

CAT 1 1998:**Sample Answers**Section A

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|-------------|--------------|--------------|
| 1. D | 8. C | 15. C |
| 2. A | 9. C | 16. B |
| 3. C | 10. A | 17. C |
| 4. C | 11. D | 18. C |
| 5. C | 12. C | 19. D |
| 6. A | 13. B | |
| 7. A | 14. B | |

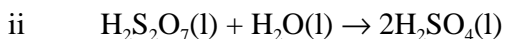
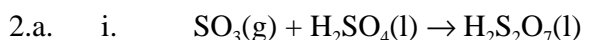
Section B

1. a
$$K = \frac{[\text{CO}][\text{H}_2]^3}{[\text{CH}_4][\text{H}_2\text{O}]} = \frac{0.900 \times (0.500)^3}{0.200 \times 0.100} = 5.63$$

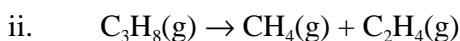
b reduced, no change, reduced, increased

c
$$Q = \frac{0.200 \times (0.200)^3}{0.100 \times 0.100} = 0.16$$
 since $Q < K$ the reaction will move in the forward direction to establish equilibrium.

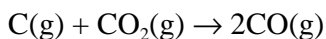
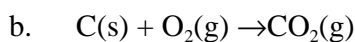
Hence: reduced, reduced, increased, increased.



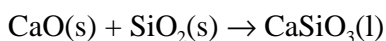
b. i. High temperature, catalyst



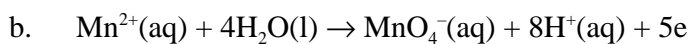
3.a. +2, +3



c. to remove silica as a slag



4.a. +7



c. 0.20 M

d. $n(\text{MnO}_4^-) = 0.20 \times 100 / 1000 = 0.020 \text{ mol}$

- e. percentage by mass (Mn) = $1.10 \times 100 / 12.5 = 8.8 \%$
- f. high absorbance by MnO_4^- at this wavelength.
- g. mass measurement error, volumetric flask volume error, incorrect absorbance scale on colorimeter, incomplete oxidation of Mn^{2+}

5.a. i.
$$\frac{(0.987 - 0.830)}{0.987} \times 100 = 15.9\%$$

ii. to remove the solution, which contained dissolved CaCl_2

b. i. $27 \times 0.100 / 1000 = 0.00270$ mol of NaOH

ii. $50 \times 0.100 / 1000 = 0.00500$ mol of HCl added to paper
 mol of HCl reacted with $\text{CaCO}_3 = (0.0050 - 0.00270) = 0.0023$ mol

iii. $n(\text{CO}_2) = 0.5 \times 0.0023 = 0.00115$ mol

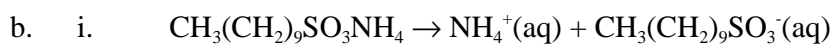
$$V = \frac{nRT}{P} = \frac{0.00115 \times 8.31 \times (273 + 21)}{100000} = 2.81 \times 10^{-5} \text{ m}^3 = 28.1 \text{ mL}$$

iv. $m(\text{CaCO}_3) = 0.0015 \times (40.1 + 12.0 + 48.0) = 0.115$ g

Percentage by mass = $0.115 \times 100 / 1.532 = 7.51 \%$

c. loss of paper during washing, incomplete washing of paper to remove CaCl_2

- 6.a. Make up a series of standard ethanol-water mixtures of known composition
 Measure the height of the capillary rise as a function of % ethanol for the standard mixtures. Plot a calibration curve of % ethanol vs capillary rise
 Measure the height of the capillary rise of the unknown ethanol-water mixture
 Use the calibration curve to determine the unknown composition



ii. detergent

iii. the ion $\text{CH}_3(\text{CH}_2)_9\text{SO}_3^-$ has a hydrophobic and a hydrophilic part
 the hydrophobic part attaches to the grease which is held in solution by the hydrophilic part being attracted to the water molecules.