IVE Engineering 工程 SOPHIE SGDC SMART CITY INNOVATION CENTRE

新視野，未來感

新能源新世代 2025

一年一度的中學生太陽能車比賽盛事 //
組別包括大車, 細車, 氫能車,太陽能船及滑翔機

可載人太陽能車(大車) 工作坊二
車輛動力ABC

工作坊內容

01 1)初談高效節能設計
1月25日

02 車輛動力ABC
2月15日

03 電力驅動技術 I
3月15日

04 電力驅動技術 II
4月5日

05 車身設計大不同
5月17日

06 太陽能車攻略
7月13日

關鍵問題

1) 1輛太陽能車的關鍵因素是什麼？
2) 您的設計是為了速度還是耐力？

主題

車輛動力ABC

1) 車輛動力

2)車架及車內防滾架 介紹

3)煞車系統

4) 太陽能板發展

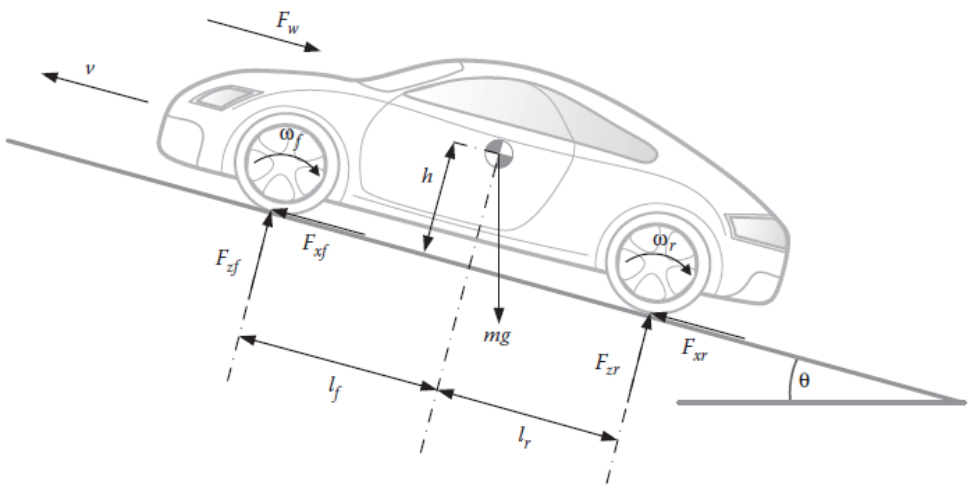
力學

a) 滾動阻力 Rolling Resistance

b) 空氣阻力 Wind Resistance

c) 加速 Acceleration

d) 上坡 Climbing(Gradient)



如何減少能源消耗

滾動阻力：

重量輕

車軸軸承/細輪胎

繞組電阻：

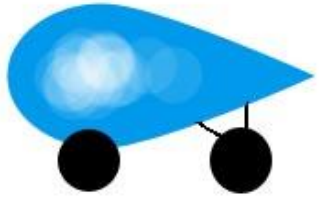
額面積小

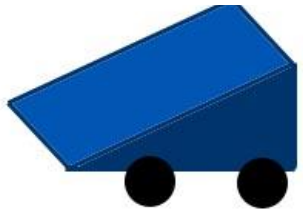
光滑的形狀

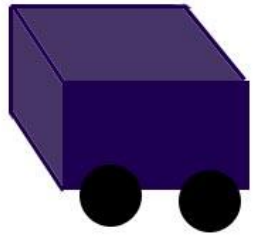
加速度：

重量輕

哪種車身最快？







如何減少能源消耗

5 個設計太陽能車的技巧

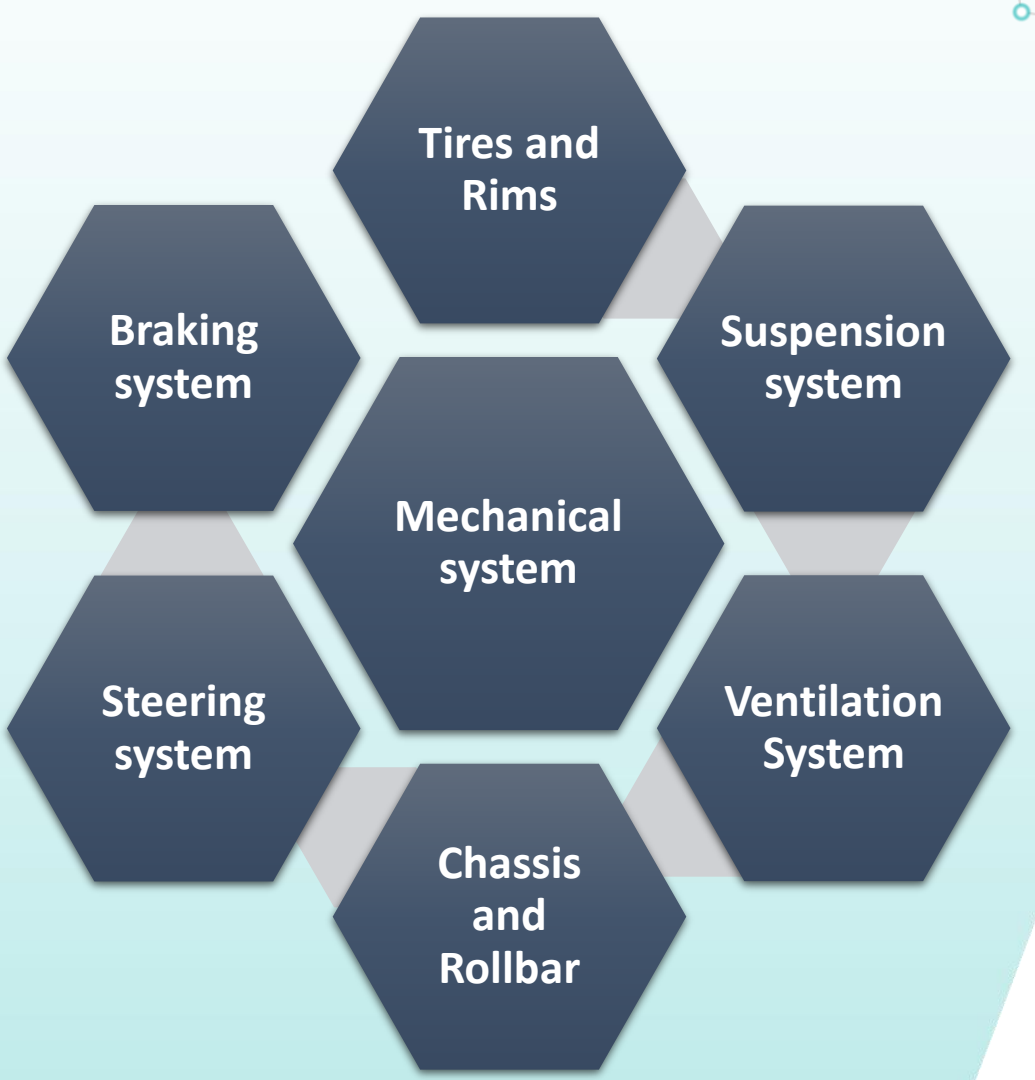
1. 減少正面面積
2. 減低摩擦
3. 讓表面變得光滑
4. 減重
5. 太陽板安裝

如何減少能源消耗

在建造太陽能車之前，
首先需要做什麼？

	重要部件
1	車身結構 Bodyshell
2	車架及車內防滾架 Chassis and Rollbar
3	車輪和輪胎 Wheels and tires
4	煞車系統 Braking system
5	安全帶 Safety belts
6	馬達 Motor
7	太陽能板 Solar Panel
8	電池組 Battery pack
9	車指示燈 Lighting
10	車輛喇叭 Horn
11	通訊 Radio
12	滅火器 Fire Extinguisher

機械部件


Tires and Rims
Braking system
Suspension system
Mechanical system
Steering system
Ventilation System
Chassis and Rollbar

車架及車內防滾架 Chassis and Rollbar

- 車架是車的重要結構
- 具有各種機械部件的框架，如煞車、轉向和車輪
- 由輕金屬或複合材料製成，提供支撐車輛部件和負載所需的強度

車架及車內防滾架 Chassis and Rollbar

Monique Chassis

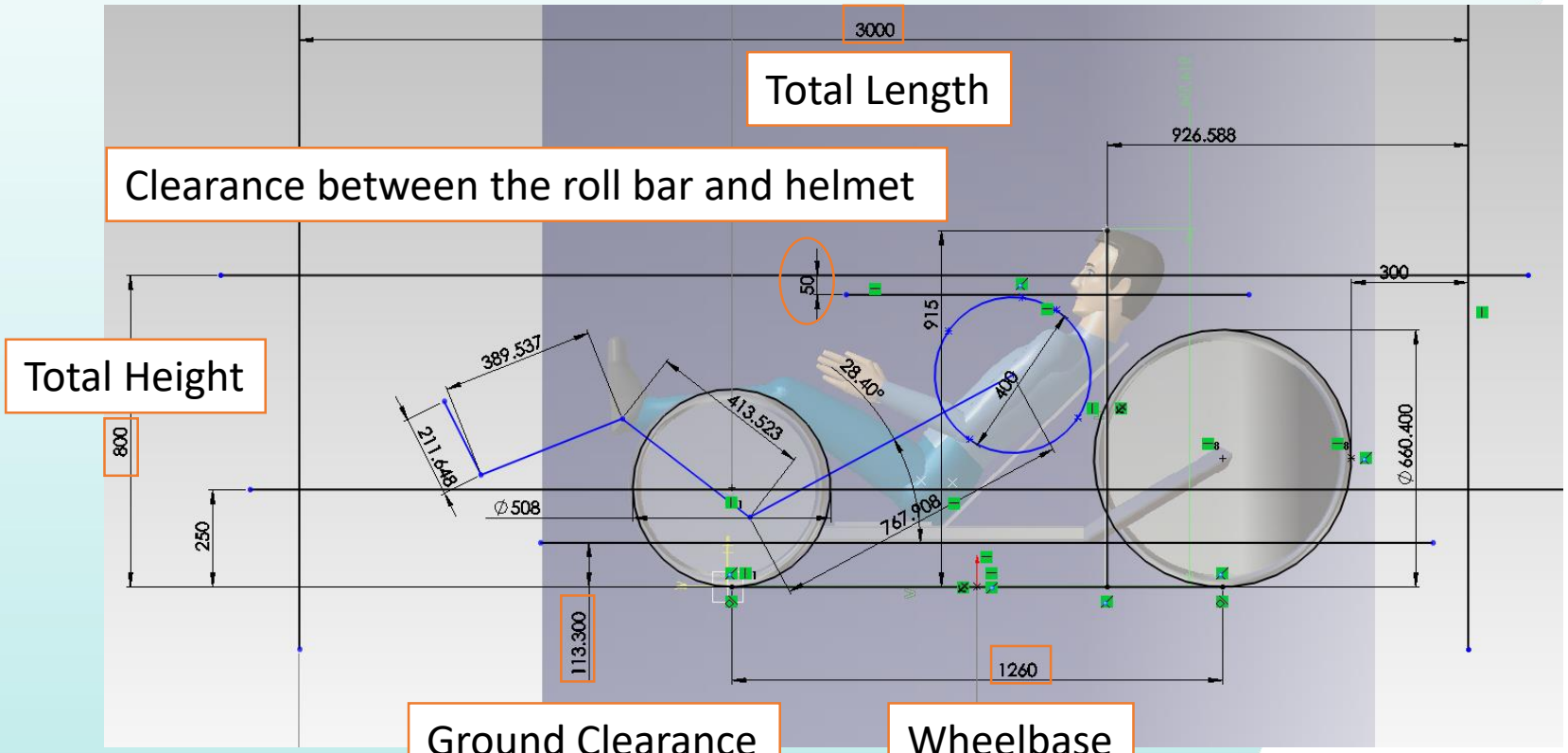
車架及車內防滾架 Chassis and Rollbar

三輪車 (Recumbent Trike)

車架及車內防滾架 Chassis and Rollbar

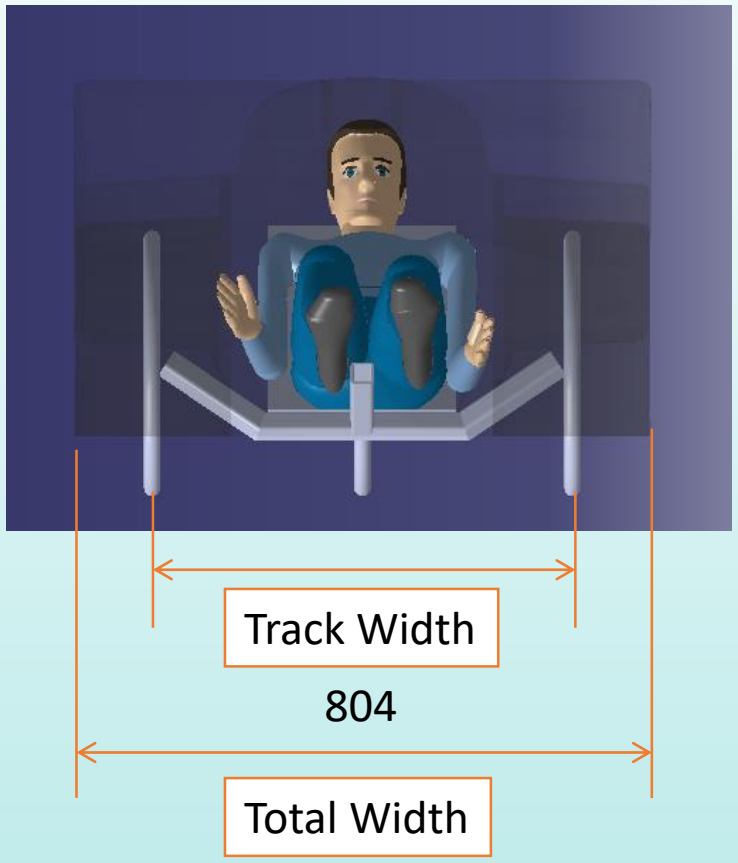
車架及車內防滾架 Chassis and Rollbar

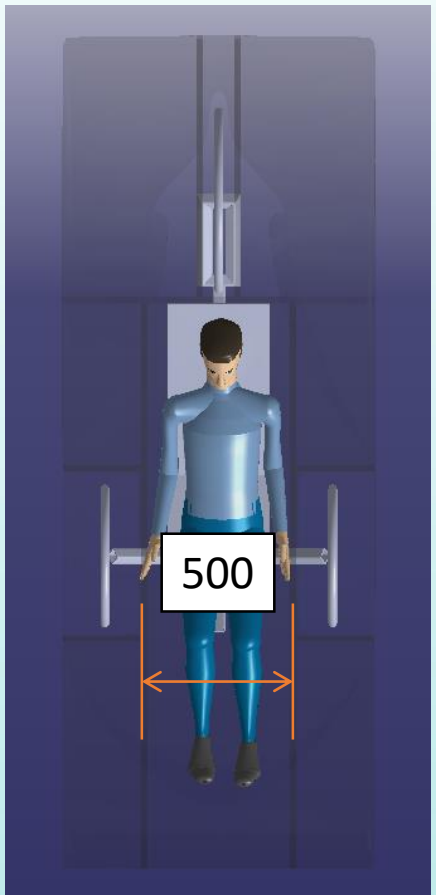
尺寸 Dimensions



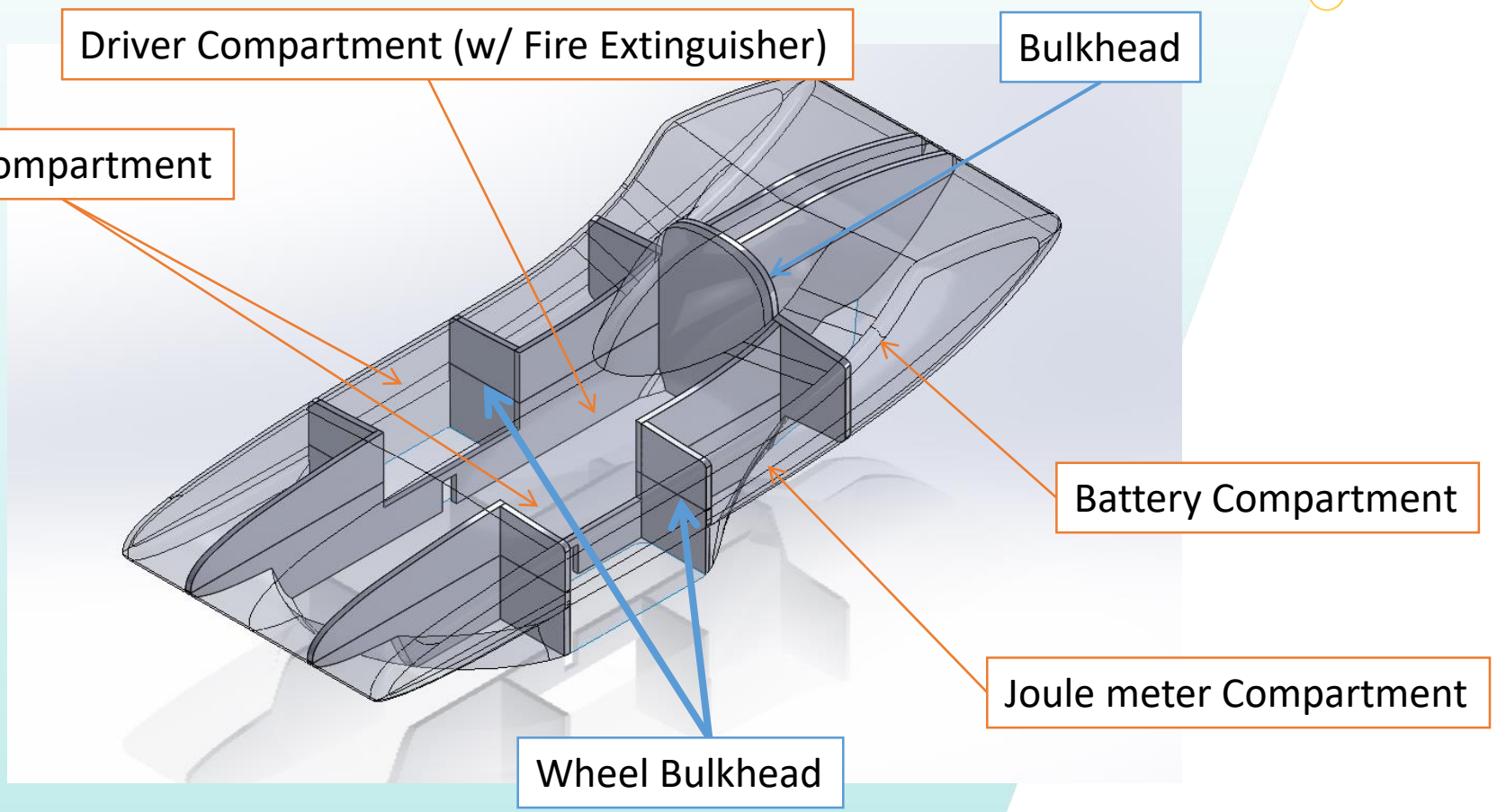
車架及車內防滾架 Chassis and Rollbar

尺寸 Dimensions

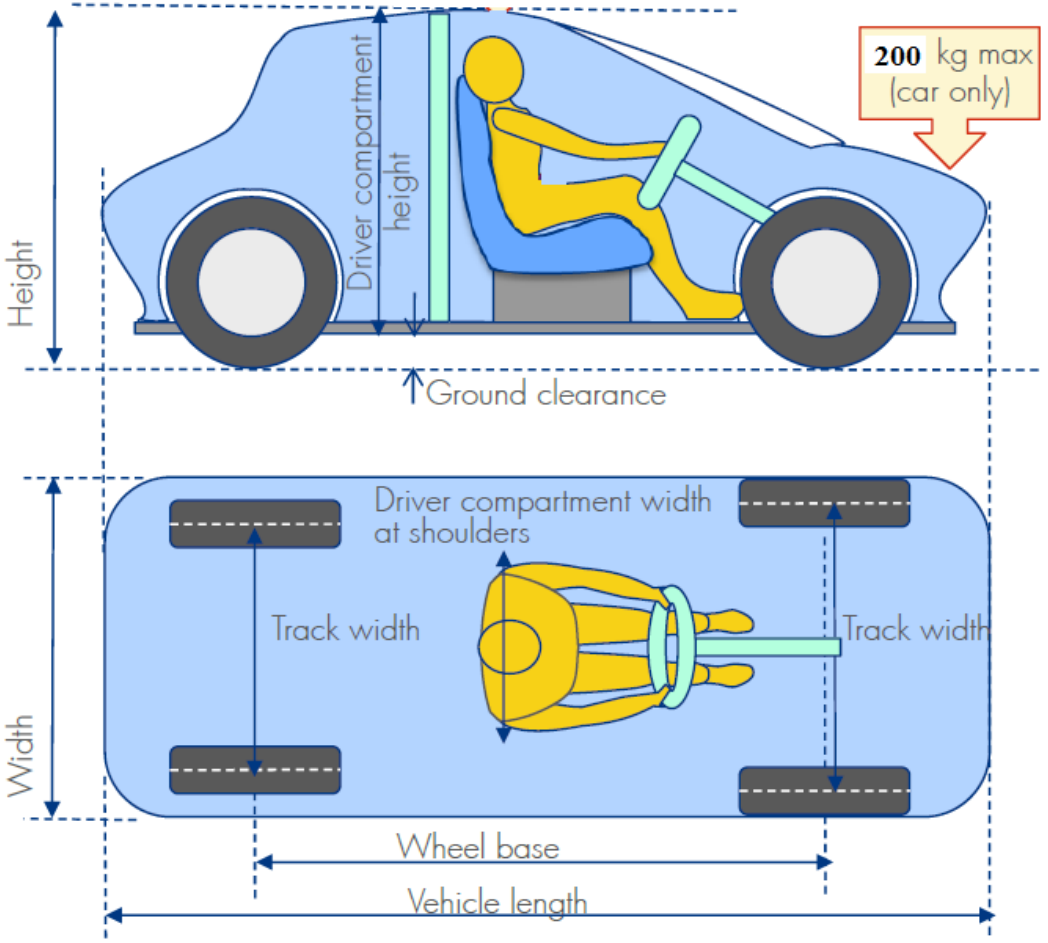




車架及車內防滾架 Chassis and Rollbar



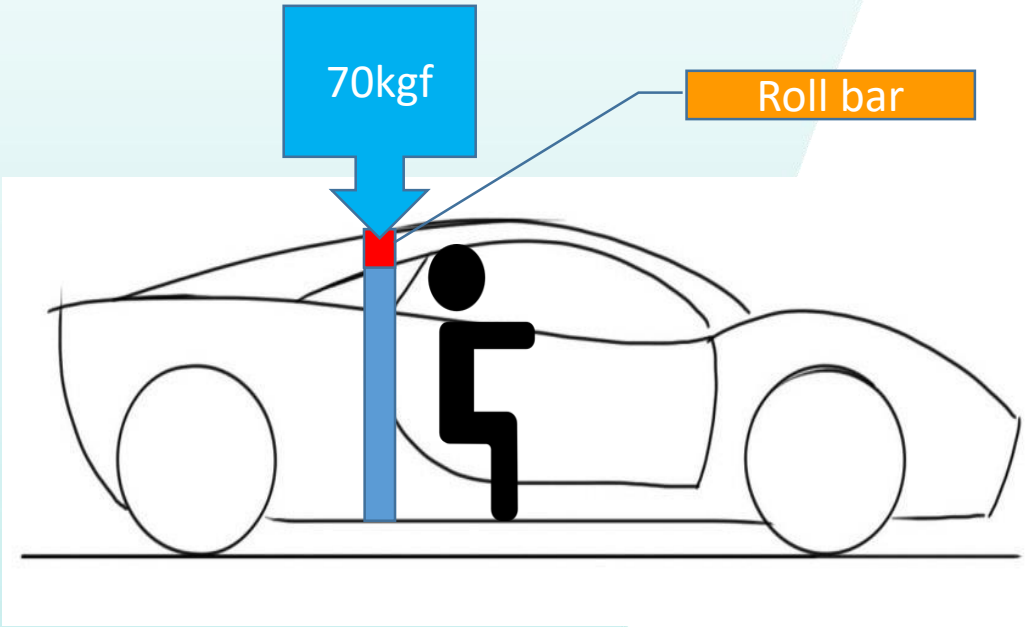
Dimension	Limits
Max. Height	1300mm
Max. Width	1300mm
Max. Length	3500mm
Track width	At least 1000mm(front axle); 800mm (rear axle) if applicable
Wheelbase	>1200mm
Ground clearance	>100mm
Max. vehicle weight (without driver)	225 kg



車架穩定性

- Chassis / Monocoque
  - Must be solid
  - Wide and long enough to protect driver

- Roll bar
  - >50mm above helmet
  - extend beyond shoulders
  - withstand 70kgf



煞車系統

- 制動器是一種透過吸收運動系統的能量來抑制運動的機械裝置。
- 它用於減慢或停止移動的車輛、車輪、車軸，或防止其運動，通常透過摩擦來實現

煞車系統 Braking system

2

2個獨立的煞車系統
Independent Braking System

- 主要煞車系統 Primary Braking
- 停車煞車系統 Parking Braking

即使其中一個系統失靈，亦能夠煞停車輛！

Ensure the car can STOP moving! Even one of them FAIL!

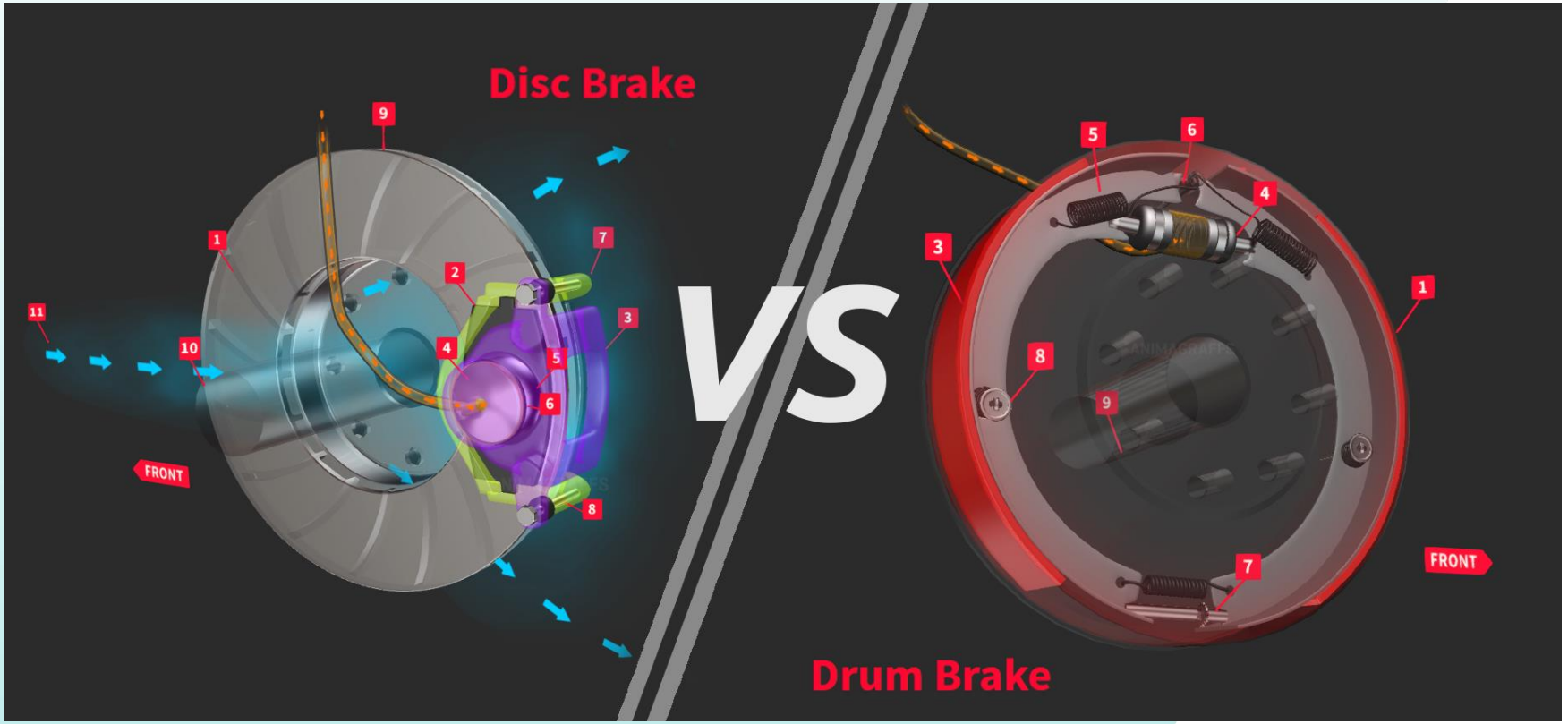
煞車系統 Braking system

煞車 Brake

- 2 Independent system
- 4 Wheels
  (Front Left, Right Wheels, and Rear Left , Right Wheels)
- Control : Pedal / Brake lever
- Disc / Drum braking
- Hydraulic /Mechanical method

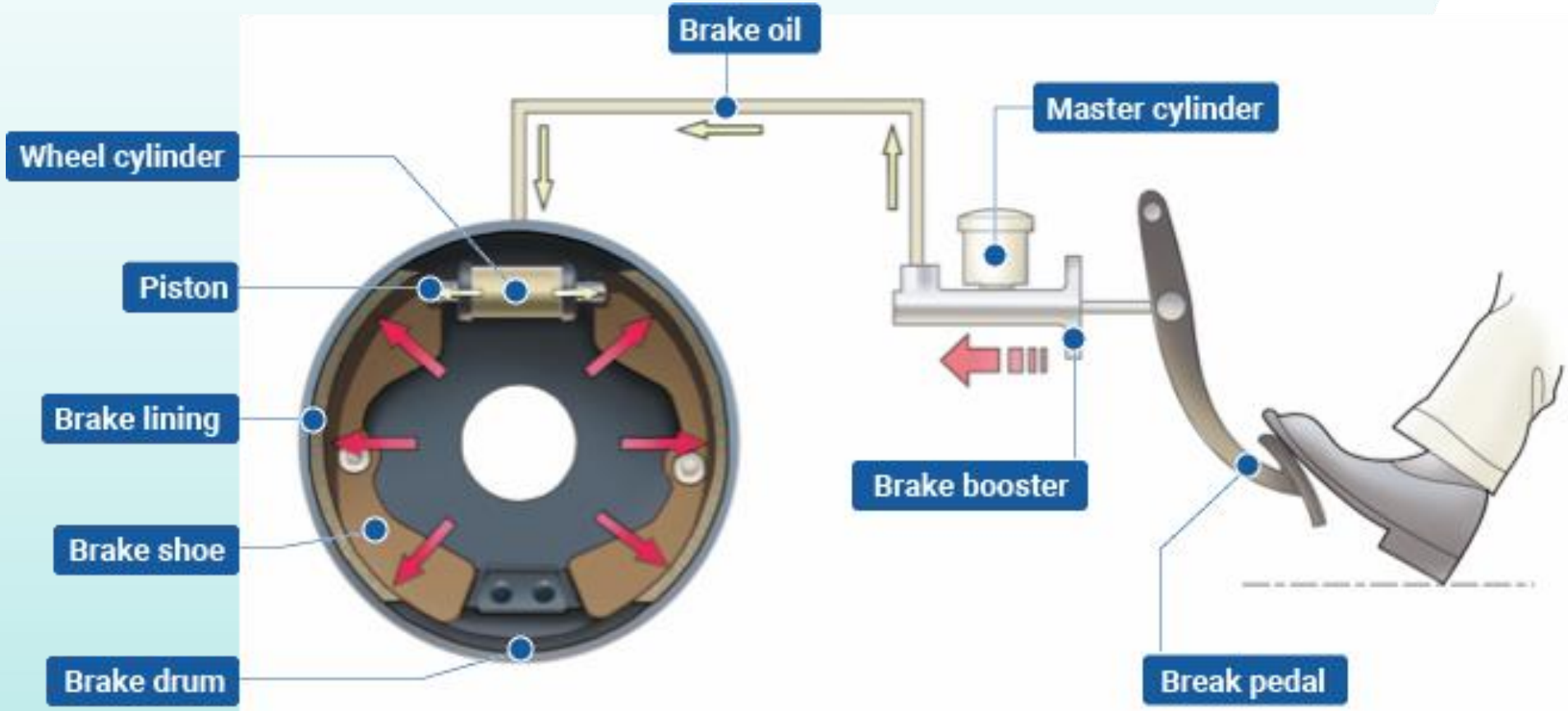
煞車系統 Braking system

碟式/鼓式 煞車器 Disc/Drum Brake



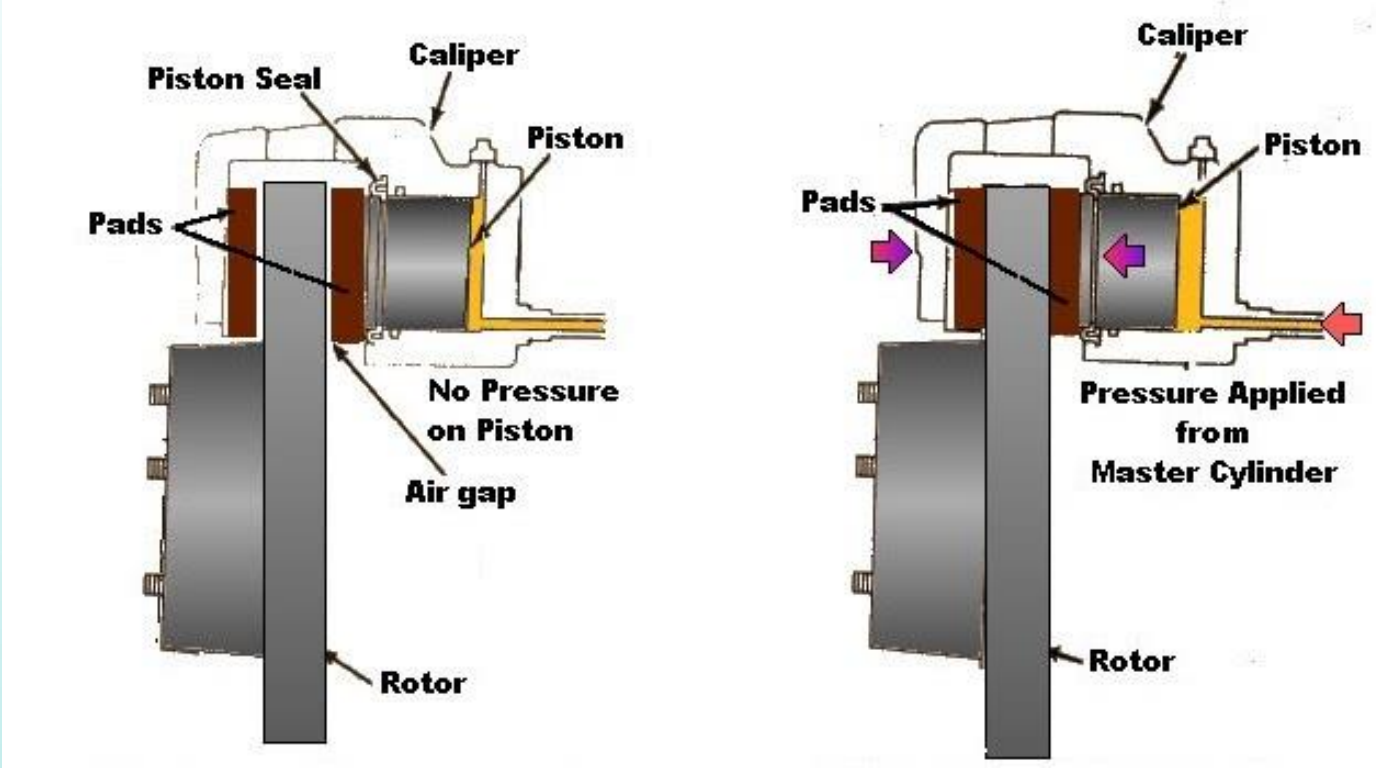
煞車系統 Braking system

鼓式 煞車器 Drum braking



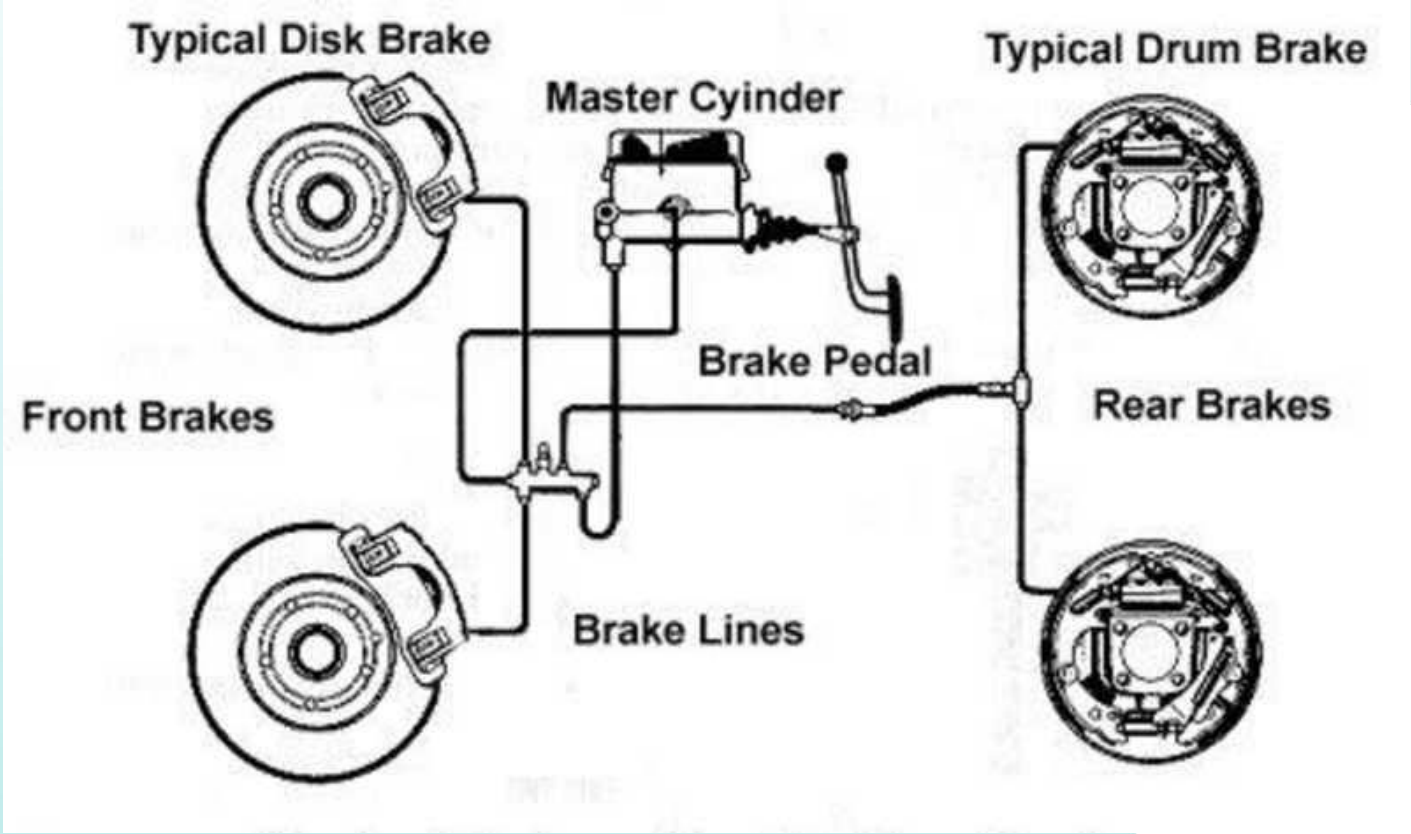
煞車系統 Braking system

碟式 煞車器 Disc Brake



煞車系統 Braking system

油壓 Hydraulic method



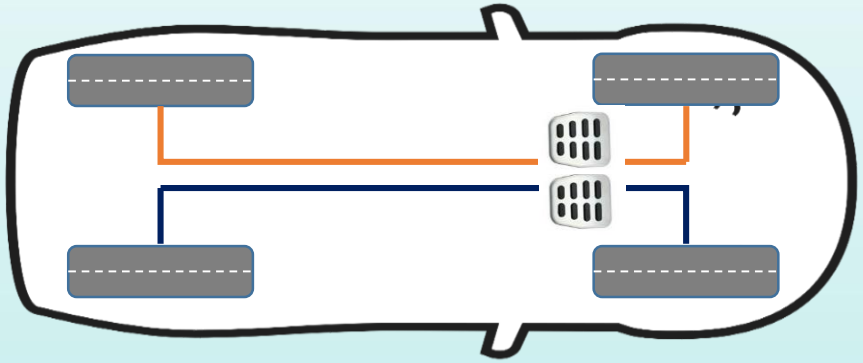
煞車系統 Braking system

Mechanical Method剎車拉線 (Cable Braking)

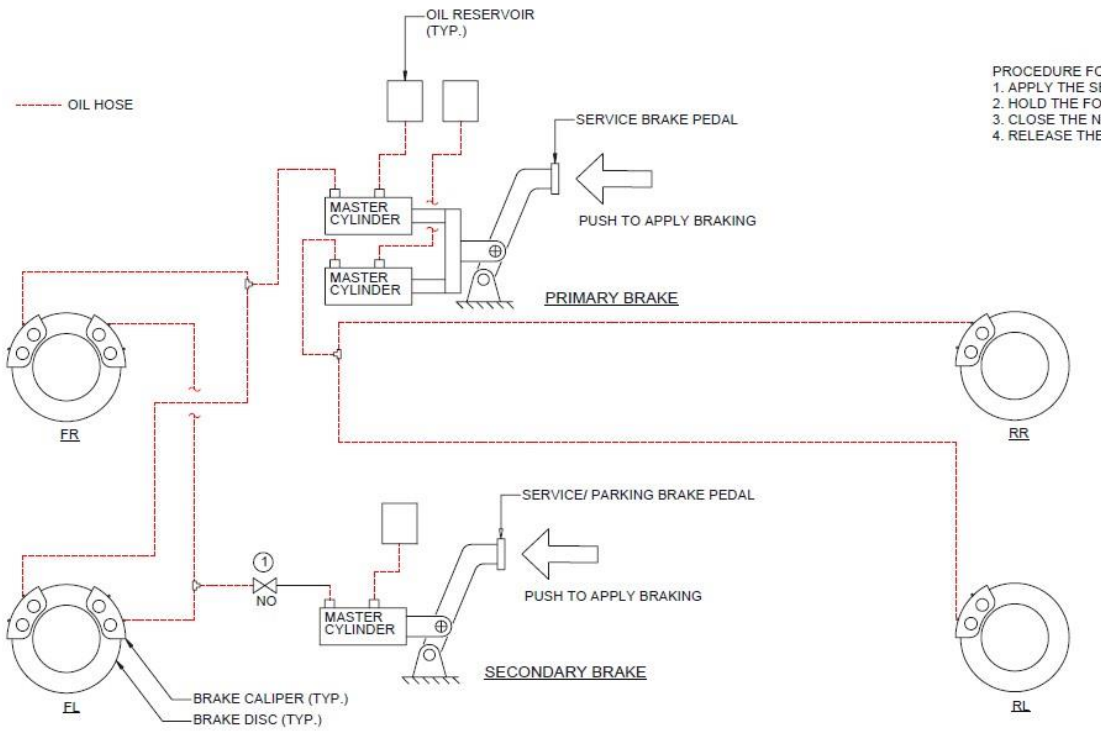
煞車系統 Braking system

Caution: Each system must NOT act only one side of wheels

Wrong connection

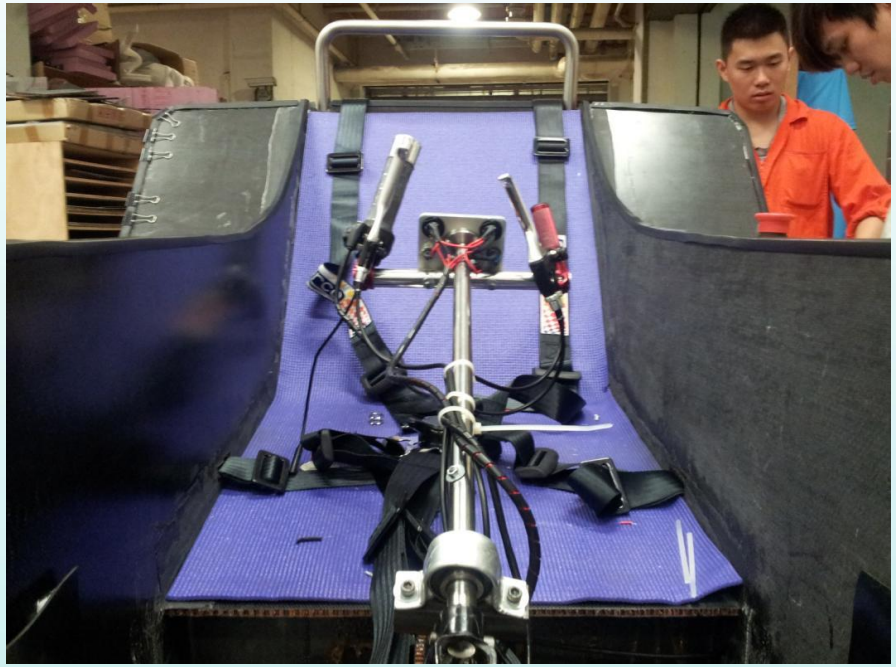


煞車系統 Braking system



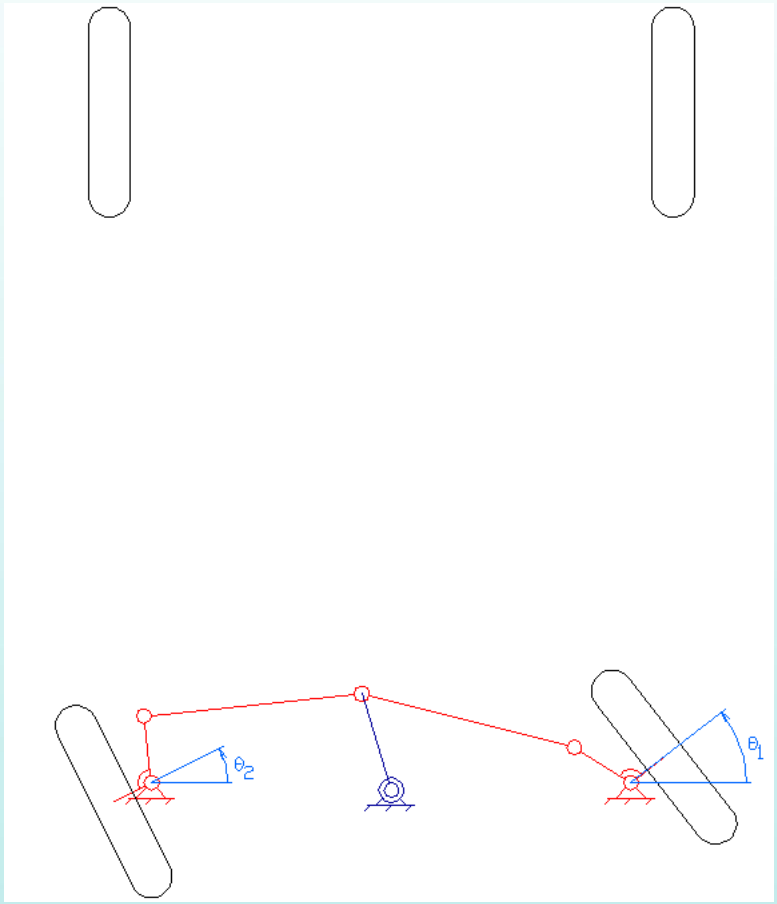
SOPHIE VI BRAKING SYSTEM DESIGN

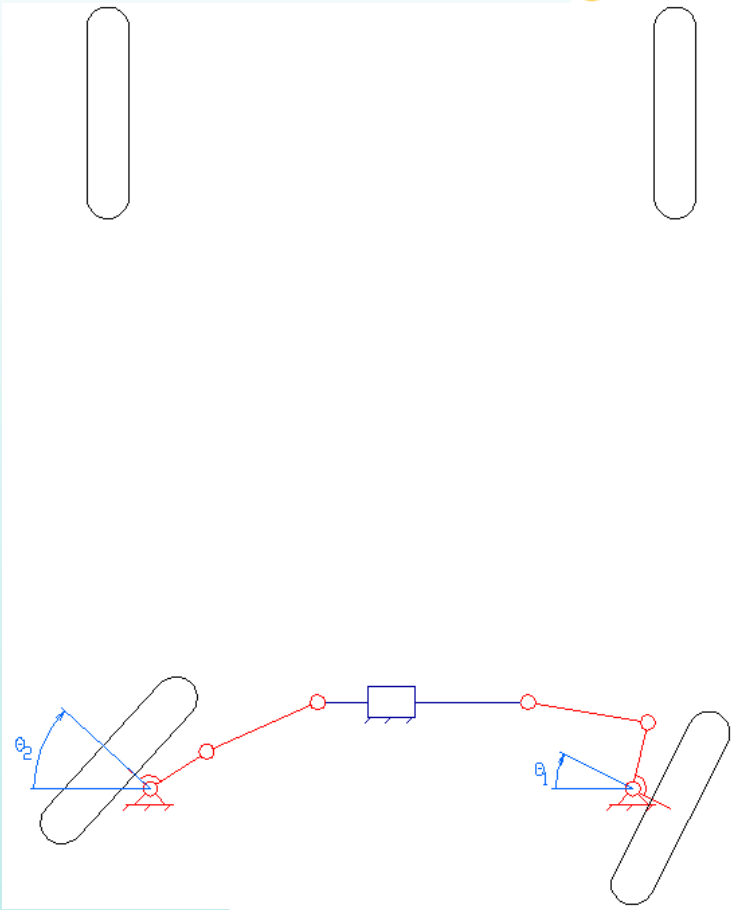
轉向系統 Steering system



The function of a steering system is to convert the rotary movement of the steering wheel in driver's hand into the angular turn of the front wheels on road.

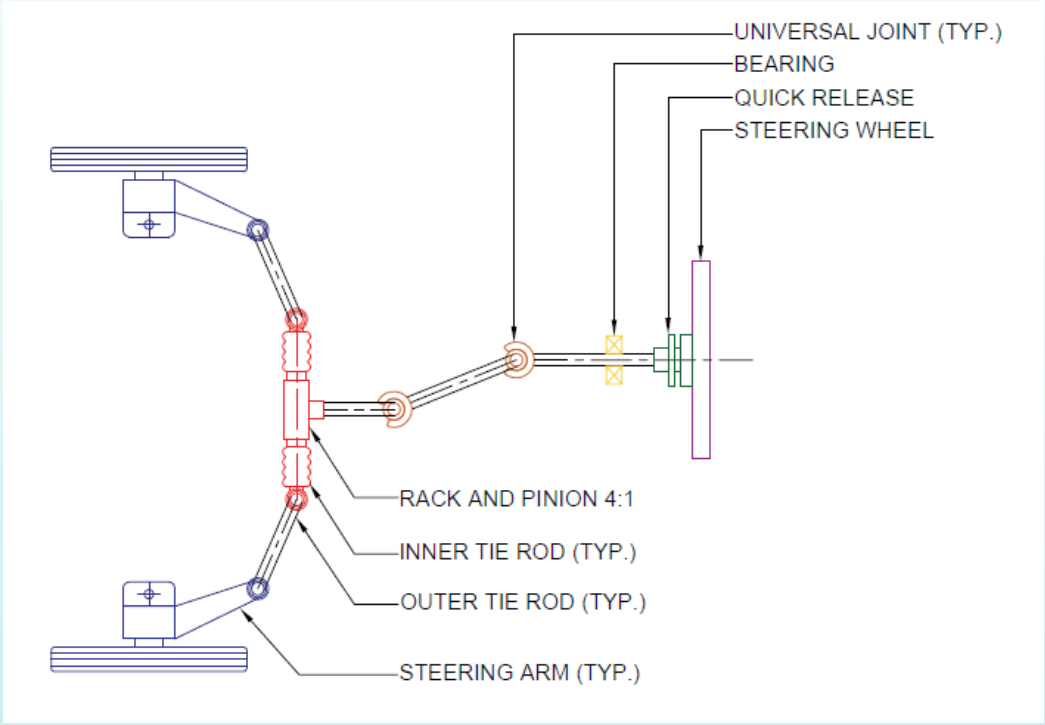
轉向系統 Steering system





轉向系統 Steering system

轉向系統 Steering system



How many deg of steering wheel need to turn?

From Catalogue:

Rack and pinion 6.4:1, 360deg->119.68mm

From Sophie V dimension:

R_{sa}= 250mm

δ_s = 20 deg

$$\tan \delta_s = \frac{travel}{R_s}$$

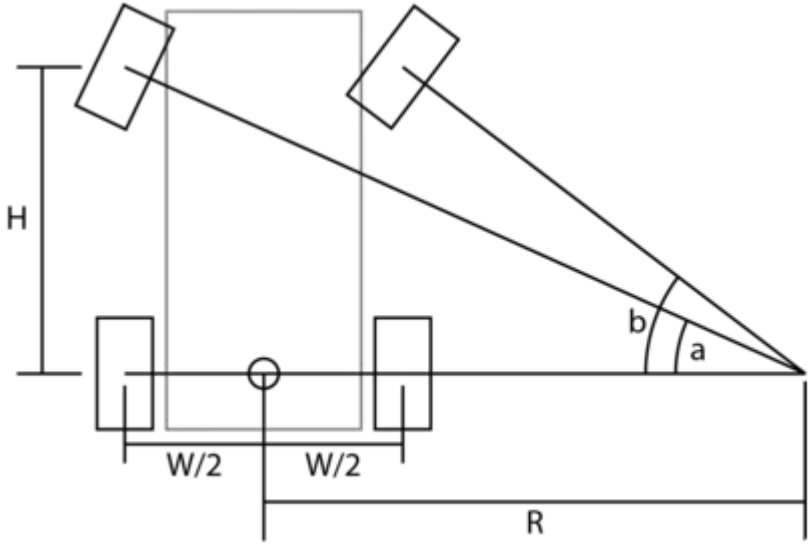
Ans: 273 deg

轉向系統 Steering system

$$\tan b = \frac{H}{R - \frac{W}{2}}$$

$$\tan a = \frac{H}{R + \frac{W}{2}}$$

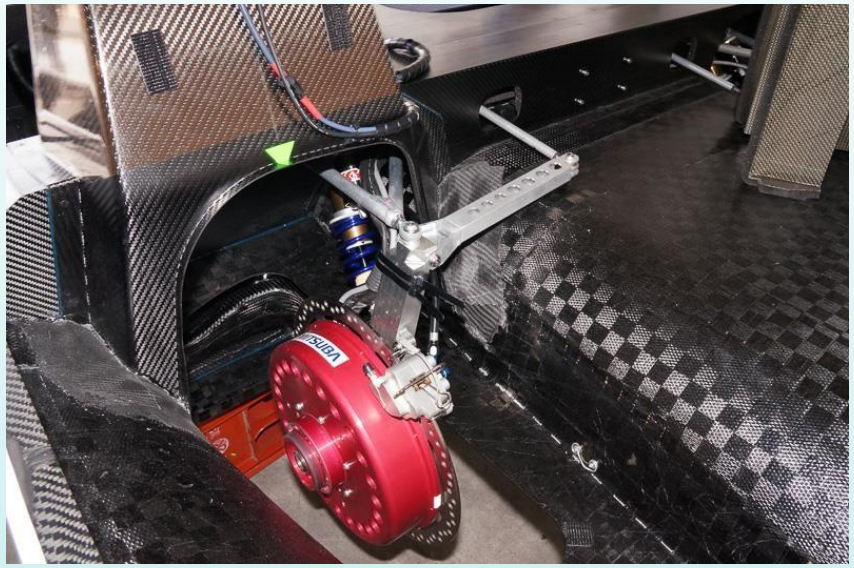
$$R + \frac{W}{2} = 8\ meters$$



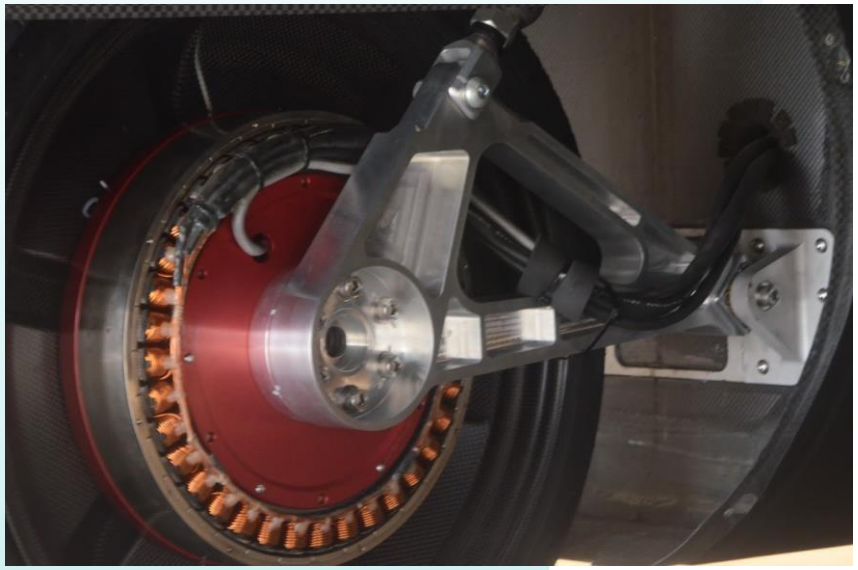
Example:

Car	H(m)	W(m)	Angle a (deg)	Angle b (deg)
Sophie V	2.35	1.4	16.37	19.60
Sophie VI	2.75	1.4	18.97	22.62

懸掛系統 Suspension System

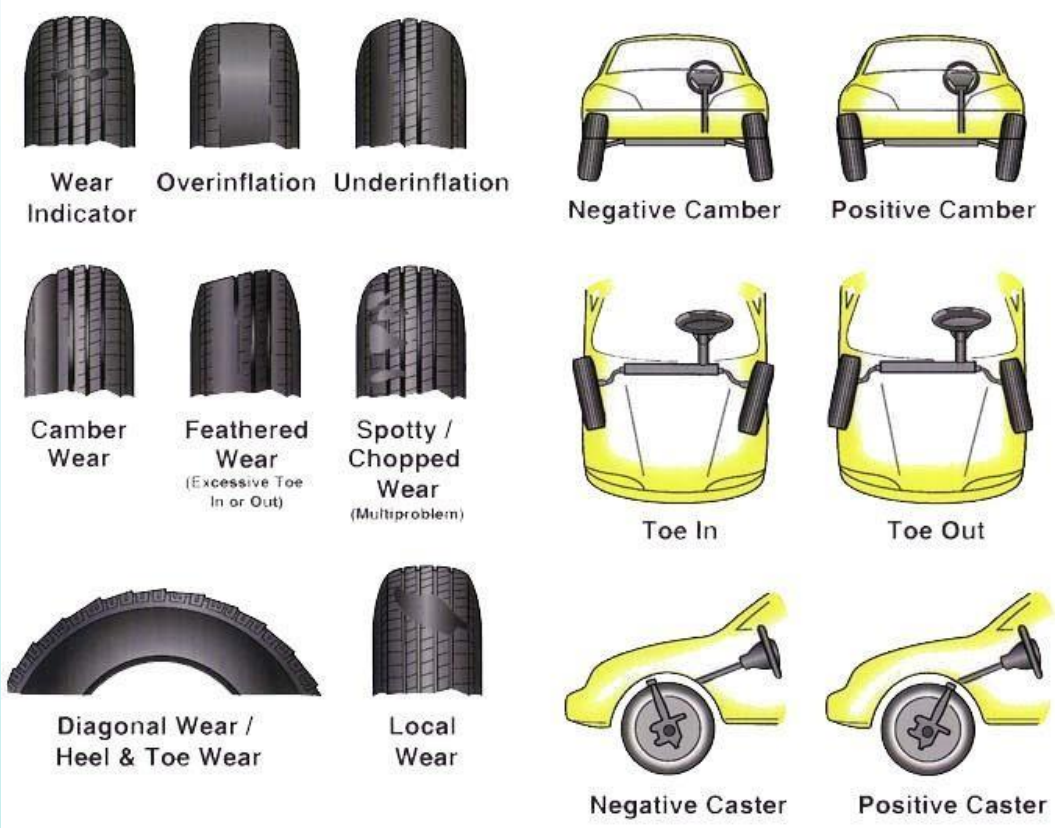


帶轉向的拖曳臂
(Tailing Arm with steering)



拖曳臂
(Tailing Arm)

四輪定位 Wheel Alignments

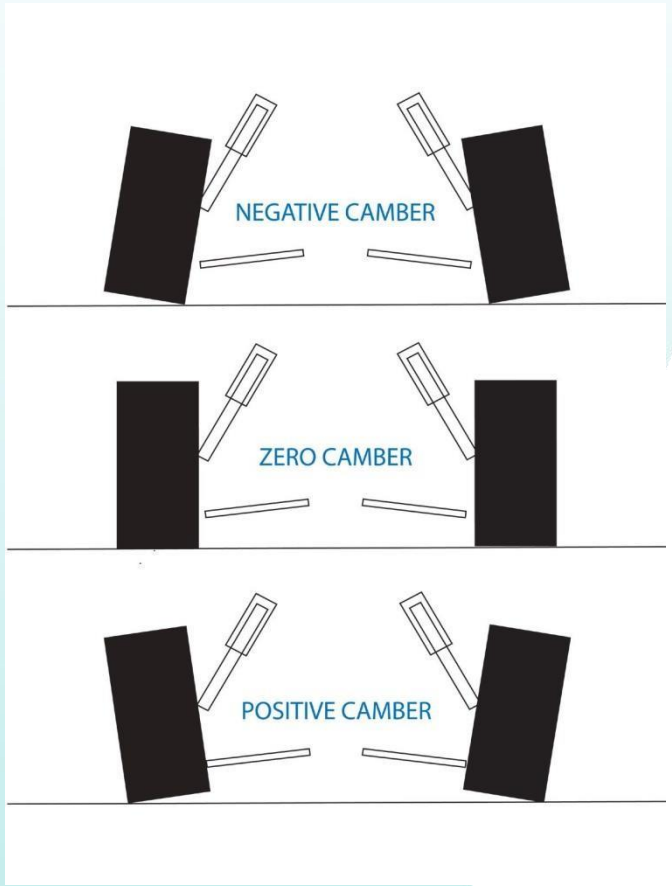


四輪定位 Wheel Alignments

外傾角(Camber)

Target Value:

- 0 ° Front
- 0 ° Rear

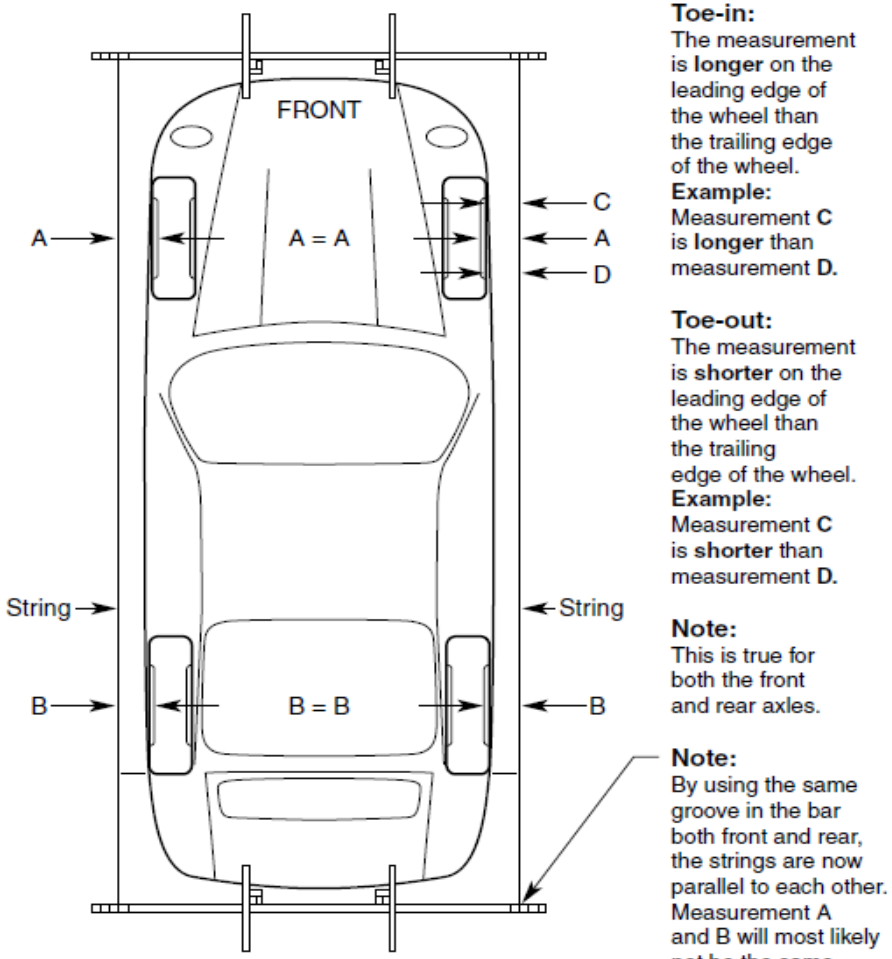


四輪定位 Wheel Alignments

內八字/外八字 Toe in/Out

Target Value:

- Less than 0.25° Front Toe In
- 0mm Rear Toe



Toe-in:
The measurement is **longer** on the leading edge of the wheel than the trailing edge of the wheel.
Example:
Measurement **C** is **longer** than measurement **D.**

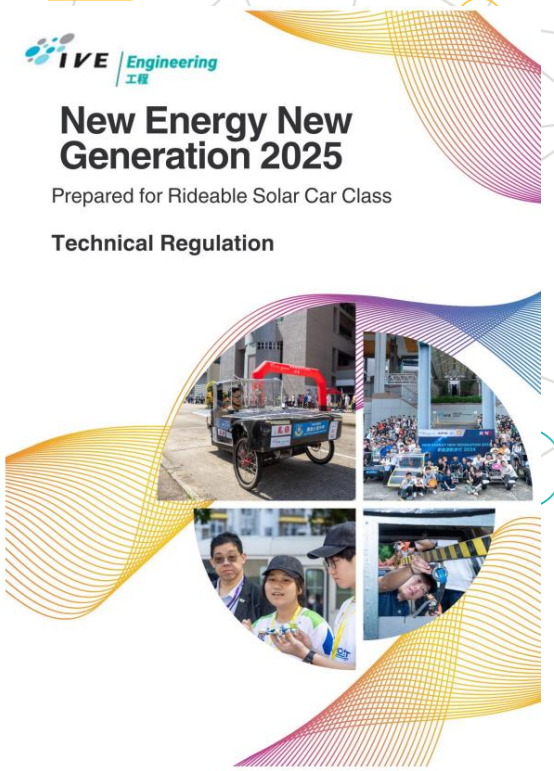
Toe-out:
The measurement is **shorter** on the leading edge of the wheel than the trailing edge of the wheel.
Example:
Measurement **C** is **shorter** than measurement **D.**

Note:
This is true for both the front and rear axles.

Note:
By using the same groove in the bar both front and rear, the strings are now parallel to each other. Measurement A and B will most likely not be the same.

Wheel Alignments

Refer to NENG Rideable Solar Car Regulation 2025



- Ventilation?
- Doors?
- Visibility? Rear vision?
- Lighting? e.g. head light, indicator light, rear light, brake light, etc.
- Horn
- Etc.

IVE | Engineering 工程

SOPHIE

SGDC

SMART CITY INNOVATION CENTRE

小休

能源應用

輸入功率

Input Power

太陽能板→電池→馬達

輸出功率

Output Power

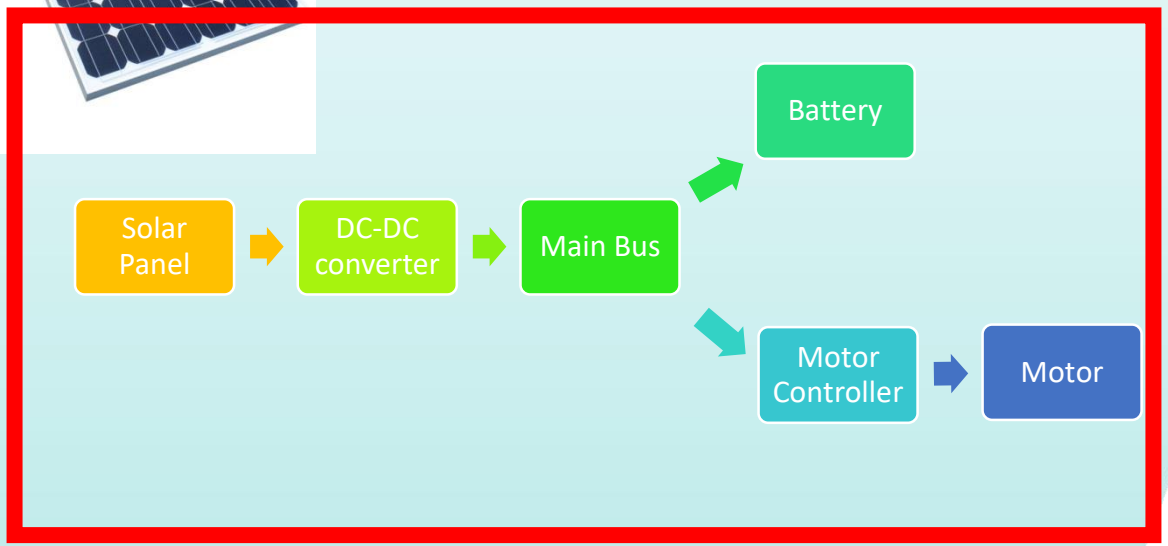
滾動阻力

空氣阻力

加速

主要元件

On-board charging by using solar energy



電能

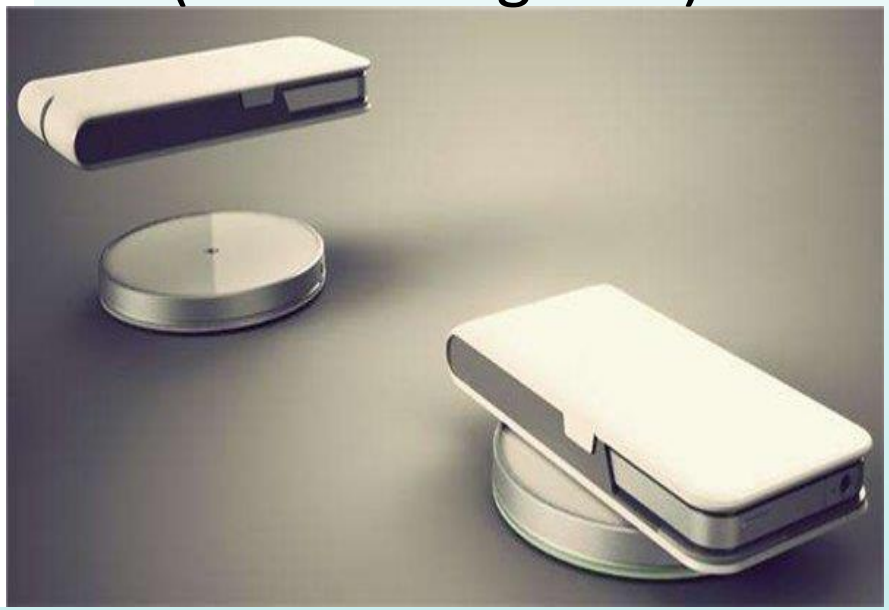
電能(**Electrical Energy)** 是電荷 (electrical charge) 的存在和流動，通常儲存在電池中，並通常透過電線以電子形式傳遞。

例如：電能儲存在車電池中

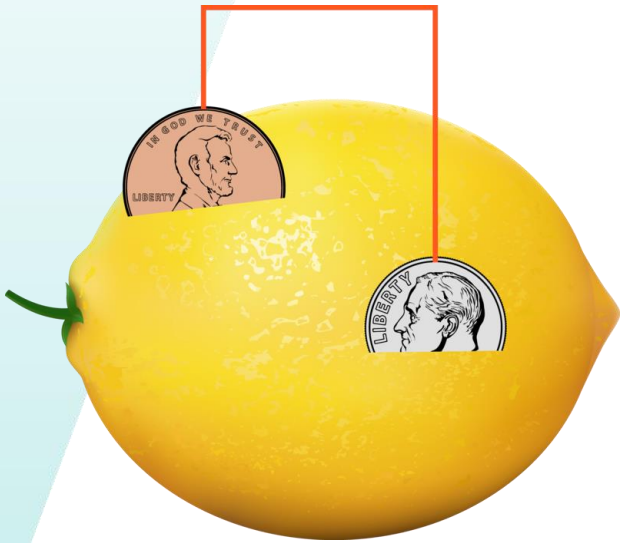
電能

靜電 (Static)

電磁
(Electromagnetic)



電化學反應
(Electrochemical reaction)



基礎電學

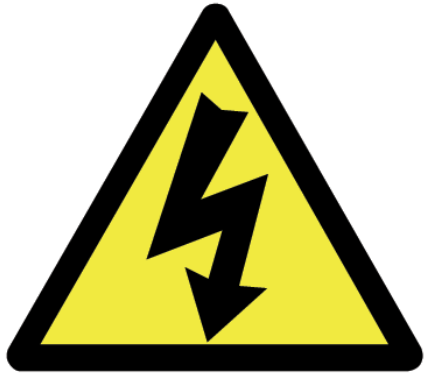
電力擁有自己的單位。在電氣系統中，最基本的三個單位是：

1) 電壓（V）是衡量電流的「推力」。電壓越高，推動電流通過電線的力量就越大。

2) 電流（I）是單位時間內通過一個點的電荷量的度量。

3) 瓦特（W）表示完成工作或使用能量的速率。

V x I =W

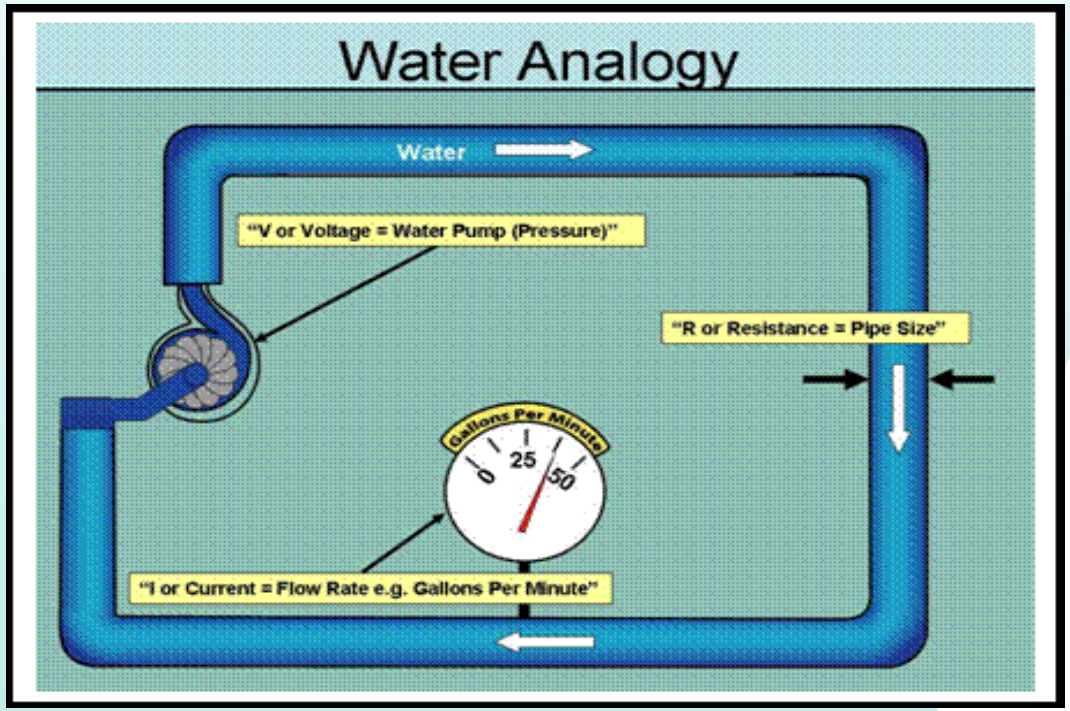


電能

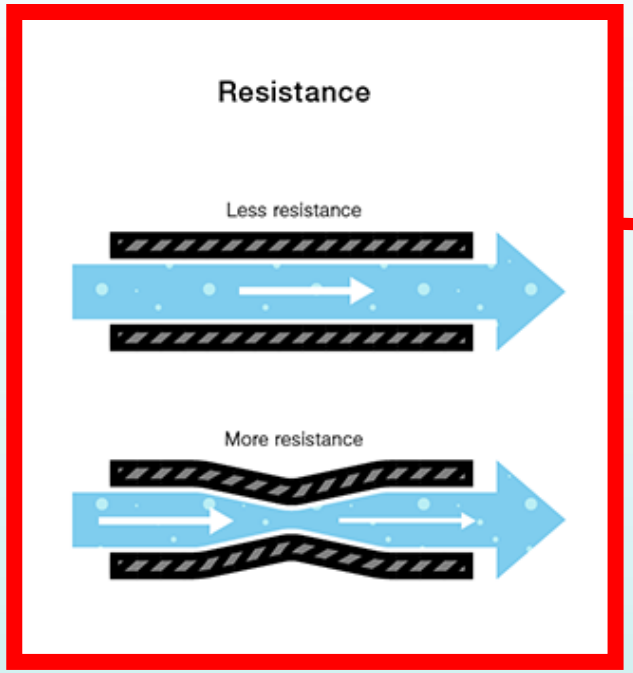
水管類比 (Water Pipe Analogy)

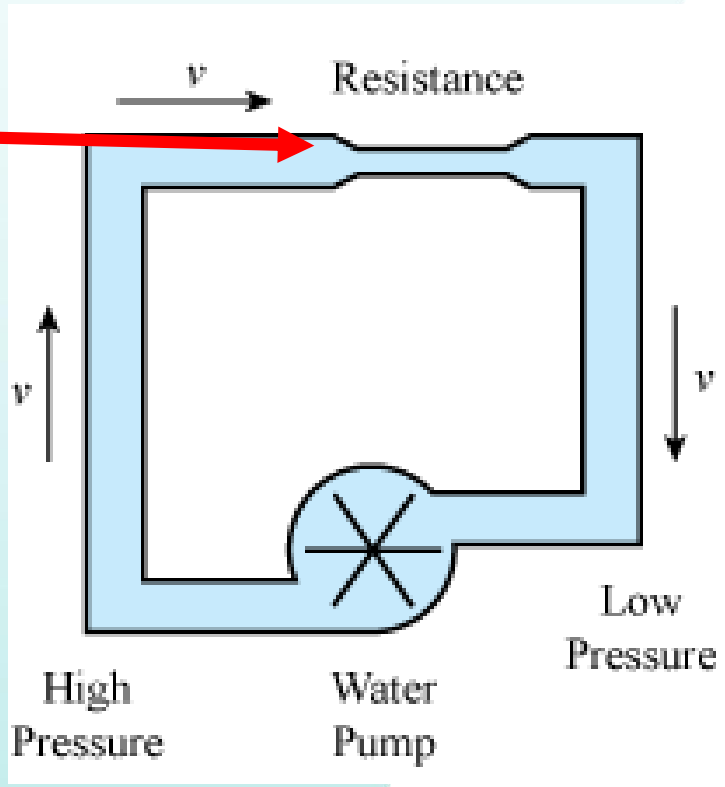
想像一下水管系統，其中水的流動可以類比為電力在電路中的流動。

Electricity: Not-Visible
Water: Visible



電能


Resistance
Less resistance
More resistance


v
Resistance
v
v
Low
Pressure
High
Pressure
Water
Pump

電能

Ohm's Law

Resistance is the opposition that a substance offers to the flow of electric current.

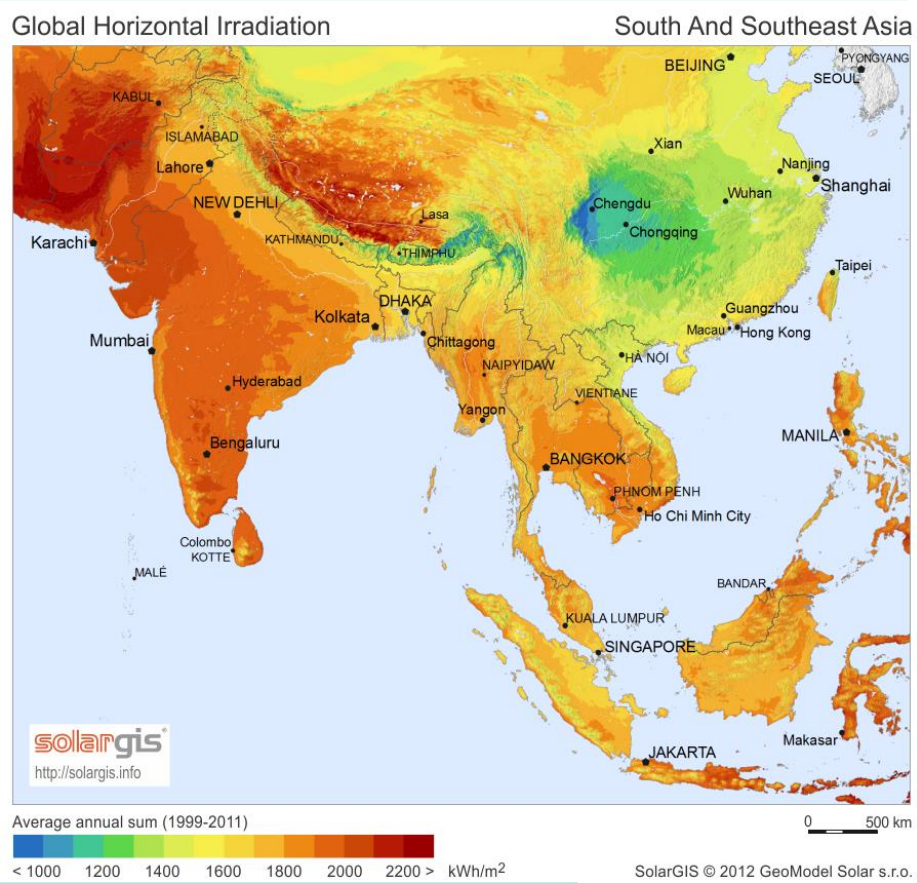
Quantities	Abbreviations	Units	Label
Voltage	V or E	Volts	V
Current	I	Amperes	A
Resistance	R	Ohms	Ω

$V=IR$ $I=V/R$ $R=V/I$

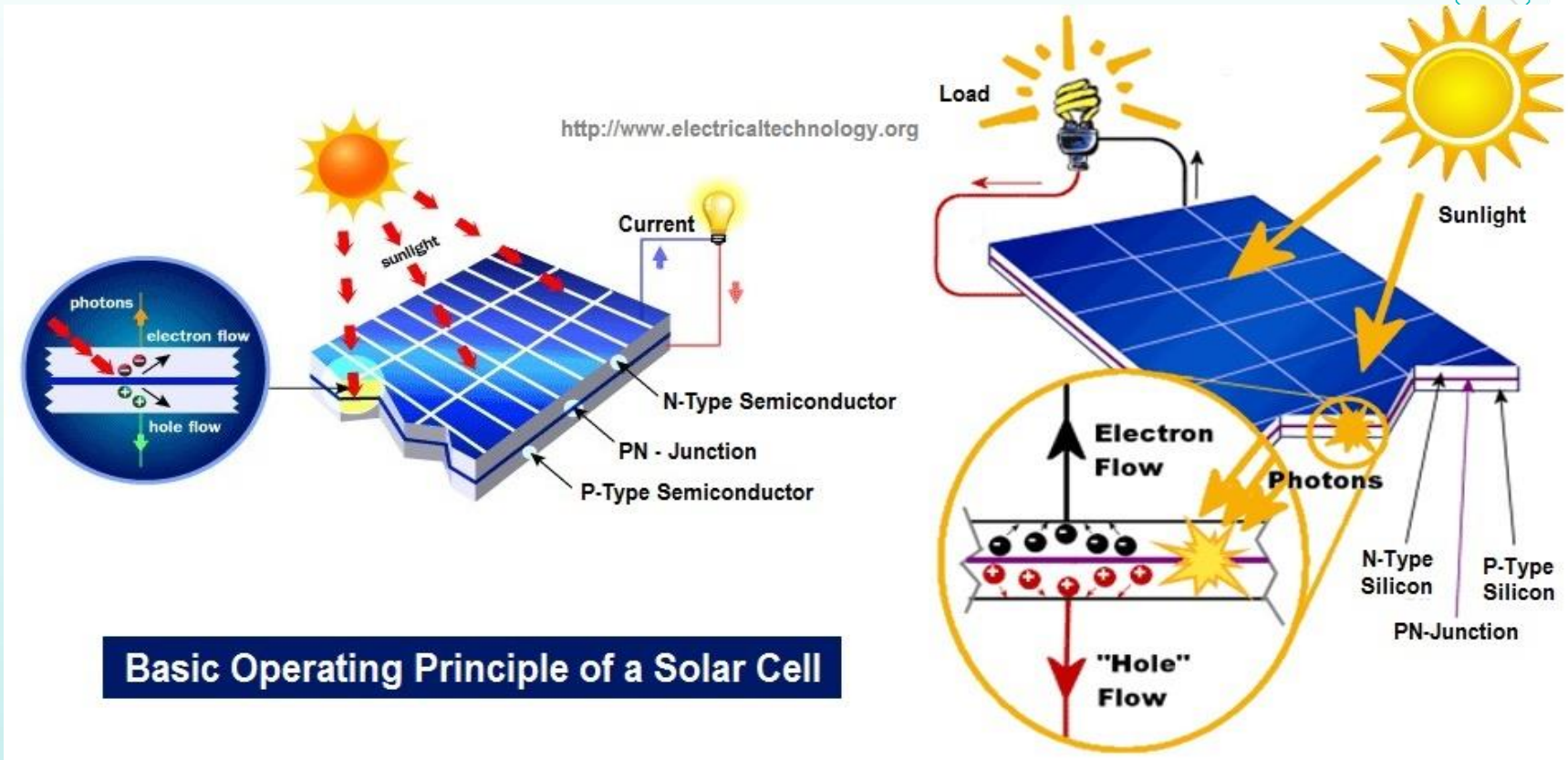
電能

輸入功率 Input power

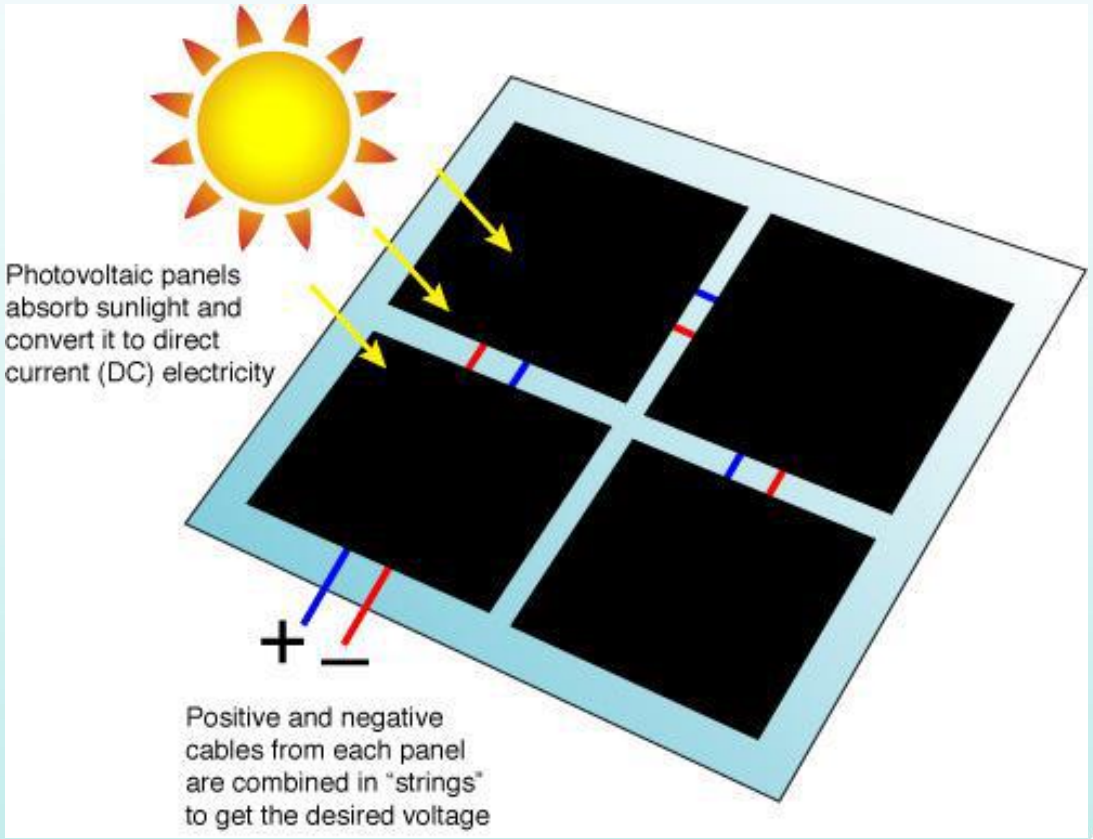
a) 太陽能



太陽能板應用


http://www.electricaltechnology.org
photons
electron flow
hole flow
sunlight
Current
N-Type Semiconductor
PN - Junction
P-Type Semiconductor
Basic Operating Principle of a Solar Cell
Load
Sunlight
Electron Flow
Photons
"Hole" Flow
N-Type Silicon
P-Type Silicon
PN-Junction

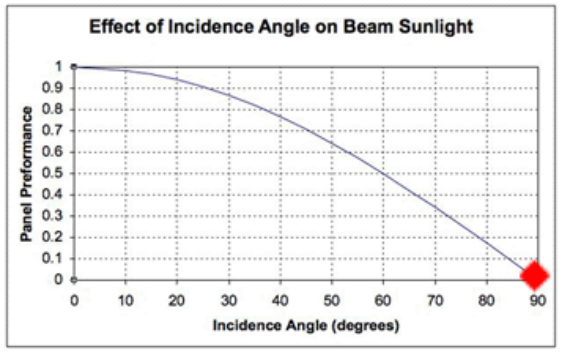
太陽能板

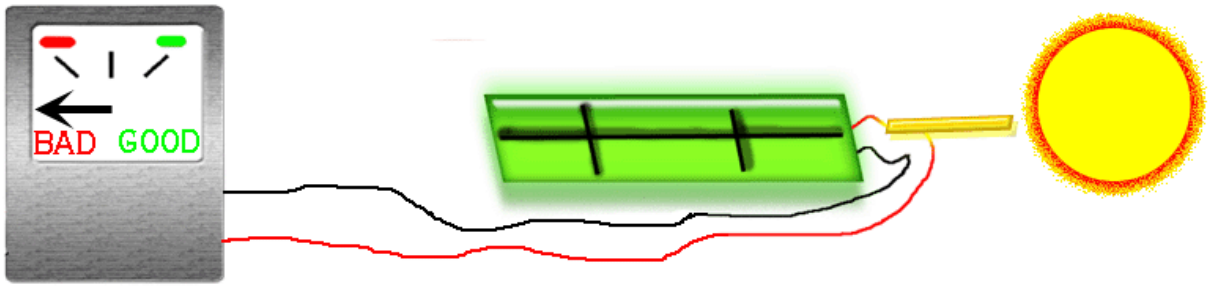

Photovoltaic panels absorb sunlight and convert it to direct current (DC) electricity
+
–
Positive and negative cables from each panel are combined in "strings" to get the desired voltage

電能

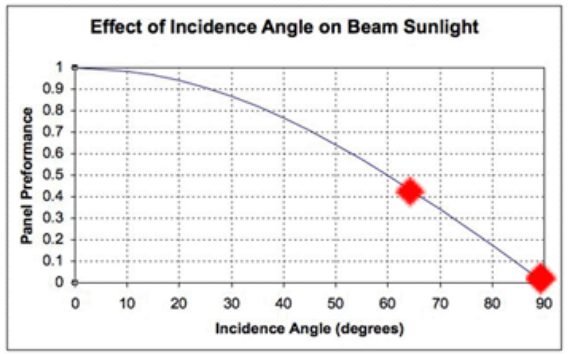
- 從太陽能板獲得最大功率輸出
  - 向太陽傾斜Tilt towards sun

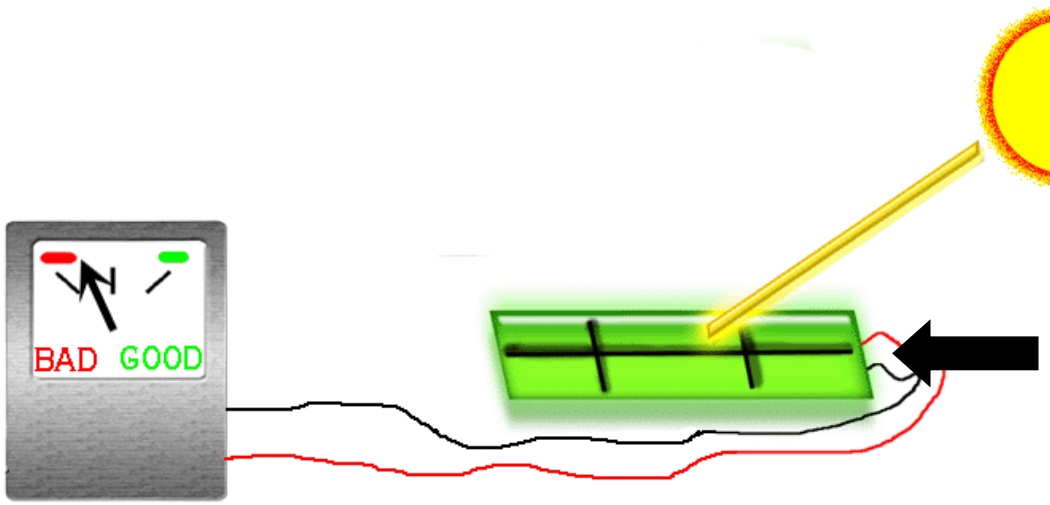
電能


Effect of Incidence Angle on Beam Sunlight
Panel Preformance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
90
Incidence Angle (degrees)


BAD
GOOD

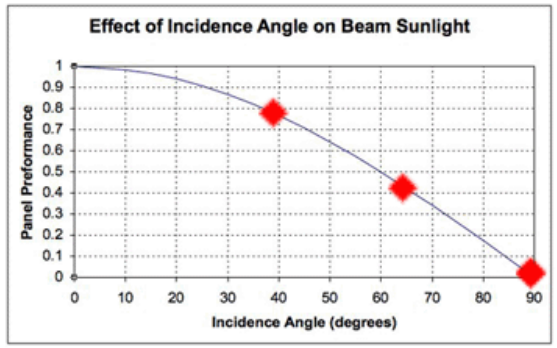
電能





Incidence angle

電能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20
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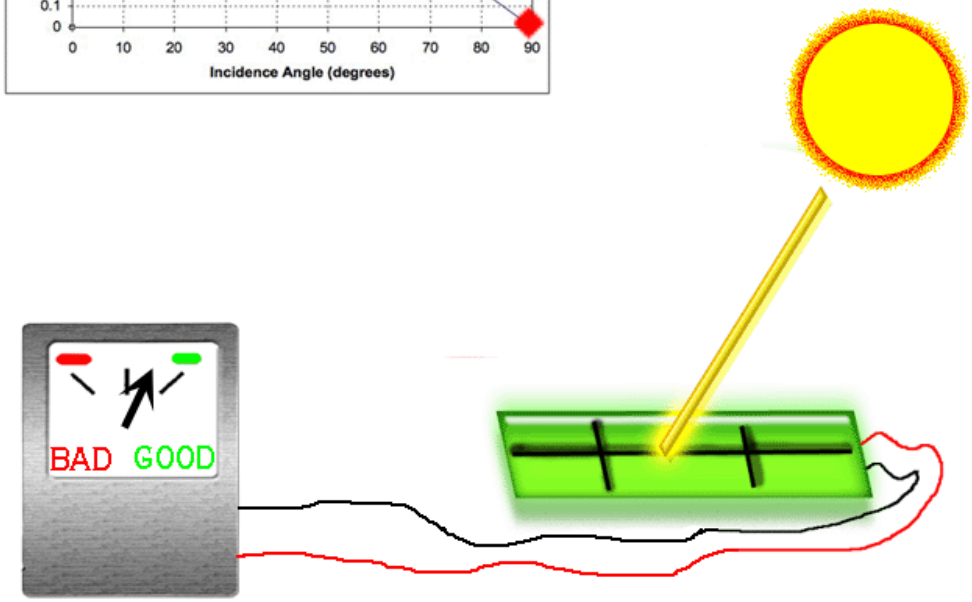
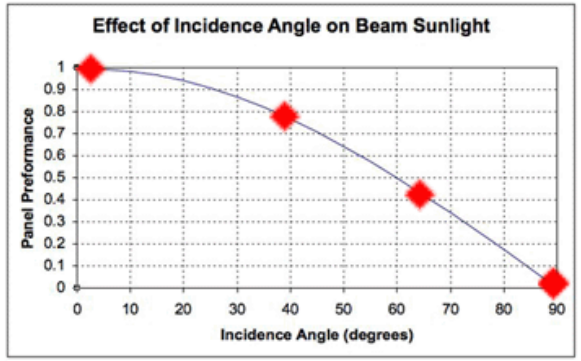
90
Incidence Angle (degrees)


BAD
GOOD

電能


Effect of Incidence Angle on Beam Sunlight
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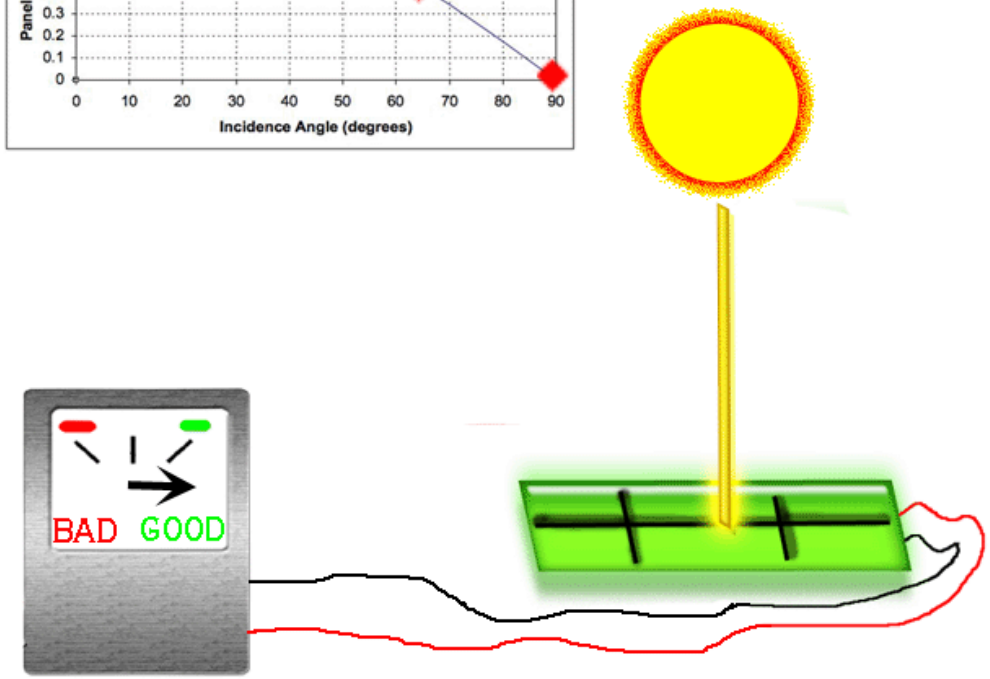
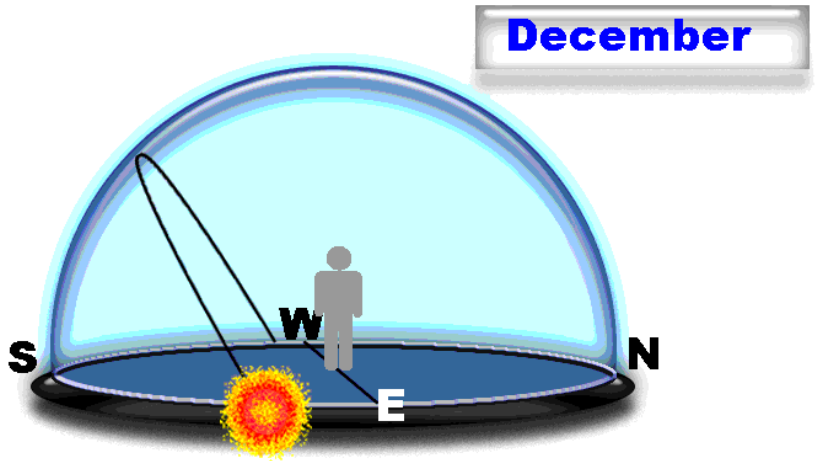
Incidence Angle (degrees)


BAD
GOOD

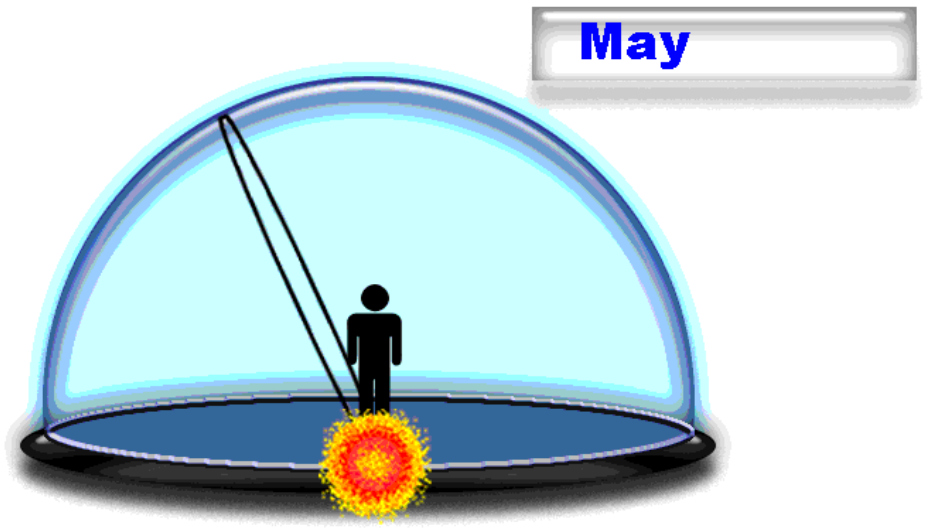
電能

太陽在哪裡？



電能

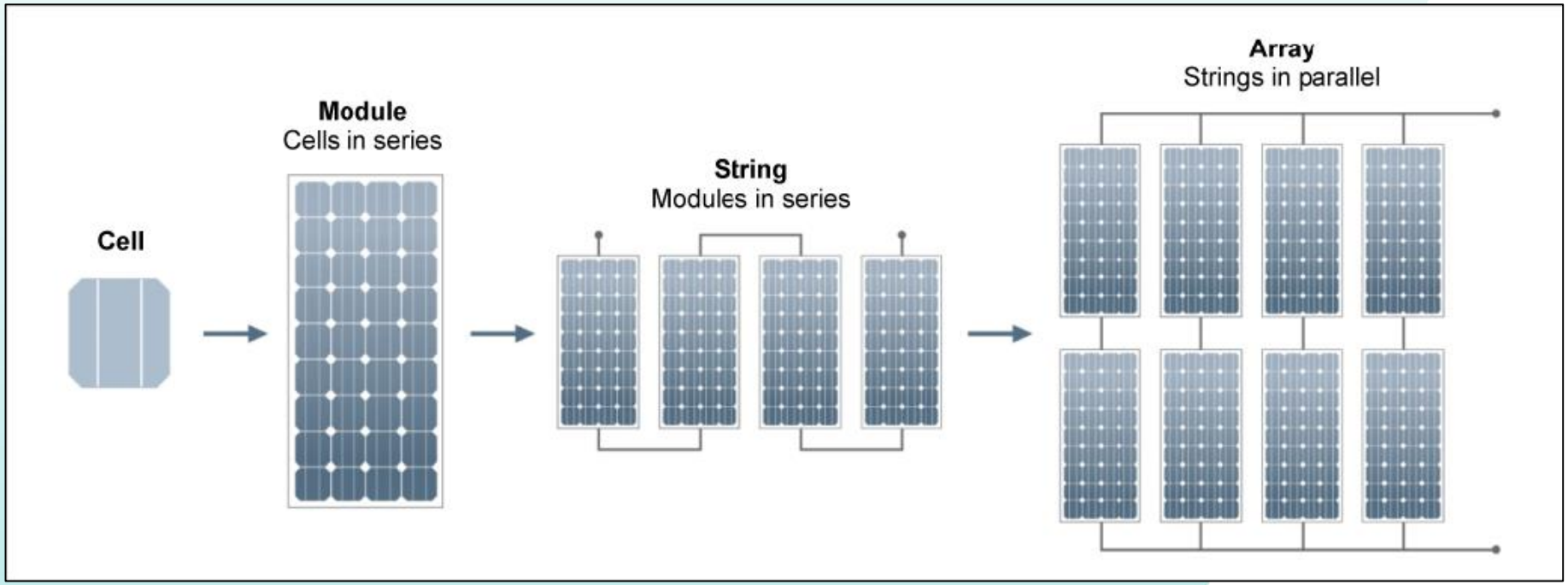
太陽在哪裡？



5月20日太陽將升到70度左右
正午（下午 1 點）。

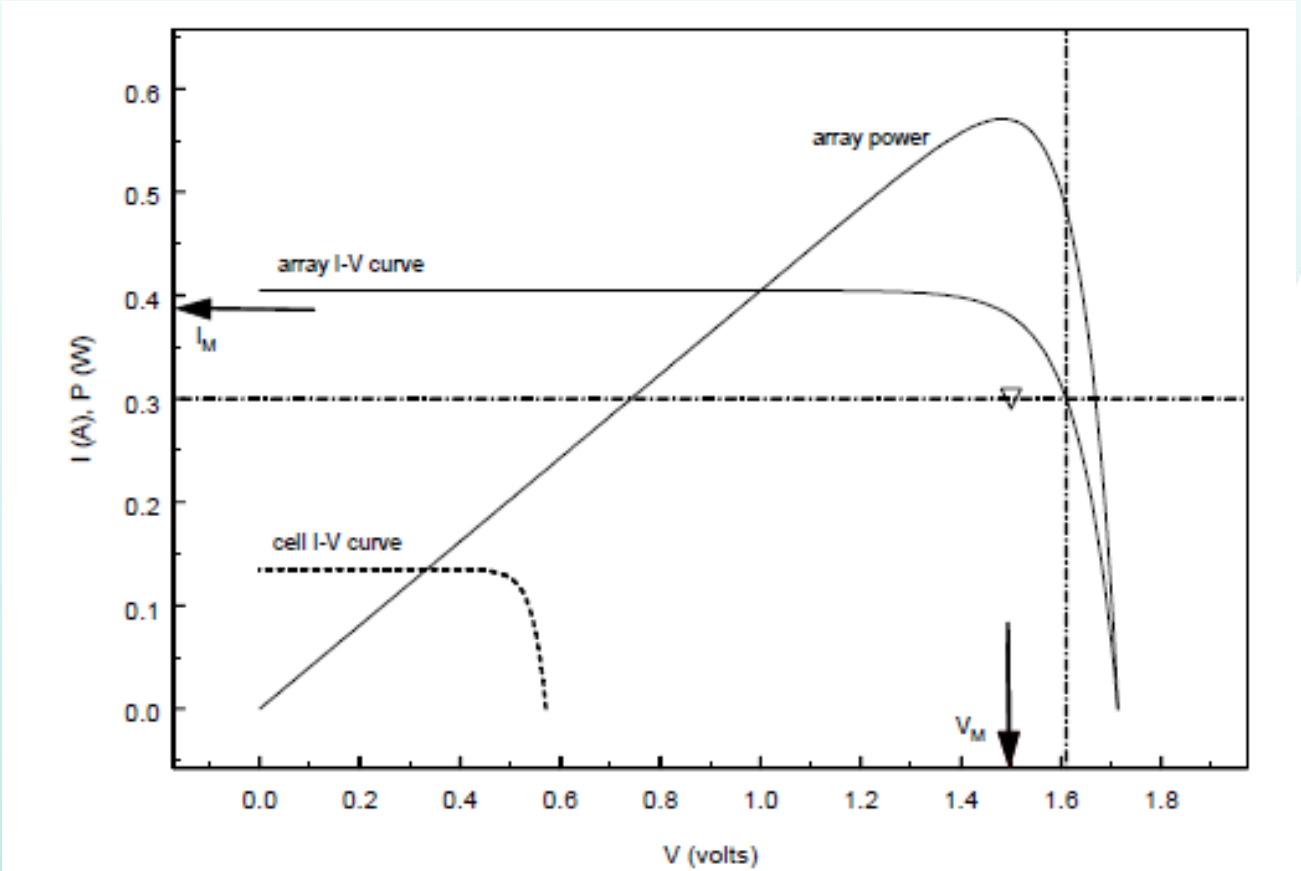
電能

太陽能板連接


Cell
Module
Cells in series
String
Modules in series
Array
Strings in parallel

電能

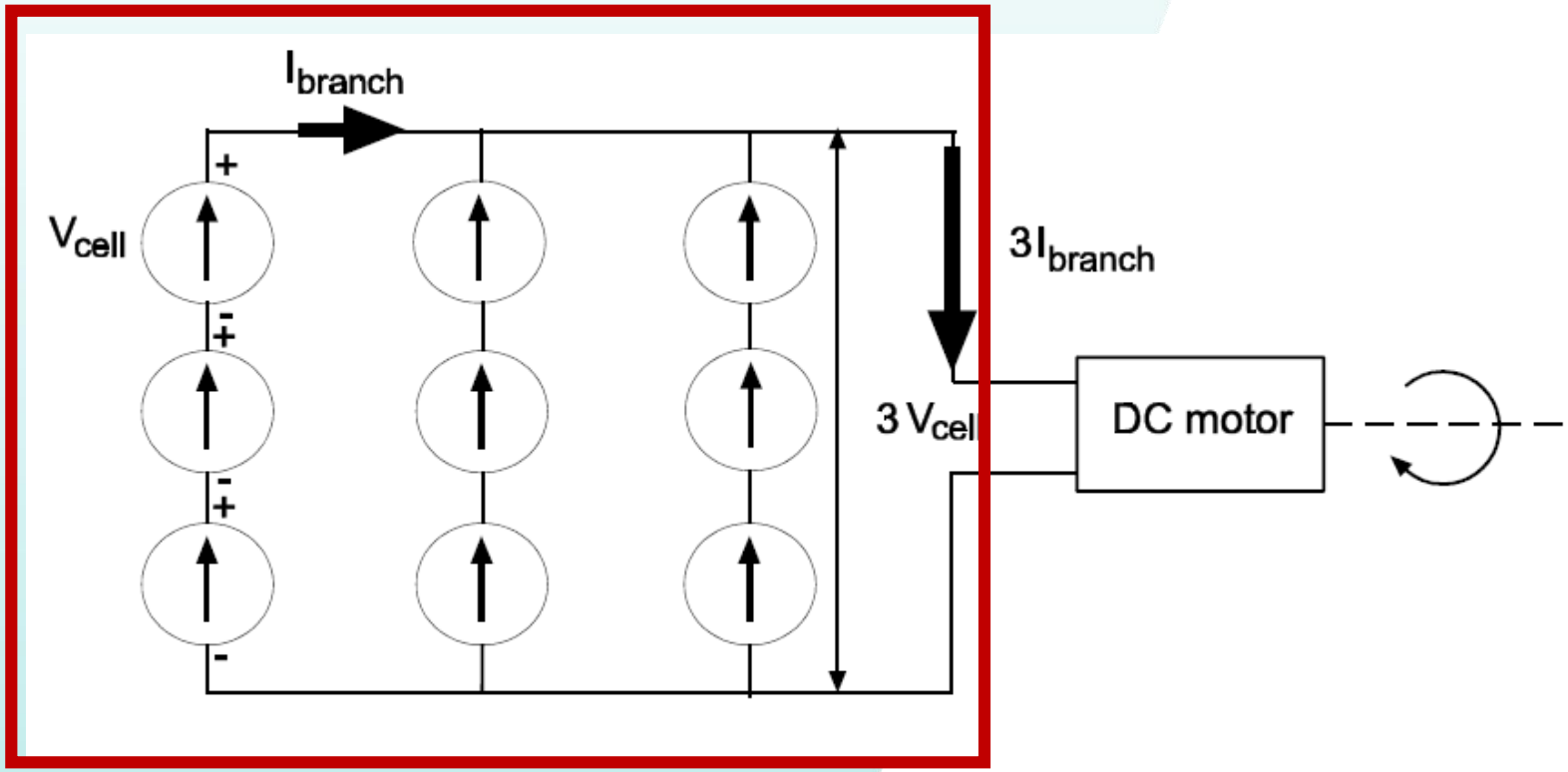
太陽能板V-I特性曲線



電能

例子

- 計算該太陽能板陣列的功率輸出。



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SMART CITY INNOVATION CENTRE

電能

A-300 SOLAR CELL
MONO CRYSTALLINE SILICON

Physical Characteristics

Construction:	All-back contact
Dimensions:	125 mm x 125 mm - nominal
Thickness:	270 µm ± 40 µm

ELECTRICAL CHARACTERISTICS OF TYPICAL CELL AT STANDARD TEST CONDITIONS (STC)

STC is defined as: irradiance of 1000W/m^2, spectrum AM 1.5g and cell temperature of 25°C

Open Circuit Voltage:	0.670 V
Short Circuit Current:	5.9 A
Maximum Power Voltage:	0.560 V
Maximum Power Current:	5.54 A
Rated Power:	3.1 W
Efficiency:	Up to 21.5 %

Temperature Coefficients

Voltage:	-1.9 mV / °C
Power:	-0.38 % / °C

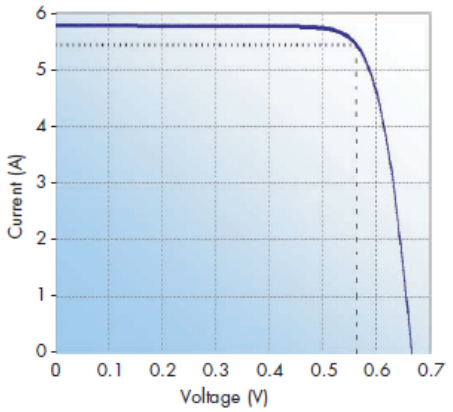
ATTRIBUTES

- High efficiency reduces module assembly and system installation costs
- Uniform front appearance - no contact grid
- Back contact design simplifies circuit assembly
- Lower temperature coefficient improves energy delivery

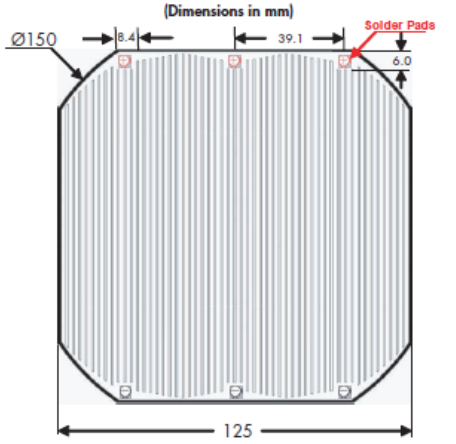
PACKAGING

- Cells are packed in boxes of 1000 each; grouped in shrink-wrapped stacks of 50 with interleaving
- Twelve boxes are packed in a water-resistant "Master Carton" containing 12,000 cells suitable for air transportation

A-300 CELL PERFORMANCE - TYPICAL I-V CURVE



CELL BACKSIDE VIEW (Dimensions in mm)



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A Subsidiary of Cypress Semiconductor

電能

例子

太陽能板陣列的電壓:

- 1 series:

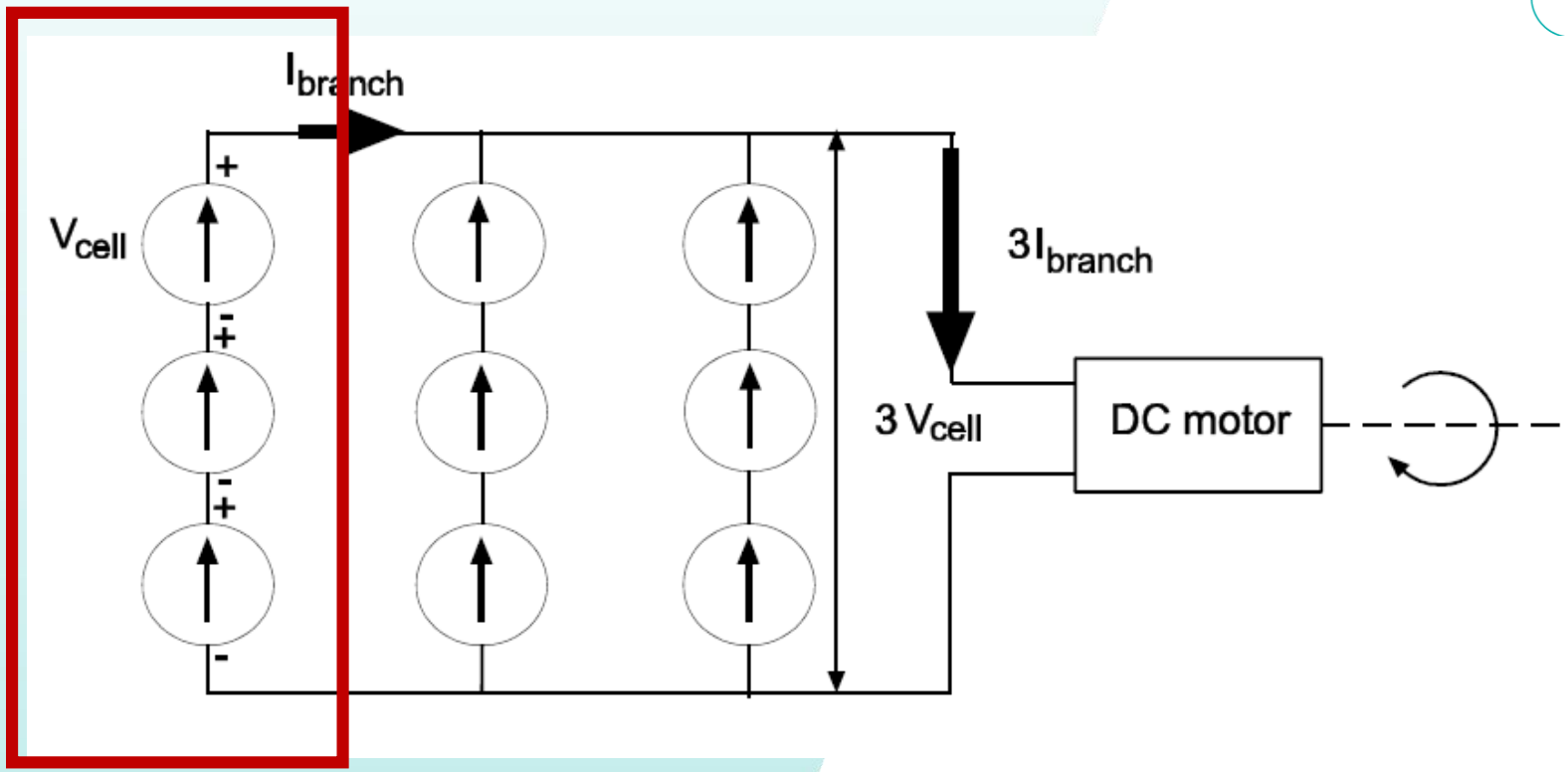
1 cell voltage:

= 0.5V

3 cell on 1 series:

= 3 x 0.5 V

=1.5 V



電能

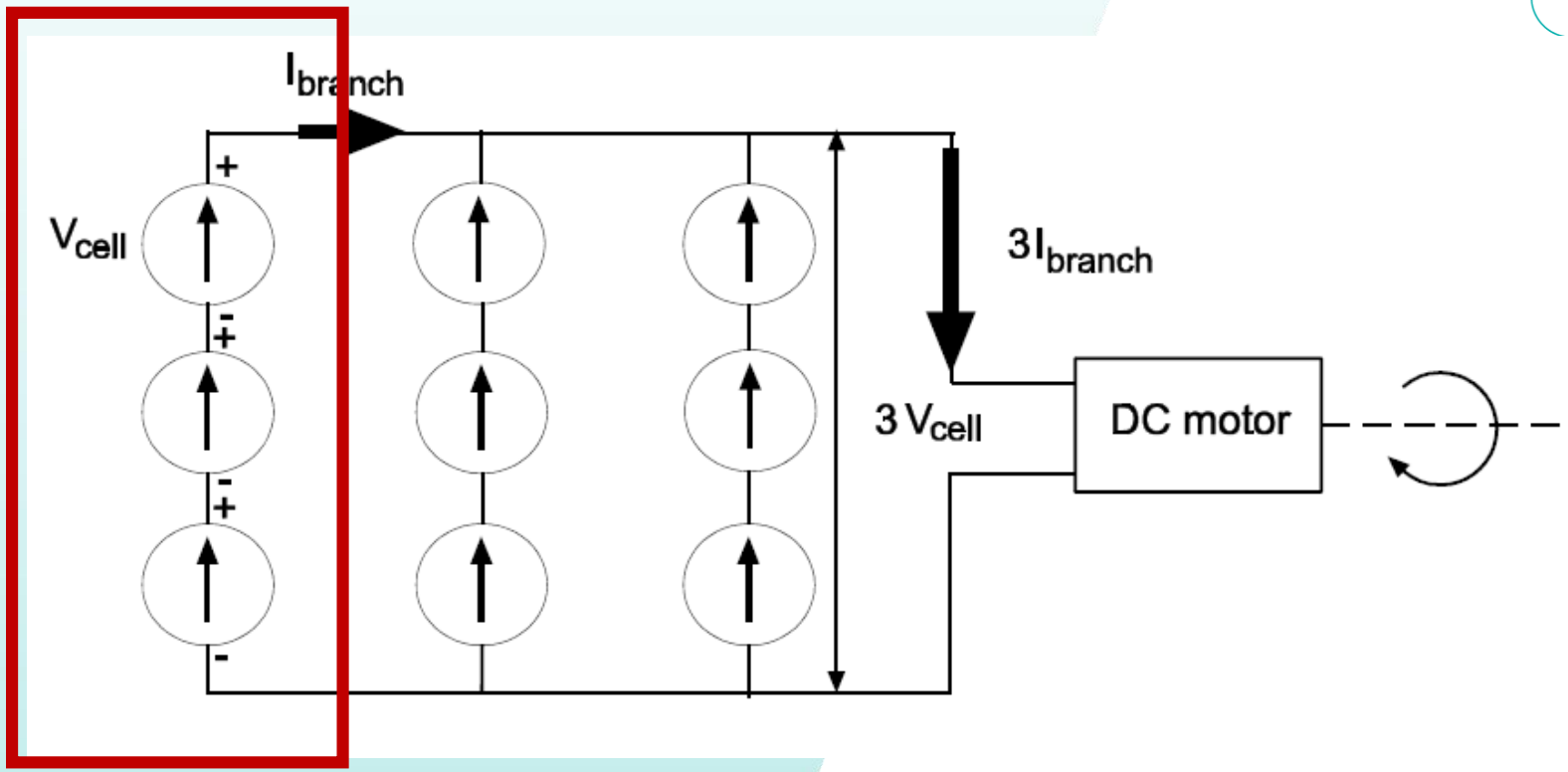
例子

太陽能板陣列的電流:

- 3 parallels:

= 5 x 3 A

=15 A



電能

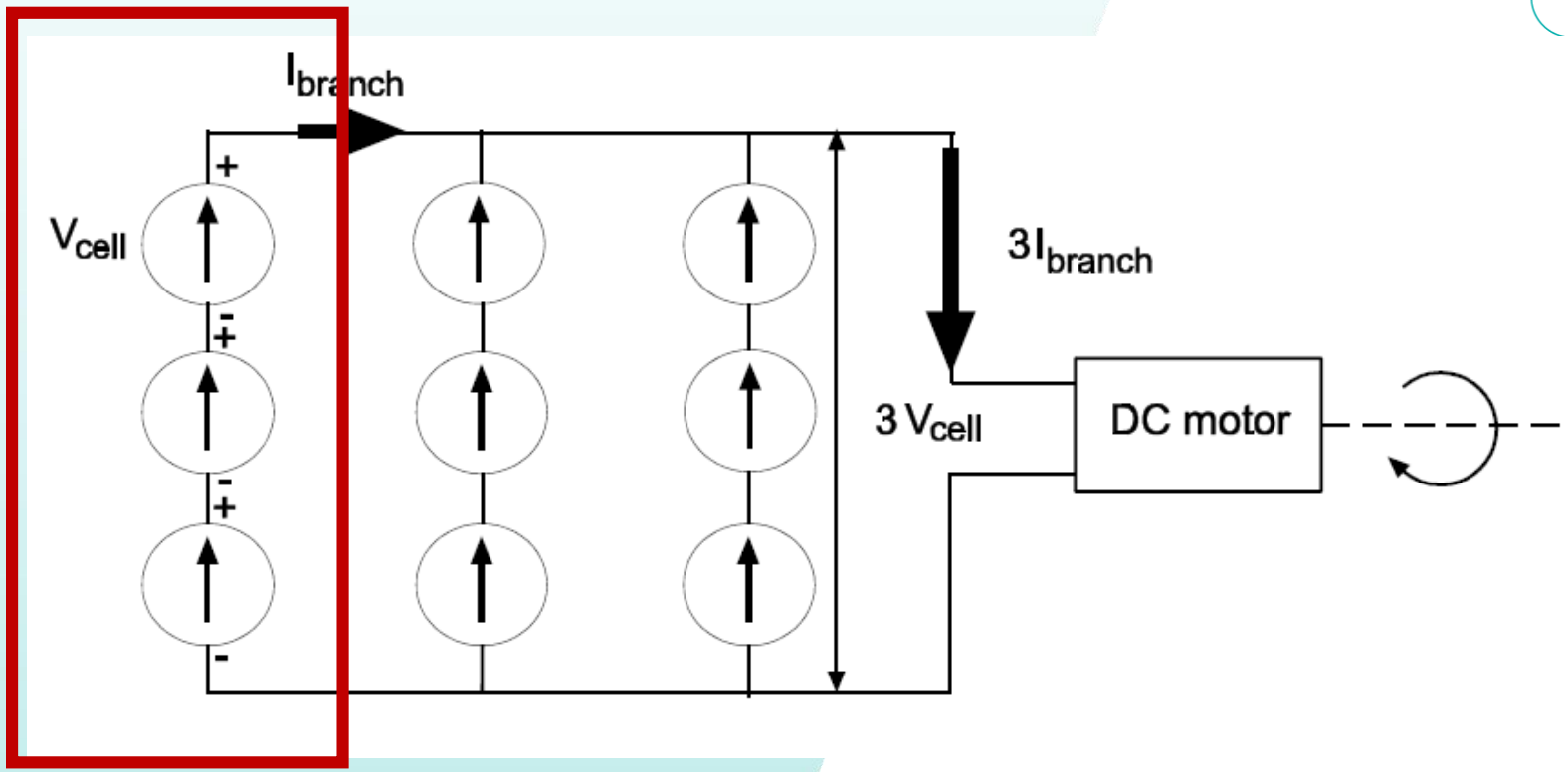
例子

太陽能板陣列的功率:

- Voltage x Current

= 1.5 x 15

= 22.5 W



電能

是時候採取行動了：設計你的太陽能車並獲取所需部件！

Chassis, Braking, Solar Panel, Battery pack, Motor…….

關鍵問題

1) What is the surface of the race like?
2) How can you design your car to be aerodynamic?
3)What tools might be needed in order to make your design?

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