Name : _____( ) Class:____ Date: _____

All calculations MUST be shown. No mark given if calculations are not shown. All mathematical answers must be in 3 significant figures.

1. Which of the substances listed below fits the description in the boxes provided. Each substance can be used only ONCE.

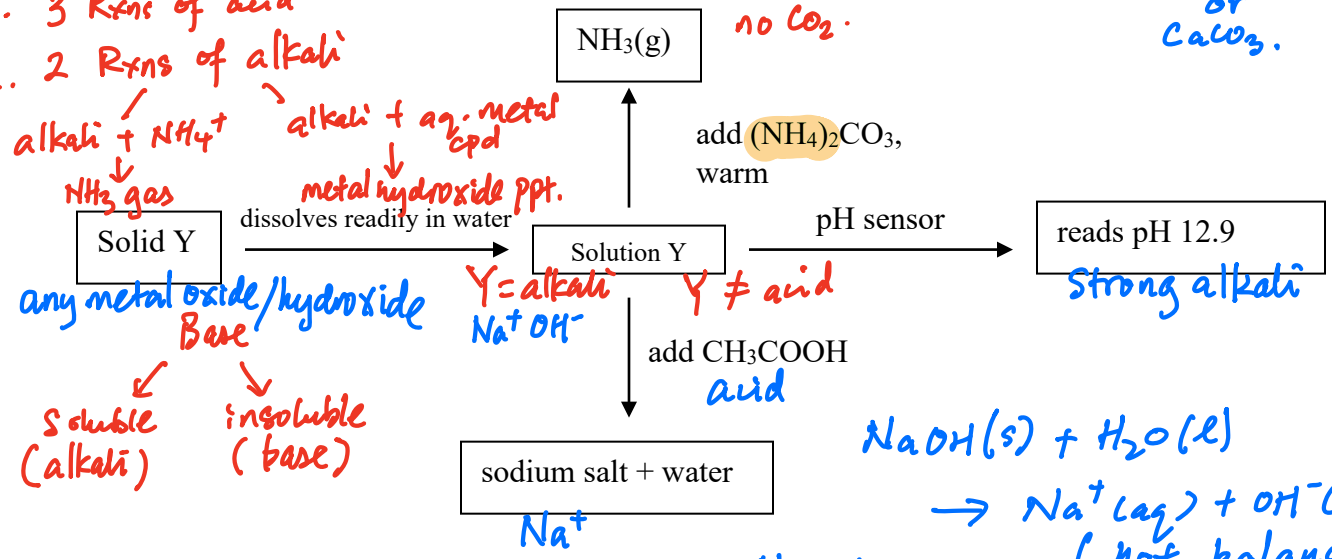
Aqueous ammonia	calcium hydroxide	carbonic acid
hydrogen chloride	sodium oxide	universal indicator

Substance	Description
a. ammonia	has a pH of about 11
b. carbonic acid	has a pH of about 5
c. hydrogen chloride	dissociates almost complete in water
d. sodium oxide	produces OH^- ions when dissolved in water
e. universal indicator	is used to test for acids and alkalis
f. calcium hydroxide	is used by farmers for the treatment of soil

weak base
weakly acid.
to form HCl(aq) strong acid.
HCl(g) - not acidic until water is added
$Na_2O + H_2O \rightarrow 2NaOH$ (strong alkali – pH 12-14)
(excess acidity) use weak base: CaO/Ca(OH)$_2$ or $CaCO_3$.

2. The chart below shows the chemical properties of a substance Y.

1. 3 Rxns of acid
2. 2 Rxns of alkali
alkali + NH_4^+ → NH_3 gas
alkali + aq. metal cpd → metal hydroxide ppt.

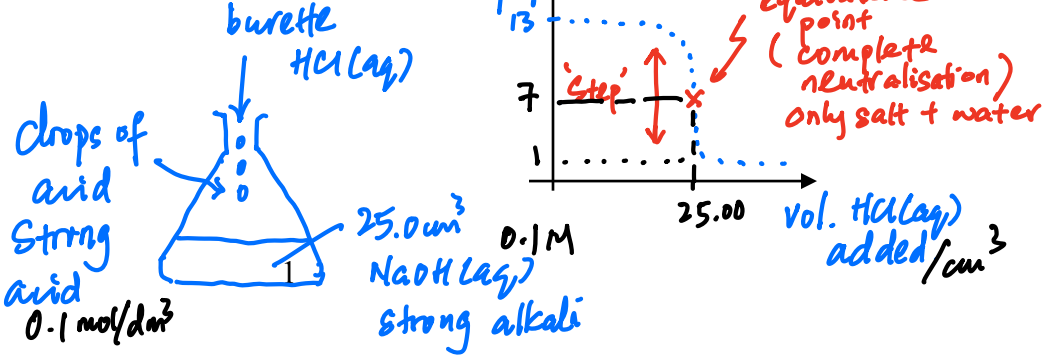


$NaOH(s) + H_2O(l) \rightarrow Na^+(aq) + OH^-(aq)$ (not balanced)

(a) Deduce the identity of substance Y : NaOH (alkaline)

(b) Suggest a test to show the presence of ammonia gas: use moist red litmus paper (turned blue)

(c) Sketch the graph of pH changes over time when dilute hydrochloric acid is slowly added to solution Y. Label the axes.



all nitrates - soluble

3. Dilute nitric acid was added to magnesium carbonate.

Mg^{2+} CO_3^{2-} → Table of solubility. all CO_3^{2-} insoluble except Gp I/NH_4^+

$HNO_3(aq)$ $HCl(aq)$ $H_2SO_4(aq)$

(a) Write the balanced equation (with state symbols).

$$2HNO_3(aq) + MgCO_3(s) \rightarrow Mg(NO_3)_2(aq) + CO_2(g) + H_2O(l)$$

0.025 mol; 0.01 mol; Salt

[1. Effervescence 2. White solid dissolved to form colourless solution 3. Test CO_2 with limewater – white ppt.]

(b) 25.0cm^3 of 1.0M of the acid was added to 0.840g of magnesium carbonate.

(i) Calculate the number of moles of the acid present.

no. of moles acid = 0.025×1.0
$= 0.0250$ mol

(ii) Calculate the number of moles of magnesium carbonate present.

do not use mole ratio yet!

no. of moles $MgCO_3 = \frac{0.840}{24+12+48} = 0.0100$ mol

(iii) Calculate the volume (in dm^3) of carbon dioxide gas given off, at room conditions.

$MgCO_3$ is limiting (all of 0.01 mol used up)

$MgCO_3 : CO_2 = 1 : 1$

no. of moles $CO_2 = 0.0100$ mol

vol. $CO_2 = 0.0100 \times 24 = 0.240$ dm^3 (or 240 cm^3)

(iv) Suggest a chemical test to test for the presence of carbon dioxide gas. Describe the observation you would see.

Bubble CO_2 gas into limewater, (aq. $Ca(OH)_2$ or $Ca(OH)_2$ solution)

white ppt. formed.

[cannot describe as chalky solution!]

4. Write balanced equations (with state symbols) for these reactions:

(a) dilute hydrochloric acid reacts with zinc

all chlorides are soluble except $PbCl_2$, $AgCl$ (white solid)

$$2HCl(aq) + Zn(s) \rightarrow ZnCl_2(aq) + H_2(g)$$

[2]

acid; reactive metal (neutral atom); salt

(b) dilute sulfuric acid reacts with potassium hydroxide

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

[2]

acid; alkali (base)

(c) dilute nitric acid reacts with lead(II) carbonate

$$2HNO_3(aq) + PbCO_3(s) \rightarrow Pb(NO_3)_2(aq) + CO_2(g) + H_2O(l)$$

[2]

white solid; colourless solution

5 polyatomic ions : OH^- NO_3^- CO_3^{2-} SO_4^{2-} NH_4^+

The Periodic Table of Elements

Group I	Group II										Group III	Group IV	Group V	Group VI	Group VII	Group 0
																2 He helium 4
3 Li lithium 7	4 Be beryllium 9										5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24										13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key: proton (atomic) number / atomic symbol / name / relative atomic mass

1 H hydrogen 1

transition metals – form coloured cpd

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

if pH = 1.5, $[H^+] = 10^{-pH} = 10^{-1.5}$

work backwards = 0.0316 mol dm^{-3}

$[H^+] = 0.2\ mol\ dm^{-3}$ $pH = -\log[H^+] = -\log(0.2) = 0.69$

H_2SO_4 - dibasic 0.1 mol/dm³ CH_3COOH - monobasic 0.1M

$[H^+]$ in weak acid = 0.1 × 0.1% = 0.0001 mol dm⁻³

0.1% (1 in 1000 molecules) H^+

$pH = -\log(0.0001) = 4$

5. Dilute sulfuric acid is a strong acid, and ethanoic acid is a weak acid.

(a) Briefly describe the differences in acid strength, using ionization.

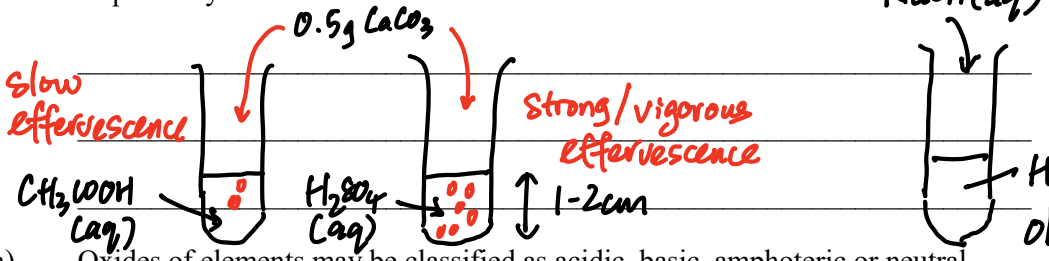
no HA left ← Strong acid dissolves and dissociate completely in water to form high concentration of H^+ ions.

many HA left ← Weak acid dissolves and dissociate partially in water to form low concentration of H^+ ions.

if pH = 3, $[H^+] = 10^{-3} = 0.001\ mol\ dm^{-3}$

(b) The same amount of calcium carbonate was added to 2 test-tubes, both containing equal volumes of 0.1M of sulfuric acid and 0.1M ethanoic acid respectively. Describe the observation in both test-tubes.

in D.A. acids



observation? no effervescence / no visible rxn

6. (a) Oxides of elements may be classified as acidic, basic, amphoteric or neutral. Name one example of each in the boxes provided.

HW - 29 Jul

Nature of Oxide	Chemical Name (List A)	Solubility
a. Neutral	Carbon monoxide	Insoluble
b. Acidic	Carbon dioxide / sulfur dioxide	Sparingly soluble / soluble
c. Basic	Sodium oxide	Soluble
d. Amphoteric	Lead(II) oxide	insoluble

(c) From the examples named in 6(a), suggest which of those substances (in List A) will react with the following reactants. Your substances can be used once, more than once, or not at all.

Reactant	Substance (from List A)
dilute hydrochloric acid	
sodium hydroxide	

HW - 29 Jul

7. Briefly explain the following observations:

(a) When dilute sulfuric acid is neutralized by aqueous sodium hydroxide, the resulting mixture is a very good conductor of electricity.

_____

_____

_____

(b) A solution of hydrogen chloride in methylbenzene does not conduct electricity and does not react with magnesium.

(c) A solution of hydrogen chloride in water conducts electricity and reacts rapidly with magnesium.

not acidic

alcohol (neutral) no H^+ / no OH^- (not alkaline)

✓ tough

8. Ethanol is an organic compound with the formula, CH_3CH_2OH. This compound is soluble in water. It seems to suggest, with the presence of the –OH group and the hydrogen atoms bonded to carbon atoms, and its good solubility, that it can be an acid or an alkali.

H^+ OH^-

(a) Other than using pH sensor or indicators, briefly describe how you can prove that a solution of ethanol is **not** an acid.

add $CaCO_3$ (chalk) - if no effervescence then alcohol is not acidic!

never use taste / touch to test!

(b) Other than using pH sensor or indicators, briefly describe how you can prove that a solution of ethanol is **not** an alkali.

add NH_4Cl (NH_4^+ salt) - no NH_3 gas produced so moist red litmus paper did not turn blue!

--- End ---

Send answers to Telegram:

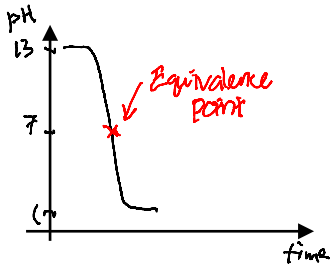
1. 3K - Joshi
2. 3D - Ethan Chin
3. 3G - Sudha

Answers

1.

Substance	Description
a. aqueous ammonia	has a pH of about 11
b. carbonic acid	has a pH of about 5
c. hydrogen chloride	dissociates almost complete in water
d. sodium oxide	produces OH^- ions when dissolved in water
e. universal indicator	is used to test for acids and alkalis
f. calcium hydroxide	is used by farmers for the treatment of soil

2a Sodium Hydroxide
2b Use moist red litmus paper. Turned blue.
2c See graph on right. 1m for shape, 1m for pHs



3. (a) $2HNO_3(aq) + MgCO_3(s) \rightarrow Mg(NO_3)_2(aq) + CO_2(g) + H_2O(l)$

(d) (i) No. of moles acid present = 0.0250 x 1.0 = 0.025mol
(ii) No. of moles carbonate present = 0.84/84 = 0.0100 mol
(iii) Limiting reagent is magnesium carbonate.
Volume of carbon dioxide gas = 0.0100 x 24.0 = 0.240 dm^3
(iv) Bubble CO_2 gas into limewater/calcium hydroxide solution. White ppt. will be formed in colourless solution.

4a. $2HCl(aq) + Zn(s) \rightarrow ZnCl_2(aq) + H_2(g)$
4b $2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$
4c $2HNO_3(aq) + PbCO_3(s) \rightarrow Pb(NO_3)_2(aq) + CO_2(g) + H_2O(l)$

5a Sulfuric acid, when dissolved in water, undergoes complete ionization to produce aqueous H^+ ions. However, ethanoic acid, when dissolved in water, only undergoes partial ionization to produce low concentration of aqueous H^+ ions.

5b Rapid, vigorous effervescence in test-tube containing the strong acid [1], slower effervescence in the other test-tube.

6a

Nature of Oxide	Chemical Name (List A)	Solubility
a. Neutral	Carbon monoxide	Insoluble
b. Acidic	Carbon dioxide	Partially soluble
c. Basic	Sodium oxide	Soluble
d. Amphoteric	Zinc oxide	Insoluble

6b

Reactant	Substance (from List A)
dilute hydrochloric acid	Sodium oxide, zinc oxide
sodium hydroxide	Carbon dioxide, zinc oxide

7a This neutralization reaction produces aqueous sodium sulfate and water. Since sodium sulfate is a soluble salt, it will dissolve to produce aqueous mobile ions, that can act as mobile charge carriers.

7b Hydrogen chloride will not ionize in methylbenzene, thus no aqueous H^+ ions are dissociated. With no aqueous hydrogen ions present, it does not react with magnesium as an acid.

7c Hydrogen chloride will ionize in water, producing aqueous hydrogen ions (mobile charge carriers) that will allow electricity to be conducted. The solution is acidic and it will react with magnesium.

8a Add calcium carbonate (or moderately reactive metal such as Mg). If no effervescence is observed, and no carbon dioxide gas evolved, the ethanol solution is then not acidic.

8b Add any ammonium salt and warm the mixture. If no effervescence observed (no ammonia gas evolved), the ethanol solution is not an alkali.