| | **The only correct answer is D**<br>***A*** *is not correct because tertiary alcohol is not oxidised*<br>***B*** *is not correct because this is incorrect colour change for acidified dichromate*<br>***C*** *is not correct because this is incorrect colour change for these reagents* | (1) |

**Q3.**

| Question Number | Acceptable Answer | Mark |
|---|---|---|
| | The only correct answer is **B**<br>***A*** *is incorrect because not a systematic name*<br>***C*** *is incorrect because it has five carbons*<br>***D*** *is incorrect because it has only three carbons* | (1) |

**Q4.**

| Question Number | Answer | Mark |
|---|---|---|
| | The only correct answer is **D** (nucleophile)<br><br>***A*** *is not correct because $OH^-$ does not neutralise an acid in this reaction*<br>***B*** *is not correct because the $OH^-$ ions are used up in this reaction*<br>***C*** *is not correct because $OH^-$ is looking to react with an electron deficient area not an electron rich one* | **(1)** |

**Q5.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is D (increase / increase)**<br><br>**A** *is not correct because both proportions increase*<br><br>**B** *is not correct because the proportion of branched chain alkanes increases*<br><br>**C** *is not correct because the proportion of cyclic hydrocarbons increases* | **(1)** |

**Q6.**

| Question number | Answer | Mark |
|---|---|---|
| | **The only correct answer is C** <br><br>***A*** *is incorrect because this has molecular formula $C_6H_{12}$*<br>***B*** *is incorrect because this has molecular formula $C_6H_8$*<br>***D*** *is incorrect because this has molecular formula $C_6H_8$* | **(1)** |

**Q7.**

| Question number | Answer | Mark |
|---|---|---|
| | **The only correct answer is C** (2,3-dimethylbut-1-ene)<br>*A is incorrect because the longest chain has 4 carbon atoms*<br>*B is incorrect because the longest chain has 4 carbon atoms*<br>*D is incorrect because the C=C should have the lowest number* | (1) |

**Q8.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is D** $CH_3CH_2CH(OH)CH_2CH_3$ only<br>**A** *is not correct because it will not form pent-2-ene*<br>**B** *is not correct because it will only form pent-1-ene*<br>**C** *is not correct because* $CH_3CH(OH)CH_2CH_2CH_3$ *will also form pent-1-ene* | (1) |

**Q9.**

| Question Number | Acceptable Answer | Mark |
|---|---|---|
| | The only correct answer is **A**<br>***B*** *is incorrect because oxides of nitrogen are not black solids*<br>***C*** *is incorrect because oxides of sulfur are not black*<br>***D*** *is incorrect because unburnt hydrocarbons are not black solids* | (1) |

**Q10.**

| Question Number | Answer | Mark |
|---|---|---|
| | **A** (3) | (1) |

**Q11.**

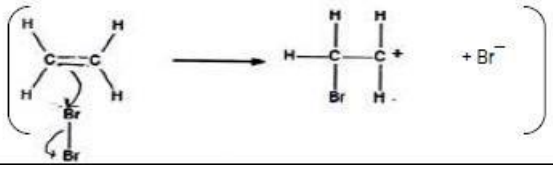
| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is A** (primary)<br><br>***B*** *is not correct because there is no chlorine atom bonded to a carbon atom which is bonded to two other carbon atoms*<br><br>***C*** *is not correct because there is no chlorine atom bonded to a carbon atom which is bonded to three other carbon atoms*<br><br>***D*** *is not correct because both chlorine atoms are bonded to carbon atoms which are bonded to only one carbon atom* | **(1)** |

**Q12.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is C** (*E/Z*)<br><br>**A** *is not correct because there are no differences in the carbon chain*<br>**B** *is not correct because the functional group (C=C) is in the same position in both molecules*<br>**D** *is not correct because cis/trans isomerism does not assign groups in order of priority* | **(1)** |

**Q13.**

| Question Number | Answer | Mark |
|---|---|---|
| **(i)** | **A** (electrophilic addition) | **(1)** |

| Question Number | Answer | Mark |
|---|---|---|
| **(ii)** | **C**<br>  <br> | **(1)** |

**Q14.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is B** (propan-1-ol)<br><br>**A** *is not correct because it does not give hydrogen chloride when $PCl_5$ is added*<br><br>**C** *is not correct because it does not give hydrogen chloride when $PCl_5$ is added*<br><br>**D** *is not correct because it does not give hydrogen chloride when $PCl_5$ is added* | **(1)** |

**Q15.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is D** (ions)<br><br>***A*** *is not correct because both anions and cations are produced*<br><br>***B*** *is not correct because homolytic fission produces free radicals*<br><br>***C*** *is not correct because homolytic fission produces free radicals and heterolytic fission also produces anions* | **(1)** |

**Q16.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is B** (4-ethyl-3-methylheptane)<br><br>***A*** *is not correct because the longest consecutive carbon chain involves the seven carbon atoms from the top left of the molecular drawing down to the bottom right which means that the stem of the name is not pentane but heptane, with the consequential effect on the numbering and length of side chains*<br><br>***C*** *is not correct because the longest consecutive carbon chain involves the seven carbon atoms from the top left of the molecular drawing down to the bottom right which means that the stem of the name is not hexane but heptane, with the consequential effect on the numbering and length of side chains*<br><br>***D*** *is not correct because the longest consecutive carbon chain involves the seven carbon atoms from the top left of the molecular drawing down to the bottom right which means that the stem of the name is not hexane but heptane, with the consequential effect on the numbering and length of side chains* | **(1)** |

**Q17.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is D** (free radical substitution)<br><br>***A*** *is not correct because electrophilic addition would be the reaction mechanism between alkenes, such as ethene, and chlorine but the substance in the question is the alkane, ethane*<br><br>***B*** *is not correct because electrophilic substitution involves the reactions of aromatic systems but this question refers to the reaction of the alkane, ethane*<br><br>***C*** *is not correct because the mechanism of reaction between an alkane such as ethane and chlorine involves substitution and not addition* | **(1)** |

**Q18.**

| Question number | Answer | Mark |
|---|---|---|
| | **The only correct answer is D** ($C_6H_{14}$)<br>***A*** *is incorrect because this has general formula $C_nH_n$ and non-cyclic, saturated hydrocarbons have the general formula $C_nH_{2n+2}$*<br>***B*** *is incorrect because this has general formula $C_nH_{2n-2}$ and non-cyclic, saturated hydrocarbons have the general formula $C_nH_{2n+2}$*<br>***C*** *is incorrect because this has general formula $C_nH_{2n}$ and non-cyclic, saturated hydrocarbons have the general formula $C_nH_{2n+2}$* | **(1)** |

**Q19.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is C (3)**<br><br>**A** *is not correct because the reaction forms but-1-ene and cis- and trans-but-2-ene*<br><br>**B** *is not correct because the reaction forms but-1-ene and cis- and trans-but-2-ene*<br><br>**D** *is not correct because the reaction forms but-1-ene and cis- and trans-but-2-ene* | **(1)** |

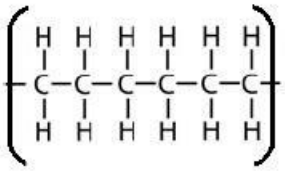
**Q20.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is A** (4-ethyloctane)<br><br>*B is incorrect because the position of the ethyl group should be shown by counting in the direction that gives the lowest possible number*<br>*C is incorrect because the longest carbon chain has 8 carbons*<br>*D is incorrect because the longest carbon chain has 8 carbons and because the position of the alkyl group should be shown by counting in the direction that gives the lowest possible number* | **(1)** |

**Q21.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is D** (use a higher temperature for a faster reaction rate)<br><br>***A** is not correct because efficient use of energy does contribute to sustainability*<br><br>***B** is not correct because efficient use of resources does contribute to sustainability*<br><br>***C** is not correct because use of catalysts do contribute to sustainability* | **(1)** |

**Q22.**

| Question Number | Answer | Mark |
|---|---|---|
| | The only correct answer is **C** (  <br><br> ***A*** *is not correct because this is the structure of the polymer and does not show three repeat units* <br><br> ***B*** *is not correct because it is one and a half repeat units* <br><br> ***D*** *is not correct because this is three polymer molecules joined together due to the n after the brackets* | (1) |

**Q23.**

| Question Number | Acceptable Answer | Mark |
|---|---|---|
| | The only correct answer is **C** <br><br> ***A*** *is incorrect because* there are not 22 hydrogen atoms <br><br> ***B*** *is incorrect because* there are not 20 hydrogen atoms <br><br> ***D*** *is incorrect because* there are not 16 hydrogen atoms | (1) |

**Q24.**

| Question Number | Answer | Mark |
|---|---|---|
| | **B** (2,3-dimethylhexane) | (1) |

**Q25.**

| Question Number | Answer | Mark |
|---|---|---|
| | **D** (*Z*-2-bromo-1-chloroprop-1-ene) | (1) |

**Q26.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is A** (*E*-2-methylbut-2-enoic acid)<br><br>***B*** *is incorrect because the two high priority groups are on opposite sides*<br><br>***C*** *is incorrect because the methyl group is on carbon 2*<br><br>***D*** *is incorrect because the two high priority groups are on opposite sides and the methyl group is on carbon 2* | (1) |

**Q27.**

| Question Number | Acceptable Answer | Mark |
|---|---|---|
| | **The only correct answer is A**<br><br>***B*** *is incorrect because* $H_2O$ *is a nucleophile – via lone pairs*<br><br>***C*** *is incorrect because* $NH_3$ *is a nucleophile – via lone pair*<br><br>***D*** *is incorrect because* $CN^-$ *is a nucleophile – via lone pairs* | (1) |

**Q28.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is D** (nucleophilic substitution)<br><br>**A** *is not correct because there is more than one product*<br><br>**B** *is not correct because substitution occurs, not elimination*<br><br>**C** *is not correct because free radicals are not involved in this reaction* | (1) |

**Q29.**

| Question Number | Acceptable Answer | Mark |
|---|---|---|
| (i) | **The only correct answer is A**<br><br>***B*** *is not correct because hydrogen chloride would be lost during heating*<br><br>***C*** *is not correct because reflux is required to ensure complete oxidation*<br><br>***D*** *is not correct because reflux is required to ensure complete oxidation* | (1) |

| Question Number | Acceptable Answer | Mark |
|---|---|---|
| (ii) | **The only correct answer is B**<br><br>***A*** *is not correct because the correct colour change is reversed*<br><br>***C*** *is not correct because the orange dichromate(VI) ions are reduced to* ***green*** *chromium(III) ions*<br><br>***D*** *is not correct because the* ***orange*** *dichromate (VI) ions are reduced to* ***green*** *chromium(III) ions* | (1) |

**Q30.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is B** (generation of biodegradable materials)<br><br>***A*** *is not correct because some poly(alkenes) may be used as a feedstock for cracking*<br><br>***C*** *is not correct because some poly(alkenes) may be used for energy from incineration*<br><br>***D*** *is not correct because some poly(alkenes) may be used for recycling to make new materials* | (1) |

**Q31.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is A** (red phosphorus)<br><br>**B** *is not correct because it will not form iodoalkanes with iodine and alcohols*<br><br>**C** *is not correct because it will not form iodoalkanes with iodine and alcohols*<br><br>**D** *is not correct because it will not form iodoalkanes with iodine and alcohols* | **(1)** |

**Q32.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is D** (cracking)<br><br>*A is incorrect because substitution would exchange atoms/groups in the reactant for other atoms/groups*<br>*B is incorrect because reforming would produce branched/cyclic alkanes*<br>*C is incorrect because fractional distillation would separate a mixture of alkanes* | **(1)** |

**Q33.**

| Question Number | Acceptable Answer | Mark |
|---|---|---|
| | The only correct answer is **D**<br><br>***A*** *is incorrect because it is not an addition reaction*<br><br>***B*** *is incorrect because no multiple bond is formed*<br><br>***C*** *is incorrect because initiation is only the first stage in the mechanism of the reaction* | **(1)** |

**Q34.**

| Question Number | Acceptable Answer | Mark |
|---|---|---|
| | The only correct answer is **D**<br><br>***A*** *is incorrect because no alkenes are produced*<br><br>***B*** *is incorrect because hydrogen is formed*<br><br>***C*** *is incorrect because the molecular formulae of the organic compounds are not the same* | (1) |

**Q35.**

| Question Number | Answer | Mark |
|---|---|---|
| (i) | **The only correct answer is B** (2-methylpentan-2-ol)<br><br>**A** *is not correct because it is a secondary alcohol*<br><br>**C** *is not correct because it is a secondary alcohol*<br><br>**D** *is not correct because it is a secondary alcohol* | (1) |

| Question Number | Answer | Mark |
|---|---|---|
| (ii) | **The only correct answer is A** (hexan-2-ol)<br><br>**B** *is not correct because it is a tertiary alcohol*<br><br>**C** *is not correct because it does not contain a $CH_3CHOH$ group*<br><br>**D** *is not correct because it does not contain a $CH_3CHOH$ group* | (1) |

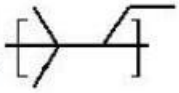
**Q36.**

| Question Number | Acceptable Answer | Mark |
|---|---|---|
| | **The only correct answer is B**<br><br>***A*** *is not correct because Z (3rd) is tertiary (fastest)*<br><br>***C*** *is not correct because Y (2nd) is primary (slower than X, secondary)*<br><br>***D*** *is not correct because X (1st) is secondary (slower than Z, tertiary)* | (1) |

**Q37.**

| Question number | Answer | Mark |
|---|---|---|
| | **The only correct answer is B** (3)<br>***A*** *is incorrect because the structural isomers of $C_5H_{12}$ are pentane, 2-methylbutane and 2,2-dimethylpropane*<br>***C*** *is incorrect because the structural isomers of $C_5H_{12}$ are pentane, 2-methylbutane and 2,2-dimethylpropane*<br>***D*** *is incorrect because the structural isomers of $C_5H_{12}$ are pentane, 2-methylbutane and 2,2-dimethylpropane* | **(1)** |

**Q38.**

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is A** (  )<br>**B** *is not correct because there is no C=C in the repeat unit*<br>**C** *is not correct because the extension bonds are not from the correct carbon atoms of the chain and there should not be a C=C in the repeat unit*<br>**D** *is not correct because the extension bonds are not from the correct carbon atoms of the chain* | **(1)** |