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CHEMISTRY

Unit 2

Trial Examination

SOLUTIONS BOOK

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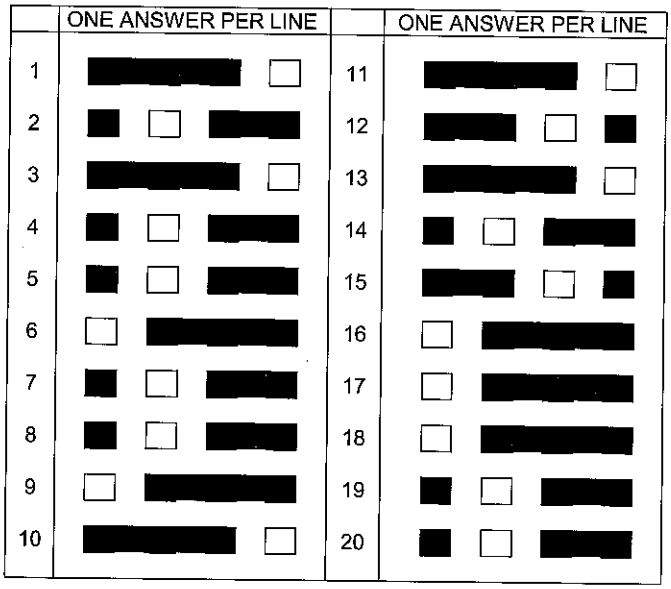
Use this page as an overlay for marking the multiple choice answer sheets. Simply photocopy the page onto an overhead projector sheet. The correct answers are open boxes below. Students should have shaded their answers. Therefore, any open box with shading inside it is correct and scores 1 mark.



SECTION A (Total 20 marks)

1.	D	**2.**	B	**3.**	D	**4.**	B	**5.**	B
6.	A	**7.**	B	**8.**	B	**9.**	A	**10.**	D
11.	D	**12.**	C	**13.**	D	**14.**	B	**15.**	C
16.	A	**17.**	A	**18.**	A	**19.**	B	**20.**	B

Comments for Section A answers

Question 1
Latent heat of vaporisation is about bonds between molecules. Water exhibits extensive hydrogen bonding between molecules. **Correct Answer: D**

Question 2
Hydrocarbons are not soluble in water. This rules out A, C, D. **Correct Answer: B**

Question 3
This question stems from a general rule which is 'All group I salts, all nitrate salts (containing NO_3^-) and ammonium salts (containing NH_4^+) are all soluble'. Hence A, B and C must be soluble. **Correct Answer: D**

Question 4
Plateau D is larger than plateau B so less heat energy is required to melt than to evaporate.
Correct Answer: B

Question 5
In between changes of state, heat weakens the bonds. **Correct Answer: B**

Question 6
$[Na^+] = 0.400$ M therefore $[Cl^-]$ from NaCl = 0.400 M

$[Cl^-]$total = 0.600 M therefore $[Cl^-]$ from $MgCl_2$ = 0.200 M; therefore $[Mg^{2+}] = 0.100$ M

Correct Answer: A

Question 7
HCl (aq) is a good conductor of electricity whereas water is a poor conductor – this confirms that HCl molecules have produced ions. **Correct Answer: B**

Question 8
$H_2PO_4^-$ is able to ionise in two separate stages to produce both HPO_4^{2-} and PO_4^{3-}.
Correct Answer: B

Question 9
HNO_3 produces H_3O^+ and KOH produces OH^-
These two ions react so that $H_3O^+ + OH^- \rightarrow 2H_2O$ **Correct Answer: A**

Question 10
The strongest acid is HCl and the highest concentration will give the lowest pH.
Correct Answer: D

Question 11
A pH of 9.5 means the solution is basic and that OH^- ions have been produced by HPO_4^{2-} ions attracting protons from water. **Correct Answer: D**

Question 12

$c_1V_1 = c_2V_2$ $1.0 \times 10^{-2.0} \times 2.0 = 1.0 \times 10^{-3.0} \times X$ so $X = 20$ L but only need to add 18 L.

Correct Answer: C

Question 13

$[Ba(OH)_2] = 0.0050$ M $[OH^-] = 0.0100$ M so $pOH = -\log_{10}[OH^-] = 2.0$

$pH + pOH = 14.0$ at 25°C ; $pH = 12.0$ **Correct Answer: D**

Question 14

$n(HNO_3)total = c_1V_1 + c_2V_2 = 0.080 \times 25 \times 10^{-3} + 0.020 \times 50 \times 10^{-3} = 3.0 \times 10^{-3}$ mol

$V_{total} = 75 \times 10^{-3}$ L

$[HNO_3] = \frac{c}{V} = \frac{3.0 \times 10^{-3}}{75 \times 10^{-3}} = 0.040$ M **Correct Answer: B**

Question 15

Lemon juice, CO_2 and vinegar are acidic. Only water (dilution) would raise the pH.

Correct Answer: C

Question 16

AsH_3 has As in -3; As_4O_6 has As in +3; H_3AsO_4 has As in +5; As_2O_5 has As in +5.

Correct Answer: A

Question 17

$Cr_2O_7^{2-}(aq) + 2OH^-(aq) \rightarrow 2CrO_4^{2-}(aq) + H_2O(l)$ No changes in oxidation number.

$2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(g)$ $Fe^{3+}(+3) \rightarrow Fe^{2+}(+2)$; $I(-1) \rightarrow I(0)$

$PbS(s) + 4H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$ $S(-2) \rightarrow S(+6)$; $O(-1) \rightarrow O(-2)$

$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$ $Fe(+3) \rightarrow Fe(0)$; $C(+2) \rightarrow C(+4)$

Correct Answer: A

Question 18

$ZnO(s) + \mathbf{CO}(g) \rightarrow Zn(s) + CO_2(g)$ CO is oxidised i.e. it is a reducing agent

$Cu(s) + \mathbf{N_2O}(g) \rightarrow CuO(s) + N_2(g)$ N_2O is reduced i.e. it is an oxidising agent

$3Cu(s) + \mathbf{N_2}(g) \rightarrow 3H_2O(g) + CuO(s) + 2NH_3(g)$ N_2 is reduced i.e. it is an oxidising agent

$H_2S(g) + \mathbf{Cl_2}(aq) \rightarrow 2H^+(aq) + 2Cl^-(aq) + S(s)$ Cl_2 is reduced i.e. it is an oxidising agent

Correct Answer: A

Question 19

$SO_3 \rightarrow SO_4^{2-}$ $S(+6) \rightarrow S(+6)$ no change in oxidation number

$O_2 \rightarrow H_2O_2$ $O(0) \rightarrow O(-1)$; decrease in oxidation number = reduction

$Mn^{2+} \rightarrow MnO_4^-$ $Mn(+2) \rightarrow Mn(+7)$; increase in oxidation number = oxidation

$CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$ $Cr(+6) \rightarrow Cr(+6)$ no change in oxidation number **Correct Answer: B**

Question 20

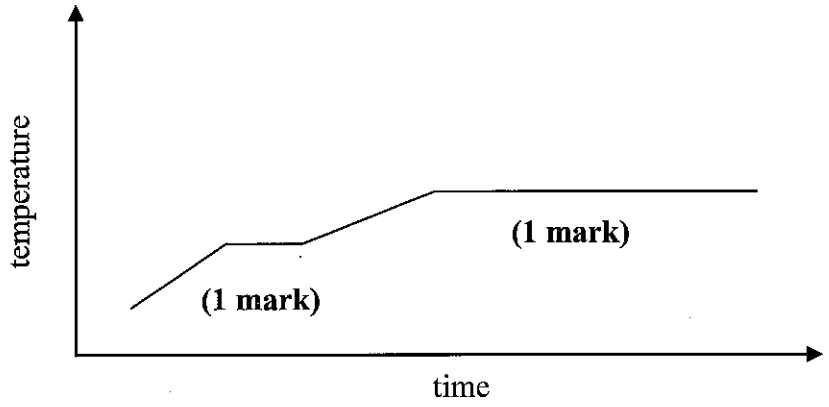
$n(Li_3PO_4) = \frac{m}{M} = \frac{3.086}{115.7} = 0.02667$ mol

$n(Li^+) = 3 \times n(Li_3PO_4) = 3 \times 0.02667 = 0.08002$ mol **Correct Answer: B**

SECTION B – Short answer questions (Total 67 marks)

Question 1 (9 marks)

a.



b. $E = mc\Delta T = 10.0 \times 4.18 \times 20 = 836$ J **(1 mark)**

c. $E = mc\Delta T = 10.0 \times 4.18 \times 25 = 1.05 \times 10^3$ J [*accept 1045 J*] **(1 mark)**

d. $E = 836 + 1050 = 1886$ J which is much less than 4816 J **(1 mark)**
This is because of the latent heat required to melt the ice and vaporise the water **(1 mark)**

e. **i.** 18.0 g **(1 mark)**

ii. $\frac{40.67}{18.0} = 2.26$ kJ g^{-1} **(1 mark)**

iii. $10 \times 2.26 = 22.6$ kJ **(1 mark)**

Question 2 (8 marks)

a. Compound Y **(1 mark)**. Dissolved gases are less soluble at higher temperatures **(1 mark)**.

b. 58 ± 1 g / 100 g of H_2O **(1 mark)**

c. At 60 °C , 55 g dissolves per 100 g of H_2O **(1 mark)**
By ratio: $\frac{100}{55} = \frac{x}{50}$ so $x = 91$ g H_2O (to 2 s.f.) **(1 mark)**

d. At 40 °C, 58 g of Z dissolves per 100 g of H_2O **(1 mark)**
In 60 g of H_2O, by ratio: $\frac{58}{100} = \frac{x}{60}$ so $x = 34.8$ g of Z dissolve **(1 mark)**
$80 - 34.8 = 45$ g (to 2 s.f.) remain undissolved **(1 mark)**

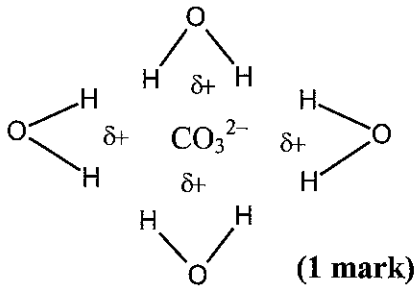
Question 3 (7 marks)

a. **i.** $AlF(s) \xrightarrow{H_2O} Al^{3+}(aq) + 3F^-(aq)$ **(1 mark)**

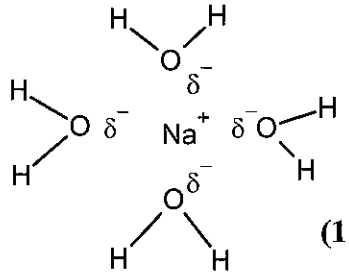
ii. $Na_2CO_3(s) \xrightarrow{H_2O} 2Na^+(aq) + CO_3^{2-}(aq)$ **(1 mark)**

b. The process involves breaking ionic bonds between sodium ions and carbonate ions **(1 mark)**, the breaking of hydrogen bonds between water molecules **(1 mark)** and the formation of ion-dipole bonds between ions and water molecules **(1 mark)**.

c.



(1 mark)



(1 mark)

Question 4 (8 marks)

a. $HBr(g) + H_2O(l) \rightarrow H_3O^+(aq) + Br^-(aq)$ **(1 mark)**

b. **i.** $2NaI(aq) + Pb(NO_3)_2(aq) \rightarrow PbI_2(s) + 2\,NaNO_3(aq)$

(1 mark for correct formulae & 1 mark for balance)

ii. $Pb^{2+}(aq) + 2I^-(aq) \rightarrow PbI_2(s)$ **(1 mark)**

c. **i.** $3KOH(aq) + Fe(NO_3)_3(aq) \rightarrow Fe(OH)_3(s) + 3NaNO_3(aq).$

(1 mark for correct formulae & 1 mark for balance)

ii. $Fe^{3+}(aq) + 3OH^-(aq) \rightarrow Fe(OH)_3(s)$ **(1 mark)**

d. ion-dipole bonding **(1 mark)**

Question 5 (7 marks)

a. $n(NaOH) = c \times V = 0.0311 \times 21.35 \times 10^{-3} = 6.64 \times 10^{-4}$ mol **(1 mark)**

b. $n(CH_3COOH) = n(NaOH) = 6.64 \times 10^{-4}$ mol **(1 mark)**

c. $n(CH_3COOH)_{\text{in 20ml sample of diluted vinegar}} = 6.64 \times 10^{-4}$ mol

$n(CH_3COOH)_{\text{in 250.0ml flask of diluted vinegar}} = \frac{250.0}{20} \times 6.64 \times 10^{-4}\text{ mol} = 8.30 \times 10^{-3}$ mol **(1 mark)**

$n(CH_3COOH)_{\text{in 20.0ml sample of undiluted vinegar}} = 8.30 \times 10^{-3}$ mol **(1 mark)**

$m(CH_3COOH)_{\text{in 20.0ml sample of undiluted vinegar}} = n \times M = 8.30 \times 10^{-3} \times 60.0 = 0.498$ g **(1 mark)**

d. An aliquot is a very accurate volume taken by pipette e.g. 20.00 mL **(1 mark)**
A titre is a very accurate volume run out of a burette during a titration **(1 mark)**

Question 6 (7 marks)

a. The results provide the following deductions

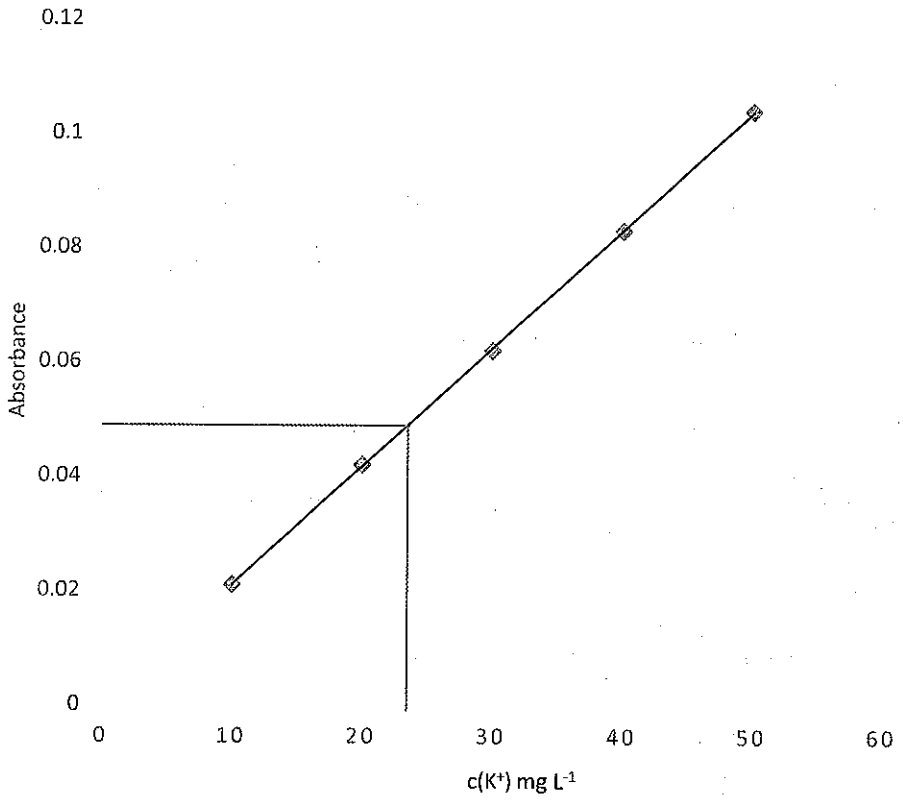
Pb and Zn are more reactive than Cu
Zn is more reactive than Fe
Pb more reactive than Cu
Fe more reactive than Pb
Sn is more reactive than Pb
Mg is more reactive than Zn
Fe is more reactive than Sn
Mg is more reactive than Sn
Zn is more reactive than either Pb or Sn

Suggests the order is: magnesium, zinc, tin, lead, copper **Answer iii.**
(1 mark for answer & 1 mark for some evidence of deductive reasoning)

b. Fe should react with lead (II) ions **(1 mark)**. Sn is more reactive than Pb and Fe is more reactive than Sn **(1 mark)**.

c. **i.** to remove any oxide coating and provide a fresh surface **(1 mark)**
ii. Aluminium is more reactive than iron **(1 mark)**
iii. The overall reaction is redox **or** the conversion of iron(III) to iron is reduction.
(For either answer award 1 mark)

Question 7 (6 marks)
a.



(1 mark for correctly plotting all points & 1 mark for correctly drawing and labelling graph)

b. Using graph accept 23 ± 1 mg L^{-1} **(1 mark).** [*Using line gradient gives 23.3 mg L^{-1}*]

c. $23 \times \frac{250}{25} = 230$ mg L^{-1} **(1 mark)**

d. $230 \times \frac{250}{1000}$ in 250 mL = 58 mg of K^+ **(1 mark)**

% by mass = $\frac{58}{2650} \times 100 = 2.2\%$ **(1 mark)**

Question 8 (5 marks)

a. Since HCl is a strong acid , $[H^+] = [HCl]$; $pH = -\log_{10}[H^+] = -\log_{10} 0.00010 = 4.00$ **(1 mark)**

b. $[H_2SO_4] = 5.0 \times 10^{-3}$. Assuming complete ionization, $[H^+] = 1.0 \times 10^{-2}$ **(1 mark)**
$pH = -\log_{10}[H^+] = -\log_{10}(1.0 \times 10^{-2}) = 2.00$ **(1 mark)**

c. $pH = 3.4$, $[H^+] = 10^{-3.4} = 4.0 \times 10^{-4}$ M **(1 mark)**
Since nitric acid is a strong acid, $[HNO_3] = 4 \times 10^{-4}$ M **(1 mark)**

Question 9 (5 marks)

The magnesium would be coated with iron **(1 mark)**

$Mg(s) + Fe^{2+}(aq) \rightarrow Mg^{2+}(aq) + Fe(s)$ **(1 mark)** The iron nail would corrode. **(1 mark)**

$2Fe(s) + O_2(g) + 2H_2O(aq) \rightarrow 2Fe(OH)_2(aq)$ **(2 marks)** [*Also accept individual half equations*]

Question 10 (5 marks)

a. Gravimetric analysis **(1 mark)**

b. Let T = titre volume in mL $n(AgNO_3) = c \times V = 0.4998 \times T \times 10^{-3}$ **(1 mark)**

$n(Ag^+) = n(Cl^-) = n(AgNO_3)$ $n(Cl^-) = n(NaCl)$ **(1 mark)**

$m(NaCl) = n \times M = 0.4998 \times T \times 10^{-3} \times 58.5$ $\%\ NaCl\ (m/m) = 100 \times \frac{m(NaCl)}{m(sample)}$

$1.58 = 100 \times 0.4998 \times T \times 10^{-3} \times 58.5 \div 50.0$ **(1 mark)**

$T = \frac{50 \times 1.58}{100 \times 0.4998 \times 10^{-3} \times 58.5} = 27.0$ mL **(1 mark)** (check sig fig)

OR alternatively

$m(NaCl) = \frac{1.58\ g}{100\ g}$ or $\frac{0.79\ g}{50\ g}$ $n(NaCl) = \frac{0.79}{58.5} = 0.0135$ mol $n(AgNO_3) = 0.0135$ mol

$v(AgNO_3) = \frac{n}{c} = \frac{0.0135}{0.4998} = 0.0270$ L = 27.0 mL

END OF SUGGESTED SOLUTIONS