REVISION QUESTIONS. IONIC THEORY AND ELECTROLYSIS

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FORM 4 PACKAGES

CHEMISTRY

1. Identify the letter correct answer from the alternatives provided.

i) One of the following is not an electrolyte:-

A) A very concentrated sulphuric acid

B) Molten aluminium oxide

C) Copper sulphate solution.

D) Sodium chloride solution.

ii) Ionic compounds are electrolyte but when they are in solid state they can not conduct electricity because ____

A) Thy do not contain charged particles.

B) They contain charged particles.

C) Ions are not free to move

D) There is free movement of ions.

iii) Any substance which found in molten state and can allow electricity to pass through is called

A) Electrolyte

B) Conductor

C) Insulator

D) Electric wire.

iv) Positively and negatively charged particles are called

A) Electrodes

B) Cations

C) Cathodes

D) Ions

v) _____is elecrolytic unit of charge.

A) Current

B) Faraday

C) Coulumb

D) Ampere

vi) During electrolysis _____ and ___ ions are discharged when dilute sodium chloride solution used as an electrolyte and platinum electrodes.

A) Cl and Na

B) O and OH

C) H and OH

D) H and Cl

vii) An electric current was passed through concentrated solution of hydrochloric acid using carbon electrodes. The substance liberated at anode was.

A) Copper

B) Sodium

C) Hydrogen

D) Chlorine

viii) Amount of charge carried by one mole of electrons.

A) Faraday

B) 96500

C) Current

D) Ions

ix) Relates the quantity of electricity passed and amount of substance liberated or deposited at the electrodes.

A) Laws of electrolysis

B) Faraday's constant

C) Electrochemical series

D) Relative molar mass

x) Migrates to positively charged electrode.

A) Copper

B) Sodium

C) Cation

D) Anion.

2. Match items in list A and items in list B.

LIST A.

i) Electrodes

ii) Conductor

iii) Electrolyte

iv) Insulator

v) Anode

vi) Cathode

vii) Weak electrolyte

viii) Strong electrolytes

ix) Cation

x) Anion

LIST B.

A: Moves in molten state.

B: Slightly ionised in aqueous solution.

C: Do not allow electricity to pass through.

D: Allows electricity to pass through when it is in molten state.

E: Electricity enter or leave electrolytes through them.

F: Only current pass through them

G: Mineral acids and salts

H: Positively charged element.

I: Negatively charged element.

J: Solid substance that allow electricity to pass through.

K: Negatively charged electrode.

L: Positively charged electrode.

M: Ethanol and water.

N: Migration of ions.

3. Write true for correct statement and false for incorrect statement.

i) Ethanol is a weak electrolyte.

ii) Non-electrolytes exist in form of molecules and do not ionize.

iii) When structure of an electrolyte destroyed ions become free to move.

iv) During electrolysis cations attracted to anode because they are negatively charged.

v) Discharge means losing property of being charged.

vi) During electrolysis chemical reactions produced at electrodes

vii) Concentration of electrolyte is among of factors for the ion to be discharged during electrolysis.

viii) Sodium chloride is a strong electrolyte.

ix) Mass liberated by one Coulomb during electrolysis refers to molar mass.

x) Electrolysis applied in crop production

4. Define the following terms:-

a) Electrodes

b) Electrolyte

c) Electrolysis

d) Anode

e) Cathode

5. Explain how ions migrate during electrolysis when an electricity is passing through copper two sulphate solution.

6. State the meaning of the following words in electrolysis.

a) Weak electrolyte

b) Conductor

c) Cation

d) Strong electrolyte

e) Anion.

f) Non- electrolyte.

g) Electrochemical equivalent.

h) Electroplating.

7. Explain reasons for

a) Sugar.

b) A very concentrated sulphuric acid.

to be incapable to conduct electricity while water can conduct.

8. Calculate number of electrons of Aluminium used to deposit 1mole of of Al during electrolysis when molten Aluminium oxide used as electrolyte and 3 Faradays were needed to deposit one mole of Aluminium .

9. State Faraday's laws of electrolysis.

10. A steady current of 2A passed through a solution containing ions of divalent metal M (M^{2+})for nine minutes. The mass of metal M liberated was 0.3552g. calculate relative atomic mass of metal M.

11. Write chemical equations for discharging process at cathode and anode when dilute sulphuric acid is electrolysed using platinum electrodes.

12. A bluish copper(ii) sulphate aqueous solution was electrolysed by copper electrodes.

(a) Write ionic equations for the reactions.

(b) Explain what will happen for blue colour of copper(ii) sulphate as electrolysis continue when carbon electrodes used.

13. A solution of sodium hydroxide was electrolysed using platinum electrodes and the solution became alkaline.

(i) write reactions that took place at electrodes.

(ii) explain why the solution remains alkaline.

14.A current of 0.5A were made to flow through silver voltameter for 30 minutes.

Calculate the mass of silver deposited and its equivalent weight.

15. 298500 coulumbs were required to deposit one mole of metalic element Q from its aqueous salt solution. Calculate the valence of Q.

16. Current of 5A passed through molten aluminium chloride for 3.5 hours, what number of coulumbs will be?

17. What mass of copper will be liberated during electrolysis of copper sulphate solution by charge of one faraday.

18. A sample of impure silver with a mass of 3.45g was used as anode during electrolysis purifying process. The cathode of pure gold with mass 6.45g used. After electrolysis the cathode found to have 9.66g.

(i) calculate number of coulumbs passed

(ii) what is percentage purity of the impure silver?

19. An element X has a relative atomic mass of 88, when a current of 0.5A was passed through the fused chloride of X for 32 minutes and 10 seconds 0.44g was deposited at cathode.

(i) Calculate the number of faradays needed to liberate 1 mole of X.

(ii) Write formula for X ion.

(iii) write formula for chloride ion.

20. Name ions that move to:-

a) Anode

b) Cathode

during electrolysis.

21. A solution of 1M copper (ii) chloride was electrolysed using graphite electrodes.

Write the reactions took place at

(a) cathode

(b) anode.

22. Differentiate chemical equivalent from electrochemical equivalent.

23. A current of 10000 A is passing through an electrolytic cell for 12 hours in order to purify copper.

(a) What mass of pure copper is deposited at cathode?

(b) Calculate mass of aluminium that would be deposited if the cell was changed to refine aluminium.

24. 0.02 moles of electrons were passed through a solution of sodium hydroxide using platinum electrodes.

(i) state gases produced

(ii) Calculate number of mole of each gas and volume of each gas at S.T.P

25. A light bulb uses a current of 0.6A how many Faraday will be used by light by each hour?

26. State the meaning of the following terms in electrolysis.

(a) Oxidation

(b) Reduction

(c) Coulumb

(d) Reducing agent

(e) Oxidizing agent

27. What are the differences between anode and cathode.

28. Electric current was passed through a solution of sodium hydroxide using platinum electrodes, draw a labelled electrolytic cell for this electrolysis. indicate the directions of movement of ions.

SOLUTIONS.

1. i) A ii) C iii) A iv) D v) C

vi) C vii) D viii) B ix) A x) D

2. i) E ii) J iii) D iv) C v) L

vi) K vii) B viii) G ix) H x) I

3. i) False vi)True

ii) True vii)True

iii) True viii)True

iv) False ix)False

v) True x) False

4. a) Electrodes:- are metal rods or plates through which electric current enter or leave the electrolytes.

b)Electrolyte:- is a substance that when it is in solution form or molten state conducts electricity.

c) Electrolysis:- defined as decomposition of the compound which is in solution or molten state by passing electricity through it.

d) Anode:- is a positively electrode which leads electrons out of the electrolyte.

e) Cathode:- is a negatively electrode which leads electrons into the electrolyte.

5. Copper (ii) solution as electrolyte it contain the following ions:-

Copper ions(Cu 2+)

Hydrogen ions(H+)

Sulphate ions(So4 2+) and

Hydroxide ions(-OH).

During electrolysis, Sulphate ions(So4 2+) and Hydroxide ions(-OH) Move to positively electrode or anode.

Copper ions(Cu 2+) and Hydrogen ions(+H) move to negatively electrode or cathode.

6. a) Weak electrolyte:- is an electrolytic compound that ionizes partially in aqueous solution.

b) Conductor:- is any solid substance which allows electricity.

b) Cation:- is a positively charged ion.

c) Strong electrolyte:- is an electrolytic compound that ionizes completely in aqueous solution.

d) Anion:- is a negatively charged ion.

e) Electrochemical equivalent:- is the mass of one element liberated by one coulomb of electricity during electricity.

f) Non- electrolyte :- is the compound which does not conduct electricity in solution or molten state.

g) Electroplating:- refers to the coating of metal with a layer of another metal by means of electrolysis.

7. a) An electrolytic compound conducts electricity due to presence of free ions when it is in solution or molten state but sugar solution contains only molecules not ions that is why it does not conduct electricity.

b) A very concentrated mineral acids contain only molecules of acids not ions. When become diluted, their molecular structure destroyed and ions formed.

There fore a very concentrated sulphuric acid contains molecules not ions, this is reason for it to be not able to conduct electricity.

8. Solution.

Electrolytic reaction indicates that Aluminium ions discharged and deposited at cathode.

$Al^{3+} + 3e^- \longrightarrow Al$.

there fore:-

3 moles(Faradays) of electrons needed 1 mole of Aluminium atom to be deposited.

3 electrons used.

Number of electrons = number of moles of aluminium x Avogadro's constant.

$N = nLAo$ where by

N=number of electrons

n=number of moles = 3

LAo=Avogadro's constant=6.02×10^{23}

N = 3 x 6.02 x 10^23.

The number of electrons of Aluminium=18.06 x10^23

9. There are two faraday's laws of electrolysis which are:-

a) Faraday's first law of electrolysis and

b) Faraday's second law of electrolysis

a) Faraday's first law of electrolysis states that " The mass of substance producedc or dissolved at the electrode during electrolysis is proportional to the moles of quantity of electricity transferred at the electrode".

b) Faraday's second law of electrolysis states that " when the same quantity of electricity is passed through the solutions of different electrolytes, the mass of the substances liberated or deposited at the electrodes is directly proportional to their chemical equivalents".

10. Solution

Data given: mass liberated=0.3552g

Current = 2 A

R.A.M = required

Time=9 min=540 sec.

Mass=ZIt Z=equivalent weight

I=current

t= time

Z=R.A.M/charge(coulumbs)

There fore:-

Mass=(R.A.M/ charge) It.

Then. R.A.M=Mass x charge/It.

Since 2Faradays required 1 mole of metal M to be liberated.

And 1mole (faraday)=96500 coulumb(charge)

96500 is faraday's constant.

Charge = number of Faradays x Faraday's constant

Number of Faraday = 2

Faraday's constant = 96500 coulumbs

R.A.M=0.3552 x 2 x 96500/2 x 540

=63.5

Relative atomic mass of metal M =63.5

11. Dilute sulphuric acid as electrolyte contains the following ions:-

H+ from water and sulphuric acid

OH- from water and

So4 2- from sulphuric acid

During electrolysis H+ migrate to cathode where by OH- and So4 2- migrate to anode.

Reaction at cathode

Hydrogen ions(H+) discharged to form hydrogen gas

Chemical equation is

$2H^+(aq) + 2e^- \longrightarrow H_2(g)$.

Reaction at anode

Hydroxide ions(OH^-) discharged in preference to sulphate ions(SO_4^{2-}) because hydroxide ions have greater tendency of losing electrons than sulphate ions. Oxygen formed and collected as gas

Chemical equation is

$4OH^-(aq) \longrightarrow 2H_2O(l) + O_2(g)$.

12. (a) Reaction at cathode

Copper ions discharged in preference to hydrogen ions and deposited as brown coat at electrode.

$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$.

Reaction at anode

Neither copper ions nor hydroxide ions discharged but copper anode dissolves to form copper ions.

$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$

NB.

The mass of cathode increases while that of anode decreases.

(b) Fading of blue colour of copper ions takes place due to decrease of copper ions, finally the colourless solution of dilute sulphuric acid obtained after all copper ions being discharged.

13. i) The ions present in dilute sodium hydroxide are:-

Na+ from NaOH

H+ from water

OH- from water and Na OH.

At cathode

Hydrogen ions discharged in preference to sodium ions. Hydrogen gas formed

$2H^+(aq) + 2e^- \longrightarrow H_2(g)$

At anode

Hydroxide ions discharged. Water and oxygen formed.

$4OH(aq), \longrightarrow 2H_2O(aq) + O_2(g)$.

ii) The solution remains alkaline because sodium ions reacts with hydroxide ions from water molecules formed during reaction which takes place at anode.

14. Solution.

Given data

Current = 0.5 A

Time=30 min.=1800 seconds

Mass = required

From

Mass=zIt

Where by z= electrochemical equivalent

I= current

t= time in seconds

First we have to find value of z

From

z= R.A.M/ charge

R.A.M of silver = 108

Reaction at cathode shows that

1Faraday required to deposit 1 mole

$Ag^+ + e^- \longrightarrow Ag$

Charge = number of Faraday x Faraday's constant

Charge=1F x 96500

= 96500 coulumbs

Z=108/96500

=0.00112

mass=0.00112 x 0.5

=1.007g

1.007g of silver deposited.

Equivalent weight (z) =R.A.M/Charge

where by R.A.T = 108

Charge=No. Faradays x F. Constant

= 1 x 96500

= 96500 coulumbs

Z=108/96500

=0.001119~ 1.119 x 10^-3.

15. solution

Given data

Charge=298500 coulumbs

1 Faraday(mole/electron)=96500 coulumbs

1F -------> 96500 coulumbs

? <-------- 298500 coulumbs.

? =298500/96500

=3.093 ~ 3

There fore:-

3Faradays were required to deposit 1 mole of metalic element Q.

NB:

-If 1F required to deposit 1 mole of metalic element(that metal is monovalent)

-If 2F used to deposit 1 mole of metalic element(that is divalent element)

Element Q is trivalent because its 3 Faradays were required to deposit one mole.

Q3+(aq) + 3e- -----> Q(s)

Its valence is 3

16. Solution

Given data.

Current= 5A

Time=3.5 hours

But time must be changed into seconds

3.5 x 60 x 60= 12600 seconds

Coulumbs = It

Q = It

Where by I= current

t= time in seconds.

Q= 5 x 12600

= 63000 coulumbs.

17. Solution

Given data.

Number of faradays = 1

Mass. = required

Copper ions discharged and its mass discharged at cathode.

$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$

In this reaction

2Faredays required to deposit 1 mole of copper.

2F ----------->63.5g

1F ----------> ?

=31.75g(answer)

18. Solution

(i) Given data

Mass of impure silver = 3.45g Mass of cathode after electrolysis=9.66g

Mass of cathode(gold) before electrolysis = 6.45g

Number of coulumbs = required.

During electrolysis the following reaction takes place at cathode.

$Ag^+(aq) + e^- \longrightarrow Ag(s)$.

It means 1 Faraday required to deposit 1 mole of silver.

Atomic mass of silver = 108g

Mass of silver deposited = 9.66g - 6.45g

= 3.21g

1F = 108g

? = 3.21g

?= 0.0297 Faradays

No. of coulumbs=No. F x F.constant

= 0.0297 x 96500

= 2868.19 coulumbs

(ii)%purity=M.of pure/M.of ipure x 100

Mass of pure silver = 9.66g - 6.45g

Mass of impure silver = 3.45g

%purity = 3.21/3.45 x 100

= 93.4%

19. (i) Solution.

Given data

R.A.M = 88

Mass = 0.44g

Time = 32 min + 10 seconds = 1930 sec.

From

Mass = zIt

Z. = mass/It = 0.44/ 0.5x 1930

= 0.000456

Z. = R.A.M/coulumbs(No. Of Faradays x Faraday's constant)

Z. = R.A.M/ No. Of F x Faraday's constant

No. Faradays = R.A.M/Z x Faraday's constant.

= 88/0.000456 x 96500

= 2

2 Faradays were required to liberate 1 mole of of X.

(ii) since 2 Faradays were required to liberate one mole of X

Number of Faraday can represent number of electrons or moles.

X2+ + 2e- --------> X

The formula for X ion is X2+.

(iii) Chlorine ionizes by gaining one electron

Its ionic formula is Cl-

20. (a) Cations

(b) Anions

21. Since the solution is dilute, preferential discharge determined by position in electrochemical series.

At cathode.

Hydrogen ions discharged in preference to copper ions

$2H^+(aq) + 2e^- \longrightarrow H_2(g)$

At anode.

Hydroxide ions discharged in preference to chlorine ions.

$4OH^-(aq) \longrightarrow 2H_2O(l) + O_2(g)$

22. Electrochemical equivalent is the mas of of an element liberated by one coulumb of electricity during electrolysis.

While

Chemical equivalent is the mass of an element deposited or liberated by one Faraday during electrolysis.

23. Solution.

(a) Given data

Current = 10000A

Time = 12hr = 12 x 60 x 60 sec.

= 43200 seconds.

Mass. = zIt

Z= R.A.M/No. of Faradays x F.constant

During electrolysis.

2F required to deposit 1mole of copper

z=63.5/2 x 96500

= 0.000329

Mass= 0.000329 x 10000 x 43200

=142128g(answer)

(b) Data given

Mass of copper=142128g

Mass of aluminium= required

From

E1/E2 = M1/M2

Where by E = chemical equivalent

M= mass

Let E1 be chemical equivalent of copper

E2 be chemical equivalent of aluminium

E = R.A.M/ No. Of faradays.

E1= 63.5/2

= 31.75

E2= 27/3

= 9

31.75/9 = 142128/ mass of Al

31.75 mass of Al=9 x 142128

mass of Al = 1279152/31.75

= 40288.252g(answer)

24. (i) Ions discharge determined by position of element in electrochemical series because sodium hydroxide solution is dilute.

At cathode.

Hydrogen ions discharged in preference to sodium ions.

$2H^+(aq) + 2e^- \longrightarrow H_2(g)$

At anode.

Hydroxide ions discharged and are only anions which found in the solution.

$4OH^-(aq) \longrightarrow 2H_2O(l) + O_2(g)$

Gases produced are hydrogen and oxygen.

(ii) volume of hydrogen gas at s.t.p

Hydrogen produced at cathode.

$2H^+(aq) + 2e^- \longrightarrow H_2(g)$

It means 2 moles used to produce 1mole of hydrogen gas.

1mole = 22.4 litres according molar volume of gases at s.t.p

2moles(F)= 22.4L

0.02moles(F)= ?

?=0.224 L

Volume of hydrogen gas at s.t.p=0.224L.

Oxygen gas produced at anode

$4OH^-(aq) \longrightarrow 2H_2O(l) + O_2(g)$.

4moles -------> 22.4L

0.02moles -----> ?

Volume of oxygen at s.t.p =0.112 L.

25. Solution.

Given data

Current = 0.6A

Time= 1hour = 60 minutes

In order to calculate number of faradays, quantity of charge (coulumbs)must be obtained.

Coulumbs(charge) = It

But time must be in seconds = 60 x 60

= 3600 seconds

Coulumbs = 0.6 x 3600

= 2160 plumb's

1 F = 96500

? = 2160

= 0.0224 F

28. Anode. Cathode

-electrons leave ele -electrons enter ele

ctrolyte through it. ctrolyte.

-it is positively cha - it is negatively cha

arged. arged.

-it attracts anions. - it attracts cations.

29. NaOH electrolyte contains, sodium ions(Na+), hydrogen ions (H+) and hydroxide ions, when electricity allowed to pass through it hydrogen and sodium ions move to cathode where by hydroxide ions move to anode.