**Questions**

**Q1.**

The dissociation of ethanoic acid in aqueous solution is represented by



Which of the following statements is true for this equilibrium?

   **A**     CH3COOH is an acid and its conjugate base is CH3COO−.

   **B**     H2O is an acid and its conjugate base is OH−.

   **C**     At equilibrium, the concentrations of each substance are the same.

   **D**     At equilibrium, the reaction from left to right and the reaction from right to
                left have stopped.

**(Total for question = 1 mark)**

**Q2.**

Which of the following is not a reaction of a Brønsted-Lowry acid and base?

   **A**     CH3Cl + OH−    →  CH3OH + Cl−

   **B**     NH3 + HCl        →  NH4+ + Cl−

   **C**     H2O + HSO4−   →  H2SO4 + OH−

   **D**     HCO3− + H2O  →  CO32− + H3O+

**(Total for question = 1 mark)**

**Q3.**The reaction between concentrated sulfuric acid and pure ethanoic acid is

CH3COOH + H2SO4 CH3COOH2+ + HSO4−

The Brønsted-Lowry acids in this equilibrium are

   **A**    CH3COOH and H2SO4

   **B**    CH3COOH2 + and HSO4−

   **C**    H2SO4 and CH3COOH2+

   **D**    CH3COOH and HSO4−

**(Total for Question = 1 mark)**

**Q4.**Which of the following statements is true about **all** substances that form acidic solutions in water?

   **A**    They are corrosive.

   **B**    They are liquids.

   **C**    They contain hydrogen atoms.

   **D**    They form H+(aq) ions.

**(Total for Question = 1 mark)**

**Q5.**The dissociation constant of water, *K*w, increases with increasing temperature. When the temperature increases, water

   **A**    remains neutral.

   **B**    dissociates less.

   **C**    becomes acidic.

   **D**    becomes alkaline.

**(Total for Question = 1 mark)**

**Q6.**An aqueous solution of ethanoic acid is gradually diluted. Which of the following statements is **incorrect**?

   **A**    The pH decreases.

   **B**    The value of *K*a is unchanged.

   **C**    The concentration of ethanoic acid molecules decreases.

   **D**    The proportion of ethanoic acid molecules which dissociates increases.

**(Total for Question = 1 mark)**

**Q7.**Methyl orange and phenolphthalein are both acid-base indicators. In the titration of a strong acid against a weak alkali

   **A**    methyl orange is a suitable indicator but phenolphthalein is not.

   **B**    phenolphthalein is a suitable indicator but methyl orange is not.

   **C**    both phenolphthalein and methyl orange are suitable indicators.

   **D**    neither phenolphthalein nor methyl orange is a suitable indicator.

**(Total for Question = 1 mark)**

**Q8.**

 In which of these reactions is the hydrogensulfate ion, HSO4−, behaving as a Brønsted-Lowry base?

   **A**      HSO4− + H3O+ → H2SO4 + H2O

   **B**      HSO4− + Ba2+ → BaSO4 + H+

   **C**      HSO4− + H2O → SO42−+ H3O+

   **D**      HSO4− + CO32− → SO42−+ HCO3−

**(Total for question = 1 mark)**

**Q9.**

Ammonia reacts with water in a reversible reaction. Which are the Brønsted-Lowry bases?

   **A**    H2O and OH−

   **B**    NH3 and OH−

   **C**    NH4+ and H2O

   **D**    NH4+ and NH3

**(Total for question = 1 mark)**

**Q10.**

In liquid ammonia the following equilibrium is present.



Identify the Brønsted-Lowry base(s).



**(Total for question = 1 mark)**

**Q11.**

When equimolar amounts of the solutions below are mixed, which forms a buffer
 solution with a pH less than 7?

   **A**  Hydrochloric acid and sodium chloride

   **B**  Ethanoic acid and sodium ethanoate

   **C**  Sodium hydroxide and sodium chloride

   **D**  Ammonia and ammonium chloride

**(Total for question = 1 mark)**

**Q12.**

A buffer solution is made from ammonia and ammonium chloride. When a small
 amount of acid is added to this buffer

   **A**     hydrogen ions in the acid combine with chloride ions to make HCl.

   **B**     hydrogen ions in the acid combine with NH3 to make NH4+.

   **C**     NH4+ ions dissociate to make more NH3.

   **D**     the hydrogen ions in the acid prevent dissociation of the NH4Cl.

**(Total for question = 1 mark)**

**Q13.**

Which of the following mixtures would form the best buffer solution with pH 9 for use in a school laboratory?

   **A**    Ethanoic acid and sodium ethanoate

   **B**    Sodium chloride and sodium hydroxide

   **C**    Hydrocyanic acid and sodium cyanide

   **D**    Ammonium chloride and ammonia

**(Total for question = 1 mark)**

**Q14.**

Which of the following mixtures would form the best buffer solution with pH 5 for use in a school laboratory?

   **A**   Ethanoic acid and sodium ethanoate

   **B**   Hydrochloric acid and sodium chloride

   **C**   Sodium hydroxide and sodium methanoate

   **D**   Ammonium chloride and ammonia

**(Total for question = 1 mark)**

**Q15.**

Which of the following solutions, when mixed, would make a buffer with pH more than 7?

   **A**     Methanoic acid and sodium methanoate.

   **B**     Sodium hydroxide and sodium chloride.

   **C**     Ammonia and ammonium chloride.

   **D**     Ammonium chloride and ammonium ethanoate.

**(Total for question = 1 mark)**

**Q16.**

What is the conjugate base of the acid, HCO3−?

   **A**     H2CO3

   **B**     CO32−

   **C**     OH−

   **D**     CO2

**(Total for question = 1 mark)**

**Q17.**

At 100 °C, pure water has a pH of 6, whereas at 25 °C it has a pH of 7.  This is because

   **A**     the dissociation of water is endothermic, so the concentration of hydrogen
                ions is lower at 100 °C than it is at 25 °C.

   **B**     the dissociation of water is exothermic, so the concentration of hydrogen ions
                is lower at 100 °C than it is at 25 °C.

   **C**     the dissociation of water is endothermic, so the concentration of hydrogen
                ions is higher at 100 °C than it is at 25 °C.

   **D**     at 100 °C, water has a higher concentration of hydrogen ions than of
                hydroxide ions.

**(Total for question = 1 mark)**

**Q18.**

Why are aqueous solutions of sodium ethanoate slightly alkaline?

   **A**     The sodium ions react with water to give an alkali.

   **B**     The ethanoate ions react with water to give hydroxide ions.

   **C**     All sodium salts give alkaline solutions.

   **D**     The sodium ethanoate is fully ionized in solution.

**(Total for question = 1 mark)**

**Q19.**

Which one of the following indicators is most suitable for titrating ethanoic acid with 0.1 mol dm−3 sodium hydroxide?

 (Refer to page 19 of your data booklet.)

   **A**     Thymol blue (acid)

   **B**     Bromothymol blue

   **C**     Thymol blue (base)

   **D**     Alizarin yellow R

**(Total for question = 1 mark)**

**Q20.**

In which of the following reactions is nitric acid acting as a base?

   **A**     HNO3 + NaOH      →   NaNO3 + H2O

   **B**     HNO3 + H2O         →   H3O+ + NO3−

   **C**     HNO3 + H2SO4     →   H2NO3+ + HSO4−

   **D**     HNO3 + NaHCO3 →   NaNO3 + H2O + CO2

**(Total for question = 1 mark)**

**Q21.**

Which of the following solutions has the lowest pH?

   **A**     0.010 mol dm−3 hydrochloric acid.

   **B**     0.100 mol dm−3 hydrochloric acid.

   **C**     0.010 mol dm−3 ethanoic acid.

   **D**     0.100 mol dm−3 ethanoic acid.

**(Total for question = 1 mark)**

**Q22.**

The pH of a 1.5 mol dm−3 solution of hydrochloric acid, HCl(aq), is

   **A**  −1.50

   **B**  −0.18

   **C**  0.18

   **D**  1.50

**(Total for question = 1 mark)**

**Q23.**

What is the approximate pH of a buffer solution containing 0.20 mol of a weak acid, HA, (p*K*a = 4.8) and 0.20 mol of the sodium salt of the acid, NaA, in a total volume of 1 dm3 of solution?

   **A**     7.0

   **B**     5.8

   **C**     4.8

   **D**     3.8

**(Total for question = 1 mark)**

**Q24.**A solution of hydrochloric acid has pH 3.0. When it is made 10 times more dilute, the pH is

   **A**     0.3

   **B**     2.0

   **C**     4.0

   **D**     13.0

**(Total for question = 1 marks)**

**Q25.**

An aqueous solution of ammonium chloride, NH4Cl, has a pH of less than 7 because

   **A**     the ammonium ions donate protons to water molecules giving rise to
                oxonium ions, H3O+(aq).

   **B**     the chloride ions combine with hydrogen ions from water to form
                hydrochloric acid, HCl(aq).

   **C**     an aqueous solution of ammonium chloride is unstable and evolves ammonia
                gas, NH3(g), leaving dilute hydrochloric acid.

   **D**     the ammonium chloride reacts with carbon dioxide from the atmosphere
                giving ammonium carbonate, (NH4)2CO3(aq), and hydrochloric acid, HCl(aq).

**(Total for question = 1 mark)**

**Q26.**

Select the correct pH for each of the following solutions.

(a)  2 mol dm−3 nitric acid.

**(1)**

   **A**    −2

   **B**    −0.3

   **C**    +0.3

   **D**    +2

(b)  0.10 mol dm−3 barium hydroxide, Ba(OH)2. Kw = 1.0 × 10−14 mol2 dm−6.

**(1)**

   **A**    13.0

   **B**    13.3

   **C**    13.7

   **D**    14.3

(c)  A mixture of 20 cm3 of 1.0 mol dm−3 hydrochloric acid and 10 cm3 of 1.0 mol dm−3 sodium hydroxide.

**(1)**

   **A**    13.0

   **B**    13.3

   **C**    13.7

   **D**    14.3

**(Total for question = 3 marks)**

**Q27.**

Suggest the most likely pH for each of the following solutions.

(a)  5.0 mol dm−3 hydrochloric acid.

**(1)**

   **A**   +5

   **B**   +0.7

   **C**   −0.7

   **D**   −5

(b)  0.20 mol dm−3 strontium hydroxide, Sr(OH)2

*K*w = 1.0 × 10−14 mol2 dm−6

**(1)**

   **A**   13.3

   **B**   13.6

   **C**   14.0

   **D**   14.3

(c)  A mixture of 20 cm3 of 1.0 mol dm−3 nitric acid and 10 cm3 of 1.0 mol dm−3 sodium hydroxide.

**(1)**

   **A**   0

   **B**   0.30

   **C**   0.48

   **D**   7

**(Total for question = 4 marks)**

**Q28.**

Information about four samples of acid is shown below.

**Sample 1:**   1.0 mol dm−3 HCl

**Sample 2:**   1.0 mol dm−3 H2SO4

**Sample 3:**   0.1 mol dm−3 HCl

**Sample 4:**   0.1 mol dm−3 CH3COOH

Which of the following lists shows the samples in order of increasing pH?

   **A**     1, 2, 3, 4

   **B**     4, 3, 2, 1

   **C**     2, 1, 3, 4

   **D**     4, 3, 1, 2

**(Total for question = 1 mark)**

**Q29.**

Why does phenolphthalein, which is colourless in acidic solutions, turn pink in alkaline
 solutions?

   **A**     It is oxidized to a pink compound by hydroxide ions.

   **B**     It forms a pink anion by loss of H+ ions.

   **C**     It forms a pink anion by gain of H+ ions.

   **D**     It forms a pink cation by gain of H+ ions.

**(Total for question = 1 mark)**

**Q30.**

A solution of a weak acid cannot be titrated with a weak base using an indicator to find
 the end-point because

   **A**     the pH change is too gradual close to the equivalence point.

   **B**     there are too few H+ ions to affect the indicator.

   **C**     there are too few OH− ions to affect the indicator.

   **D**     the pH change occurs outside the range of any indicator.

**(Total for question = 1 mark)**

**Q31.**The titration curves below were obtained using different acids and bases, each with concentration 0.1 mol dm−3.



(a) Which curve is produced by adding ammonia to 25 cm3 of hydrochloric acid?                                                                                                                                                                                **(1)**

   **A**

   **B**

   **C**

   **D**

(b) Which curve is produced by adding ethanoic acid to 25 cm3 of sodium hydroxide?                                                                                                                                                                                **(1)**

   **A**

   **B**

   **C**

   **D**

(c) An indicator with p*K*In 8.5 is suitable for the following titrations.                                                                                                                                                                                **(1)**

   **A**     Titrations **A** and **B** only.

   **B**     Titrations **A**, **B** and **D** only.

   **C**     Titration **C** only.

   **D**     Titrations **A**, **B**, **C** and **D**.

**(Total for question = 3 marks)**

**Mark Scheme**

Q1.



**Q2.**



**Q3.**



**Q4.**



**Q5.**



**Q6.**



**Q7.**



**Q8.**



**Q9.**



**Q10.**



**Q11.**



**Q12.**



**Q13.**



**Q14.**



**Q15.**



**Q16.**



**Q17.**



**Q18.**



**Q19.**



**Q20.**



**Q21.**



**Q22.**



**Q23.**



Q24.


**Q25.**



**Q26.**



**Q27.**



**Q28.**



**Q29.**



**Q30.**



Q31.
