1 **(a) (i)** hydrogen (atoms) replaced by (atoms) of a different element e.g. chlorine [1]
NOT: substitute

(ii) light required [1]

(b) exothermic reaction gives out energy [1]
endothermic reaction absorbs
takes in energy [1]

(c)

bonds broken	energy
C-	+41
C*l*-C*l*	+2
total energy	+65

[1]

bonds formed	energy
C-C*l*	–3
H-C*l*	–431
total energy	–769

[1]
energy change –115 [1]
negative sign indicates exothermic [1]

[Total: 8]

2 **(a) (i)** correct structure of an isomer e.g. 2-chloropropane; [1]

(ii) chlorine; [1]
light / heat / lead tetraethyl; [1]

(iii) could produce 2-chloropropane; [1]
could produce HCl; [1]
or
could produce dichloropropanes = [2]

(b) add silver nitrate / lead nitrate; [1]
yellow precipitate; [1]
note: do not insist on presence of dilute nitric acid

(ii) propanol / propan-1-ol; [1]

(c) (i) for A;
reaction slower;
decreased collision rate;
less bromobutane present / concentration of bromobutane less / less reacting particles; [2]
any two
accept: reverse arguments for B

(ii) halogens Cl > Br > I reactivity / reactivity decreases down group; [1]
organic halides I > Br > Cl / reactivity increases down group; [1]
opposite without explanation = [1]

(iii) any three from:
less energy;
particles move slower;
less collisions / fewer particles have energy to react / fewer successful collisions;
slower rate; [3]

[Total: 15]

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3 **(a) (i)** coal **or** coke **or** peat

[1]

NOT wood **or** charcoal

(ii) natural gas **or** methane **or** propane **or** butane **or** petroleum gases **or** calor gas **or** refinery gas [1]

(b) (i) petrol **or** gasoline
paraffin **or** kerosene
diesel
aviation fuel **or** jet fuel
fuel oil
heavy fuel oil
heating oil
Any **TWO** [2]
NOT a named alkane e.g. octane

(ii) waxes **or** grease **or** lubricants **or** polishes **or** bitumen (tar, asphalt) **or** naphtha [2]
Any **TWO** from the primary or secondary distillation of petroleum

(iii) (liquid) air **or** ethanol and water **or** alkenes (made by cracking) **or** Noble Gases [1]

[Total: 7]

4 **(a) (i)** heat (energy) [1]

(ii) exothermic [1]

(iii) $C_2H_5OH + 3O_2 = 2CO_2 + 3H_2O$ [2
For $CO_2 + H_2O$ **ONLY** [1]

(iv) plotting points correctly [1]
straight line [1]
between –2640 and –2700kJ/mol [1]
NOTE minus sign needed

(v) general (molecular) formula
same functional group
consecutive members differ by CH_2
similar chemical properties **or** react same way
NOT a comment about physical properties
ANY TWO [2]

(b) CH_3- CH(OH)-CH_3 [1]
NOT C_3H_7OH
propan-2-ol "2" is needed [1]
NOTE the name and the formula must correspond for both marks
accept full structural formula – all bonds shown correctly
accept formulae of the ether
NOT CH_3- CH(HO)-CH_3

(c) (i) <u>cracking</u>
heat (alkane) **or** (alkane) and catalyst
NOTE thermal cracking or catalytic cracking [2]
alkane = alkene + hydrogen
ANY TWO [2]

OR steam reforming
$CH_4 + H_2O = CO + 3H_2$ [2]
or water/steam [1]
catalyst **or** heat [1]

(ii) combustion **or** burning [1]
incomplete **or** insufficient oxygen/air [1]
OR ACCEPT steam reforming as above [2]

(iii) high pressure [1]
COND forward reaction volume decrease
or volume of reactants greater than that of products
or fewer moles of gas on the right
or fewer gas molecules on right [1]
NOTE accept correct arguments about either reactants **or** products

(d) methyl ethanoate [1]

(ii) propanoic acid **or** propanal [1]

(iii) ethene [1]

[Total: 20]