TRIAL TEST 2 – SOLUTIONS

• Time allowed: 60 minutes	Part 1 – Multiple Choice	– 10 marks
• Total marks: 50	Part 2 – Short Answer	– 20 marks
	Part 3 – Calculations	– 15 marks
	Part 4 – Extended Answer	– 5 marks

Part 1 – Multiple Choice (1 mark per question)

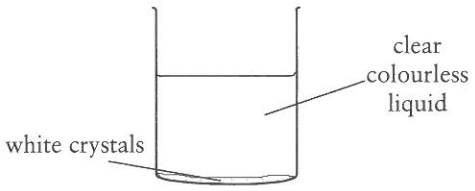
1. A solution may best be described as

   (a) a pure substance of constant composition.
   (b) two elements combined in variable proportions.
   (c) a homogeneous mixture of uniform composition.
   (d) a substance which can be purified by filtration.
   (e) a heterogeneous mixture of variable composition.

2. Gases most easily dissolve in water at

   (a) low temperature and low pressure.
   (b) low temperature and high pressure.
   (c) high temperature and low pressure.
   (d) high temperature and high pressure.
   (e) none of the above.

3. A quantity of sodium chloride is added to water in a beaker and stirred briskly for several minutes. The mixture is allowed to settle and appears as a clear colourless liquid with some white crystals at the bottom as illustrated. It would be true to say that



   (a) the clear liquid is a saturated solution.
   (b) a little more water is needed in order to produce a saturated solution.
   (c) adding more salt and heating would produce a saturated solution.
   (d) the clear liquid is a supersaturated solution.
   (e) cooling the solution would make it more concentrated.

4. Adding some salt to water will affect its properties. It would be true to say that the salt would

   (a) raise the water's vapour pressure.
   (b) raise the water's boiling point.
   (c) raise the water's freezing point.
   (d) lower the water's boiling point.
   (e) allow water to freeze more easily.

5. Approximately equal volumes of the two solutions in the following pairs of solutions listed at right are mixed together. All solutions are 0.1 mol L^{-1}.

(i)	$Pb(NO_3)_{2(aq)}$	and	$Na_2CO_{3(aq)}$
(ii)	$NaCl_{(aq)}$	and	$AgNO_{3(aq)}$
(iii)	$BaCl_{2(aq)}$	and	$Na_2SO_{4(aq)}$
(iv)	$NH_4NO_{3(aq)}$	and	$KCl_{(aq)}$
(v)	$MgCl_{2(aq)}$	and	$(NH_4)_2SO_{4(aq)}$

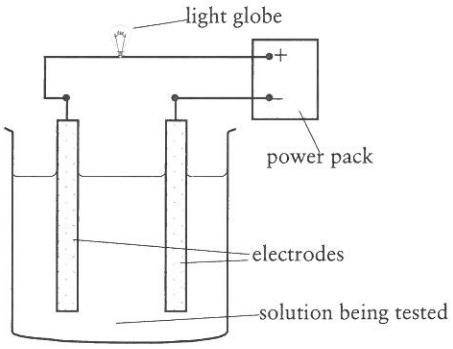
A precipitate will form in

(a) (i) and (ii) only.
(b) (ii) and (iii) only.
(c) (i), (ii) and (iii) only.
(d) (i), (ii) and (iv) only.
(e) (iii) and (v) only.

6. Which of the following equations correctly expresses the dissolving of barium chloride in water?

(a) $BaCl_{2(s)} + H_2O \longrightarrow BaCl_{2(aq)}$
(b) $BaCl_{2(s)} \longrightarrow Ba^{2+}_{(aq)} + 2Cl^-_{(aq)}$
(c) $BaCl_{2(s)} + H_2O \longrightarrow BaCl^+_{(aq)} + Cl^-_{(aq)}$
(d) $BaCl_{2(s)} \longrightarrow BaCl^+_{(aq)} + Cl^-_{(aq)}$
(e) $BaCl_{2(s)} \longrightarrow BaCl_{2(aq)}$

7. Conductivity tests were carried out using the apparatus shown at right.



Test A - beaker contains distilled water. When hydrogen chloride gas is bubbled through it the globe begins to glow brightly.

Test B - beaker contains ethanol. When hydrogen chloride gas is bubbled through it the globe does not glow.

Which of the following best explains these observations?

(a) Electrons are able to flow through an aqueous solution of $HCl_{(g)}$ but not through an ethanol solution of $HCl_{(g)}$.
(b) Distilled water is a good conductor of electricity whereas ethanol is not.
(c) Water molecules are more easily ionised than ethanol molecules.
(d) There are a greater number of $HCl_{(g)}$ molecules in the water than there are in the ethanol.
(e) $HCl_{(g)}$ dissolves in water to form charged particles whereas in ethanol it remains as neutral molecules.

8. Conductivity apparatus similar to that in question 7 is used to test the conductivity of the following solutions. In which case will the globe glow brightest?

(a) 100 mL of 2.0 mol L^{-1} $HCl_{(aq)}$
(b) 300 mL of 1.0 mol L^{-1} $HCl_{(aq)}$
(c) 100 mL of 2.0 mol L^{-1} $H_2CO_{3(aq)}$
(d) 300 mL of 1.0 mol L^{-1} $H_2CO_{3(aq)}$
(e) 200 mL of 2.0 mol L^{-1} $CH_3COOH_{(aq)}$

9. Which of the following statements is INCORRECT?

   (a) Rainwater is always a little acidic due to the presence of carbon dioxide gas in the atmosphere.
   (b) Carbon dioxide gas in the atmosphere is a factor in the formation of underground caves.
   (c) Temporary hardness in water can be removed simply by boiling the water.
   (d) Permanent hardness in water is caused by the presence of carbonate ions.
   (e) Distilled water has a greater purity than deionised water.

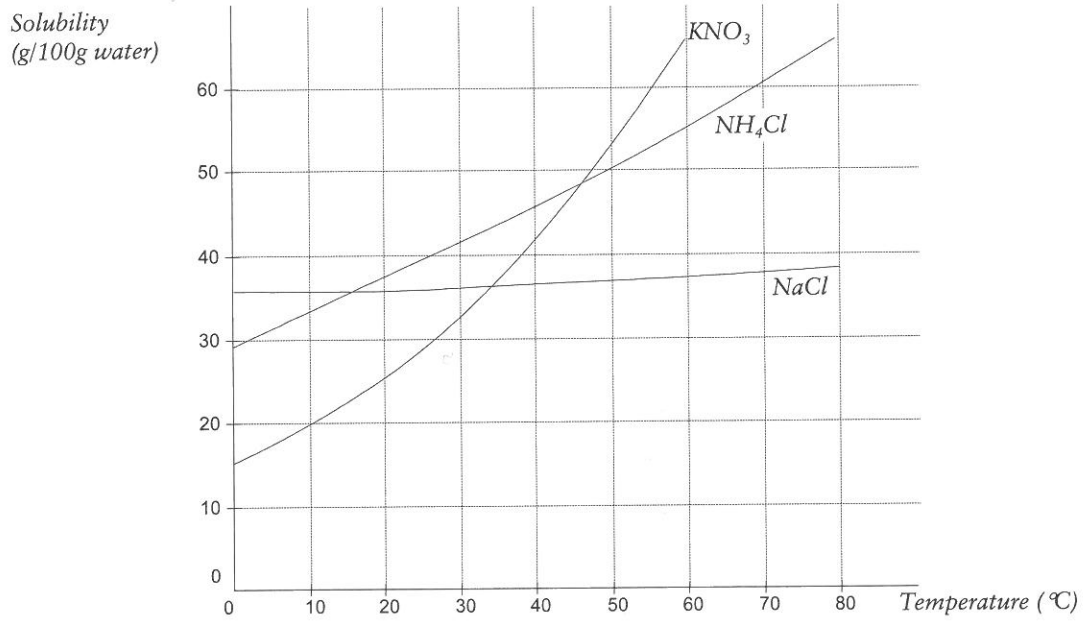
10. If 2.0 mg of sodium chloride crystals were dissolved in 100 mL of distilled water which of the following would most correctly describe the solution? Assume density of the resulting solution to be 1.0 g mL^{-1}.

   (a) A 2.0% salt solution.
   (b) A 20 gL^{-1} salt solution.
   (c) A 2.0×10^{-4} mol L^{-1} salt solution.
   (d) A 0.348 mol L^{-1} salt solution.
   (e) A 20 ppm salt solution.

END OF PART 1

Part 2 - Short Answer **Answer each question in the space provided beneath the question.**

11. Use the graph of solubility shown to answer the following. Show all working.



   (a) What is the maximum amount of NaCl that can be dissolved in 5.0 kg of water at 20°C?

   _____

   _____

   (b) 100 g of NH_4Cl were dissolved in 250 g of warm water. To what temperature must this solution be cooled if crystals are to form?

   _____

   _____

11. (c) 100 g of KNO_3 crystals are dissolved in 200 g of distilled water at 50°C. The solution is then allowed to cool to 10°C. What mass of KNO_3 crystals will form?

_____

_____

_____

[6 marks]

12. Write balanced **ionic** equations and describe what would be observed when:

(a) sodium sulfate solution is mixed with barium hydroxide solution.

equation: _____

observation: _____

(b) a solution of calcium hydrogencarbonate is gently boiled.

equation: _____

observation: _____

(c) a few drops of silver nitrate are added to household tap water.

equation: _____

observation: _____

[3 marks]

13. Briefly explain what is meant by a saturated solution.

_____

_____

[2 marks]

14. (a) Briefly describe what is meant by an **electrolyte.**

_____

_____

(b) List each of the following as either strong, weak or non-electrolytes.

$C_{12}H_{22}O_{11}$ *(sugar)* , K_2CO_3 , $NaCH_3COO$, H_3PO_4 , $MgSO_4$, H_2O ,
NH_3 , H_2CO_3 , CH_3CH_2OH *(ethanol)*

(i) strong electrolytes: _____

(ii) weak electrolytes: _____

(iii) non-electrolytes: _____

[5 marks]

15. Limestone ($CaCO_3$) is almost insoluble in water. However calcium ions are often present in bore water from limestone areas.
Explain how this is possible (an equation should be included).

_____

_____

[4 marks]

END OF PART 2

Part 3 - Calculations **Show working in the space provided beneath the question.**

16. A solution of barium chloride is made up by dissolving 2.55 g of this substance in distilled water and making up to 250.0 mL. Calculate the concentration of this solution in:

(a) grams per litre

(b) moles per litre

[4 marks]

17. A 5.00 kg sample of sea water was evaporated to dryness and 155.5 g of solids remained. Calculate the concentration of the solids in:

(a) % by mass

(b) ppm

[4 marks]

18. 200 mL of 2.00 mol L^{-1} $Pb(NO_3)_{2(aq)}$ solution is added to 200 mL of 2.50 mol L^{-1} $NaCl_{(aq)}$ solution. A reaction occurs as follows.

$$Pb(NO_3)_{2(aq)} + 2NaCl_{(aq)} \longrightarrow PbCl_{2(s)} + 2NaNO_{3(aq)}$$

Determine:

(a) moles of $Pb(NO_3)_{2(aq)}$ used.

(b) moles of $NaCl_{(aq)}$ used.

(c) the mass of lead (II) chloride produced.

(d) the concentration of the Na^+ ions in the final solution.

[7 marks]

END OF PART 3

Part 4 - Extended Answer

19. Water which is hard will not work effectively with soap.
Explain how hard water is chemically different from soft water, some of the problems associated with its use and how hard water may be softened. Use equations where appropriate.

[5 marks]

END OF TEST **TOTAL 50 MARKS**

TRIAL TEST 2 SOLUTIONS – Solutions

Part 1

1. *c*
2. *b*
3. *a*
4. *b*
5. *c*
6. *b*
7. *e*
8. *b*
9. *d*
10. *e*

[10]

Part 2

11. *(a)* *At 20 °C solubility of NaCl ≈ 36 g/100 g*
∴ mass (NaCl) in 5.0 kg
≈ 36 × 5000/100 ≈ 1800 g or 1.8 kg
(b) *100 g/250 g = 40 g/100 g*
∴ crystals of NH_4Cl appear ≈ 27 °C
(c) *At 10 °C solubility of KNO_3*
≈ 20 g/100 g ie. ≈ 40 g/200 g
∴ mass (KNO_3) that will ppt
≈ 100 − 40 ≈ 60 g *[6]*

12. *(a)* $Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \longrightarrow BaSO_{4(s)}$
A white precipitate forms.
(b) $Ca(HCO_3)_{2(aq)} \longrightarrow$
$CaCO_{3(s)} + H_2O_{(l)} + CO_{2(g)}$
A white precipitate (sediment) forms.
(c) $Ag^+_{(aq)} + Cl^-_{(aq)} \longrightarrow AgCl_{(s)}$
A white precipitate forms. *[3]*

13. *A saturated solution is a solution that contains as much dissolved solute as is possible to dissolve at that temperature.* *[2]*

14. *(a)* *Electrolytes are substances which form ions in aqueous solutions.*
(b) *(i)* K_2CO_3 , $NaCH_3COO$, $MgSO_4$
(ii) H_3PO_4 , NH_3 , H_2CO_3 , H_2O
(iii) $C_{12}H_{22}O_{11}$, CH_3CH_2OH
[5]

15. *$CO_{2(g)}$ in the atmosphere dissolves in rain water forming a slightly acidic solution. This reacts with limestone ($CaCO_3$) to form soluble $Ca(HCO_3)_2$. Hence the presence of Ca^{2+} ions.*
$CaCO_{3(s)} + H_2O_{(l)} + CO_{2(g)} \longrightarrow$
$Ca^{2+}{}_{(aq)} + 2HCO_3^{-}{}_{(aq)}$
[4]

Part 3

16. *(a)* $c(BaCl_2) = \dfrac{2.55\ g}{0.250\ L} = 10.2\ g\ L^{-1}$

16. *(b)* $n(BaCl_2) = \dfrac{m}{M} = \dfrac{2.55}{208.2}$
$= 1.224 \times 10^{-2}\ mol$
$c = \dfrac{n}{V} = \dfrac{1.224 \times 10^{-2}}{0.250} = 0.0490\ mol\ L^{-1}$
[4]

17. *(a)* $\%\ by\ mass = \dfrac{155.5\ g}{5000\ g} \times 100 = 3.11\%$
(b) $ppm = \dfrac{155500\ mg}{5.0\ kg} = 3.11 \times 10^4\ ppm$
[4]

18. *(a)* $n = cV = (2.00)(0.200)$
$= 0.40\ mol\ Pb(NO_3)_2$
(b) $n = cV = (2.50)(0.200)$
$= 0.50\ mol\ NaCl$
(c) *from eqn*
1 mol $Pb(NO_3)_2$ req 2 mole NaCl
∴ NaCl is limiting reagent
∴ $n(PbCl_2) = (½)(0.50) = 0.25$ mol
∴ $m(PbCl_2) = (0.25)(278.1) = 69.5$ g
(d) $c = \dfrac{n}{V} = \dfrac{0.50}{0.40} = 1.25\ mol\ L^{-1}$
[7]

Part 4

19. ▪ *Unlike soft water, hard water contains significant amounts of Ca^{2+} and/or Mg^{2+} ions.*
▪ *Hard water is not suitable for washing as it reacts with soap to form scum.*
Hard water also forms a scale when used in kettles and boilers. This scale consists of $CaCO_3$ and/or $CaSO_4$ and can cause blockages.
▪ *Hard water may be softened by*
- boiling if it is temporary hardness. This removes the Ca^{2+} ions.
- $Ca(HCO_3)_{2(aq)} \xrightarrow{boiled}$
$CaCO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$
- adding washing soda ($Na_2CO_3.10H_2O$). This also removes the Ca^{2+} and /or Mg^{2+} ions.
$Ca^{2+}_{(aq)} + CO_3^{2-} \longrightarrow CaCO_{3(s)}$
- water softeners are also able to remove Ca^{2+} and/or Mg^{2+} ions from water.
[5]

MARKS **Total = 50**