Chemistry

Unit 2

Area of Study 7 Test Answers:

Chemistry in our water

Section 1: Multiple choice 31% (14 marks)

Question 1

D Water has a high specific heat capacity and so is able to store heat energy effectively. The temperatures of large bodies of water do not change as much as that of surrounding land, thus moderating extremes of temperature.

Question 2

C Sucrose dissolves in water by forming hydrogen bonds with water. It does not dissociate or ionise but forms an aqueous solution with hydrogen bonds between sucrose molecules and water molecules.

Question 3

D Hydrogen chloride is a covalent molecular compound. Its atoms are held together by covalent bonds that break when the HCl dissolves in water. The new bonds formed are ion–dipole between the chloride ions and water. The protons released from HCl covalently bond with water molecules to form H3O+ ions.

Question 4

B Option A would form a precipitate of BaSO4. Option C would form a precipitate of CuCO3. Option D would form a precipitate of CuS.

Question 5

B At 0°C, 28 g dissolves in 100 g water. So, at 0°C, 7.0 g dissolves in 25 g water. As there is a total of 8.0 g solute, 8.0 − 7.0 = 1.0 g crystallises out.

Question 6

D Lemon juice and hydrochloric acid are acidic so have a pH lower than 7. In a 1.0 mol L−1 sodium hydroxide (NaOH) solution there will be 1.0 mol L−1 of hydroxide ions, and in a 1.0 mol L−1 barium hydroxide ((Ba(OH)2) solution there will be 2.0 mol L−1 of hydroxide ions; thus barium hydroxide will have the highest pH.

Question 7

A Electrical conductivity in a solution is due to the presence of ions. The higher the concentration of ions, the higher the conductivity.

H2CO3 is a weak acid and so the concentration of ions in 0.01 mol L−1 H2CO3 is less than 0.01 mol L−1. NH4Cl dissociates into NH4+ ions and Cl− ions − a total of two ions − so the solution will have an ion concentration of 0.02 mol L−1. NaCl dissociates into Na+ ions and Cl− ions, so the solution will also have an ion concentration of 0.02 mol L−1. Na2SO4 dissociates into two Na+ ions and one SO42− ions − a total of three ions − so the solution will have an ion concentration of 0.03 mol L−1 and thus have the highest electrical conductivity.

End of section 1

Section 2: Short answer 69% (31 marks)

\* indicates 1 mark

Question 8

a The water molecule is very polar\*. It is an asymmetrical molecule with a large difference in electronegativity between the H atoms and the O atom\*. With ionic compounds, it forms ion–dipole interactions with the positive and negative ions, thus allowing them to dissolve in water\*. Polar covalent compounds are dissolved by forming hydrogen bonds or dipole–dipole attractions with water molecules\*. (4 marks)

b Necessary substances for metabolic processes include ionic compounds\* such as NaCl (or polar molecular compounds\* such as glucose). These readily dissolve in water and are carried to the various parts of the body, dissolved in the bloodstream\*. Waste products such as urea are also water soluble and can be excreted as a solution.

Note: Students need to identify at least one type of biological substance in their response, either ionic compounds or polar covalent molecular compounds, for one mark. (2 marks)

c Because of its excellent solvent properties, water in nature contains dissolved mineral salts and some soluble organic matter\*. Many salts are leached from rocks or result from the decay of plant and animal matter\*. (In nature, rain water is slightly acidic due to dissolution of CO2.)

(2 marks)

Question 9

a i MgCl2(s)  Mg2+(aq) + 2Cl−(aq)\*

ii ionic bonds\*

iii ion-dipole\*

(3 marks)

b i C2H5OH(s)  C2H5OH(aq)\*

ii hydrogen bonds and dispersion forces\* (In liquid ethanol, there are dispersion forces between the hydrocarbon portion of ethanol molecules and hydrogen bonds between the OH groups of the molecules.)

iii hydrogen bonds\* (between water molecules and the OH group of the ethanol molecules)

(3 marks)

c i the magnesium chloride solution\*

ii Charged particles in the form of Mg2+(aq) and Cl−(aq) ions are present in the solution after the MgCl2 has dissolved\*, whereas the dissolved ethanol molecules do not have a charge\*.

(3 marks)

Question 10

a i Ba2+(aq) + SO42−(aq) → BaSO4(s)\*

ii 2H+(aq) + Zn(s) → Zn2+(aq) + H2(g)

reactants and products correctly shown\*

equation balanced\*

iii 2H+(aq) + Na2CO3(s) → 2Na+(aq) + CO2(g) + H2O(l)

reactants and products correctly shown\*

equation balanced\*

iv H+(aq) + OH−(aq) → H2O(l)\*

(6 marks)

b i Two colourless solutions\* combine to give effervescence (bubbling) and a colourless solution\*. (The solutions also become warm.)

ii A blue solution combines with a colourless solution\* to form a blue-green precipitate and colourless solution\*.

(4 marks)

Question 11

n(NaOH) = c(NaOH) × V(NaOH) = 0.188 × 0.01275 = 2.397 × 10−3 mol\*

n(Pb2+) = n(Pb(NO3)2) = 0.5 × n(NaOH)\* = 0.5 × 2.397 × 10−3 = 1.198 × 10−3 mol\*

M(Pb) = 207.2 g mol−1

m(Pb2+) = n(Pb2+) × M(Pb) = 1.198 × 10−3 × 207.2 = 0.248 g\* (3 significant figures)

(4 marks)

End of answers