1. (a) (i) Hydrogen (atoms) replaced by (atoms) of a different element e.g. chlorine
   \( \text{NOT: substitute} \)

   (ii) Light required

(b) Exothermic reaction gives out energy
    Endothermic reaction absorbs
    Takes in energy

(c) Bonds broken
    Energy
    \( \text{C-} \) +41
    \( \text{Cl-Cl} \) +2
    Total energy +65

    Bonds formed
    Energy
    \( \text{C-Cl} \) -3
    \( \text{H-Cl} \) -431
    Total energy -769

    Energy change -115
    Negative sign indicates exothermic

   \[ \text{Total: 8} \]

2. (a) \( \text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2 \)/ \( \text{Zn} + 2\text{H}^+ \rightarrow \text{Zn}^{2+} + \text{H}_2 \)

    Marks are for correct reactants [1] correct products [1]
    If ionic equation is given don't penalise \( \text{SO}_4^{2-} \) spectator ions on both sides

(b) Exothermic because a cell produces (electrical) energy/electricity

    The next two marks score for
    Electrons are lost \( \text{AND} \) gained / oxidation no. or state/valency \( \text{both} \) increases and decreases / two correct half equations i.e. \( \text{Zn} \rightarrow \text{Zn}^{2+} + 2e \) and \( 2\text{H}^+ + 2e \rightarrow \text{H}_2 \)

(c) Zinc
    Cond it is the more reactive metal / it supplies electrons / it forms ions more readily than iron

(d) Replace zinc with magnesium
    Replace iron with copper
    Use (more) concentrated sulfuric acid
    Accept use a more concentrated acid / a more concentrated solution

    Any two
(a) (i) any Group 1 metal
   accept: LiOH [1]

   (ii) \( \text{Cu(OH)}_2 \rightarrow \text{CuO} + \text{H}_2\text{O} \)
   note: products only = 1 [2]

   (iii) reactivity of metals / metals have different reactivities [1]

(b) (i) zinc oxide, nitrogen dioxide, oxygen
   note: two correct = 1 [2]

   (ii) \( 2\text{KNO}_3 \rightarrow 2\text{KNO}_2 + \text{O}_2 \)
   note: unbalanced = 1, correct word equation = 1 [2]

(c) calculation:
   \( M_r \) for \( \text{NaHCO}_3 \) = 84 g; \( M_r \) for \( \text{Na}_2\text{O} \) = 62 g; \( M_r \) for \( \text{NaOH} \) = 40 g
   \( M_r \) for \( \text{Na}_2\text{CO}_3 \) = 106 g

   (i) number of moles of \( \text{NaHCO}_3 \) used = \( \frac{3.36}{84} = 0.04 \) [1]

   (ii) if residue is \( \text{Na}_2\text{O} \), number of moles of \( \text{Na}_2\text{O} = \frac{2.12}{62} \)
        = \( 0.034 / 0.03 \)

        if residue is \( \text{NaOH} \), number of moles of \( \text{NaOH} = \frac{2.12}{40} \)
        = \( 0.053 / 0.05 \)

        if residue is \( \text{Na}_2\text{CO}_3 \), number of moles of \( \text{Na}_2\text{CO}_3 = \frac{2.12}{106} = 0.02 \) all three correct [2]

        note: two correct = 1

   (iii) equation 3
        mole ratio 2:1 agrees with equation [1]
4  (a) fractional distillation

(b)  (i) O=O / oxygen(–)oxygen / H–H / hydrogen(–)hydrogen

(ii) O-H / oxygen(–)hydrogen / OH / bond between hydrogen and oxygen
not H-O-H

(iii) endothermic.

(c)  (i) no pollution / no CO / no CO₂ / no oxides of nitrogen / only produces steam or water / no greenhouse gases / no global warming
does not use up fossil fuels / water is not a finite resource / water is a renewable source of energy / hydrogen is renewable / available from electrolysis of water

(ii) obtaining hydrogen from water requires fossil fuels / storage problems / transport problems / limited range of vehicles available / gaseous nature means only produces small amount of energy per unit volume / methane as a source of steam reforming is finite / lack of distribution network
not expensive / anything regarding safety / flammability / explosiveness

5  (a) (total endothermic change = 436 + 242 = +)678 kJ
(total exothermic change = 2 × 431 = –)862 kJ
accept correct sign/supplied/absorbed for endo etc.
accept correct sign/evolved/produced for exo etc.
change for reaction = –184 kJ

not necessary to calculate –184, just show that exo change > than endo
ecf allowed provided negative
–184 kJ scores all 3 mark

(b)  because it accepts a proton
accepts hydrogen ion or H⁺ ONLY
proton and H⁺

(ii) hydrogen chloride is a strong acid
hydrogen fluoride is a weak acid
weaker or stronger correctly applied for

(iii) hydrogen chloride (aqueous) would have lower pH
OR hydrogen fluoride (aqueous) would have higher pH
If values suggested, not over 7

[Total: 8]
6  (a)  (fine powder) *large surface area*  
*high/faster/collision rate/more collisions/fast collisions*  
*(between solid and oxygen in air)*  

(ii) carbohydrate + oxygen $\rightarrow$ carbon dioxide + water  
ACCEPT flour  

(b) rate depends on light  
more light more silver or blacker  
thicker card less light  

(c) (i) *biological catalyst*  
accept protein catalyst  

(ii) production of energy (from food)  
by living “things” or by cells, etc.  

(iii) “kill” yeast or denature enzymes (due to increase in temperature)  

(iv) all *glucose* used up  
yeast “killed” or denatured or damaged by *ethanol/alcohol*  

(v) filter or centrifuge  
*fractional distillation*  

[Total: 14]  

7  (a) (i) $\text{Zn(OH)}_2 = \text{ZnO} + \text{H}_2\text{O}$  

(ii) it would melt or it does not decompose or it does not react  
NOT no change  

(iii) blue (solid)  
to black (solid)  
*brown gas*  

Mark consequentially to any error but *not involving simple integers*  
There has to be some evidence that the candidate has attempted to work through the calculation and not merely inserted whole numbers.  
For example 2, 1, 160 or 1, 0.5, 80  
number of moles of $\text{Fe}_2(\text{SO}_4)_3$ = $1/40$ or 0.025  
number of moles of $\text{Fe}_2\text{O}_3$ formed = $1/40$ or 0.025  
mass of iron(III) oxide formed = $0.025 \times 160 = 4g$  
number of moles of $\text{SO}_3$ produced = $3/40$ or 0.075  
volume of sulphur trioxide at r.t.p. = $0.075 \times 25$  
= 1.8dm$^3$  

TOTAL = 11