ANSWERS TO EXERCISES

Exercise 1

1. a) acid b) both c) acid d) both e) base
   f) base g) both h) both i) both j) both
   k) both
2. a) H_2O b) $HClO_4$ c) HSO_4^- d) H_3O^+
3. a) HCO_3^- (acid) and CO_3^{2-} (base), H_2O (base) and H_3O^+ (acid)
   b) HCO_3^- (base) and $CO_2 + H_2O$ (acid), H_3O^+ (acid) and H_2O (base)
   c) H_2SO_4 (acid) and HSO_4^- (base), HNO_3 (base) and $NO_2^+ + H_2O$ (acid)
   d) HSO_4^- (acid) and SO_4^{2-} (base), OH^- (base) and H_2O (acid)

Exercise 2

1. a) 3.00 b) 11.30 c) 2.60 d) 4.89 e) 1.65
   f) 12.60
2. a) 1.0×10^{-3} moldm^{-3} b) 6.3×10^{-3} moldm^{-3} c) 1.0×10^{-3} moldm^{-3}
3. 2.0×10^{-5} moldm^{-3}
4. 76

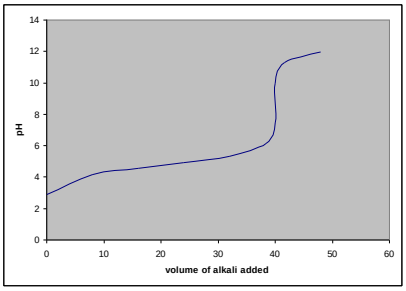
Exercise 3

1. a) resists large pH change on addition of small amounts of acid or alkali
   b) 4.60
   c) $CH_3CH_2COOH + OH^- \rightarrow CH_3CH_2COO^- + H_2O$
   $CH_3CH_2COO^- + H^+ \rightarrow CH_3CH_2COOH$
   d) 4.84 e) 4.30 f) 12.30
   g) the buffer solution restricts the pH change to 0.24 units, but the water changes its pH by 5.30 units (from 7 to 12.3).
2. a) 2.85 b) 3.33 g c) 4.41 d) 4.77
3. 8.65
4. salt: acid ratio 1.58:1
5. a) 10.21 b) 10.01 c) 10.54 d) 13.00
   e) buffering capacity has been exceeded, so cannot resist change in pH.

Exercise 4

1. a) i) 2.37 ii) 3.27 iii) 3.74 iv) 4.22 v) 11.85

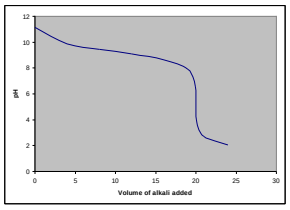
b)



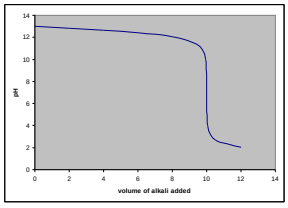
c) the salt produced is sodium methaoate, and the methanoate ion is basic: $HCOO^- + H_2O \rightarrow HCOOH + OH^-$

2. a) 1.70 b) 12.30

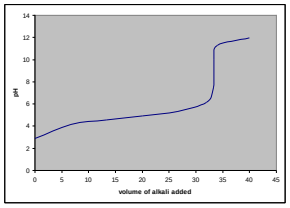
3. a)



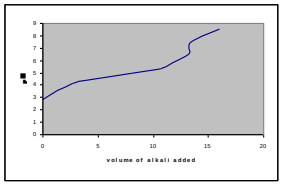
b)



c)



d)



4. a) methyl red, as it will change colour completely within the pH range (4 – 7), over which the equivalence point occurs

b) both, as they will both change colour completely within the pH range (4 – 10), over which the equivalence point occurs

c) phenolphthalein, as it will change colour completely within the pH range (7 – 10), over which the equivalence point occurs

d) neither, as there is no sharp pH change at the equivalence point of this titration, so indicators will not change colour sharply