

*Allow multiples*

*Ignore state symbols in equation*

1

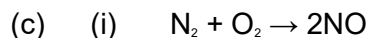
(b) Solidifies/freezes/goes viscous/waxing occurs

*Allow does not vapourise/less volatile*

*Lack of Oxygen = 0*

*Apply list principle*

1



*Allow multiples/Ignore state symbols in equation*

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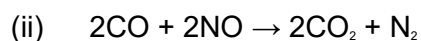
Spark/(very) high temp/2500 °C – 4000 °C

*Ignore pressure/catalyst/low % of oxygen*

*Not just heat/hot*

*Apply list principle eg if high temp 150 °C = 0*

1



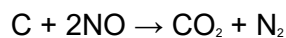
*Allow multiples/Ignore state symbols in equation*

**OR**

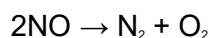


*Allow other alkane reacting with NO in correctly balanced equation*

**OR**



**OR**



1

Pt/Pd/Rh/Ir

*Penalise contradiction of name and symbol*

1

(iii)  $4\text{NO}_2 + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{HNO}_3$   
*Allow multiples/Ignore state symbols in equation* 1

(d) (i) High temp/  
anywhere in range 400 °C – 900 °C/  
anywhere in range 670-1200K/high pressure/anywhere  
in range 5000 kPa up to 8000 kPa/  
*Not catalyst/heat* 1

(ii)  $\text{C}_{16}\text{H}_{34} \rightarrow \text{C}_6\text{H}_{14} + 2\text{C}_4\text{H}_8 + \text{C}_2\text{H}_4$   
Or  $\text{C}_{16}\text{H}_{34} \rightarrow \text{C}_6\text{H}_{14} + \text{C}_4\text{H}_8 + 3\text{C}_2\text{H}_4$   
*Do not allow multiples*  
*Ignore state symbols in equation* 1

(iii) Polymers/plastics/named polymer  
*Allow polyesters or polyamides*  
*Ignore object made from polymer* 1

[10]

**M2.** (a) (i) any two from:  
show a gradation/trend/gradual change in physical properties/  
a specified property  
differ by  $\text{CH}_2$   
chemically similar or react in the same way  
have the same functional group  
*(penalise 'same molecular formula')*  
*(penalise 'same empirical formula')* 2

- (ii) fractional distillation or fractionation 1
- (iii) contains only single bonds or has no double bonds  
*(credit 'every carbon is bonded to four other atoms' provided it does not contradict by suggesting that this will always be H)* 1
- (b) (i) the molecular formula gives the actual number of atoms of each element/type in a molecule/hydrocarbon/compound/formula  
*(penalise 'amount of atoms')*  
*(penalise 'ratio of atoms')* 1
- (ii) C<sub>14</sub>H<sub>30</sub> only  
*(penalise as a contradiction if correct answer is accompanied by other structural formulae)* 1
- (iii) C<sub>10</sub>H<sub>22</sub> + 5½O<sub>2</sub> → 10C + 11H<sub>2</sub>O  
*(or double this equation)* 1
- (c) (i) ½N<sub>2</sub> + ½O<sub>2</sub> → NO  
*(or double this equation)* 1
- (ii) Platinum or palladium or rhodium 1
- (iii) 2CO + 2NO → 2CO<sub>2</sub> + N<sub>2</sub> or  
 2NO → N<sub>2</sub> + O<sub>2</sub> or  
*(ignore extra O<sub>2</sub> molecules provided the equation balances)*  
 C + 2NO → CO<sub>2</sub> + N<sub>2</sub>  
*(or half of each of these equations)*  
 C<sub>8</sub>H<sub>18</sub> + 25NO → 8CO<sub>2</sub> + 12½N<sub>2</sub> + 9H<sub>2</sub>O  
*(or double this equation)* 1

[10]

- M3.** (a) (i) Covalent;  
*If not covalent CE = 0.*  
*If blank, mark on.* 1
- Shared pair of electrons (one from each atom);  
*Not shared electrons.* 1
- (ii) Hydrogen bonds / H bonds;  
*Not just hydrogen.* 1
- Van der Waals/London/dispersion forces/temporary  
induced dipole; 1
- (b) Showing all the lone pairs on both molecules;  
*Allow showing both lone pairs on the O involved in the  
H-bond.* 1
- Showing the partial charges on O and H on both molecules;  
*Allow showing both partial charges on the O and H of the  
other molecule involved in the H bond.* 1
- Showing the Hydrogen bond from the lone pair on O of one  
molecule to the delta + on the H of the other molecule; 1
- (c) (i)  $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ ;  
*Accept multiples.*  
*Allow  $C_2H_6O$ .* 1
- (ii) CO is (produced which is) toxic/ poisonous/C (may be produced)  
which is toxic/ C is a respiratory irritant/ C (particles) exacerbate  
asthma/C causes global dimming/ smog;

*Must relate to C or CO.  
Any mention of SO<sub>2</sub> NO<sub>2</sub> or other pollutants CE = 0.*

1

- (iii) More fuel needed (which costs more)/Wastes fuel/  
less fuel burnt (so need more to buy more)/engine gets sooty so  
need to pay for engine to be cleaned/Have to fit catalytic converter;  
*Not just costs more.  
Not engine gets sooty unless qualified.*

1

- (d) (i) (React) with CaO/ calcium oxide/quicklime/lime;  
*Accept CaCO<sub>3</sub>/ calcium carbonate/limestone.  
Not chalk.*

1

All the sulfur dioxide may not react with the CaO or CaCO<sub>3</sub> /  
may not have time to react/ incomplete reaction;  
*Accept incomplete reaction.*

1

- (ii) Occupies a (much) smaller volume;  
*Not easier to store or transport.*

1

[13]

- M4.** (a) (i) single (C-C) bonds only/no double (C=C) bonds

1

*Allow all carbon atoms bonded to four other atoms  
Single C-H bonds only = 0  
C=H CE*

C and H (atoms) only/purely/solely/entirely  
*Not consists or comprises  
Not completely filled with hydrogen  
CH molecules = CE  
Element containing C and H = CE*

1

(ii)  $C_nH_{2n+2}$   
*Formula only*  
 $C_xH_{2x+2}$  1

(b) (i)  $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$   
*Accept multiples*  
*Ignore state symbols* 1

(ii) gases produced are greenhouse gases/contribute to Global warming/effect of global warming/climate change  
*Allow CO<sub>2</sub> or water is greenhouse gas/causes global warming*  
*Acid rain/ozone CE = 0* 1

(c) carbon  
*Allow C*  
*Allow soot* 1

(d) (i)  $C_9H_{20} \rightarrow C_5H_{12} + C_4H_8$   
**OR**  
 $C_9H_{20} \rightarrow C_5H_{12} + 2C_2H_4$   
*Accept multiples* 1

(ii) Plastics, polymers  
*Accept any polyalkene/haloalkanes/alcohols* 1

(iii) so the bonds break **OR** because the bonds are strong  
*IMF mentioned = 0* 1

- (e) (i) 1,4-dibromo-1-chloropentane/1-chloro-1,4-dibromopentane  
*Ignore punctuation* 1
- (ii) Chain/position/positional  
*Not structural or branched alone* 1

[11]

- M5.** (a) O = 74.1% 1

$$\frac{25.9}{14} \quad \frac{74.1}{16}$$

*If atomic numbers or molecular masses are used lose M2*

$$\begin{array}{cc} 1.85 & 4.63 \\ 1 & 2.5 \\ \text{N}_2\text{O}_5 & \end{array}$$

*This ratio alone will not score the final mark. (It would get 2)  
Allow 3 marks for N<sub>2</sub>O<sub>5</sub>*

- (b) Toxic/poisonous/forms an acidic gas/forms NO<sub>2</sub> which is acidic/  
respiratory irritant/forms HNO<sub>3</sub> when NO reacts with water and oxygen/  
triggers asthma attacks/greenhouse gas/photochemical smog/  
contributes to global warming/formation of acid rain  
*ignore NO is an acidic gas or NO is acidic in water  
Not references to ozone layer* 1

- (c)  $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$   
*Accept multiples or fractions of equation  
Ignore wrong state symbols* 1

- (d) Nitrogen/N<sub>2</sub> and oxygen/O<sub>2</sub> combine/react  
*QWC (not N and O combine)  
Not nitrogen in fuel*

Allow  $N_2 + O_2 \rightarrow 2NO$  for M1 only

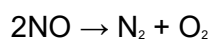
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spark/high temperature/2500-4000 °C

1

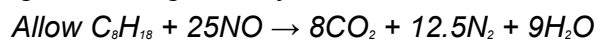


**OR**



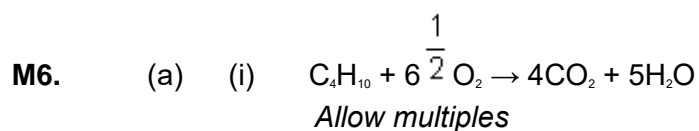
Accept multiples or fractions of equation

Ignore wrong state symbols



1

[8]



1

(ii) insufficient oxygen/low temperature/poor mixing of butane and air

Allow insufficient air

Allow lack of oxygen/air

Do not allow no oxygen

Not incomplete combustion

1

(b) (i) Sulfur dioxide/ $SO_2$   
Allow sulfur trioxide/ $SO_3$   
(allow spelling of sulphur to be sulphur)

1

(ii) It is basic/the gas ( $SO_2$ ) is acidic



*Idea of neutralisation*  
*It = calcium oxide*

1

(iii) bigger surface area to react  
*Do not allow cheaper*

1

**[5]**