1 **(a** any two from:
bleaching (wood pulp / silk / straw);
manufacture of sulfuric acid / SO_3 / in Contact process;
fumigating / sterilising; refrigerant; making dyes; making wine; insecticide;
fungicide; [2]

(b) burn / heat / react sulfur; [1]
in air / oxygen; [1]
or
burn / heat / roast zinc sulfide or lead sulfide;
in air / oxygen;

(c) from purple / pink; **not:** red [1]
to colourless; **not** clear [1]

(d) number of moles of Na_2SO_3 = 3.15/126 = 0.025 [1]
number of moles of SO_2 formed = 0.025 [1]
volume of SO_2 = 0.025 x 24 = 0.6 dm^3/litres **or** 600 cm^3 [1]
allow: ecf
for 1.6 g of SO_2 [1] only
If used 22.4 max [2]
note: need correct units for last mark

[Total: 9]

2 **(a (i)** $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$ [2]
not balanced only [1]

(ii) **two** reagents from named metal(s) more reactive than zinc/carbon monoxide [2]
not hydrogen

(iii) they have different boiling points [1]
cadmium will distil first then zinc leaving lead/lead distilled last [1]

(b) for a high yield need low temperature [1]
then rate would be too slow or uneconomic [1]
a discussion of optimum temperature could score mark 1 and 2

presence of catalyst would increase rate (at same temperature) [1]
does not alter the yield (at that temperature) [1]
/ economic rate at lower temperature, therefore higher yield

higher pressure which would increase yield / rate [1]
yield high enough / high pressure expensive [1]
max [4]

accept reverse arguments
note increase yield ≡ position of equilibrium to right

3 **(a** burns to form sulfur dioxide   [1]
        acid rain / any problem associated with acid rain / sulfur dioxide is poisonous   [1]

   (b) (i) bigger surface area   [1]
               burns / reacts faster / greater number of collisions   [1]
               not: more sulfur dioxide

        (ii) kills microbes / bacteria / fungi etc.   [1]
                accept: anti-oxidant / stops oxygen oxidising juice / prevents growth of bacteria

       (iii) bleach / refrigerant / making wine / fumigant /insecticide / dyes   [1]
                not: making sulfuric acid

   (c) $2SO_2 + O_2 \rightarrow 2SO_3$ [1]
          temperature 400 to 450 °C   [1
          pressure 1 to 10 atmospheres   [1]
          catalystvanadium(V) oxide / vanadium oxide   [1]

   (d) $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ [1]
          $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$ [1]

4 **(a** **(i)** kills microbes / bacteria / fungi / micro-organisms etc. [1]

   (ii) as a <u>bleach</u> [1]

   (iii) burn / heat sulfur in air / oxygen [1]

   (b) oxygen [1]
   vanadium oxide / vanadium(V) oxide / vanadium pentoxide [1]
   not an incorrect oxidation state
   400 °C to 450 °C [1]
   water [1]

   (c) <u>proton donor</u> [1]

   (ii) measure pH / use pH paper [1]
   sulfuric acid has the lower pH [1]
   accept colours / appropriate numerical values

   OR

   measure electrical conductivity [1]
   sulfuric acid is the better conductor [1]

   OR

   add magnesium / named fairly reactive metal [1]
   ethanedioic acid gives the slower reaction [1]
   NOTE result must refer to rate not amount

   OR

   add a carbonate [1]
   ethanedioic acid gives the slower reaction [1]
   NOTE result must refer to rate not amount

   (d) **(i)** how many moles of H_2SO_4 were added = 0.02 × 0.3 = 0.006 [1]

   (ii) how many moles of NaOH were used = 0.04 × 0.2 = 0.008 [1]

   (iii) sulfuric acid [1]
   only mark ecf if in accord with 1:2 ratio and with values from **(i)** and **(ii)**.
   reason   0.006 > 0.008/2 [1]
   for ecf mark candidate must use 1:2 ratio in answer

   (iv) less than 7 [1]

[Total: 15]

5 (a (i) burn sulfur in air **or** oxygen   [1]
          or heat a metal sulfide in air

     (ii) bleach for wood pulp/cloth/straw **or** preserve food **or** sterilising
           or making wine **or** fumigant **or** refrigerant   [1]
           Accept making paper

    (iii) vanadium(V) oxide **accept** vanadium oxide **or** V_2O_5
           or vanadium pentoxide   [1]
           oxidation state not essential but if given it has to be (V)

     (iv) rate too slow **or** rate not economic   [1]

      (v) reaction too violent **or** forms a mist   [1]

   (b) (i) add water to yellow powder **or** to anhydrous salt   [1]
            it would go green   [1]

       (ii) change from purple **or** pink   [1]
            to colourless **NOT** clear   [1]

      (iii) reacts with <u>oxygen</u> in air   [1]

   (c) number of moles of $FeSO_4$ used = 9.12/152 = 0.06   [1]
        number of moles of Fe_2O_3 formed = 0.03*   [1]
        mass of one mole of Fe_2O_3 = 160 g   [1
        mass of iron(III) oxide formed = 0.03 × 160 = 4.8 g   [1
        number of moles of SO_3 formed = 0.03   [1]
        volume of sulfur trioxide formed = 0.03 × 24 = 0.72 dm^3 [1]
        If mass of iron(III) oxide greater than 9.12 g, then only marks 1 and 2 available

        Apply **ecf** to number of moles of Fe_2O_3* when calculating volume of sulfur trioxide.
        Do not apply **ecf** to integers

                                                                                   [Total: 16]

6　(a)　(i)　Burn sulphur in air (or oxygen)　　　　　　　　　　　　　　**[1]**

　　　　(ii)　as a <u>bleach</u>　　　　　　　　　　　　　　　　　　　**[1]**

　　　　(iii)　kill bacteria/micro-organisms　　　　　　　　　　　　　**[1]**
　　　　　　　NOT prevents food going bad or rotten or decaying

　　(b)　(　decrease　　　　　　　　　　　　　　　　　　　　　　**[1]**

　　　　(ii)　exothermic　　　　　　　　　　　　　　　　　　　　　**[1]**
　　　　　　　COND increase temperature favours back reaction so it is
　　　　　　　endothermic, so forward reaction must be exothermic　　**[1]**
　　　　　　　OR any similar explanation will be awarded the mark, for example
　　　　　　　The forward reaction is not favoured by an increase in temperature
　　　　　　　so it is exothermic (rather than endothermic)

　　　　(iii)　Low enough for good yield　　　　　　　　　　　　　　**[1]**
　　　　　　　High enough for (economic) rate　　　　　　　　　　　**[1]**
　　　　　　　Any similar explanation will be awarded the mark
　　　　　　　NOT just that it is the optimum temperature

　　　　(iv)　bubble into (conc) sulphuric acid　　　　　　　　　　　**[1]**
　　　　　　　add water　　　　　　　　　　　　　　　　　　　　**[1]**
　　　　　　　NOT consequential

　　　　　　　　　　　　　　　　　　　　　　　　　　　[TOTAL = 10]