Correlation

Rank correlation

$$\gamma_K = 1 - \frac{6\,\Sigma D^2}{N^3 - N}$$

$$\text{Correlation} = \gamma = \frac{\Sigma dx \cdot dy}{\sqrt{\Sigma dx^2 \cdot dy^2}}$$

x	dx	dx^2	y	y	dy^2	dxdy
2	-3	9	4	-6	36	18
3	-2	4	7	-3	9	6
4	-1	1	8	-2	4	2
5	0	0	9	-1	1	0
6	1	1	10	0	0	0
7	2	4	14	4	16	8
8	3	9	18	8	64	24
	0	28		0	130	58

$$\gamma = \frac{\Sigma dx\,dy}{\sqrt{\Sigma dx^2 \cdot dy^2}}$$

Exponential and Logarithmic Function & Example & Solution

Example-14. Differentiate the following w.r.t x.

(i) $\log_{10} x$ (ii) $\log_e(x+2)$ (iii) $\log(\sin x)$

Sol.

(i) $\frac{d \log_{10} x}{dx} = \frac{1}{x} \log_{10} e$ Ans

(ii) $\log_e(x+2) =$.

(iii) $\log(\sin x) = \frac{1}{\sin x} \cdot \cos x = \cot x$ Ans.

Example. 15. If $y = \sqrt{\log x + \sqrt{\log x + \sqrt{\log x + \cdots \text{to} \infty}}}$,

prove that $(2y-1)\frac{dy}{dx} = \frac{1}{x}$

Sol.

$$\frac{d}{dx}(y^2 - y) = \frac{d}{dx}(\log x)$$

$$\Rightarrow 2y\frac{dy}{dx} - \frac{dy}{dx} = \frac{1}{x}$$

$$\therefore (2y-1)\frac{dy}{dx} = \frac{1}{x} \quad \text{(Ans.)}$$

$\Rightarrow 15 + \frac{5}{3}$

$\Rightarrow \frac{45+5}{3} = \frac{50}{31}$ 16.66

mode is = 16.66

mode = 3median - 2mean

$$r = \frac{58}{\sqrt{28 \times 130}}$$

$$= \frac{58}{\sqrt{3640}} = \frac{58}{60.33}$$

$$r = +0.96$$

Individual

1, 7, 9, 11, 13, 15, 17, 19, 21, 23

even number $= \frac{\left(\frac{n}{2}\right)^{th} + \left(\frac{n}{2}+1\right)^{th}}{2}$

$$\frac{\left(\frac{10}{2}\right)^{th} + \left(\frac{10}{2}+1\right)}{2}$$

$$\frac{(5)^{th} + (6)^{th}}{2}$$

5th term is = 13
6th term is = 15

$$\frac{13 + 15}{2}$$

$$= \frac{14}{2} = 14$$

Median is 14

Q Discrete Series

Continuous Frequency

C.I	F	x (mid value)	$d' = \frac{x-A}{h}$	Fd'
0 - 7	19	3.5	-3	-57
7 - 14	25	10.5	-2	-50
14 - 21	36	17.5	-1	-36
21 - 28	72	(24.5) A	0	0
28 - 35	51	31.5	1	51
35 - 42	43	38.5	2	86
42 - 49	28	45.5	3	84
	274			78

Step-deviation method $\bar{X} = A + \frac{\Sigma Fd'}{\Sigma F} \times h = 24.5 + \frac{78}{274} \times 7 = 26.5$

Median

Individual series in N is odd $\left(\frac{n+1}{2}\right)^{th}$

Individual series in N is even $\frac{\left(\frac{n}{2}\right)^{th} + \left(\frac{n}{2}+1\right)^{th}}{2}$

$$m = l + \frac{\frac{n}{2} - CF}{F} \times i$$

l = lower limit

$\frac{N}{2}$ = ~~no~~ total Frequency

CF = Cumulative Frequency

F = Frequency of median

h = length of median class

$$m = 30 + \frac{95}{7}$$

$$\frac{210 + 95}{7}$$

$$\frac{115}{7} = 16.42$$

median = 16.42

⇒ Mode

in individual series to calculate the modes pt has maximum no of times

continous series

$$l + \frac{F_1 - F_0}{2F_1 - F_0 - F_2} \times h$$

individual series

mode: (16), 18, 22, (16), 15, (16), 22, (16) 14, 10, 11, (16)

16 occurs maximum number of times i.e 5 times

So mode = 16

x	F	CF
3	5	5
5	7	12
7	4	16
9	2	18
	18	

$\frac{18}{2} = \frac{N}{2} = 9$

median = 5

Continuous series

Class interval	F	CF
0 - 10	2	2
10 - 20	3	5
20 - 30	5	10 - CF
30 - 40	7 - F	17
40 - 50	4	21
	II	

$\frac{N}{2} = 10.5$

$\text{median} = l + \frac{\frac{N}{2} - CF}{F} \times i$

$= 30 + \frac{10.5 - 10}{7} \times 10$

Differential Calculus

Differentiation Rule

General Formulas

Assume u and v are differentiable function of x.

Constant: $\frac{d}{dx}(c) = 0$

Sum: $\frac{d}{dx}(u+v) = \frac{du}{dx} + \frac{dv}{dx}$

Difference: $\frac{d(u-v)}{dx} = \frac{du}{dx} - \frac{dv}{dx}$

constant multiple: $\frac{d}{dx}(cu) = c\frac{du}{dx}$

product: $\frac{d}{dx}(u \cdot v) = u \cdot \frac{dv}{dx} + v\frac{du}{dx}$

Quotient: $\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v\frac{du}{dx} + u\frac{dv}{dx}}{v^2}$

power: $\frac{d}{dx}(x^n) = nx^{n-1}$

Chain Rule: $\frac{d}{dx}(f(g(x))) = f'(g(x)) \cdot g'(x)$

Trigonometric Functions & ITF

$\frac{d}{dx}(\sin x) = \cos x$

$\frac{d}{dx}(\cos x) = -\sin x$

$\frac{d}{dx}(\tan x) = \sec^2 x$

$\frac{d}{dx}(\cot x) = -\operatorname{cosec}^2 x$

$\frac{d}{dx}(\sec x) = \sec x \cdot \tan x$

$\frac{d}{dx}(\operatorname{cosec} x) = -\operatorname{cosec} x \cdot \cot x$

$\frac{d}{dx}(\sin^{-1} x) = \frac{1}{\sqrt{1-x^2}}$

$\frac{d}{dx}(\cos^{-1} x) = \frac{-1}{\sqrt{1-x^2}}$

$\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$

$\frac{d}{dx}(\sec^{-1} x) = \frac{1}{|x|\sqrt{x^2-1}}$

$\frac{d}{dx}(\cot^{-1} x) = \frac{-1}{1+x^2}$

$\frac{d}{dx}(\operatorname{cosec}^{-1} x) = \frac{-1}{|x|\sqrt{x^2-1}}$

Note.

$\lim_{x \to 0} \frac{\sin x}{x} = 1$

$\lim_{x \to 0} \cos x = 1$

$\lim_{x \to 0} \frac{\tan x}{x} = 1$

$\lim_{\theta \to 0} \frac{\tan n\theta}{n\theta} = 1$

$\lim_{x \to 0} \frac{x}{\tan x} = 1$

$\lim_{x \to 0} \frac{x}{\sin x} = 1$

Statistics

measures of Central Tendency

1) mean it denoted by $\bar{x}$
2) mode it is denoted by z
3) median it is denoted by m

it is Divided in 3 series

1) individual
2) Discrete
3) continuous

mean has three method $\bar{x} = \frac{x_1 + x_2 + x_3 + \ldots + x}{n}$

(i) Direct method $= \frac{\Sigma fx}{\Sigma f} =$

(ii) Short cut method $= a + \frac{\Sigma Fd}{\Sigma f} \times h$

$=$

(iii) Step Deviation method $= A + \frac{\Sigma Fd'}{\Sigma f} \times h$

Example. 3 write down the diff of the following

(i) $3x^4 - 7x^3 + 5x + 9$

(ii) $ax^2 + bx + c$

Sol. (i) $\frac{d}{dx}(3x^4 - 7x^3 + 5x + 9) = \frac{d\,3x^4}{dx} - \frac{d(7x^3)}{dx} + \frac{d}{dx}(5x) + \frac{d(9)}{dx}$

$= 12x^3 - 21x^2 + 5 + 0$

$= 12x^3 - 21x^2 + 5$ Ans.

Example. 4. Diff. $(x-2)(x-3)$ w.r.t. x.

Sol. $\frac{d}{dx}(x-2)(x-3) = (x-2)\frac{d(x-3)}{dx} + (x-3)\frac{d}{dx}(x-2)$

$= (x-2)\cdot 1 + (x-3)\cdot 1$

$= (x-2) + (x-3) = 2x - 5$ Ans

Example. 6. Differentiate $\frac{x^2+1}{x+1}$ w.r.t x.

Sol. $y = \frac{x^2+1}{x+1}$

$\frac{dy}{dx} = \frac{(x+1)\frac{d}{dx}(x^2+1) - (x^2+1)\frac{d}{dx}(x+1)}{(x+1)^2}$

$= \frac{2x^2 + 2x - x^2 - 1}{(x+1)^2} = \frac{x^2 + 2x - 1}{(x+1)^2}$ Ans

Trigonometric formulas Based on Examples solution

Example. 7. Differentiate w.r.t x, $\sin\sqrt{a^2+x^2}$

Exam Sol.

$$y = \sin\sqrt{a^2+x^2} = \sin(a^2+x^2)^{\frac{1}{2}}$$

S Differentiating both sides w.r.t x.

$$\frac{dy}{dx} = \cos(a^2+x^2)^{\frac{1}{2}} \times \frac{d}{dx}(a^2+x^2)^{\frac{1}{2}}$$

$$= \frac{\cos\sqrt{a^2+x^2}}{2\sqrt{a^2+x^2}} \times (0+2x) = \frac{x\cos\sqrt{a^2+x^2}}{\sqrt{a^2+x^2}}$$ Ans.

Example. 8. Diff. the following w.r.t x.

(i) $\sin x^n$. (ii) $\sqrt{\cos x}$

Sol.

(i) $\frac{d\sin x^n}{dx} = n x^{n-1} \cos x^n$ Ans.

(ii) $\frac{d\sqrt{\cos x}}{dx} = \frac{-\sin x}{2\sqrt{\cos x}}$ Ans

ITE Example Solution

Example 12. Differentiate $\sin^{-1}\left(2x\sqrt{1-x^2}\right)$ w.r.t. x

Sol.

$$y = \sin^{-1}\left(2x\sqrt{1-x^2}\right)$$

$$x = \sin\theta \Rightarrow \theta = \sin^{-1}x$$

$$y = \sin^{-1}\left(2\sin\theta\sqrt{1-\sin^2\theta}\right) = \sin^{-1}\left(2\sin\theta\sqrt{\cos^2\theta}\right)$$

$$= \sin^{-1}\left(2\sin\theta\cdot\cos\theta\right) = \sin^{-1}\left(\sin 2\theta\right) = 2\theta$$

$$y = 2\sin^{-1}x$$

Differentiating both side w.r.t x, we get

$$\frac{dy}{dx} = 2\frac{1}{\sqrt{1-x^2}} = \frac{2}{\sqrt{1-x^2}} \quad \text{Ans.}$$

Example 13. Diff. the following w.r.t x.

(i) $\sin^{-1}\frac{x}{a}$ (ii) $\cos^{-1}\frac{x}{a}$

Sol.

(i) $d\sin^{-1}\frac{x}{a} = \frac{a^1}{\sqrt{a^2-x^2}}$ Ans

(ii) $d\cos^{-1}\frac{x}{a} = \frac{-1}{\sqrt{a^2-x^2}}$ Ans.

Exponential And Logarithmic Function

$\frac{d}{dx}(e^x) = e^x$

$\frac{d}{dx}\ln x = \frac{1}{x}$

$\frac{d}{dx}(a^x) = a^x \ln a$

$\frac{d}{dx}(\log_a x) = \frac{1}{x \ln a}$

$\frac{a^m}{a^n} = a^{m-n}$

$(a^m)^n = a^{mn}$

$a^m \times a^n = a^{m+n}$

$\log_a a = 1$

$\lim_{x \to 0} \frac{e^x - 1}{x} = 1$

$\frac{a^m}{a^n} = a^{m-n}$

Hyperbolic Function

$d(\sinh x) = \cosh x$

$d(\cosh x) = \sinh x$

$\frac{d}{dx}(\tanh x) = \operatorname{sech}^2 x$

$\frac{d}{dx}(\operatorname{sech} x) = -\operatorname{sech} x \cdot \tanh x$

$\frac{d}{dx}(\coth x) = -\operatorname{cosech}^2 x$

$\frac{d}{dx}(\operatorname{cosech} x) = -\operatorname{cosech} x \cdot \coth x$

Inverse Hyperbolic Function

$\frac{d}{dx}(\sinh^{-1} x) = \frac{1}{\sqrt{1+x^2}}$

$\frac{d}{dx}(\cosh^{-1} x) = \frac{1}{\sqrt{x^2-1}}$

$\frac{d}{dx}(\tanh^{-1} x) = \frac{1}{1-x^2}$

$\frac{d}{dx}(\operatorname{sech}^{-1} x) = \frac{-1}{x\sqrt{1-x^2}}$

$\frac{d}{dx}(\coth^{-1} x) = \frac{1}{1-x^2}$

$\frac{d}{dx}(\operatorname{cosech}^{-1} x) = \frac{-1}{|x|\sqrt{1+x^2}}$

Parametric Equations

$x = f(t)$ and $y = g(t)$ are differentiable, then

$y' = \frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}}$ and

$\frac{d^2y}{dx^2} = \frac{\frac{dy'}{dt}}{\frac{dx}{dt}}$

Fuels

The combustible substance which a large amount of

(1) Sludge ~~and Scale~~ formation :- If the precipitation takes place in the form of loose and slimy layer, it is called sludge.

Disadvantage:

(i) Sludges are poor conductors of heat, so they tend to waste a portion of the heat generated.

(ii) Excessive sludge formation disturbs the working of the boiler.

Scale formation :- If the precipitated matter forms a hard, adhering crust or coating on the inner walls of the boiler, it is called scale.

Disadvantage of scale :-

(i) The scale is a bad conductor of heat.

(ii) Due to the formation of scale, heat available to water is reduced and hence more heat is required to regulate the steam supply.

(iii) Due to non-uniform heating, the scale may crack.

(2) Boiler corrosion :- Boiler corrosion is slow but constant destruction of boiler material by the acid present or produced by electrochemical attack by the environment

Disadvantage of boiler corrosion :-

(i) It shortens the life of the boiler.

(ii) The joints and rivets are attacked by the acid which begin to leak.

(iii) The cost of repairs and maintenance is increased.

(3) Caustic Embrittlement :- When the boiler material becomes brittle due to the presence of caustic substances present in feed water, the phenomenon is called caustic embrittlement.

Disadvantage :-

(i) It makes the boiler material brittle.

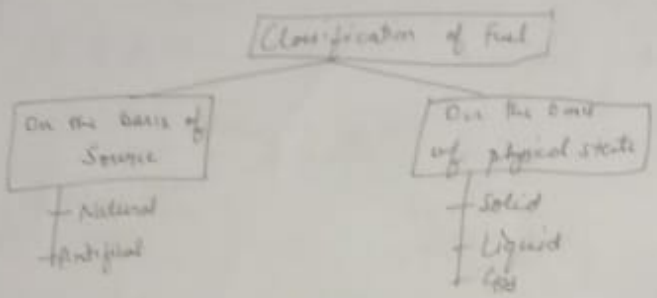
(ii) The rivets and joints become loose and Result in leakage.

(iii) The cost of repair and maintenance is increased.

Fuels

Definition of fuel :- It is combustible substance which on burning in air produce large amount of heat that can be used economically for domestic and industrial purposes are called fuels.

Ex:- Oil, Diesel, Coal gas



A) On the Basis of Source :- There are different fuels such as :-

i) Natural Fuels :- Fuels which occur in nature are called natural fuels

Ex:- Coal, Wood

ii) Artificial Fuel :- Fuels which are prepared artificially are called artificial fuels

Ex:- Diesel, Petrol, coal gas.

B) On basis of physical state :- The fuels are classified on basis of physical state as :-

i) Solid :- They are hard, have fixed shape and volume.

Ex:- Wood, Coal, Coke.

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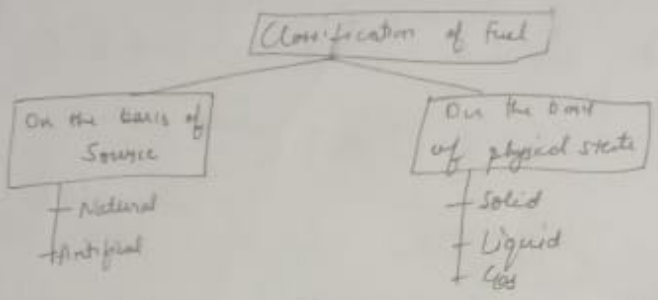

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Water

Water :- Water is nature's most wonderful, abundant and useful gift to mankind. The very existence of life cannot be imagined without water. One can live without food or any other thing but life without water is just not possible.

Types of water

- Soft water
- Hard water

Soft water :- Water that forms lather with soap solution easily is called soft water.

for ex- Rain water and distilled water.

Hard water :- Water that does not form lather with soap solution easily is called hard water.

for ex- river water and sea water.

Types of hardness of water

- Temporary hardness
- Permanent hardness

Temporary hardness :- Temporary hardness of water is due to the presense of bicarbonates of calcium and magnesium.

It is called temporary because it can be removed by simply boiling hard water.

Permanent hardness :- Permanent hardness of water is due to the presence of chlorides and sulphates of calcium and magnesium.

It is called Permanent as it cannot be removed by simply boiling hard water.

Gaseous Fuel

① **LPG** → LPG stands for Liquefied Petroleum Gas

Composition: It contains 3-4 carbon atoms. It is compressed under pressure as liquid & is stored in iron cylinder.

Calorific Value: Its calorific value is 27,500 Kcal/m³

Application: It is used as domestic & industrial fuel.

② **CNG:** It stand for Compressed Natural Gas.

Composition: Its octane Number is 130. It consist of methane & small amount of ethane & propane.

Application: It is used as fuel for running buses, cars & three wheelers.

③ **Biogas** :- It is produced by bacterial degradation of biological matter in absence of air.

Composition:-

Methane = 55%.
Carbon dioxide = 35%.
Hydrogen = 8%.
Nitrogen = 2%.

Calorific Value:- 12000 Kcal/m³.

Characteristics of a Good fuel

1. **High Calorific Value** :- A good fuel have a high calorific value i.e, it produces large amount of heat in burning.
2. **Moderate Temperature** :- A good fuel should have the moderate temperature.
3. **Low Moisture Content** :- A good fuel should have low temperature control as moisture content reduces the calorific value.
4. **Moderate Rate of Combustion** :- If rate of combustion is low then required high temperature may not be reached soon. Too much high combustion rate causes high temperature.
5. **Minimum Smoke** :- A good fuel is that which produces very less amount of smoke.
6. **Cheap** :- A good fuel is that which is very cheap.
7. **Easy Transportation** :- A good fuel is that which is easy to transport from one place to another.
8. **Low Storage Cat** :- The good fuel is that which have very low storage cat.

Unit of Hardness

(i) **Parts per million (ppm) :-** It is defined as the number of parts of calcium carbonate equivalent hardness present per million (10^6) part of water.

1 ppm = 1 part of $CaCO_3$ equivalent hardness in 10^6 parts of water.

(ii) **Milligrams per litre (mg/L) :-** It is defined as the number of milligrams of calcium carbonate equivalent hardness present per litre of water.

1 mg/L = 1 mg of $CaCO_3$ equivalent hardness in 1L

As 1 L of water weighs = 1 kg = 100g = 1000×1000 mg of water
= 10^6 mg of water

Drinking water :- water, which is suitable for drinking purposes is called potable water.

Drinking water should have the following characteristics

(i) It should be colourless and odourless.
(ii) It should be free form suspended impurities.
(iii) It should not contain germs and bacteria, which cause diseases.
(iv) It should be free form objectionable gases and minerals.
(v) It should be reasonably soft.
(vi) It should be good to taste.
(vii) It should be free from iron.

Disadvantages of hard water in boilers :- water is mainly used in boilers for the generation of stem. this results in many troubles such as :-

(1) Sludge and scale formation.
(2) Boiler corrosion
(3) Caustic Embrittlement.

General formulas Based on Example solution

Example 1. Write down the differential co-efficent of the following w.r.t x.

(i) x^{-9} (ii) x^{100} (iii) $x^{-\frac{3}{2}}$

Solution:

(i) $\frac{d(x^{-9})}{dx} = -9x^{-9-1} = -9x^{-10}$ Ans.

(ii) $\frac{d(x^{100})}{dx} = 100x^{100-1} = 100x^{99}$ Ans

(iii) $\frac{d(x^{-\frac{3}{2}})}{dx} = \frac{-3}{2}x^{-\frac{3}{2}-1} = \frac{-3}{2}x^{-\frac{5}{2}}$ Ans

Ex. 2. Write down the diff. of:

(i) 7 (ii) a (iii) 9 (iv) π.

Sol.

(i) $\frac{d7}{dx} = 0$

(ii) $\frac{da}{dx} = 0$

(iii) $\frac{d9}{dx} = 0$

(iv) $\frac{d\pi}{dx} = 0$

Fuels

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Ex:- Oil, Diesel, Coal gas

Classification of Fuel

- On the Basis of Source
  - Natural
  - Artificial
- On the basis of physical state
  - Solid
  - Liquid
  - Gas

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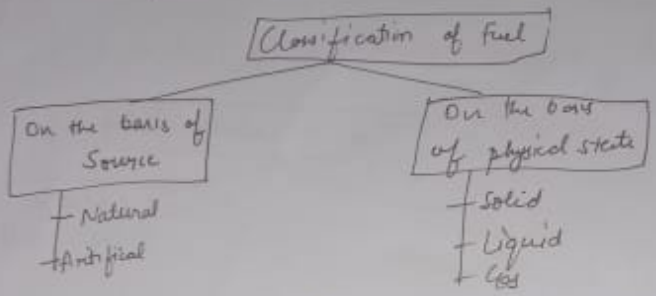

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Continouse Series

Daily wages	F
0 - 5	4
5 - 10	5
10 - 15	(12) - F_0
l = 15 - 20	(16) - F_1
20 - 25	(8) - F_2
25 - 30	3
30 - 35	2

$$Z = l + \frac{F_1 - F_0}{2F_1 - F_0 - F_2} \times i$$

$l = 15$

$F_1 = 16$

$F_0 = 12$

$F_2 = 8$

$i = 5$

$$15 + \frac{16 - 12}{2(16) - 12 - 8} \times 5$$

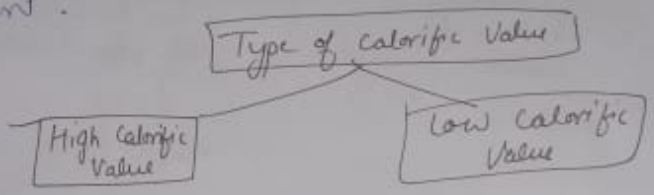
$$15 + \frac{4}{32 - 20} \times 5$$

$$15 + \frac{4}{12} \times 5$$

ii) Liquid :- These don't have fixed shape and volume. They have definite mass.
for eg:- Petrol, Diesel, Kerosene oil

iii) Gaseous fuel :- These have definite mass & have very loose space amongst their particles
for eg:- Oil gas, Biogas.

Definition of calorific Value It is the amount of heat produced when a unit mass of fuel is burnt.



i) **High calorific Value :-** It is the total amount of heat produced when a unit mass of fuel is burnt completely and products of combustion are cooled to room temprature. (15°C or 60°F)

ii) **Low Calorific Value :-** It is the net heat produced when a unit mass of fuel is burnt completely and the products of combustion are allowed to escape.

Net Calorific Value = Gross Calorific Value − Latent heat of vapour

= Gross calorific Value − Weight of H_2 × 9 × Latent heat of steam.

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why the cost of repair and maintenance is increased.

1200 Kcal/m³.

Advantages of Gaseous fuels over solid fuels

1) The calorific value of gaseous fuel is quite high as compared to solid fuels.
2) The gaseous fuel don't produce any smoke.
3) The supply of gas to burner can easily be controlled.
4) They can be easily lighted.
5) These are economical.
6) They don't produce ash.

Definition of coal :- The composition of coal varies widely from mine to mine.

Analysis of coal

(Proximate Analysis)

Proximate Analysis :- It gives us information about the % of moisture, Volatile matter, ash & fixed carbon in given sample of coal.

1) **Determination of moisture :-** A weight of powdered dried coal sample is taken in a silica crucible which is already weighted.

$$\% \text{ of moisture} = \frac{\text{Weight of moisture}}{\text{Weight of coal}} \times 100$$

Individual series

x	F	Fx
1	3	3
2	6	12
3	4	12
4	7	28
5	2	10
	22	65

Direct method $= \frac{\Sigma Fx}{\Sigma f} = \frac{65}{22} = 2.95$

Discrete series

x	F	d(x-a)	Fd
1	3	-2	-6
2	6	-1	-6
a = (3)	4	0	0
4	7	1	7
5	2	2	4
	22		-1

Short cut $A + \frac{\Sigma Fd}{\Sigma F} = 3 + \frac{-1}{22}$

$\frac{66-1}{22} = \frac{65}{22} = 2.95$

4) Fixed Carbon :- Higher the percentage of fixed carbon, greater is its calorific value and better the quality of coal.

Fuel Quality Rating :- The quality of petrol is expressed in terms of Octane & quality of diesel is expressed in terms of Cetane Number

Octane Cetane

(1) Octane :- Octane rating of fuel may be defined as percentage of isooctane by volume in a mixture of iso-octane & n-heptane which has same anti-knock properties as fuel. All good quality petrol fuels with octane number 80 or more are regarded as good fuel.

(2) Cetane :- It is defined as the % of cetane by volume in a mixture of cetane which have same ignition properties as diesel under examination.

Eg: If given sample of diesel have cetane number 80 it has 20% α-methyl naphthalene.

Example 9. Differentiate w.r.t x. $\sqrt{\frac{1-\cos x}{1+\cos x}}$

Sol. $y = \sqrt{\frac{1-\cos x}{1+\cos x}} = \sqrt{\frac{2\sin^2\frac{x}{2}}{2\cos^2\frac{x}{2}}}$

$\Rightarrow \tan\frac{x}{2}$ Ans.

Example 10. Diff. $x \sin x$ w.r.t x.

Sol.

$$\frac{d\,x\sin x}{dx} = \frac{x\,d(\sin x)}{dx} + \sin x \frac{dx}{dx}.$$

$$= x\cos x + \sin x \quad \text{Ans.}$$

Example 11. Diff. $\sin^n x$ w.r.t x.

Sol. $\frac{d(\sin x)^n}{dx}$

$$n\sin^{n-1} x \frac{d}{dx}(\sin x) = n\sin^{n-1} x \cos x \quad \text{Ans.}$$

ii) Determination of Volatile matter :- A known weight of moisture free coal sample is taken in a weighed silica crucible covered with a lid.

% of Volatile matter = $\frac{\text{Weight of Volatile Matter}}{\text{Weight of Moisture free coal}} \times 100$

iii) Determination of Ash :- The residual coal sample after determination of Volatile matter is then heated without lid in a muffle furnace.

% of ash = $\frac{\text{Weight of ash formed}}{\text{Weight of coal taken}} \times 100$

iv) Determination of % of fixed carbon :- The percentage of carbon alone in sample of coal is called percentage of fixed carbon.

Importance of Proximate Analysis :-

① Moisture :- Moisture in coal evaporate during burning and is removed as steam, it take certain amount of heat liberated during burning of coal.

ii) Volatile Matter :- Lesser the Volatile matter Better the quality of coal.

iii) Ash :- Ash is a non-combustible matter and it reduces the calorific value of coal.

(1) Sludge ~~and scale~~ formation :- If the precipitation takes place in the form of loose and slimy layer, it is called sludge.

Disadvantage:

(i) Sludges are poor conductors of heat, so they tend to waste a portion of the heat generated.

(ii) Excessive sludge formation disturbs the working of the boiler.

Scale formation :- If the precipitated matter forms a hard, adhering crust or coating on the inner walls of the boiler, it is called scale.

Disadvantage of scale :-

(i) The scale is a bad conductor of heat.

(ii) Due to the formation of scale, heat available to water is reduced and hence more heat is required to regulate the steam supply.

(iii) Due to non uniform heating, the scale may crack.

(2) Boiler corrosion :- Boiler corrosion is slow but constant distruction of boiler material by the acid present or produced by electrochemical attack by the environment

Disadvantage of boiler corrosion :-

(i) It shortens the life of the boiler.

(ii) The joints and rivets are attacked by the acid which begin to leak.

(iii) The cost of repairs and maintenace is increased.

(3) Caustic Embrittlement :- When the boiler material becomes brittle due to the presence of caustic substances present in feed water, the phenomenon is called caustic embrittlement.

Disadvantage :-

(i) It makes the boiler material brittle.

(ii) The rivets and joints become loose and result in leakage.

(iii) The cost of repair and maintenance in increased.