

Numerical Problems.

- 1) In a cell containing Zn/Zn^{2+} and Sn^{2+}/Sn couples,
 - a) What is the cell potential if the $[\text{Zn}^{2+}] = 3.0 \text{ M}$ and $[\text{Sn}^{2+}] = 2 \times 10^{-5} \text{ M}$ at 298 K.
 - b) Calculate the ΔG and ΔG° for the reduction of 1.0 M of Sn^{2+} by Zn.
[Given $E^\circ_{\text{cell}} = 0.62 \text{ V}$]
- 2) The standard reduction potentials of Zn/Zn^{2+} and Ag^+/Ag electrodes are -0.76 and 0.80 V respectively. Construct a galvanic cell using these electrodes so that its standard emf is positive. What concentration of Ag^+ will result the 0 emf for the cell at 25°C if $[\text{Zn}^{2+}] = 0.02 \text{ M}$.
- 3) A cell is formed by dipping Zn rod in 0.05 M Zn^{2+} solution and Cu rod in 0.15 M Cu^{2+} solution. The standard electrode potential of Zn and Cu are -0.76 V and 0.34 V respectively. Write the cell representation, cell reaction and calculate the emf of the cell.
- 4) Calculate the valency of copper ions with the help of the following cell:
 $\text{Cu}|\text{CuSO}_4 (0.005 \text{ M}) \parallel \text{CuSO}_4|\text{Cu} (0.05 \text{ M})$, when the emf is 0.029 V.
- 5) The emf of the cell, $\text{Ag}|\text{AgNO}_3 (0.02 \text{ M}) \parallel \text{AgNO}_3 (x \text{ M})|\text{Ag}$ is 0.0764 V at 25° C. Find the concentration x.

Fill in the blank

- 1) The potential of standard hydrogen electrode (SHE) is taken as
- 2) In the electrochemical series, elements are arranged in the order of standard reduction potential (SRP)
- 3) $\text{Ag}|\text{AgCl}$ electrode is an example of electrode
- 4) Calomel electrode is an example of electrode
- 5) In case of calomel electrode, the potential decreases as the concentration of KCl
.....
- 6) In Nernst equation, if the concentration of the solution is increased electrode potential

- 7) Calomel is made by grinding and using Hg with
- 8) Nernst equation is based on the principle
- 9) Anode material used in the Lithium ion battery is.....
- 10) Cathode material used in the Lithium ion battery is.....
- 11) Role of separator in the rechargeable battery is
- 12) Anode receives the electrons during the process of the secondary battery
- 13) During the discharge process Li^+ ions move from to in the lithium ion battery
- 14) battery activated just before using it
- 15) battery is used in mobile phones
- 16) Cell representation for Ni-MH battery is
- 17) Cell representation for Li-ion battery is
- 18) Fuel cell is an example of cell
- 19) gas is used as fuel in the Fuel cell
- 20) gas is used as an oxidant in the Fuel cell
- 21) Efficiency of the Fuel cell in converting chemical energy into electrical energy is
- 22) Hydrogen and Oxygen are bubbled at the surfaces of and respectively
- 23) electrode is used in hydrogen-oxygen fuel cell

Reasoning

- 1) Always reduction potential is taken for calculating the cell voltage, give reason.
- 2) Give reason for the origin of single electrode potential.
- 3) Why potential of SHE is taken as zero.
- 4) Why salt bridge is used in the construction of Daniel cell?
- 5) Why do electrochemical cells stop working after some time?
- 6) Why calomel electrode is called a secondary reference electrode?
- 7) Nickel spatula cannot be used to stir copper sulphate solution, give reason.
- 8) Blue color of copper sulphate fades when electrolyzed using platinum electrode,

why?

- 9) Give reason: EMF of a cell is always positive.
- 10) Give reason: Reactivity of the metal varies inversely with its electrode potential.
- 11) EMF of the concentration cell decrease gradually: give reason.
- 12) No electricity flows out of concentration cell when the metal ion concentration at the two electrodes is same: give reason
- 13) The potential of concentration cell doubles when the concentration ratio is changed from 0.0001 to 0.01: give reason.
- 14) Why a dry cell does become dead after sometime even if it has not been used?

One Mark Question

1. Give the unit of calorific value of a solid fuel? Kcal/Kg or KJ/Kg
2. Give an example of primary fuel? Wood/Coal/crude oil/natural gas.
3. Give an example of secondary fuel? Coke/petrol/diesel/producer gas.
4. Which device is used to automobile that reduces the amount of pollutants? catalytic converter.
5. Define reforming?
6. Define an Octane number of the fuel?
7. Define photovoltaic cell?
8. Which dopant is used to get n-type semiconductor? P/As
9. Which diode used in solar cell? p-n junction diode
10. Define Power alcohol/Gasohol?
11. Which method is adopted for the determination of Calorific value of a solid/liquid fuel? Bomb calorimeter
12. Which standard hydrocarbon has the octane number 0? n-heptane
13. What additive used to improve the octane number of petrol? TEL
14. Which standard hydrocarbon has cetane number 0? α -methyl naphthalene
15. Which device convert solar energy into electricity? PV cell
16. What happens during combustion of fuel in IC engine? chemical energy is converted into heat and light
17. How to express the efficiency of diesel fuel? cetane number
18. Give the principle of Zone refining?
19. Which dopant is used to get p-type semiconductor? B/Al
20. Define Knocking?
21. Which reference mixture used to determine the octane number of gasoline? n-heptane and isooctane
22. Which reference mixture used to determine the cetane number of gasoline? α -methyl naphthalene and cetane
23. Which catalyst used in catalytic cracking? Zeolite/ $\text{Al}_2\text{O}_3 + \text{SiO}_2$
24. What reaction is involved in the preparation of biodiesel? transesterification

25. Which process used to convert metallurgical grade silicon to solar grade silicon? Union carbide process

Give Reasons

1. Gross calorific value is always higher than its net caloric value
GCV includes latent heat of steam hence it is always higher than NCV
2. TEL is always used along with ethylene dibromide as an anti-knocking agent.
TEL is used to convert less volatile Pb and PbO into more volatile $PbBr_2$ which escape into air along with exhaust gases.
3. Why solar grade silicon is preferred in solar cell
Silicon used for solar cells can tolerate higher concentration of impurities than in semiconductor grade without affecting the efficiency of the cell considerably and solar grade silicon works out cheap.
4. Why catalytic converters are used in automobiles
It is used in the exhaust of automobiles to reduce the amount of pollutants
5. Why TEL is added to gasoline
It increases the octane number, efficiency of the engine and minimizes the knocking
6. What is compression ratio of IC engine
The ratio of the gaseous volume in the cylinder at the end of suction stroke to the volume at the compression stroke of the piston
7. What is 80 octane fuel
80 octane fuel is one which has same combustion characteristic as an 80:20 mixture of isooctane and n-heptane
8. How TEL reduces knocking in IC engine
During the combustion TEL is converted into PbO , which reduces formation of peroxide molecules thereby slowing down the chain reaction.
9. How octane rating can be increased in petrol
By adding TEL, MTBE etc.
10. Why MTBE is preferred to convert leaded to unleaded petrol
It contains oxygen which supplies to combustion process to minimize peroxide molecules and avoid Pb pollution in the atmosphere.
11. Why alkali is used in transesterification

It acts as catalysts by converting triglycerides into biodiesel

12. Arrange straight chain, aromatic and branched chain hydrocarbons in increasing order of their knocking tendency

Straight chain > branched chain > aromatic hydrocarbons

13. Why power alcohol is preferred than petrol

Octane rating of power alcohol is about 90, while that of gasoline is 60-70

14. Why octane number of 2,3-dimethyl pentane is higher than n-heptane

2,3-dimethyl pentane is a branched structure while n-heptane is straight chain

15. In catalytic cracking process, used catalyst requires regeneration

During catalytic cracking process, catalyst used gets coated with carbon, loses its catalytic activity hence it is regenerated

16. Why diesel is preferred over petrol as a fuel

Diesel is more efficient, less expensive and produce only about one tenth of CO than petrol

17. What energy conversion takes place when fuel is burnt

Chemical energy is converted into heat and light

18. What are chemical process used to improve the efficiency of petrol

Cracking and reforming

19. Why octane number of gasoline is so important in automobiles

Which indicates the rating of gasoline

20. How to rise the cetane number of diesel

By adding ethyl nitrate, acetone and nitro naphthalene

Problems

1. A coal sample with 93% carbon, 5% of Hydrogen and 2% Ash is subjected to combustion in a bomb calorimeter. Calculate GCV and NCV.

Given that

Mass of the coal sample = 0.95g

Mass of water in copper calorimeter = 2000g.

Water equivalent wt of calorimeter = 700g.

Rise in temp = 2.8°C

Latent heat of = 587 cal/g.

Specific heat of water = 1 cal/g/ $^{\circ}\text{C}$

GCV = $\frac{(W+w) \times S \times \Delta t}{m}$

m

$$= \frac{(2000+700) \times 10^{-3} \times 2.8^{\circ}\text{C} \times 4.184}{0.95 \times 10^{-3} \text{ kg}}$$

$$= 33295.83 \text{ J/kg.}$$

$$\begin{aligned}\text{NCV} &= \text{GCV} - 0.09 \times \% \text{H}_2 \times 587 \times 4.184 \text{ J/kg.} \\ &= 33295.83 \text{ J/kg} - 0.09 \times 5 \times 587 \times 4.184 \text{ J/kg.} \\ &= 32190.62 \text{ J/kg}\end{aligned}$$

2. When 0.84g of coal was burnt completely in Bomb calorimeter the increase in temp of 2655 grams of water was 1.85°C if the water equivalent calorimeter is 156g Calculate GCV.

$$\text{GCV} = \frac{(W+w) \times S \times \Delta t}{m}$$

m

$$\begin{aligned}\frac{(2655+156) \times 1.85 \times 10^{-3} \times 4.187}{0.84 \times 10^{-3}} \\ 25921.26 \text{ J/Kg}\end{aligned}$$

3. Calculate GCV and NCV of a fuel from the following data. Mass of fuel = 0.75g, W = 350g. $t = 3.02^{\circ}\text{C}$, Mass of water = 1150, % $\text{H}_2 = 2.8$.

$$\text{GCV} = \frac{(W+w) \times \Delta t \times S}{m}$$

m

$$= \frac{(1150+350) \times 10^{-3} \times 3.02 \times 4.184}{0.75 \times 10^{-3}}$$

$$\text{GCV} = 25271.36 \text{ KJ/Kg}$$

$$\begin{aligned}\text{NCV} &= \text{GCV} - 0.09 \times \text{H} \times 587 \times 4.184 \\ &= 25271.36 - 0.09 \times 2.8 \times 587 \times 4.184\end{aligned}$$

$$\text{NCV} = 24652.44 \text{ KJ/Kg}$$

4. Calculate calorific value of a fuel sample of a coal from the following data. Mass of the coal is 0.6g. Water equivalent wt of calorimeter is 2200g. Specific value 4.187 Kg/KJ/ $^{\circ}\text{C}$ rise in temperature = 6.52°C .

$$\text{GCV} = \frac{(W_1+W_2) \times S \times \Delta t}{m}$$

m

$$= \frac{(2200) \times 10^{-3} \times 4.184 \times 6.52}{0.6 \times 10^{-3}}$$

$$= 100025.49 \text{ KJ/Kg.}$$

5. 0.82g of a coal sample when burnt in a bomb calorimeter increased the temperature of water by 7°C . Calculate the water equivalent of calorimeter, if the weight of water taken in calorimeter is 150kg, gross calorific value is 2590 kJ/kg. Given the specific heat of water is 4.2 kJ/kg/ $^{\circ}\text{C}$ and neglect all the corrections. [**$W_2 = -149.92\text{kg}$**]