3. The charging current rate is the most ~~the~~ important factor & it can significantly influence the battery behaviour.

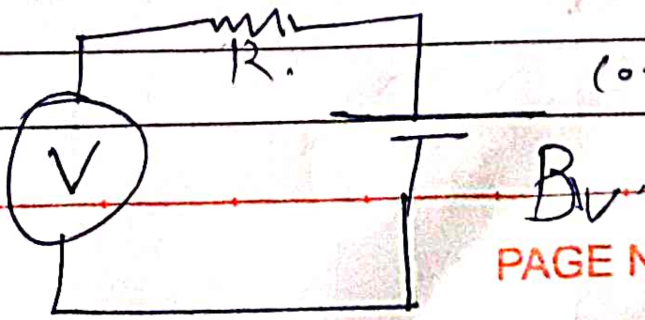
4. A high charging current provides a quick charge but also significantly ~~of the the~~ ~~batt~~ affect the battery aging process.

5. 0.5C — 0.8C (For EV Battery) current rate.

+ Constant voltage charging :-)

1. CV charging regulates a predefined constant voltage to charge the batteries. Its main advantage is that ~~it~~ circumvents overvoltages & irreversible side reaction, thus prolong battery life.

2. Since the voltage is constant, the charging current decrease as the battery charges.



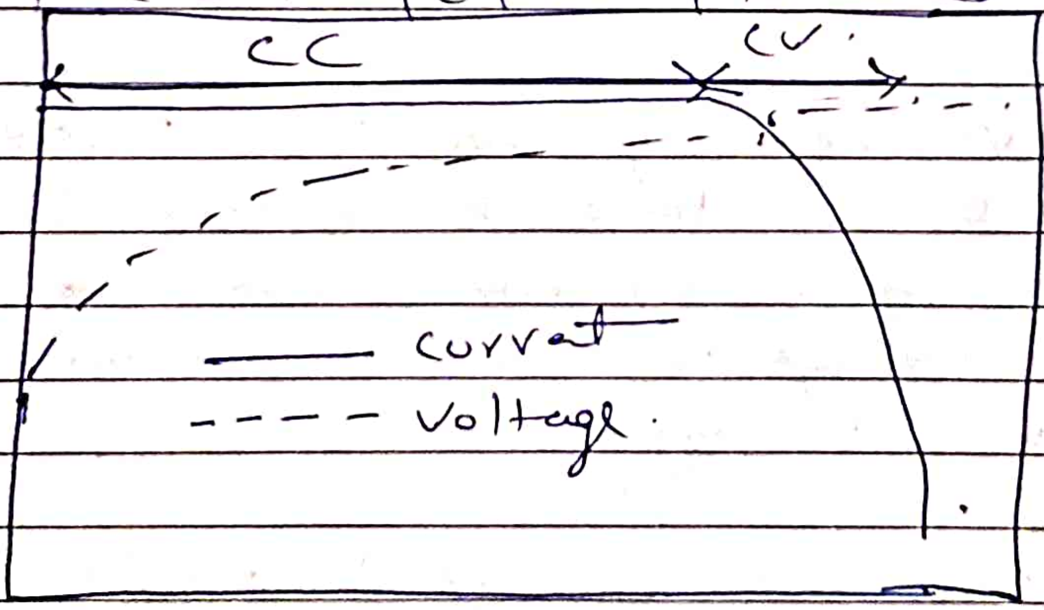
Constant voltage charging.

PAGE NO.

Success has No Shortcuts.

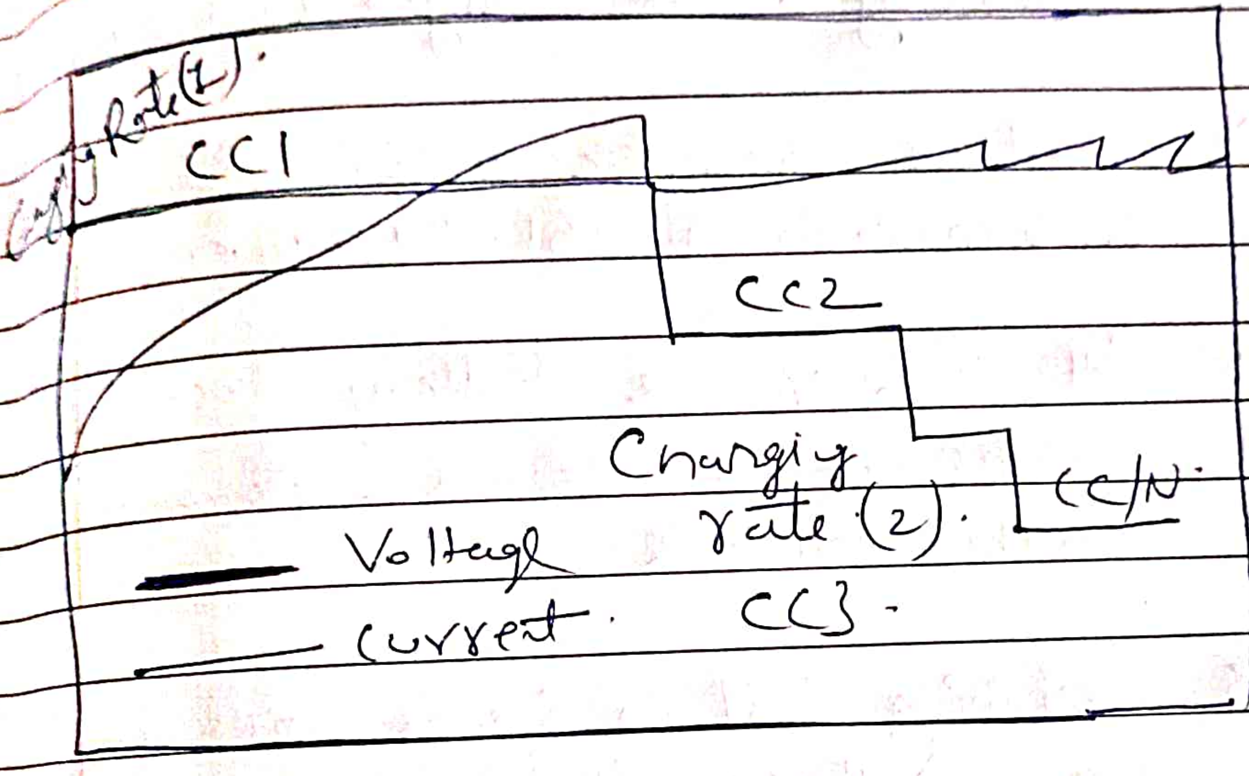
— CC/CV Charging

① The CC-CV charging method is a hybrid approach that combines the two previously mentioned charging methods. It uses CC charging in the first charging state, & when the voltages reaches the max. safe threshold value, the charging process shifts to the CV charging method, The charging process is complete when the current level off or when the full battery capacity is reached.



→ fast charging 80% charge with an hour.

* Multi Stage Constant current (MCC) Scanes.



CC1 → capacity reach at some Stage at high rate.

CC2 →

Subject :

* Lecture 2.1.13.

Battery Calculation Basics.

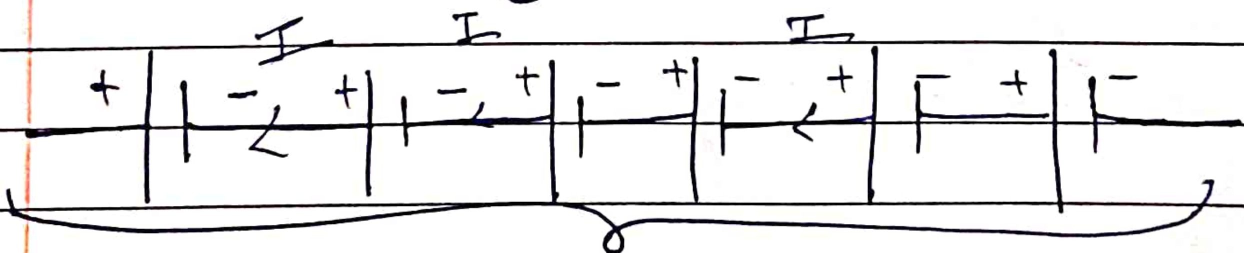
→ Battery Pack Design Calculation.

1. Let us consider an EV with Energy consumption of 161.74 Wh/km

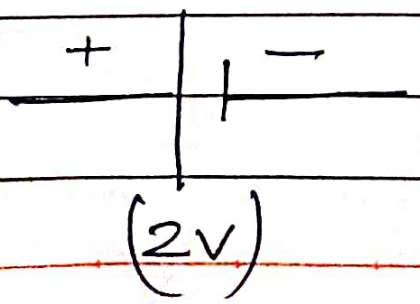
2. All high voltage Battery Packs are made up of series & parrallel combination cell.

3. Combining cell in series will give as Voltage shutdown. rating.

4. Parrallel Combination of cell increase current rating.



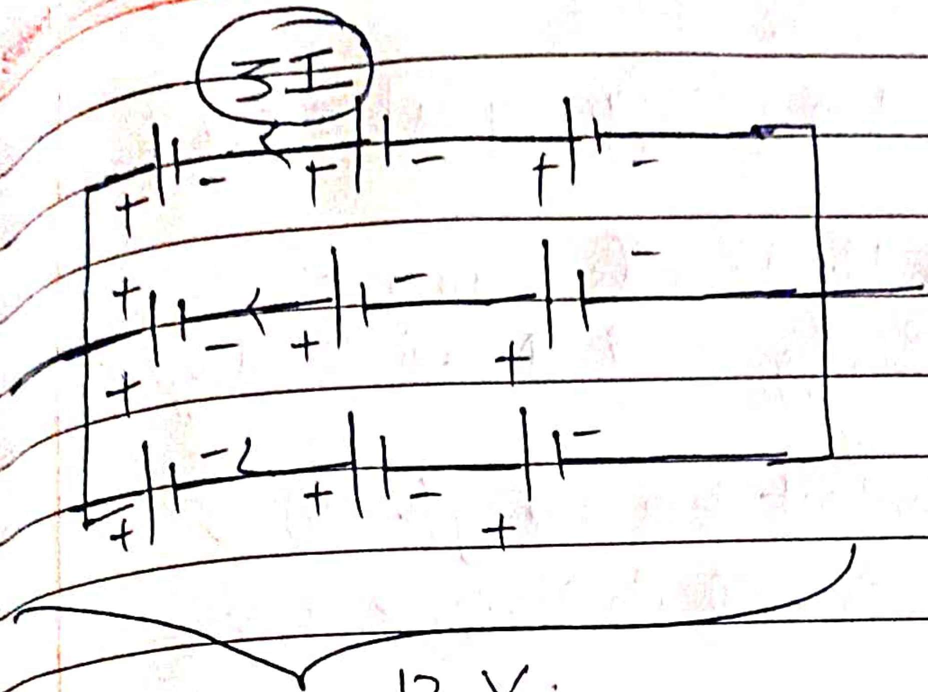
$6 \times 2 = 12V$



Current in Series is Contant.

Date: ___/___/___

MON TUE WED THR FRI SAT SUN



Parallel connection

12 V.

3 times more capacity

3 times more current

So for range of 300 km, we require a battery pack with energy capacity of : $161.74 \times 300 = 48.52$ Wh.

Subject :

* Steps for designing a battery Pack.

1. Calculate No. of cells connected in Series in a String ⟶ Nominal voltage / Cell voltage

2. Energy Content of a String (Whr) ⟶ No. of cell in String × energy of cell (Whr).

3 Total No. of Strings in battery pack ⟶ Total battery pack Energy / Energy of string.

4 Battery pack capacity (Ah) ⟶ No. of Strings × capacity of cell (Ah).

5 String peak current (amp) ⟶ String peak current × Crate (peak)

6. Battery pack peak power (W) ⟶ B.P. peak current × Battery votage.

7. String Continuous Current ⟶ Continous Crate × Battery Cell Capacity (Ahr).

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Date __/__/__

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8 Battery Pack Continous Current →
String Continous Current ×
Battery Cell capacity

9 Battery pack continous power →
Battery pack cont. current ×
Battery pack voltage

$$P = V_n I_{cont}$$

Subject :

MON TUE WED THU FRI SAT SUN

* Lecture 2.1.14.

Energy Consumption Pt01.

→ Energy calculation :→.

Power. Energy.

$P = F \times V$ (force × velocity).

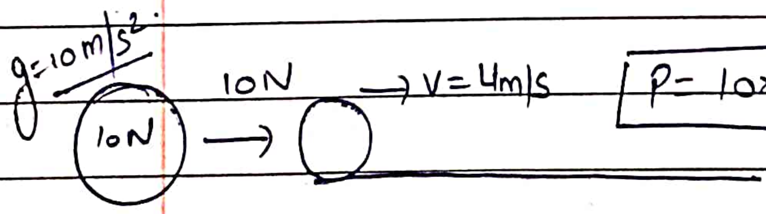
$P = \tau \times \omega$ (Angular torque × Angular velocity)

force → force applied on the body.

Velocity → velocity is speed by which is travel in direction.

For power train of a vehicle.

Power :→ How much faster the vehicle can carry a load.



$\boxed{P = 10 \times 4 = 40W}$

Energy.

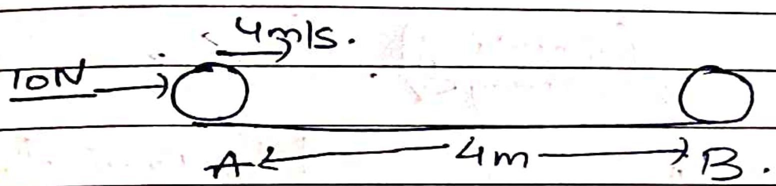
$E = P \times t$

$= F \times S$ (Force & load × Distance).

Energy ⇒ $10 \times 4 = 40Wh$ →

$F =$ Force → load.

$S =$ distance travelled.



$t = \dfrac{\cancel{4000h}}{\cancel{40W}} \quad \cancel{4h}$

$= \dfrac{40J}{40W} = 1s.$

→ for PowerTrain.

Energy :→ How much further the vehicle can go carrying the load.

chemical → electrical

Battery Pack ← Stores energy.

Electrical energy $= P \times t$

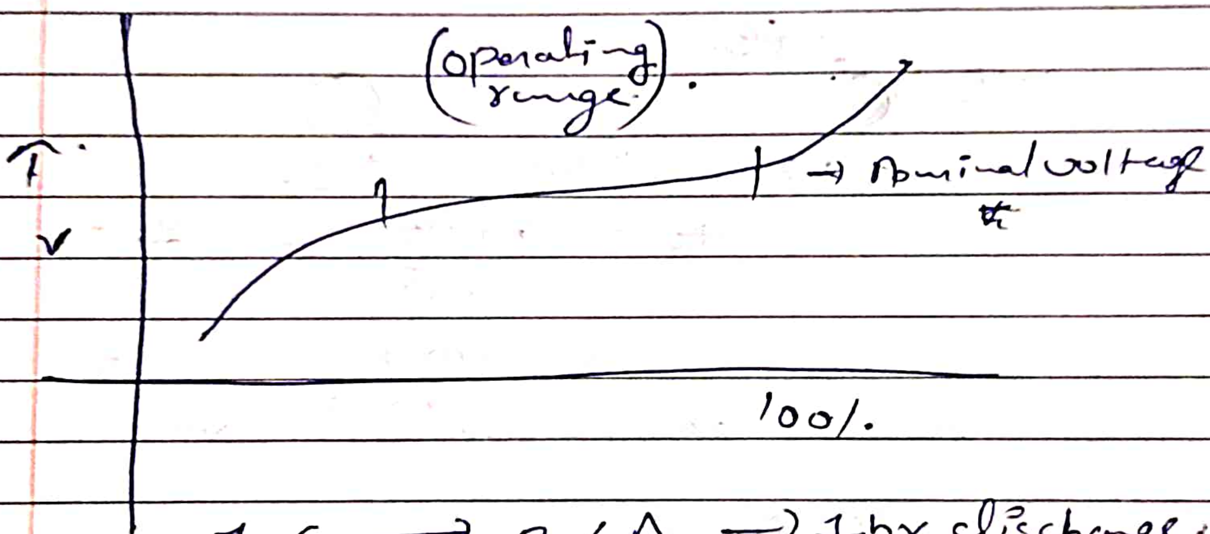
$= V \times I \times t$

Voltage × current × time.

Gagina Pandri

Nominal voltage → V.
Nominal Capacity → C (Ah) → Amphere hour.

NMC 18650 → Nominal voltage → 3.6V.
Nominal capacity =).



1C → 2.6A → 1hr discharge.
2C → 5.2A → 30 minute.

Nominal Energy → Nominal voltage × Nominal capacity

$= 3.6 \times 2.6 \times 9.36 Wh$.

$P = V \times I = V \times A = W$.

Voltage Current. energy.

Power (EVs).

→ Power → Motor Power Rating.

Voltage → Motor voltage / controller voltage Rng.
(upper & lower cutoff

48V ← 60 Volt Motor → 72V.

operating range.

49V
Lower cutoff

70/71V.
Upper cutoff

Subject :

⇒. Energy :→.

EVs :

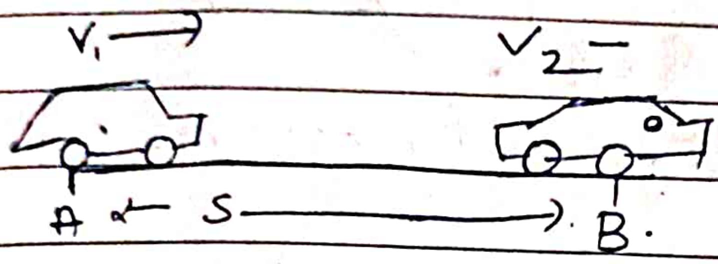
Energy Consumption → (Wh/km)
(Milage) in electrical vehicle.

1 Wh → 1 unit of electricity/
40 kWh → 40 u/s.

1000 Wh → 1 unit

Energy Consumption Pt 02.

- Energy consumption calculation :-



Energy consumed → ΔE.

Energy consumed = Kinetic energy of vehicle + Energy lost on resistance

Kinetic energy of vehicle $= \Delta KE = \frac{1}{2} m (V_2^2 - V_1^2)$.

Energy lost on resistance

$$\Rightarrow \underbrace{(R_a + R_R + R_g)}_{\text{Resistive force.}} \times \text{distance travelled.}$$

$$= (R_a + R_R + R_g) \times S.$$

$$\Delta E = \Delta KE + (R_a + R_R + R_g) \times S$$

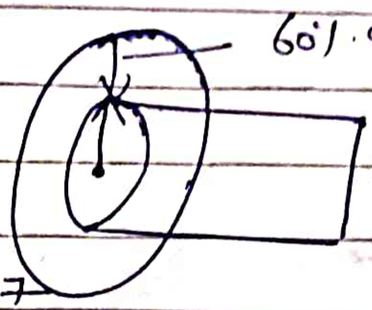
Energy consumption → $\Delta E'$

$$\boxed{\Delta E' = \frac{\Delta E}{S}}$$

Subject :

*. Vehicle.

mass $\Rightarrow m = 1100\,kg$.



60% of 270.

PM.

wheels = 270/60R17

wheel radius $= \left(\frac{17 \times 25.4}{2}\right) + \left(\frac{270 \times 60}{100}\right)$

$= 377.9$.

front projected area $= 2.1\,m^2$

$\mu_r = 0.02$

$C_d = 0.26$

$\rho = 1.225\,g/m^3$.

Assue. $\theta = 0^\circ \Rightarrow$ Ground is flat.

* Aerodynamic Resistance.

$R_a = \frac{1}{2} \times \rho \times C_d \times A \times V^2$

Intial acceleration.

at $t=0 \rightarrow v = 0\,m/s$.

$t = 5s \rightarrow V = 60\,kmph = \frac{60 \times 5}{18} = 16.67\,m$

$\Rightarrow$

$$S = ut + \frac{1}{2}at^2 = \frac{1}{2}at^2$$

$$= \frac{1}{2}\frac{(v-u)}{t} \times t^2$$

$$= \frac{1}{2} \times V_2 \times t^2$$

$$= \frac{1}{2} \times V_2 \times t$$

$$= \frac{16.67 \times 5}{2} = 41.67m.$$

Aerodynamic Force.

$$R_a = \frac{1}{2} \times \rho \times C_d \times A (V_2^2 - V_1^2)$$

$$= \frac{1}{2} \times 1.225 \times 0.26 \times 2.21 \times (16.67)^2$$

$$= 97.80N.$$

Rolling Resistance. $\Rightarrow \mu_r = 0.02.$

$$R_e = \mu_r . mg = 0.02 \times 1100 \times g$$

$$= 0.02 \times 1100 \times 9.81$$

$$= 215.82N.$$

$$R_g \Rightarrow mg \sin\theta \Rightarrow 0N$$