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MARK SCHEME

GCSE

CHEMISTRY

AQA - TRIPLE SCIENCE

C4 - TEST 6

CHEMICAL CHANGES

Advanced

1.

(a) solid (zinc chloride) does not conduct (electricity)
or
zinc chloride needs to be in solution **or** molten
allow liquid / aqueous

1

(because) ions cannot move in the solid
or
(as) ions can (only) move in liquid / solution
*do **not** accept references to movement of electrons in zinc chloride*

1

(b) each carbon / atom forms 3 (covalent) bonds

1

one electron per carbon / atom is delocalised

1

(so) these electrons carry charge through the graphite
or
(so) these electrons move through the structure
ignore carry current / electricity

1

*if no other mark scored, allow **1** mark for delocalised / free electrons*
allow free electrons for delocalised electrons

(c) use measuring cylinders (instead of test tubes)
allow use burettes
allow use (gas) syringes
allow Hoffmann voltameter

1

(because) test tubes cannot measure volume
or
(because) test tubes have no graduations / scale
allow (so that) volume can be measured

1

(d) any **three** from:

- the volume of hydrogen collected is directly proportional to the time

  allow the (volume of) hydrogen is collected at a constant / steady rate

- the rate of collection of hydrogen is 0.45 (cm^3/min)

- up to 8 minutes chlorine is collected at an increasing rate

  allow any value from 6 to 8 minutes

  allow initially chlorine is collected at an increasing rate

- after 8 minutes the rate of collection of chlorine is the same as that of hydrogen

  allow any value from 6 to 8 minutes

  or

  after 8 minutes the rate of collection of chlorine is 0.45 (cm^3/min)

  allow after 8 minutes the (volume of) chlorine is collected at a constant / steady rate

  *if neither bullet point 3 nor bullet point 4 is awarded allow **1** mark for chlorine is collected slowly up to 8 minutes and then more quickly*

  allow any value from 6 to 8 minutes

3

(e) chlorine reacts with water

or

chlorine dissolves (in the solution).

1

(f) $(\text{volume} =) \frac{6.6}{1000}\ (\text{dm}^3)$

or 0.0066 (dm^3)

allow 6.5 (cm^3) for 6.6 (cm^3)

1

$(\text{moles} =) \frac{0.0066}{24}$

allow use of incorrect volume from step 1

1

= 2.75×10^{-4} (mol)

allow 2.8×10^{-4} (mol)

allow answer from incorrect calculation given in standard form

alternative approach for marking points 1 and 2

24 dm^3 = 24 000 cm^3 (1)

$(\text{moles} =) \frac{6.6}{24\,000}$ (1)

1

*an answer of 2.75×10^{-4} (mol) or 2.8×10^{-4} (mol) scores **3** marks*

*an answer of 0.000275 / 0.00028 / 2.75×10^{-1} / 2.8×10^{-1} (mol) / scores **2** marks*

*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[10]

2. (a) chlorine is toxic

allow carbon monoxide is toxic

allow poisonous for toxic
ignore harmful / deadly / dangerous

allow a poisonous gas is used / produced

allow titanium chloride is corrosive

1

(b) any **one** from:

- very exothermic reaction

  allow explosive
  allow violent reaction
  ignore vigorous reaction
  ignore sodium is very reactive

- produces a corrosive solution

  allow caustic for corrosive
  ignore alkaline

- produces hydrogen, which is explosive / flammable

  allow flames produced
  ignore sodium burns

1

(c) argon is unreactive / inert

allow argon will not react (with reactants / products / elements)

1

oxygen (from air) would react with sodium / titanium
or
water vapour (from air) would react with sodium / titanium

allow elements / reactants / products for sodium / titanium

1

(d) metal chlorides are usually ionic

allow titanium chloride is ionic

1

(so)(metal chlorides) are solid at room temperature
or
(so)(metal chlorides) have high melting points

allow titanium chloride for metal chlorides

1

(because) they have strong (electrostatic) forces between the ions

ignore strong ionic bonds

or
(but) must be a small molecule or covalent

allow molecular

1

allow alternative approach:

*titanium chloride must be covalent **or** has small molecules (1)*

with weak forces between molecules
*do **not** accept bonds unless intermolecular bonds(1)*

(but) metal chlorides are usually ionic (1)

(e) sodium (atoms) lose electrons

*do **not** accept references to oxygen*

1

(f) $Na \longrightarrow Na^+ + e^-$

*do **not** accept e for e^-*

1

(g) (M_r of $TiCl_4$ =) 190

$$(\text{moles Na} = \frac{20\,000}{23} =) \ 870 \text{ (mol)} *$$

1

$$(\text{moles } TiCl_4 = \frac{40\,000}{190} =) \ 211 \text{ (mol)} *$$

1

allow **1 mark for 0.870 mol Na **and** 0.211 mol $TiCl_4$*

allow use of incorrectly calculated M_r from step 1

either

(sodium is in excess because) 870 mol Na is more than the 844 mol needed

or

(because) 211 mol $TiCl_4$ is less than the 217.5 mol needed

the mark is for correct application of the factor of 4

other correct reasoning showing, with values of moles or mass, an excess of sodium or insufficient $TiCl_4$ is acceptable

allow use of incorrect number of moles from steps 2 and / or 3

1

alternative approaches:

approach 1:

(M_r of $TiCl_4$ =) 190(1)

(40 kg $TiCl_r$ needs)

$$\frac{40}{190} \times 4 \times 23 \text{ (kg Na) (1)}$$

(=) 19.4 (kg) (1)

so 20 kg is an excess (1)

approach 2:

(M_r of $TiCl_4$ =) 190(1)

(20 kg Na needs)

$$\frac{20}{4 \times 23} \times 190 \text{ (kg } TiCl_4\text{) (1)}$$

(=) 41.3 (kg) (1)

so 40 kg is not enough (1)

(h) $(\text{actual mass} =) \frac{92.3}{100} \times 13.5$

or

(actual mass =) 0.923 × 13.5

1

= 12.5 (kg)

allow 12 / 12.46 / 12.461 / 12.4605 (kg)

1

*an answer 12.5 (kg) scores **2** marks*

[15]

3. (a) (strong because) completely ionised (in aqueous solution)

ignore pH

allow dissociated for ionised

*do **not** accept hydrogen is ionising*

*do **not** accept H^+ are ionised*

1

(dilute because) small amount of acid per unit volume

ignore low concentration

1

(b) 5.0

allow 5

1

(c) (titre):
chooses titrations 3, 4, 5

1

average titre = 22.13 (cm^3)

allow average titre = 22.13(3…) (cm^3)
allow a correctly calculated average from an incorrect choice of titrations

1

(calculation):
(moles NaOH =
$\frac{22.13}{1000} \times 0.105 = 0.002324$)

allow use of incorrect average titre from step 2

1

(moles H_2SO_4 =
½ × 0.002324 =) 0.001162

allow use of incorrect number of moles from step 3

1

(concentration =
$\frac{0.001162}{25} \times 1000$)

= 0.0465 (mol/dm^3)

allow use of incorrect number of moles from step 4

1

alternative approach for step 3, step 4 and step 5

$\frac{2}{1} = \frac{22.13 \times 0.105}{25.0 \times conc.\ H_2SO_4}$ *(1)*

(concentration H_2SO_4 =)

$\frac{22.13 \times 0.105}{25.0 \times 2}$

= 0.0465 (mol/dm^3) (1)

an answer of 0.046473 ***or*** *0.04648 correctly rounded to at least 2 sig figs scores marking points 3, 4 and 5*

an answer of 0.092946 ***or*** *0.09296* ***or*** *0.185892* ***or*** *0.18592 correctly rounded to at least 2 sig figs scores marking points 3 and 5*

an incorrect answer for one step does ***not*** *prevent allocation of marks for subsequent steps*

(d) pipette measures a fixed volume (accurately)

1

(but) burette measures variable volume

allow can measure drop by drop

1

(e) $(\text{moles} =) \frac{30}{1000} \times 0.105$

or 0.00315 (mol)

or

(mass per dm^3 =) 0.105 × 40

or 4.2 (g)

1

$(\text{mass} = \frac{30}{1000} \times 0.105 \times 40)$

= 0.126 (g)

1

*an answer of 0.126 (g) scores **2** marks*

*an answer of 126(g) scores **1** mark*

*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[12]

4. (a) produces H^+ / hydrogen ions in aqueous solution

1

(but is) only partially / slightly ionised

1

(b) indicator changes colour

1

from blue to yellow

allow from blue to green

1

(when) the acid and alkali are (exactly) neutralised

or

(when) no excess of either acid or alkali

1

(c) pipette measures one fixed volume (accurately)

1

(but) burette measures variable volumes (accurately)

1

(d) $\frac{12.10 + 12.15 + 12.15}{3}$

1

(mean titre =) 12.13(3) (cm^3)

1

(moles NaOH = conc × vol) = 0.00255

1

(moles citric acid = $\frac{1}{3}$ moles NaOH) = 0.00085

1

(conc acid = moles / vol) = 0.0701 (mol / dm^3)

allow ecf from steps 1, 2, 3 and / or 4

*allow an answer of 0.0701 (mol / dm^3) without working for **1** mark only*

1

[12]

5. (a) (delivery) tube sticks into the acid

1

the acid would go into the water **or** the acid would leave the flask or go up the delivery tube

ignore no gas collected

1

(b) any **one** from:

- bung not put in firmly / properly
- gas lost before bung put in
- leak from tube

1

(c) all of the acid has reacted

1

(d) take more readings in range 0.34 g to 0.54 g

1

take more readings is insufficient

ignore repeat

(e) $\frac{95}{24000}$

1

0.00396

or

3.96×10^{-3}

1

*accept 0.00396 or 3.96 × 10^{-3} with no working shown for **2** marks*

(f) use a pipette / burette to measure the acid

1

because it is more accurate volume than a measuring cylinder
or
greater precision than a measuring cylinder
or
use a gas syringe to collect the gas

so it will not dissolve in water

or
use a flask with a divider
accept description of tube suspended inside flask

so no gas escapes when bung removed

1

(g) they should be collected because carbon dioxide is left in flask at end

1

and it has the same volume as the air collected / displaced

1

[11]

6. (a) Gas A = Chlorine / Cl_2 <u>not</u> Cl <u>and</u> Gas B = Hydrogen / H_2 <u>not</u> H
for 1 mark

Solution C = sodium hydroxide/NaOH/spent brine
for 1 mark

2

(b) (i) 2, 2
for 1 mark

(ii) 2, 2
for 1 mark

2

(c) water/H_2O/hydrogen oxide <u>not</u> hydrogen hydroxide
for 1 mark

1

(d) ions/positive ions/negative ions/cations/anions
<u>not</u> charged particles/positive particles/negative particles
<u>not</u> H^+ / Cl^-/Na^+ / OH^-
<u>Allow</u> hydrogen <u>ions</u> etc.
<u>not</u> sulphate ions
for 1 mark

1

[6]

7. (a) sodium hydroxide / caustic soda / NAOH

for 1 mark

1

(b) negative ions move to the positive electrode etc.
/because it is negative
/opposite charges attract

for 1 mark

1

(c) loss of electrons

for 1 mark

1

[3]

8. (a) unreactive / near bottom of reactivity series

1

(b) carbon more reactive / higher up reactivity series

1

(c) very reactive / near top of reactivity series

1

cannot use displacement methods / can only be extracted by electrolysis / had to wait discovery of electricity

1

[4]

9. (i) hydrogen, hydroxide and sulphate

*all **three** and no others*

any order

do not credit any formula(e)

1

(ii) the anode is positive

1

(so) only the negative ions are attracted to it

***or** (so) only the hydroxide ions and the sulphate ions are attracted (to it)*

***or** (so) only the anions are attracted (to it)*

1

(iii) $2H_2O + O_2 + 4e^-$

1

[4]

10. (a) $\underline{2}Cl^- - \underline{2}e^- \rightarrow Cl_2$ (allow unaltered LHS to produce $\underline{1/2}\ Cl_2$)
$Na^+ + \underline{e^-} \rightarrow Na$ (allow × 2 for **all** terms)

(*credit* candidates who point out that hydrogen / H_2 is in fact produced)

for 1 mark each

2

(b) for product 1*, *idea of* a solid / precipitate **or** silver bromide

gains 1 mark

but solid / a precipitate of silver bromide

gains 2 marks

for product 2*, *idea of* aqueous / a solution / dissolved (in water) / **or** sodium nitrate

gains 1 mark
(do not allow liquid)

but aqueous / a solution / dissolved (in water) of sodium nitrate

(*do not credit formulae)

gains 2 marks

4

[6]