05 Acids, Bases and Salts

Set B Competition Practice

Name	Time 45 minutes	Total 25 marks	Score ____ / 25

Marks by notes section For the marker: total each row. A score below the target means that section of the notes needs revising.

Notes section	Questions	Marks	Target	Score
1 Acids	1, 2	2	2	
2 Strong and Weak Acids	3, 4	2	2	
3 Bases and Alkalis	5, 6	2	2	
4 The pH Scale and Indicators	7	1	1	
5 Oxides	8, 9	2	2	
6 Theories of Acids and Bases	10, 11, 12, 13, 14, 15	6	4	
7 Salts	16, 17, 18	3	2	
8 Acid–Base Titrations	19, 20, 21, 22, 23, 24, 25	7	5	

A Competition questions

25 MARKS

1 Calcium oxide and magnesium sulfide each react with acid.

$CaO(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l)$
$MgS(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2S(g)$

A mixture of these two compounds, X, reacts with exactly 0.125 mol of dilute hydrochloric acid. The amount of hydrogen sulfide formed is 0.0250 mol. What is the mass of calcium oxide in mixture X?

A 2.1 g **B** 2.8 g **C** 4.2 g **D** 5.6 g

/1

Answer ☐ [1]

2024 CHS O Prelim P1 Q12

2 The mineral dolomite is a double carbonate of magnesium and calcium, $CaMg(CO_3)_2$. When 2.00 g of an impure sample of dolomite was completely dissolved in excess hydrochloric acid, 0.45 g of carbon dioxide was given off. $CaMg(CO_3)_2 + 4HCl \rightarrow MgCl_2 + CaCl_2 + 2CO_2 + 2H_2O$. What is the percentage purity of the sample?

A 22.5% **B** 47.0% **C** 77.5% **D** 94.1%

/1

Answer ☐ [1]

2024 SNGS O Prelim P1 Q11

3 Excess magnesium powder is added to 25 cm^3 of 0.10 mol/dm^3 solutions of three different acids: (1) methanoic acid, HCOOH, a weak monobasic acid, (2) hydrochloric acid and (3) sulfuric acid. Which statement is correct?

A Experiment 1 produced the smallest volume of gas.

B Experiments 1 and 2 produced the same volume of gas.

C Experiments 1 and 2 had the same speed of reaction.

D Experiments 2 and 3 had the same speed of reaction.

/1

Answer [1]

2023 SJI O Prelim P1 Q19

4 The table shows the results of experiments on two acids, K and L, of equal concentration.

	K	L
conductance / mS	400	7.0
temperature change when excess acid reacted with 200 cm^3 of 1.00 mol/dm^3 sodium hydroxide / °C	6.9	6.7
reaction with magnesium	rapid effervescence	gradual effervescence

Which deduction can be made about the two acids?

A Both are strong acids, but per mole K forms fewer hydrogen ions than L.

B Both are strong acids, but per mole L forms fewer hydrogen ions than K.

C K is a strong acid while L is a weak acid.

D K is a weak acid while L is a strong acid.

/1

Answer [1]

2024 Bukit View O Prelim P1 Q21

5 All ammonium salts produce ammonia gas when heated with sodium hydroxide. From which ammonium salt can the greatest mass of ammonia be obtained?

A 1.0 mol $(NH_4)_3PO_4$ **B** 1.0 mol $(NH_4)_2SO_4$ **C** 2.0 mol NH_4Cl **D** 2.0 mol NH_4NO_3

/1

Answer [1]

2024 Zhonghua O Prelim P1 Q31

6 A sodium nitrate solution is prepared by adding 0.10 mol of sodium nitrate, $NaNO_3$, to 2.00 L of water. Which of the following is incorrect?

A There are equal moles of sodium ions and nitrate ions in the solution.

B The concentration of the sodium nitrate solution is 0.05 M.

C The solution is neutral.

D The solution is weakly acidic.

/1

Answer [1]

2023 SJChO P1 Q9

7 Which of the following has the lowest pH?

A baking soda solution **B** gastric juice **C** ammonia solution **D** vinegar

/1

Answer [1]

2023 SJChO P1 Q10

8 Rainfall from unpolluted air should be

A weakly acidic. **B** strongly acidic. **C** neutral. **D** weakly basic.

/1

Answer [1]

2023 SJChO P1 Q41

9 To obtain the magnesium compound in a mineral ore containing impurities of Al_2O_3 and P_4O_{10}, which reagent could be used to dissolve the impurities in the ore?

A dilute NH_3 **B** dilute HCl **C** dilute HNO_3 **D** dilute NaOH

/1

Answer [1]

2024 CJC J2 Prelim P1 Q6

10 Which pair is **not** a Brønsted–Lowry conjugate acid–base pair?

A BH_3 and BH_4^-

B $H_2PO_4^-$ and HPO_4^{2-}

C $HCO_2H_2^+$ and HCO_2H

D NH_4^+ and NH_3

/1

Answer [1]

SJChO Mock 3 P1 Q6

11 Which statement about the ammonium ion, NH_4^+, is incorrect?

A All bond angles are 109°.

B Ammonium ions are formed when ammonia acts as a Lewis base and accepts a lone pair of electrons.

C Ammonium ions can react with NaOH(aq).

D The bonds are all of the same length.

/1

Answer [1]

2018 NYJC J2 MYE P1-P3 Q3

12 In which reactions does NH_3 behave as a Lewis base?

1 $2NH_3 \rightarrow NH_2^- + NH_4^+$
2 $HSO_4^- + NH_3 \rightarrow SO_4^{2-} + NH_4^+$
3 $Ag^+ + 2NH_3 \rightarrow [Ag(NH_3)_2]^+$

A 1 only **B** 1 and 2 **C** 2 and 3 **D** 1, 2 and 3

/1

Answer [1]

2019 NJC J2 Prelim P1 Q12

13 The following reaction takes place in a suitable solvent: $Na^+NH_2^- + NH_4^+Cl^- \rightarrow Na^+Cl^- + 2NH_3$. Which statements explain why this is a Brønsted–Lowry acid–base reaction?

1 NH_2^- is an electron pair acceptor.
2 NH_2^- and NH_3 are a conjugate acid–base pair.
3 The ammonium ion acts as a proton donor.

A 1, 2 and 3 **B** 1 only **C** 2 and 3 **D** 3 only

/1

Answer [1]

2021 TMJC J2 Prelim P1 Q13

14 BF_3 reacts with $(CH_3)_3N$ to give $(CH_3)_3NBF_3$. Which statement is correct?

A $(CH_3)_3NBF_3$ contains hydrogen bonds.

B The B atom in $(CH_3)_3NBF_3$ is not electron deficient.

C $(CH_3)_3N$ is the Lewis acid while BF_3 is the Lewis base.

D N and B atoms in $(CH_3)_3NBF_3$ are trigonal pyramidal and trigonal planar in shape respectively.

/1

Answer [1]

2023 NYJC J2 Prelim P1 Q4

15 Ammonium carbonate is a crystalline solid. On gentle warming a reaction occurs, forming ammonia as one product. How are the carbonate ions behaving during this reaction?

A Brønsted–Lowry acid **B** Brønsted–Lowry base **C** oxidising agent **D** reducing agent

/1

Answer [1]

2024 NJC J2 Prelim P1 Q9

16 A sample of solid magnesium hydroxide is prepared by adding an excess of aqueous sodium hydroxide to an aqueous solution containing 1.20 g of magnesium sulfate. The mass of magnesium hydroxide collected is 0.32 g. What is the percentage yield?

A 26.7% **B** 34.2% **C** 55.2% **D** 73.3%

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Answer [1]

2024 PLMGSS O Prelim P1 Q20

17 10.0 cm^3 of 0.10 mol/dm^3 lead(II) nitrate, $Pb(NO_3)_2$, is added to 30.0 cm^3 of 0.05 mol/dm^3 sodium chloride, NaCl. After the reaction a white precipitate of lead(II) chloride is present. What else is present?

A aqueous lead(II) nitrate only

B aqueous lead(II) nitrate and aqueous sodium nitrate

C aqueous sodium nitrate only

D aqueous sodium chloride and aqueous sodium nitrate

/1

Answer [1]

2024 Serangoon O Prelim P1 Q20

18 Leo accidentally contaminated a sample of pure lead(II) sulfate with a small amount of lead(II) carbonate. Which sequence of steps would help Leo re-obtain pure lead(II) sulfate?

A add excess hydrochloric acid, filter, crystallise, then rinse and dry

B add excess hydrochloric acid, filter, then rinse and dry

C add excess nitric acid, filter, crystallise, then rinse and dry

D add excess nitric acid, filter, then rinse and dry

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Answer [1]

Source: 2023 SJI O Prelim P1 Q2

19 20 cm^3 of an aqueous 1.0 mol/dm^3 solution of the hydroxide of metal X exactly neutralises 40 cm^3 of 0.25 mol/dm^3 dilute sulfuric acid. What is the formula of the sulfate of X?

A XSO_4 **B** $X(SO_4)_2$ **C** X_2SO_4 **D** $X_2(SO_4)_3$

/1

Answer [1]

2024 Dunman O Prelim P1 Q13

20 A sample of lithium oxide, Li_2O, is dissolved in 250 cm^3 of distilled water. 25.0 cm^3 of the solution is neutralised by 30.0 cm^3 of 0.5 mol/dm^3 dilute sulfuric acid. What is the mass of lithium oxide dissolved in the 250 cm^3 of water?

A 0.6 g **B** 4.5 g **C** 9.0 g **D** 18.0 g

/1

Answer [1]

2024 AES O Prelim P1 Q16

21 Dilute sulfuric acid, dilute nitric acid and dilute ethanoic acid were separately titrated with 0.10 mol/dm^3 aqueous sodium hydroxide. The same volume and concentration of each acid was used. In order to react completely,

A all three acids would require the same volume of aqueous sodium hydroxide.

B ethanoic acid and nitric acid would require the same volume of aqueous sodium hydroxide but sulfuric acid would require more.

C nitric acid would require more aqueous sodium hydroxide than ethanoic acid but less than sulfuric acid.

D sulfuric acid and nitric acid would require the same volume of aqueous sodium hydroxide but ethanoic acid would require less.

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Answer [1]

2024 SNGS O Prelim P1 Q12

22 A tablet of aspirin, $C_9H_8O_4$, is crushed and dissolved in water. The acid in the tablet is neutralised by 12.25 cm^3 of 0.147 mol/dm^3 sodium hydroxide: $C_9H_8O_4 + NaOH \rightarrow C_9H_7O_4Na + H_2O$. One grain of aspirin is 0.0648 g. How many grains of aspirin are there in the tablet? [M_r: $C_9H_8O_4$ 180]

A 0.0018 **B** 0.324 **C** 5 **D** 15

/1

Answer [1]

2024 BTYSS FYE O EOY P1 Q12

23 Oxalic acid, $H_2C_2O_4$, is a dibasic acid. 25.0 cm^3 of oxalic acid solution reacts completely with 15.0 cm^3 of 2.50 mol/dm^3 aqueous sodium hydroxide. What is the concentration of the oxalic acid?

A 0.750 mol/dm^3 **B** 2.08 mol/dm^3 **C** 1.50 mol/dm^3 **D** 4.17 mol/dm^3

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Answer [1]

2024 QTSS O Prelim P1 Q11

24 Group 1 and Group 2 ionic hydrides react with water: $H^- + H_2O \rightarrow OH^- + H_2$. In an experiment, 1.01 g of a sample of an ionic hydride is dissolved in excess water. The resulting solution required 24.0 cm^3 of 2.0 mol dm^{-3} HCl for complete neutralisation. What is the formula of the hydride?

A LiH **B** NaH **C** MgH_2 **D** CaH_2

/1

Answer [1]

2023 ACJC J2 Prelim P1 Q6

25 The salt $(C_2H_5)_4N^+Cl^-$ is reacted with hydrogen chloride to form a white solid X, which is dissolved in water to form an acidic solution. 20 cm^3 of this solution required 24.6 cm^3 of 0.1 M NaOH for neutralisation. Another 20 cm^3 of the same solution needed exactly 49.2 cm^3 of 0.1 M aqueous $AgNO_3$ for complete precipitation of AgCl. What is the anion in solid X?

A HCl_3^{2-} **B** $H_2Cl_3^-$ **C** $H_2Cl_5^{3-}$ **D** HCl_2^-

/1

Answer [1]

2023 SJChO P1 Q2

10 The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1.0										2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0		**Key** atomic number atomic symbol name relative atomic mass									5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium –	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium –	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
actinoids	89 Ac actinium –	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	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 –