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CHEMISTRY

Unit 2

Trial Examination

SOLUTIONS BOOK

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Question 6 (4 marks)

a. $4 \times P + 10 \times (-2) = 0 \therefore 4P = 20 \therefore P = +5$ **(1 mark)**

b. $n(P) = m / M = 1.0 \div (4 \times 31) = 8.06 \times 10^{-3}$ **(1 mark)**
$n(CO) / n(P) = 10 / 1$ **(1 mark)** $n(CO) = 10 \times 8.06 \times 10^{-3} = 8.06 \times 10^{-2}$
$n = V / V_m \therefore V(CO) = n \times V_m = 8.06 \times 10^{-2} \times 24.5 = 1.97$ L **(1 mark)**

Question 7 (6 marks)

In each case award 1 mark for generally correct equation and 1 mark for correct balance.

a. $NO_2^- + H_2O \rightarrow NO_3^- + 2H^+ + 2e^-$

b. $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$

c. $(COOH)_2 \rightarrow 2CO_2 + 2H^+ + 2e^-$

Question 8 (8 marks)

a. $n(AgNO_3) = c \times V = 0.070 \times 0.100 = 0.0070$ mol **(1 mark)**
$n(Na_2S) = 0.075 \times 0.080 = 0.0060$ mol **(1 mark)**
Required mole ratio is 2:1 ∴ only 0.0035 mol of Na_2S is required **(1 mark)**. Na_2S is in excess by 0.0025 mol **(1 mark)**
$M(Na_2S) = 78.1$ g mol^{-1} ∴ $m(Na_2S) = 0.010 \times 78.1 = 0.781$ g **(1 mark)**

b. $n(Ag_2S) = n(Na_2S)_{used} = 0.0035$ mol **(1 mark)**
$M(Ag_2S) = 247.9$ g mol^{-1} **(1 mark)** ∴ $m(Ag_2S) = n \times M = 0.0035 \times 247.9 = 0.868$ g **(1 mark)**

Question 9 (7 marks)

a. **i.** pipette **(1 mark)** **ii.** burette **(1 mark)**

b. A base is a proton acceptor. **(1 mark)**

c. $n(HCl) = 0.100 \times 24.4 \times 10^{-3} = 2.44 \times 10^{-3}$ mol **(1 mark)**
$n(NaX)_{in\ 20.00\ mL} = n(HCl) = 2.44 \times 10^{-3}$ mol **(1 mark)**
$n(NaX)_{in\ 100\ mL} = 5 \times 2.44 \times 10^{-3} = 1.22 \times 10^{-2}$ mol **(1 mark)**
$n = m / M \therefore M(NaX) = m / n = 1.0 \div (1.22 \times 10^{-2}) = 82.0$ g mol^{-1} **(1 mark)**

END OF SUGGESTED SOLUTIONS

SECTION B

Question 1 (6 marks)

a. For HCl, if pH = 1.0, $[H^+] = 10^{-pH} = 10^{-1.0} = 0.10$ M **(1 mark)**
For citric acid, if pH = 1.6, $[H^+] = 10^{-1.6} = 0.025$ M **(1 mark)**

b. HCl is a strong acid **(1 mark)** and is virtually completely ionised. **(1 mark)** Citric acid, although triprotic, is a weak acid **(1 mark)** and only a relatively small proportion of molecules are ionised at any point in time. **(1 mark)**

Question 2 (6 marks)

a. $Ba(OH)_2\,(aq) + H_2SO_4\,(aq) \rightarrow BaSO_4\,(s) + 2H_2O\,(l)$ **(2 marks** – one for correct formulae and one for balance). Deduct one mark if states are not included.

b. Precipitation **(1 mark)**

c. **i.** Conductivity is caused by ions being able to move freely in solution. **(1 mark)**
ii. In the first section, the conductivity drops as the precipitate forms and ions are removed from the solution. **(1 mark)** Eventually, all the barium ions have reacted and the further addition of sulfuric acid simply adds more ions to the solution. **(1 mark)**

Question 3 (2 marks)

a. $H_2O\,(aq) + CH_3COO^-\,(aq) \rightleftharpoons OH^-\,(aq) + CH_3COOH\,(aq)$ **(1 mark)**

b. $H_2O\,(aq) + NH_4^+\,(aq) \rightleftharpoons H_3O^+\,(aq) + NH_3\,(aq)$ **(1 mark)**

Question 4 (4 marks)

a. 2.0 g per 250 mL = 2.0×10^3 mg per 250 mL = 8.0×10^3 mg / L **(1 mark)**

b. % (m/V) = g per 100 mL ∴2.0 g per 250 mL is 0.8 g per 100 mL = 0.80 % (m/V) **(1 mark)**

c. n(NaCl) = m / M = 2.0 / 58.5 = 0.0342 mol **(1 mark)**
C = n / V = 0.0342 / 0.250 = 0.137 M or mol L^{-1} **(1 mark)**

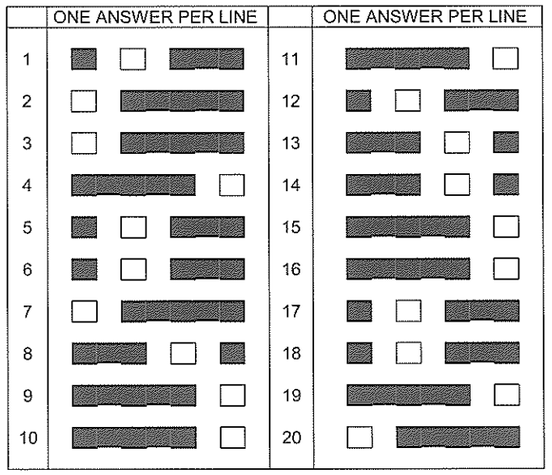
Question 5 (7 marks)

a. $C\,(s) + O_2\,(g) \rightarrow CO_2\,(g)$ **(1 mark)**
$2\,C_8H_{18}\,(l) + 25\,O_2\,(g) \rightarrow 16\,CO_2\,(g) + 18\,H_2O\,(g)$ **(1 mark)**
CO_2 is being trapped by the Earth's atmosphere to create a greenhouse effect. **(1 mark)**

b. **i.** The CO_2 is bubbled into limewater. If the limewater solution turns milky (formation of a white precipitate), the gas is CO_2. **(1 mark)**
ii. $Ca(OH)_2\,(aq) + CO_2\,(g) \rightarrow CaCO_3\,(s) + H_2O\,(l)$ **(1 mark)** (Do not penalise states here.)

c. Dry ice, some fire extinguishers, carbonated drinks etc. **(1 mark for each; maximum of 2)**

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

Comments for Section A answers

Question 1
Flocculation enables small suspended particles to join together so that they can settle and be filtered out. Most of the particles consist of hydroxide precipitates such as $Al(OH)_3$. This requires that the particles must settle and be filtered out. **Correct answer: B**

Question 2
Carbon dioxide is much less acidic than nitrogen dioxide. The other two gases do not have acid/ base properties. **Correct answer: A**

Question 3
Ammonia is the only base in the set – all the others are acidic. **Correct answer: A**

Question 4
$n(CO) / n(O_2) = 2$ therefore 3 mol of CO would require only 1.5 mol of O_2 leaving 0.5 mol of O_2 unreacted. **Correct answer: D**

Question 5
$n(S) = m / M = 8.00 / 32.1 = 0.249$ mol. $n = V / V_m \therefore V = n \times 24.5$ (at SLC) $= 0.249 \times 24.5$ L $= 6.11$ L.
Correct answer: B

Question 6
Chlorine is widely used in keeping water free of micro-organisms. **Correct answer: B**

Question 7
The new $[OH^-] = 0.200 \times 50 / 2000 = 0.0050$ M
$pOH = -\log_{10} [OH^-] = -\log_{10} 0.0050 = 2.3 \therefore pH = 14 - 2.3 = 11.7$ **Correct answer: A**

Question 8
$M(CuSO_4.5H_2O) = 249.6$ g mol^{-1}. $n(CuSO_4.5H_2O) = c \times V = 0.080 \times 1.50 = 0.12$ mol.
$m(CuSO_4.5H_2O) = n \times M = 0.12 \times 249.6 = 30$ g
Correct answer: C

Question 9
32 g of O_2 is one mole of O_2 molecules i.e. 6.0×10^{23} molecules. **Correct answer: D**

Question 10
Each cluster (formula unit) of $FeCl_3$ has 4 ions. 2.0 mol has $2.0 \times 6.02 \times 10^{23}$ clusters. Therefore the number of ions is $4 \times 2.0 \times 6.02 \times 10^{23}$. **Correct answer: D**

Question 11
HPO_4^{2-} ions accept H^+ ions from water to form OH^- ions according to

$H_2O\,(aq) + H_2PO_4^-\,(aq) \rightleftharpoons OH^-\,(aq) + H_3PO_4\,(aq)$

causing the pH to be greater than 7. At 9.5 the solution is basic. **Correct answer: D**

Question 12
$PV = nRT \therefore V = nRT/P$
On the top line, T changes by 673/473 i.e. approx 1.42
On the bottom line, P changes by 400/200 = 2
Overall the volume decreases. **Correct answer: B**
(Could also use $P_1V_1 / T_1 = P_2V_2/T_2$)

Question 13
At high pressure and low temperature, gas particles are less likely to behave independently.
Correct answer: C

Question 14
Zinc is a reductant (zinc atoms lose electrons) and the copper ions (oxidant) are reduced to copper on the surface of the zinc. **Correct answer: C**

Question 15
Refer to the electrochemical series (ES). A spontaneous reaction is predicted if the oxidant is higher in the ES than the reductant. The only combination where this is true is Sn^{2+} (oxidant) / Ni (reductant).
Correct answer: D

Question 16
$Na_2Cr_2O_7$ consists of ions ie. Na+ and $Cr_2O_7^{2-}$
In $Cr_2O_7^{2-}$, if x = oxidation number of chromium, $2x + 7(-2) = -2$ then $2x - 14 = -2$ and $x = +6$.
Correct answer: D

Question 17
$n(CaCO_3) = 10 / 100 = 0.10$ mol; $n(HCl) = 2 \times n(CaCO_3) = 0.20$ mol
$C = n / V \therefore V = n / C = 0.20 \div 2.0 = 0.10$ L $= 100$ mL **Correct answer: B**

Question 18
The HCl virtually completely ionises in aqueous solution to produce ions.
$HCl\,(g) + H_2O\,(l) \rightarrow H_3O^+\,(aq) + Cl^-\,(aq)$. Hence the acid is highly conducting. **Correct answer: B**

Question 19
Conversion of O_3 (g) into O_2 (g) does not involve a change in oxidation numbers. All the other reactions are redox reactions. **Correct answer: D**

Question 20
Reducing agents (reductants) are oxidised. Oxidation involves an increase in oxidation number. In answer A the oxidation number of C in CO is +2 but in CO_2 the oxidation number of C is +4.
Correct answer: A