IVE | Engineering 工程

NENG

Rideable Solar Car Workshop 2
Vehicle Power ABC

IVE | Engineering 工程

SOPHIE

SGOC

SMART CITY INNOVATION CENTRE

2026工作坊內容

01 1)初談高效節能設計
1月31日

02 車輛動力ABC
2月28日

03 電力驅動技術 I
3月14日

Shell Nxplorers Programme - 5月尾

04 車身設計大不同
5月23日

05 太陽能車攻略
7月4日

06 技術支援 網上直播
7月25日

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2026 SHELL NXPOLRERS PROGRAMME

ALERT!

Shell NXplorers

TO RIDERABLE SOLAR CAR TEAM

CLASS A:

◯ 23/5/2026 (10:00AM - 5:00PM)
◯ 24/5/2026 (10:00AM - 1:00PM)

CLASS B:

◯ 30/5/2026 (10:00AM - 5:00PM)
◯ 31/5/2026 (10:00AM - 1:00PM)

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	學校名稱	
1	新界鄉議局大埔區中學	A
2	嗇色園主辦可譽中學暨可譽小學	
3	靈糧堂劉梅軒中學	
4	獅子會蔣翠琼中學	
5	元朗公立中學	
6	樂善堂顧超文中學	
7	香海正覺蓮社佛教正覺中學	
8	東華三院邱金元中學	
9	裘錦秋中學(元朗)	
10	香港四邑商工總會陳南昌紀念中學	
11	聖公會聖西門呂明才中學	
12	聖若瑟書院	
13	嶺南鍾榮光博士紀念中學	
14	東華三院馮黃鳳亭中學	B
15	嗇色園主辦可藝中學	
16	地利亞修女紀念學校（吉利徑）	
17	保良局馬錦明夫人章馥仙中學	
18	馬鞍山崇真中學	
19	香港布廠商會朱石麟中學	
20	林大輝中學	
21	天主教郭得勝中學一隊	
22	天主教郭得勝中學二隊	
23	鳳溪第一中學	
24	瑪利諾中學	
25	樂善堂梁植偉紀念中學	

Key questions

1) What are the key factors of a solar car?
2) Is your design for speed or endurance?

Theme

Vehicle Power ABC

1) Power
2) Introduction to Chassis and Internal Roll Cage
3) Brake System
4) Development of Solar Panels

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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)

How to reduce energy consumption

Rolling Resistance:

- **Light weight**
- **Axle bearings / narrow tires**

Winding Resistance:

- **Small frontal area**
- **Smooth shape**

Acceleration:

- **Light weight**

Which body shape is the fastest?

How to reduce energy consumption

5 個設計太陽能車的技巧

5 Tips for Designing a Solar Car

1. Reduce frontal area
2. Reduce friction
3. Make the surface smooth
4. Reduce weight
5. Solar panel installation

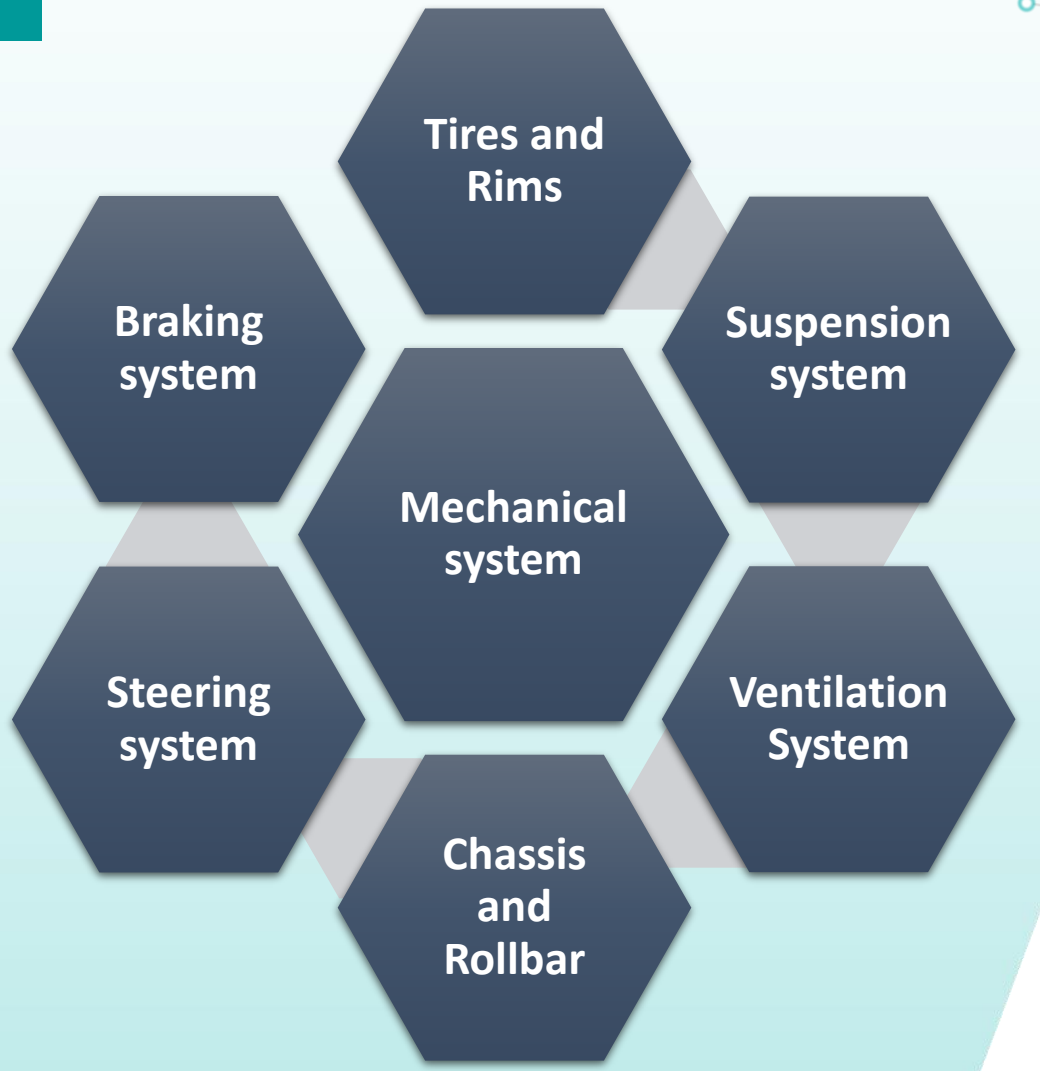
主要部件

在建造太陽能車之前，要做什麼？

-車殼?
-電力系統?
-機械系統?

	重要部件 Important Parts
1	車身結構 Bodyshell
2	車架及車內防瀝架 Chassis and Rollbar
3	車輪和輪胎 Wheels and tires
4	然車系統 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

Mechanical Parts



車架及車內防滾架 Chassis and Rollbar

- The frame is an important structure of the vehicle.
- It is the framework that holds various mechanical components, such as the brakes, steering, and wheels.
- Made of lightweight metal or composite materials, it provides the strength needed to support the vehicle’s parts and load.

車架及車內防滾架 Chassis and Rollbar

Monique Chassis

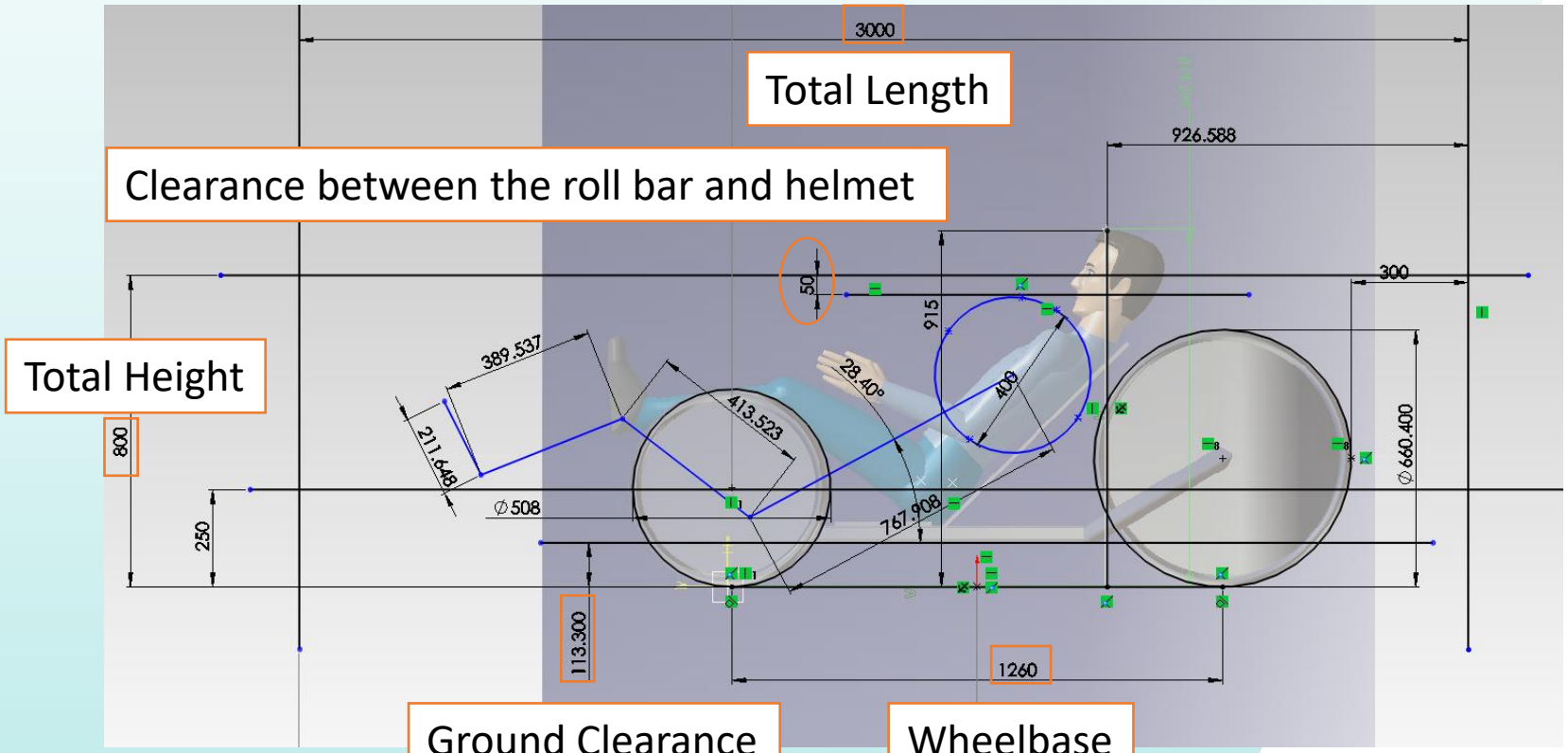
車架及車內防滾架 Chassis and Rollbar

三輪車 (Recumbent Trike)

車架及車內防滾架 Chassis and Rollbar

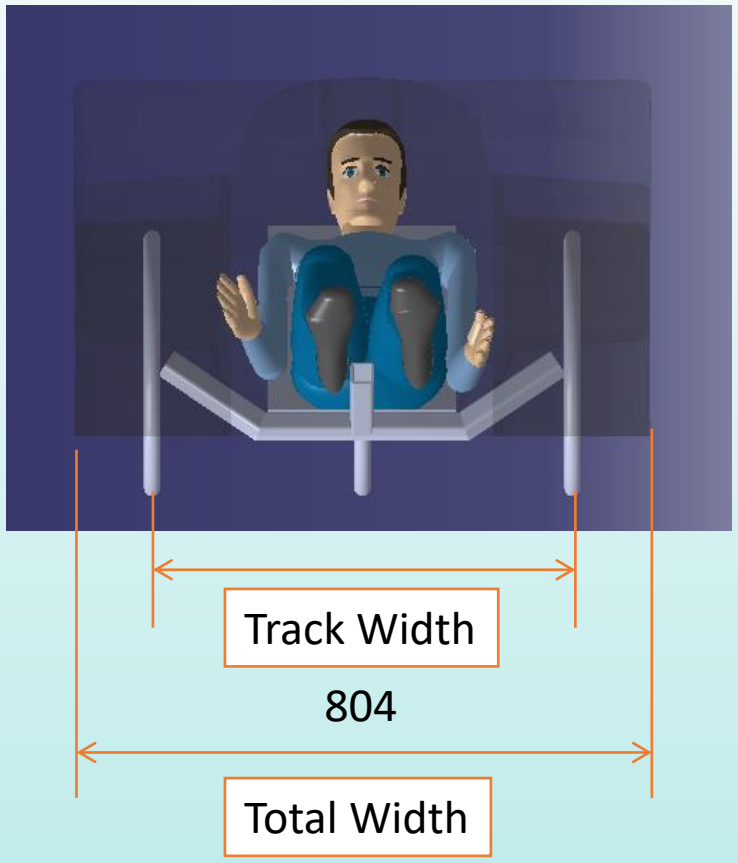
車架及車內防滾架 Chassis and Rollbar

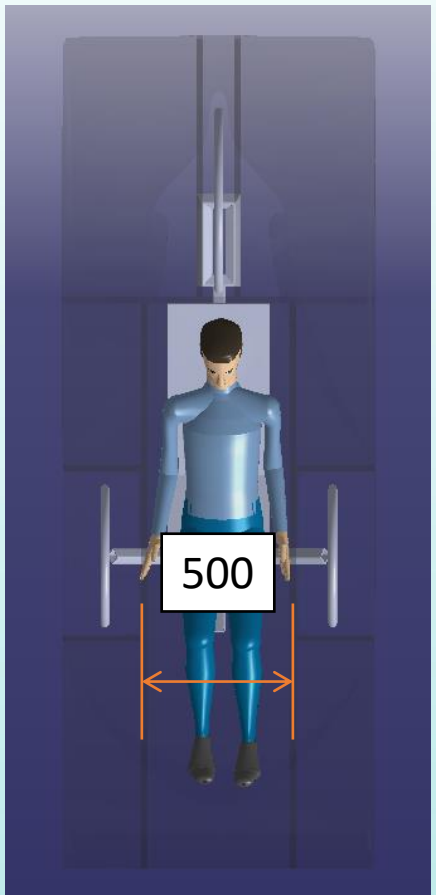
尺寸 Dimensions



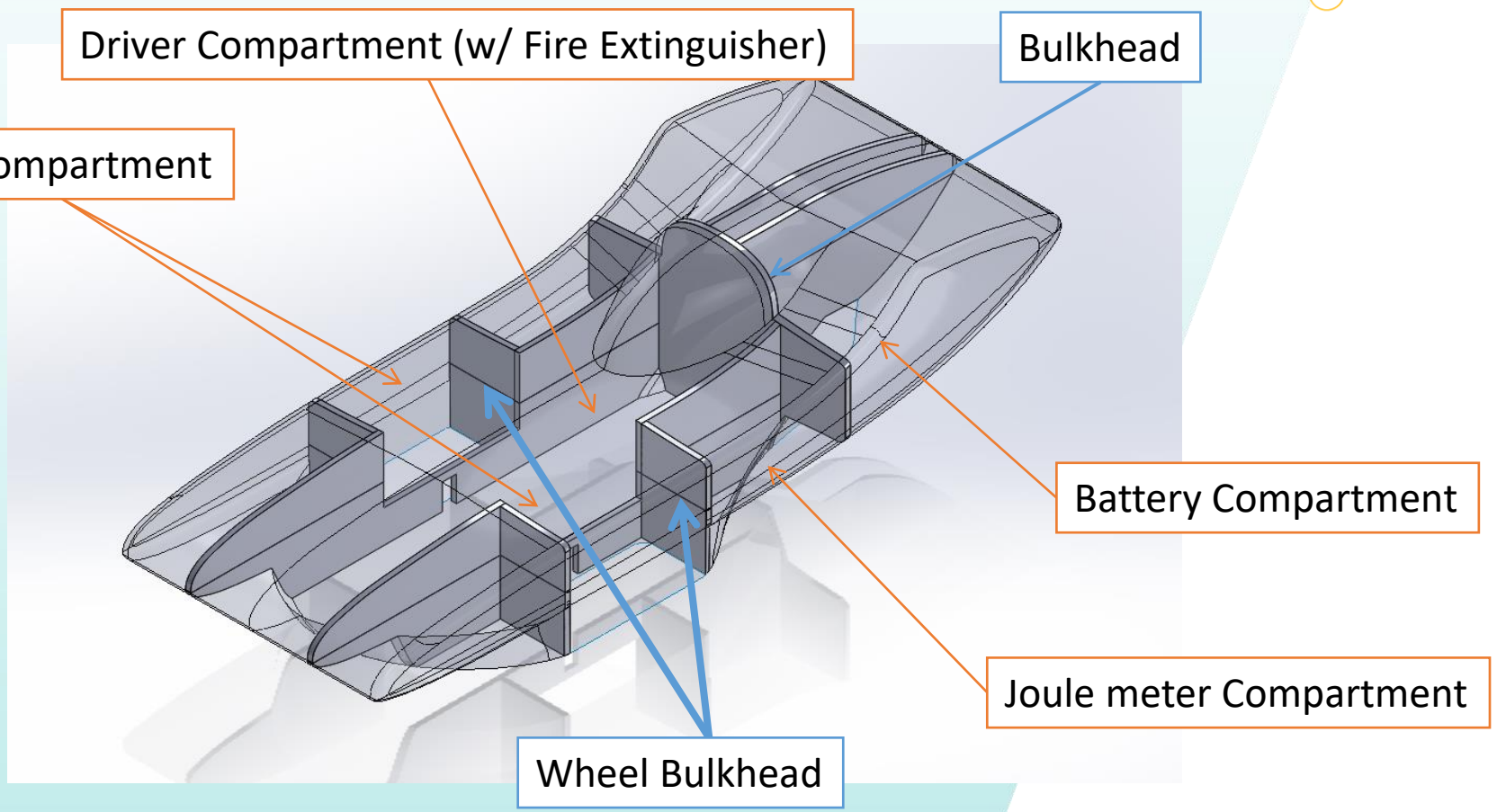
車架及車內防滾架 Chassis and Rollbar

尺寸 Dimensions

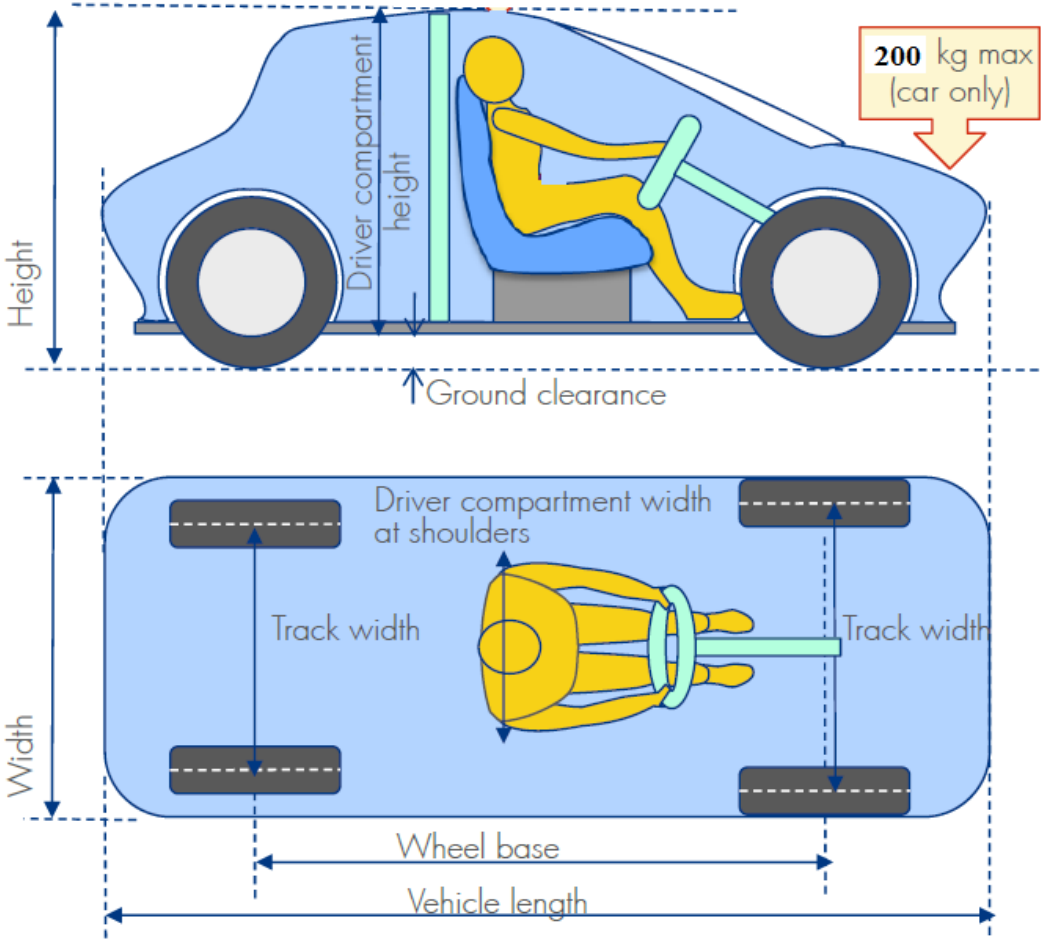




車架及車內防滾架 Chassis and Rollbar



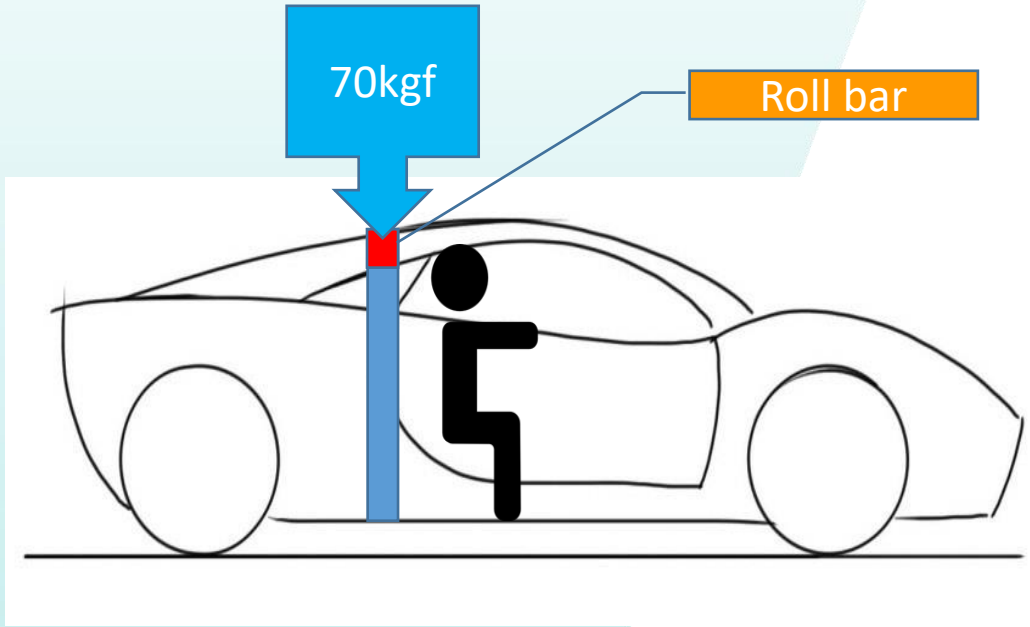
Dimension	Limits
Max. Height	1300mm
Max. Width	1300mm
Max. Length	3500mm
Track width	At least 1000mm(front axle); 800mm (rear axle) if applicable
Wheelbase	>1200mm
Ground clearance	>100mm
Max. vehicle weight (without driver)	225 kg



Frame Stability

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

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



Braking system

- A brake is a mechanical device that suppresses motion by absorbing energy from a moving system.
- It is used to slow down or stop a moving vehicle, wheel, or axle, or to prevent its motion, usually achieved through friction.

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!

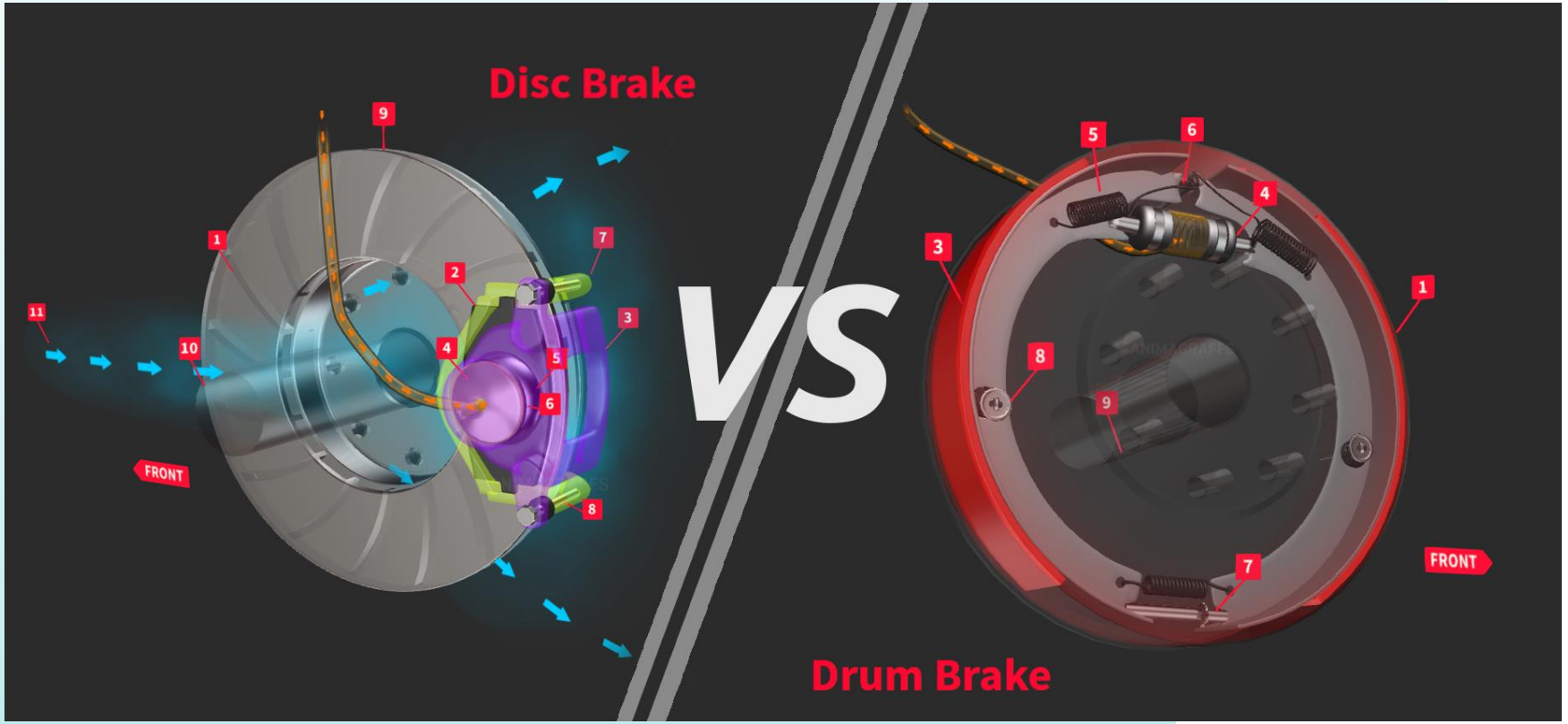
煞車系統 Braking system

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

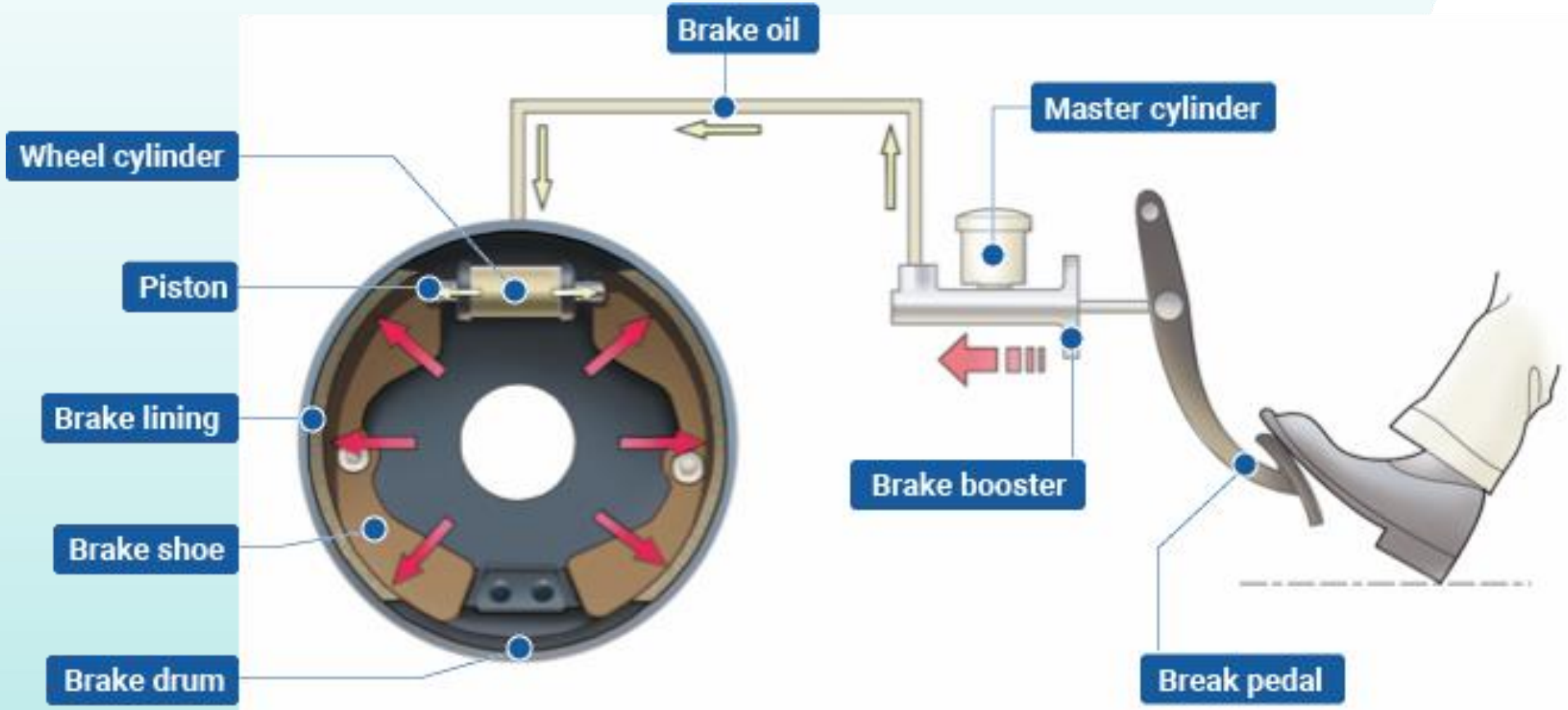
煞車系統 Braking system

碟式/鼓式 煞車器 Disc/Drum Brake



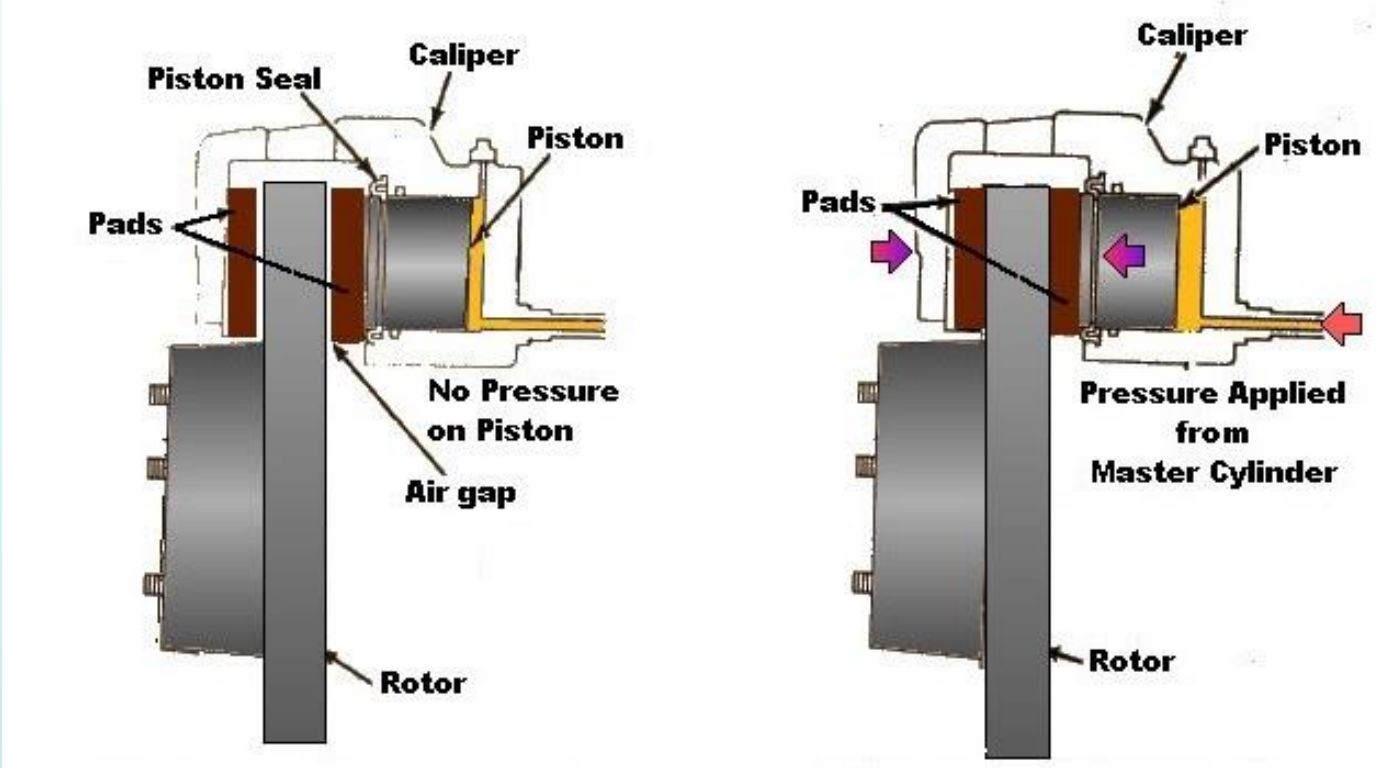
煞車系統 Braking system

鼓式 煞車器 Drum braking



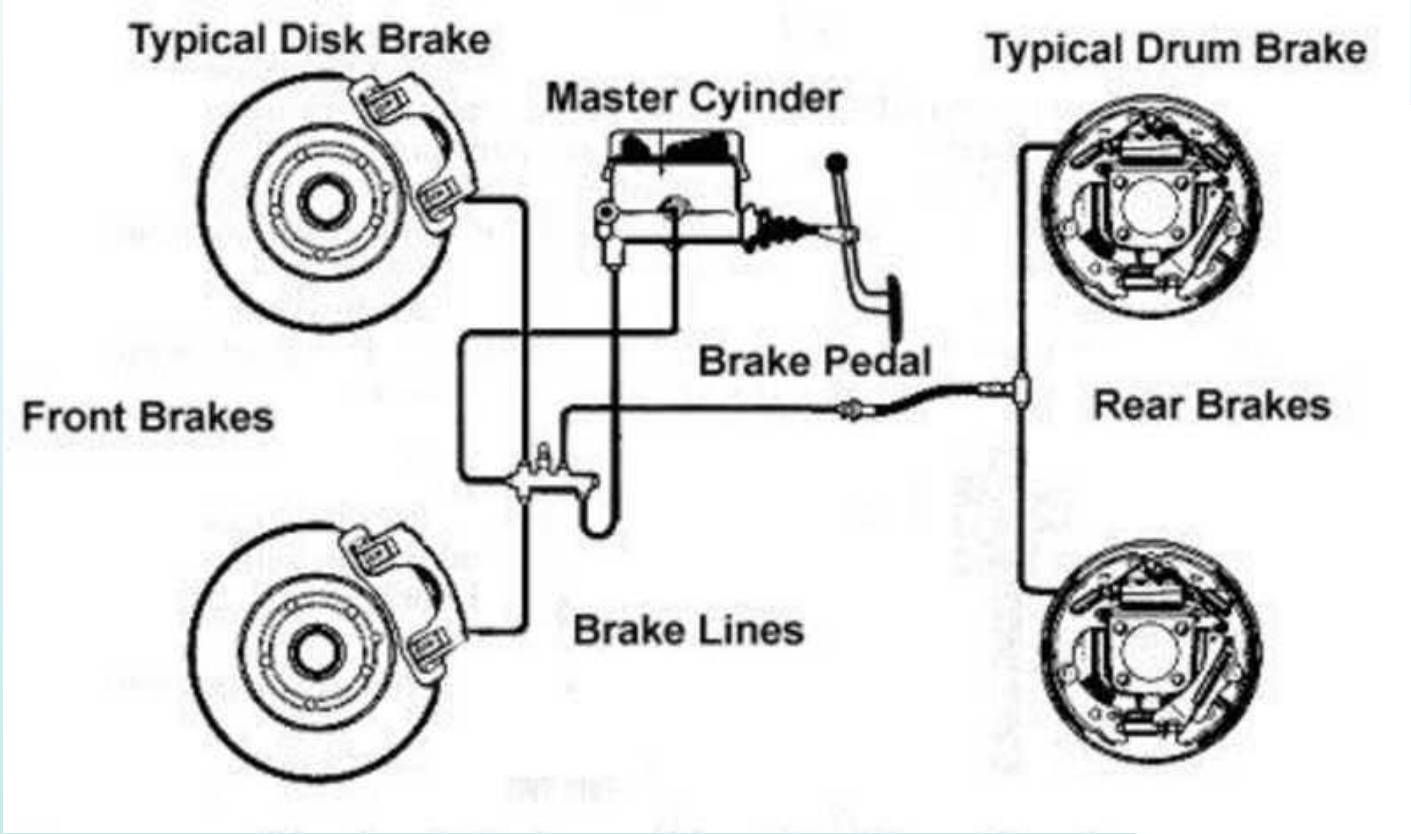
煞車系統 Braking system

碟式 煞車器 Disc Brake



煞車系統 Braking system

油壓 Hydraulic method



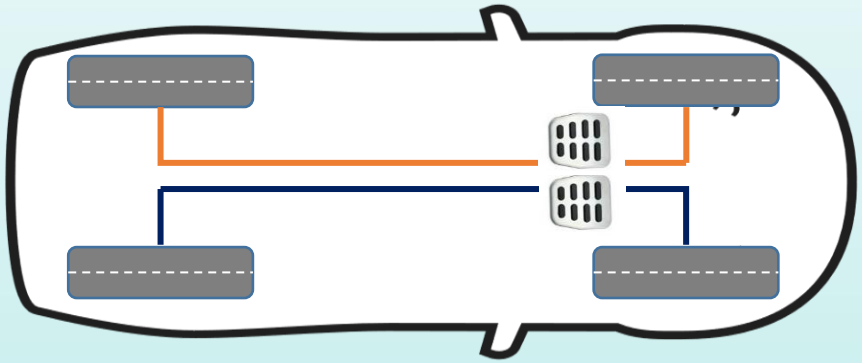
煞車系統 Braking system

Mechanical Method剎車拉線 (Cable Braking)

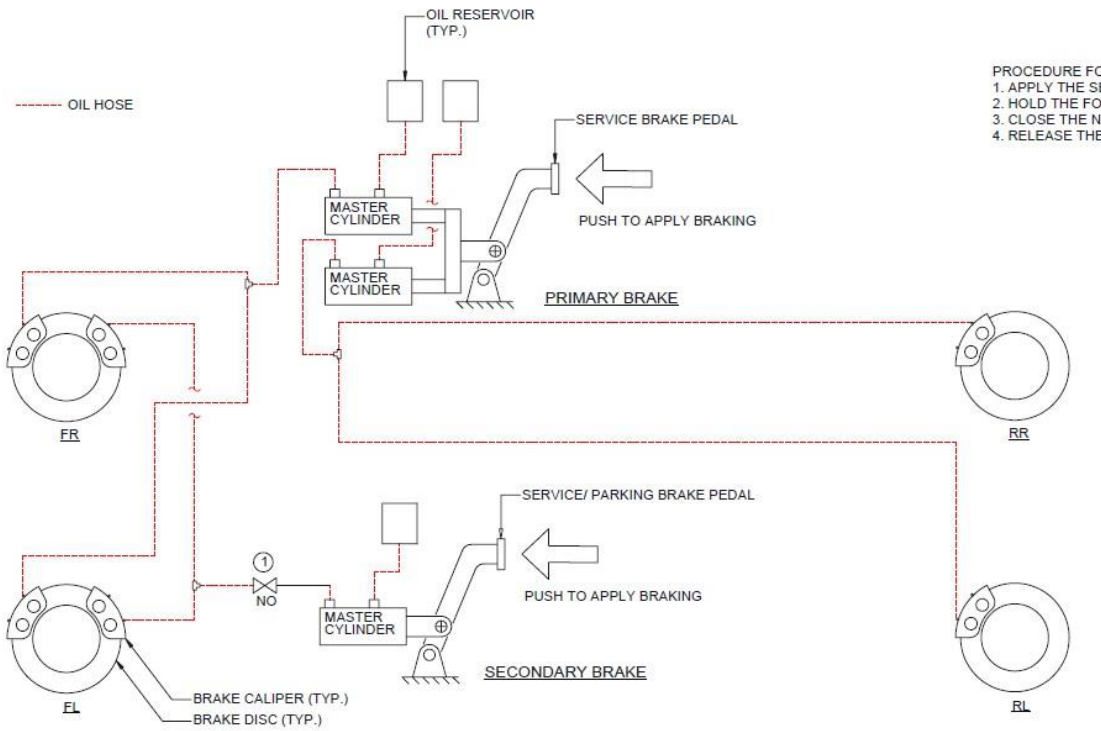
煞車系統 Braking system

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

Wrong connection



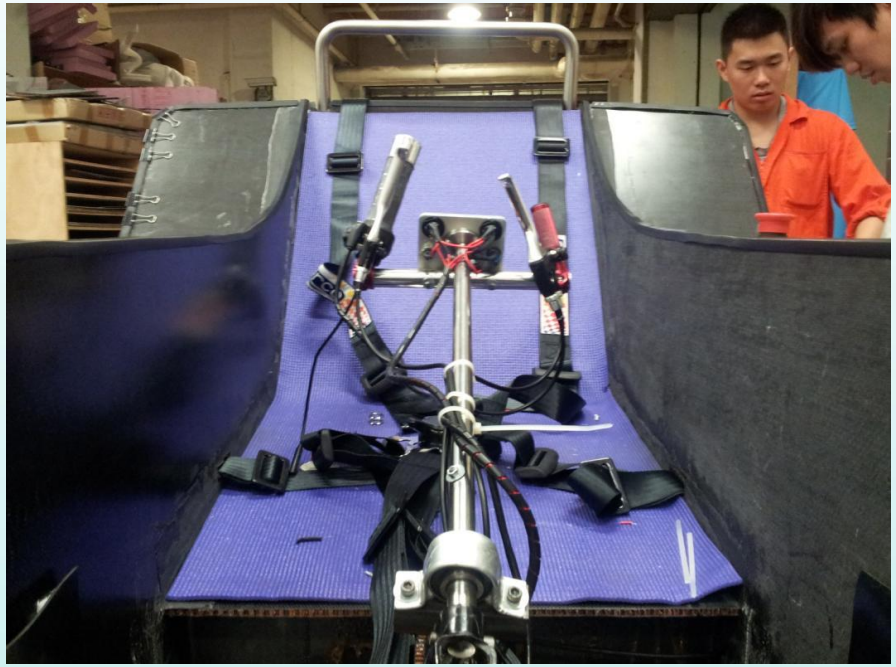
煞車系統 Braking system



PROCEDURE FOR USING PARKING BRAKE:
1. APPLY THE SECONDARY BRAKE.
2. HOLD THE FOOT PEDAL.
3. CLOSE THE NORMALLY OPENED VALVE 1.
4. RELEASE THE FOOT PEDAL.

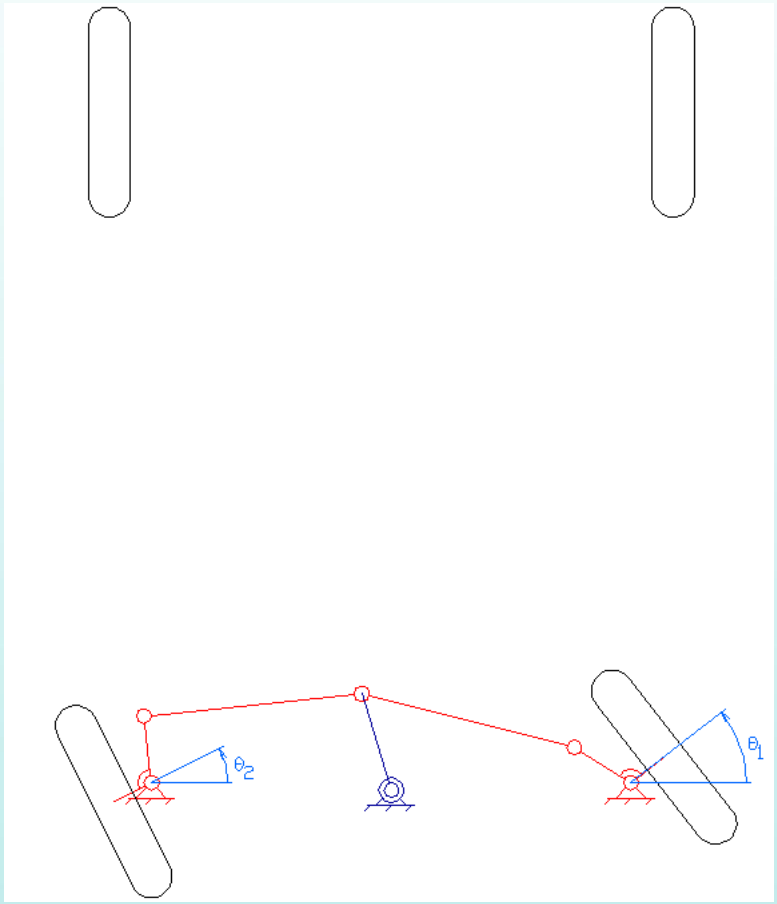
SOPHIE VI BRAKING SYSTEM DESIGN

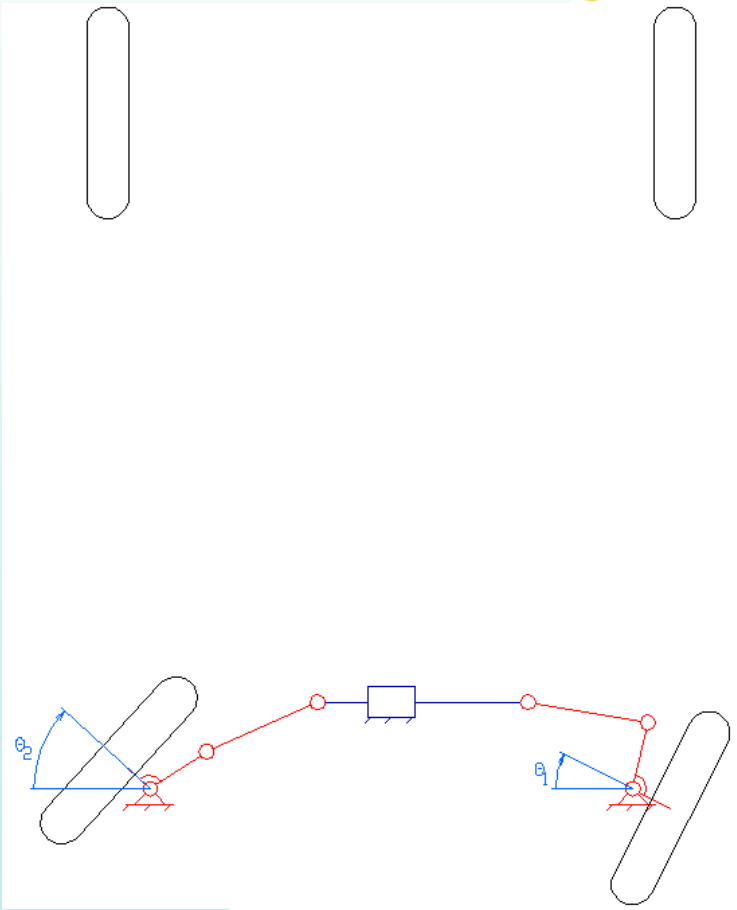
轉向系統 Steering system



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.

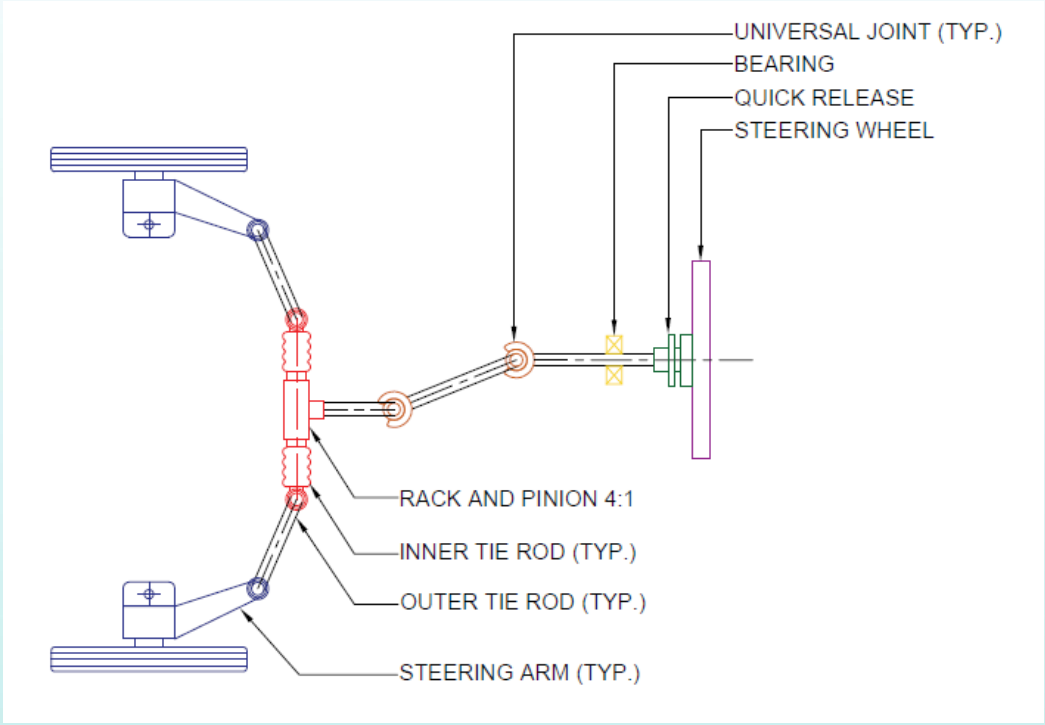
轉向系統 Steering system





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

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

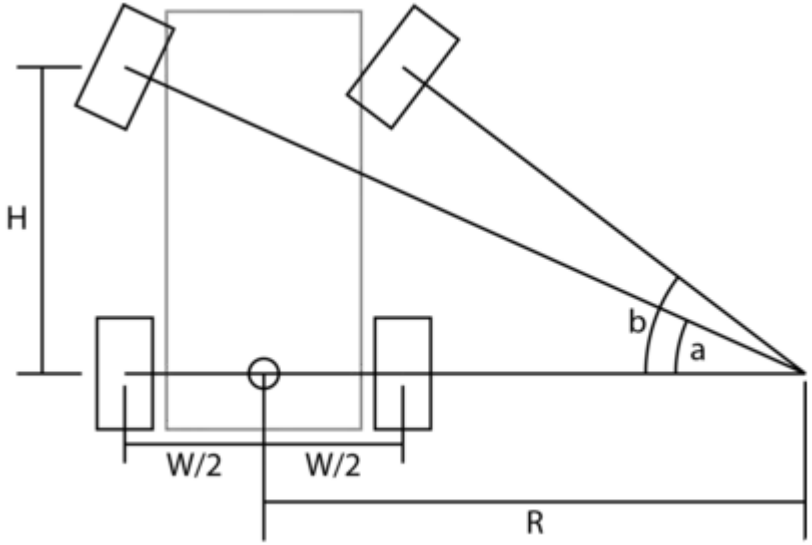
Ans: 273 deg

轉向系統 Steering system

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

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

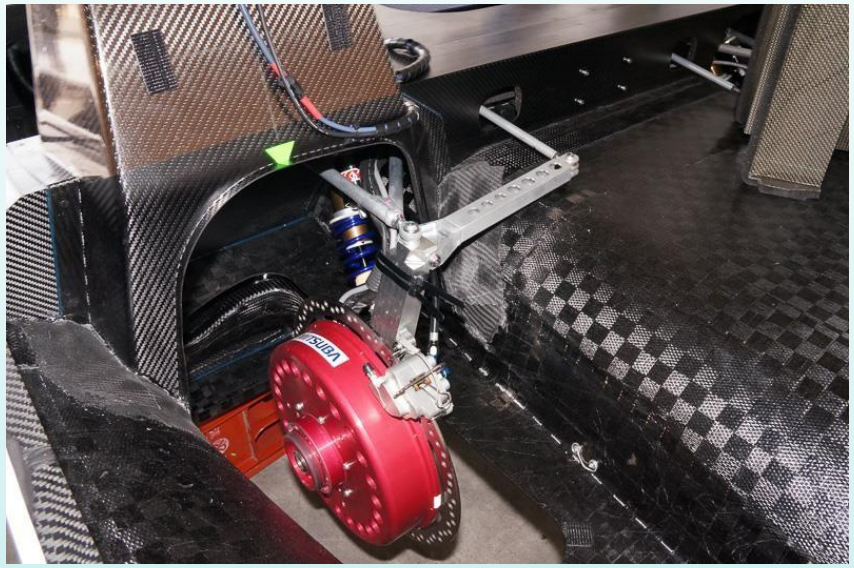
$$R + \frac{W}{2} = 8\ meters$$



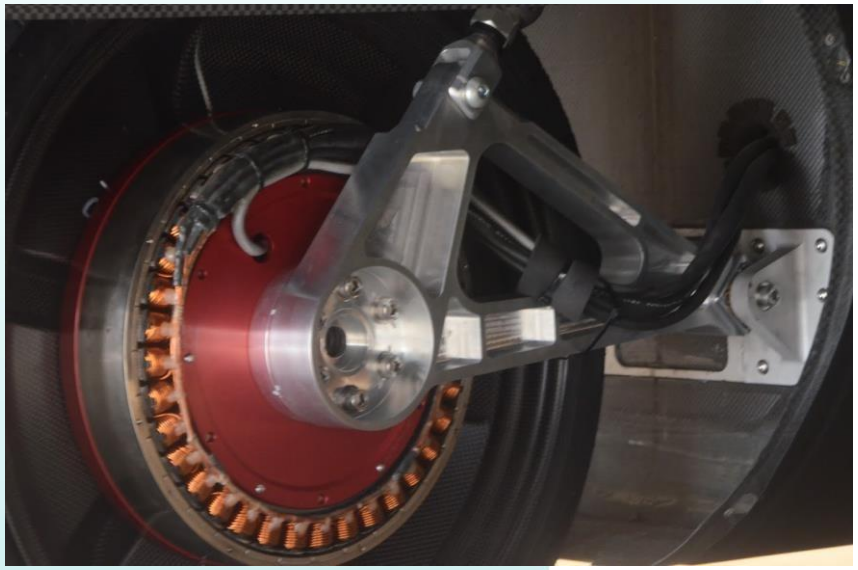
Example:

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

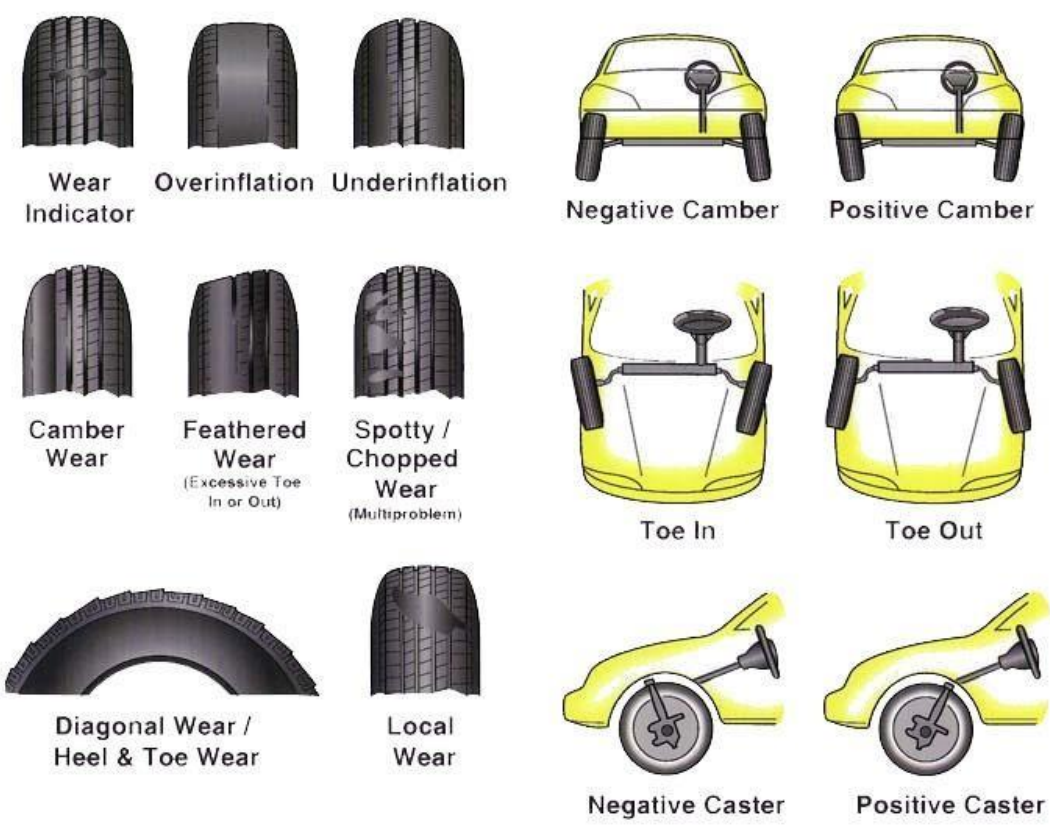


帶轉向的拖曳臂
(Tailing Arm with steering)



拖曳臂
(Tailing Arm)

四輪定位 Wheel Alignments

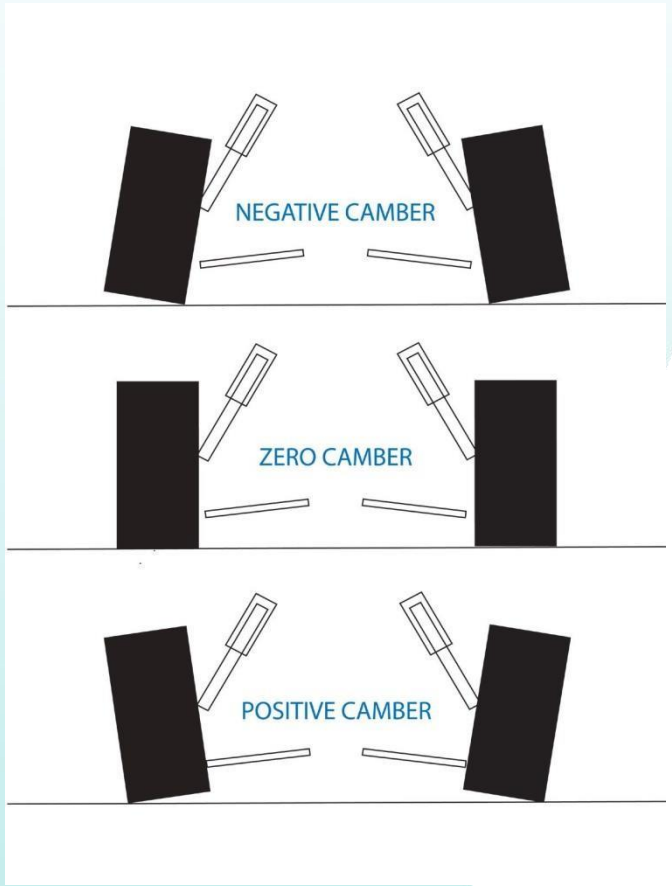


四輪定位 Wheel Alignments

外傾角(Camber)

Target Value:

- 0 ° Front
- 0 ° Rear

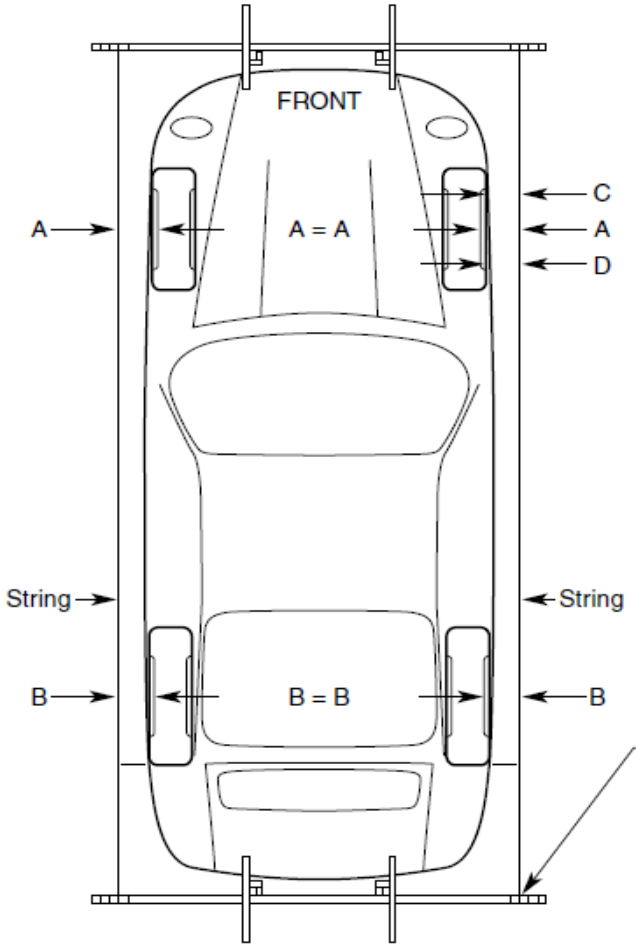


四輪定位 Wheel Alignments

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.**

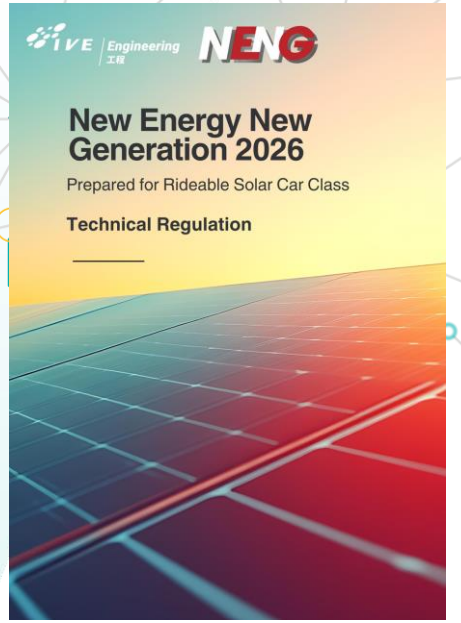
Toe-out:
The measurement is **shorter** on the leading edge of the wheel than the trailing edge of the wheel.
Example:
Measurement **C** is **shorter** than measurement **D.**

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 2026



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

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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

IVE Engineering 工程

SOPHIE SGOC SMART CITY

主要部件

太陽能車

使用太陽能進行車載充電

Battery

Solar Panel → DC-DC converter → Main Bus

Main Bus → Motor Controller → Motor

Electric

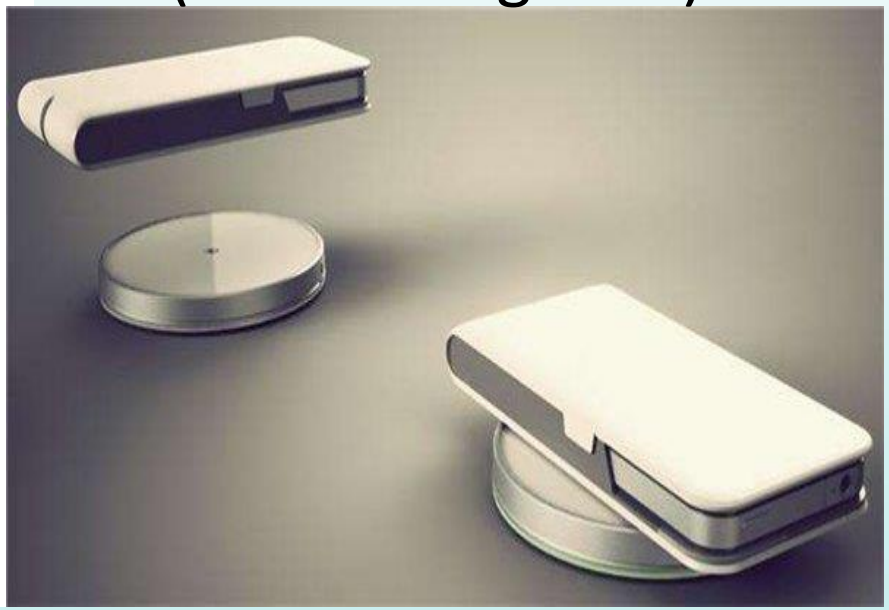
Electrical energy is the presence and flow of electrical charge, usually stored in batteries and transmitted in the form of electrons through wires.

Example: Electrical energy is stored in the car battery.

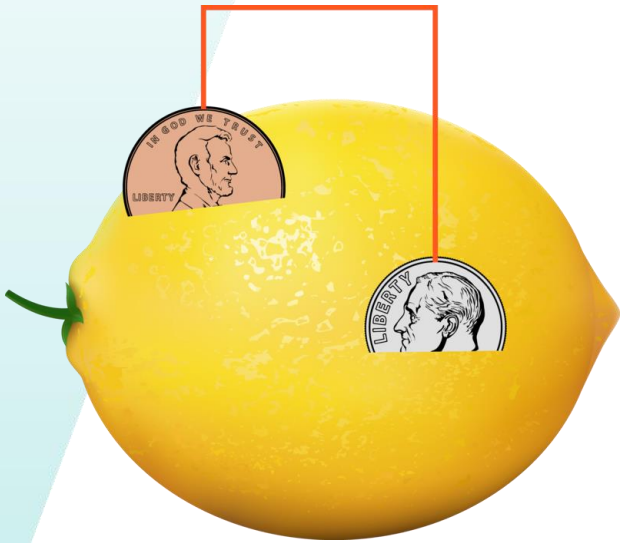
Electric

靜電 (Static)

電磁
(Electromagnetic)



電化學反應
(Electrochemical reaction)

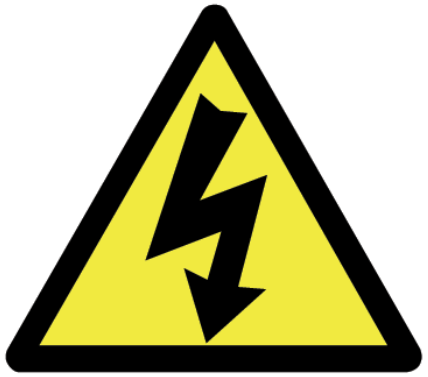


Basic

Electricity has its own units. The three basic units in an electrical system are:

1. Voltage (V) measures the "push" of electric current. The higher the voltage, the greater the force pushing the current through the wires.
2. Current (I) is a measure of the amount of electric charge passing through a point per unit of time.
3. Watt (W) represents the rate at which work is done or energy is used.

$$V \times I = W$$

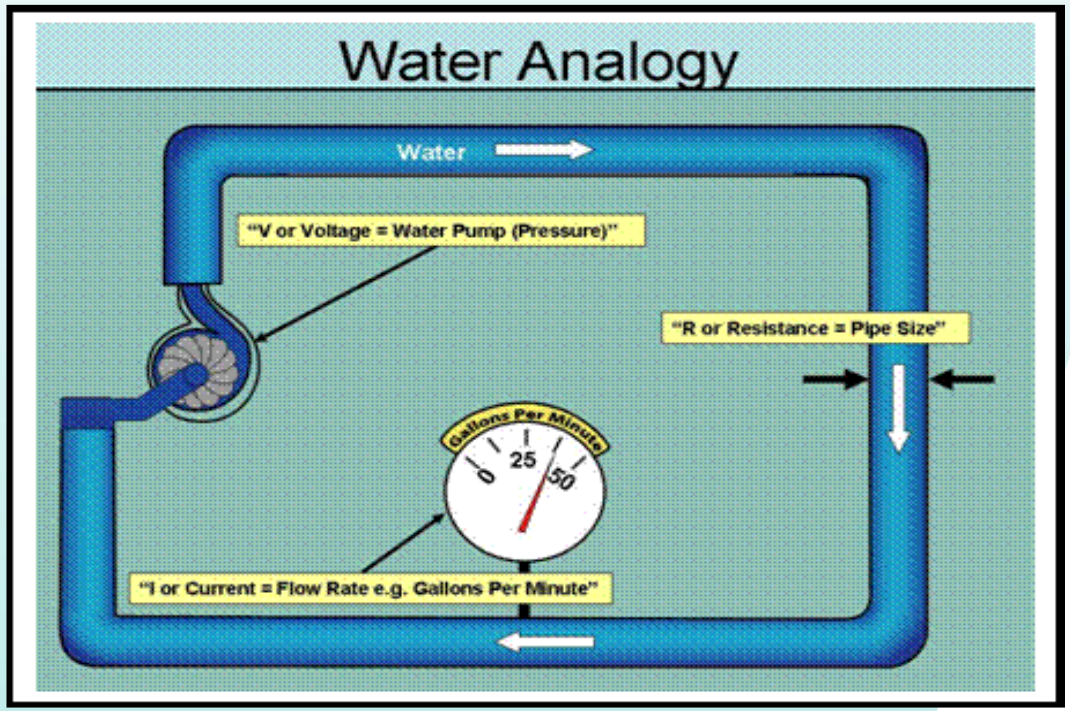


Electric

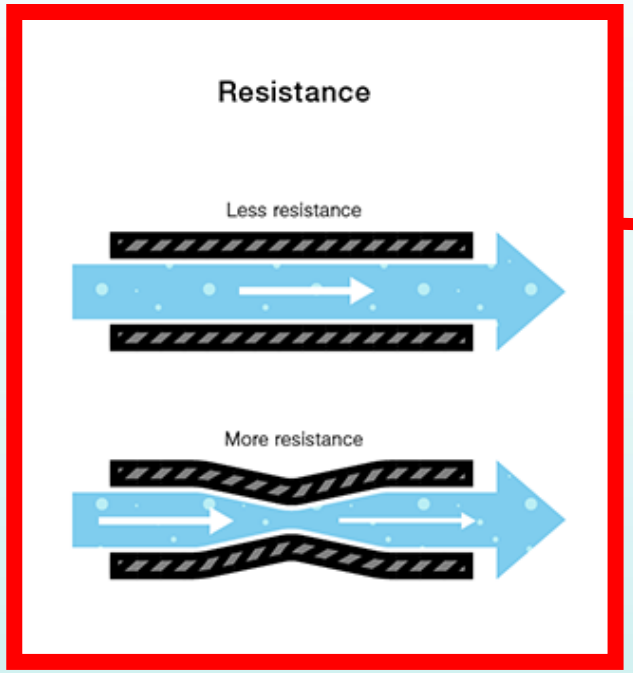
水管類比 (Water Pipe Analogy)

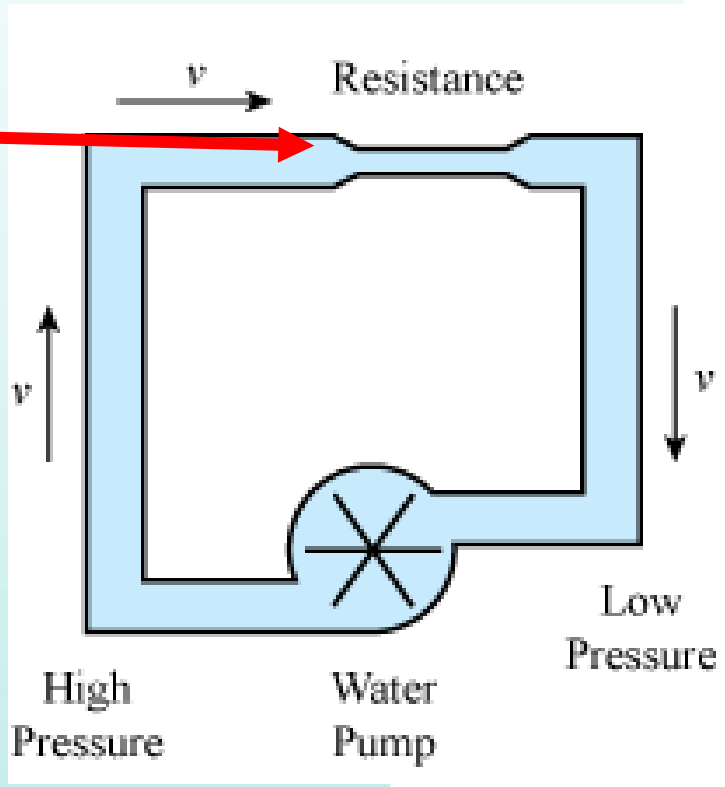
Imagine a water pipe system, where the flow of water can be compared to the flow of electricity in a circuit.

Electricity: Not-Visible
Water: Visible



Electric


Resistance
Less resistance
More resistance


v
Resistance
v
v
Low
Pressure
High
Pressure
Water
Pump

Electric

Ohm's Law

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

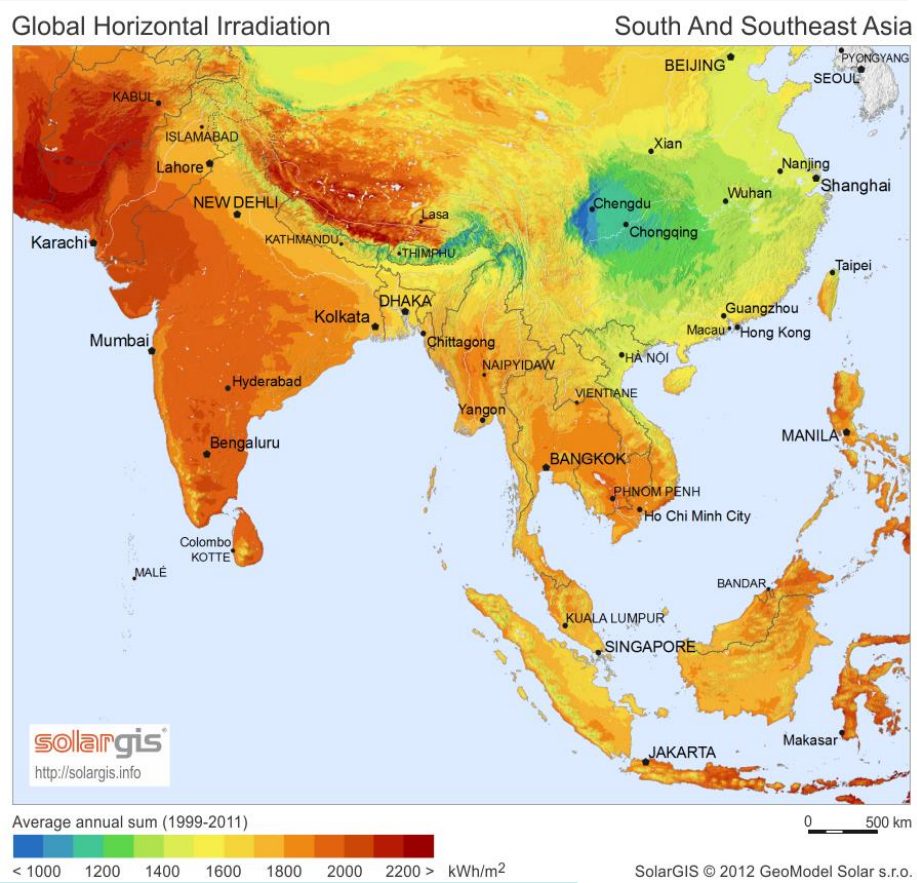
Quantities	Abbreviations	Units	Label
Voltage	V or E	Volts	V
Current	I	Amperes	A
Resistance	R	Ohms	Ω

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

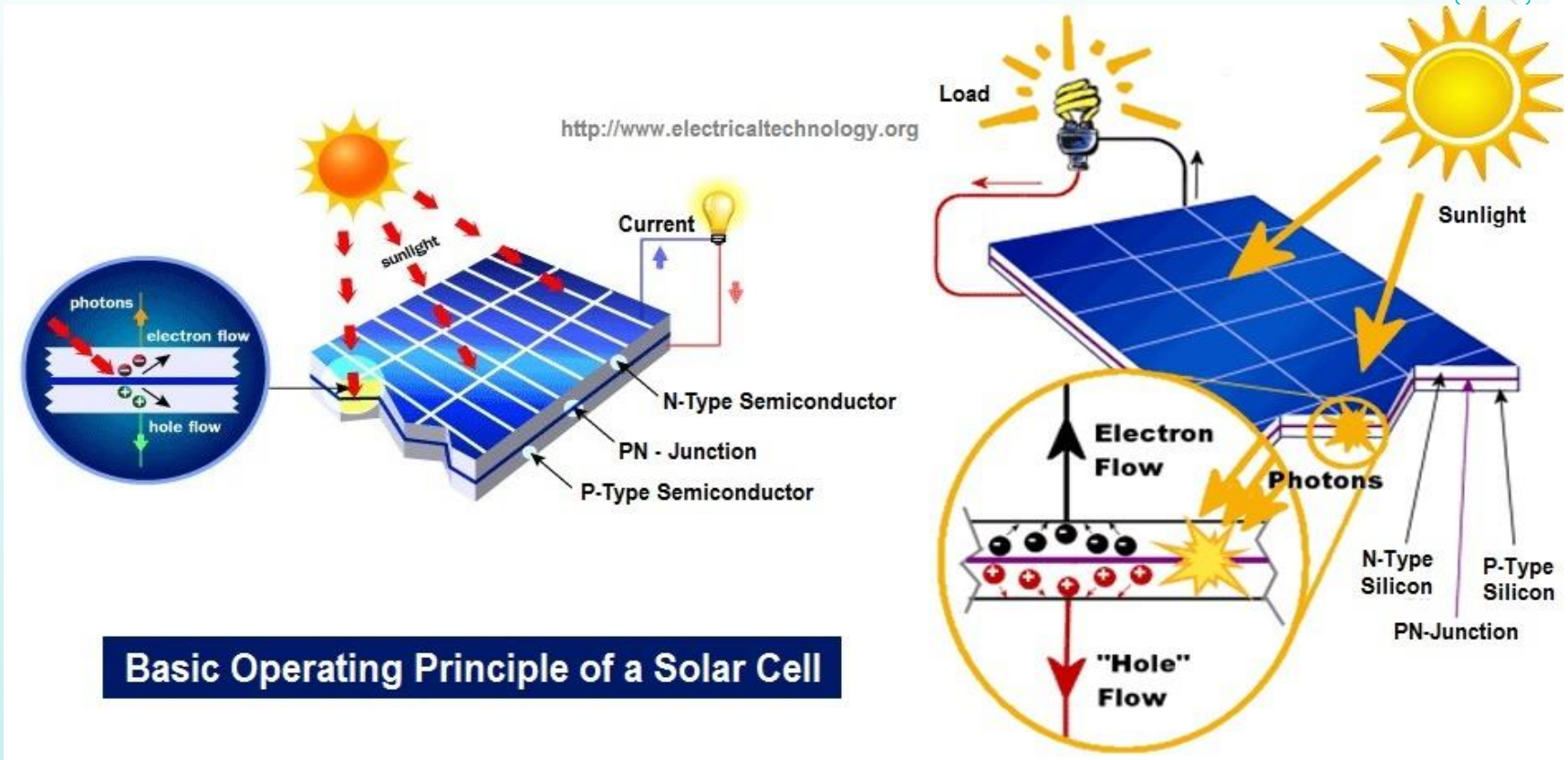
Electric

輸入功率 Input power

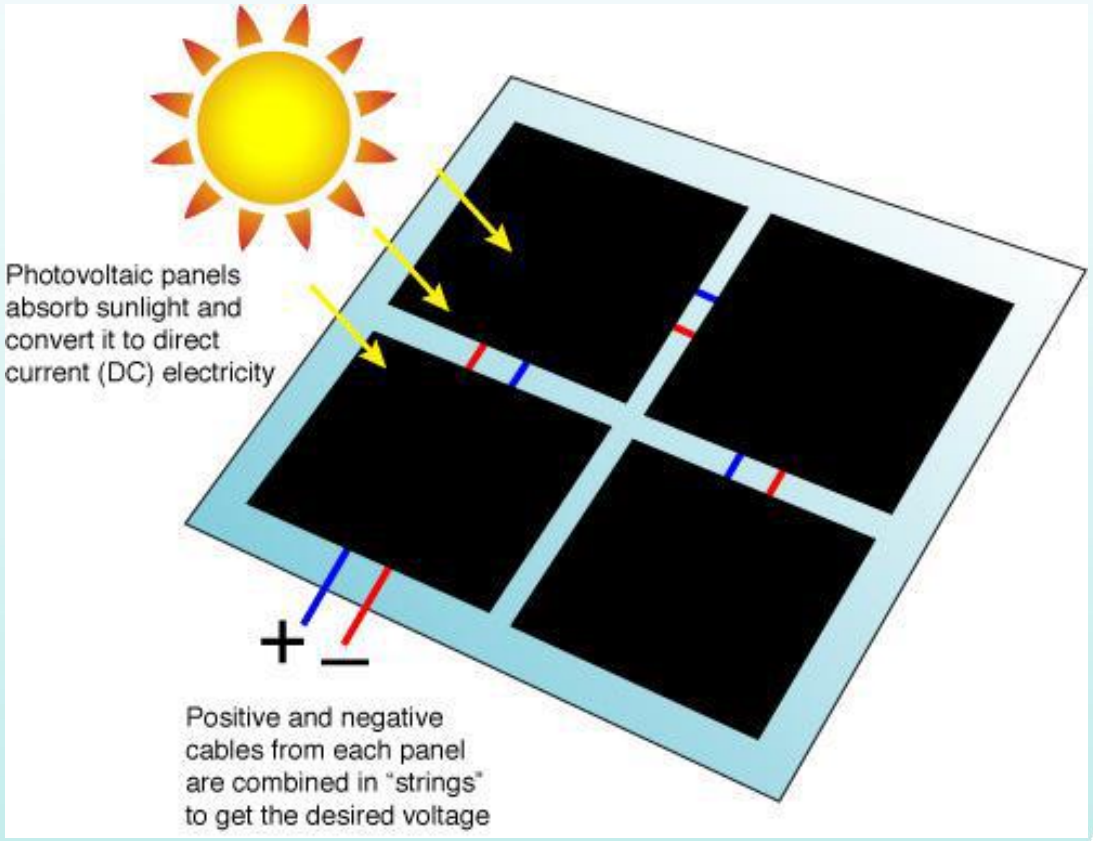
a) Solar energy



Solar panel application



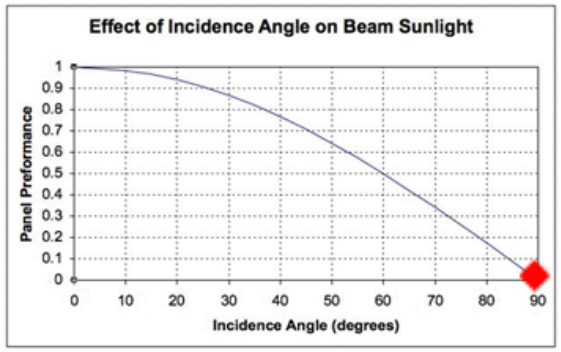
Solar panel

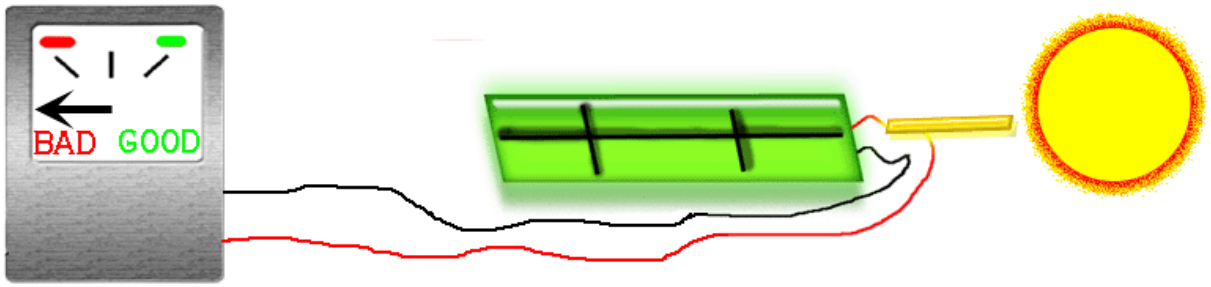

Photovoltaic panels absorb sunlight and convert it to direct current (DC) electricity
+
–
Positive and negative cables from each panel are combined in "strings" to get the desired voltage

Electric

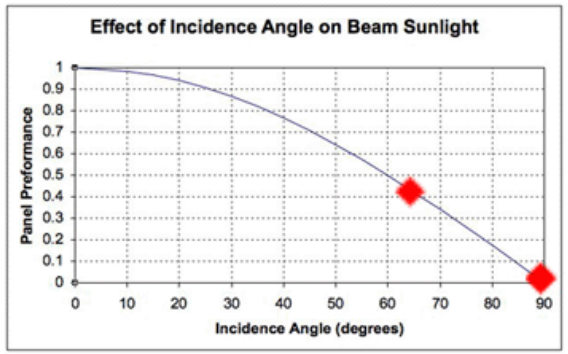
- Maximize power output from solar panels
  - 向太陽傾斜Tilt towards sun

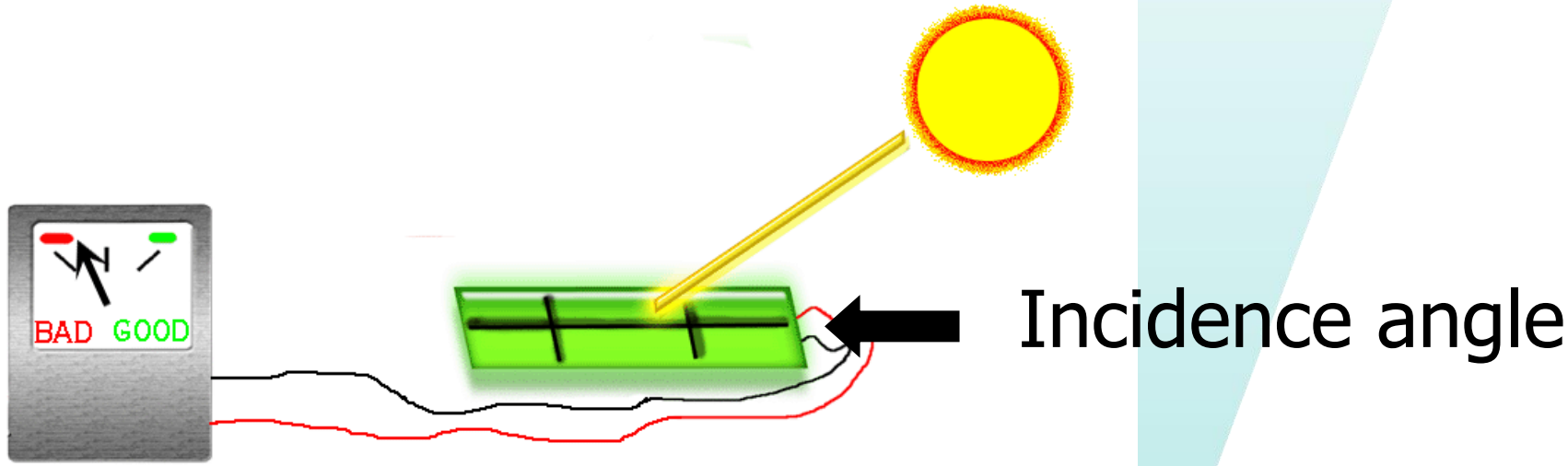
Electric


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

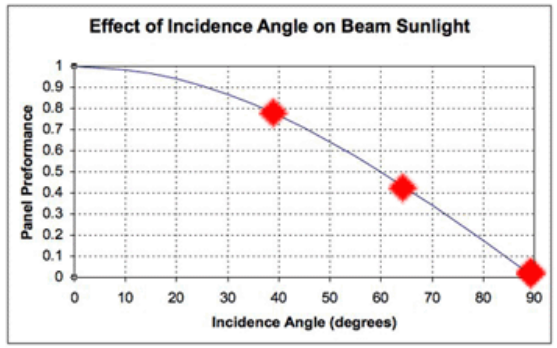
Electric

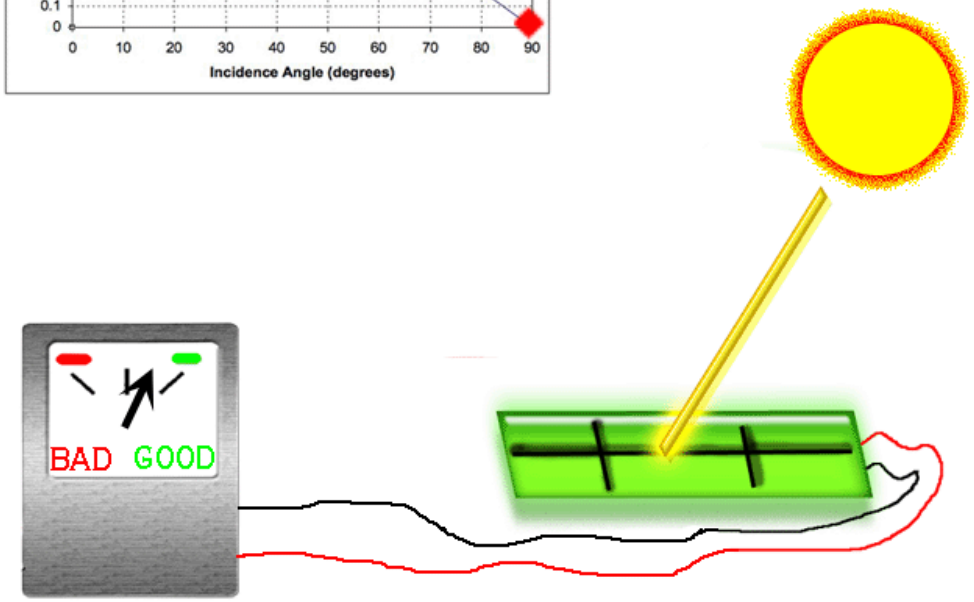




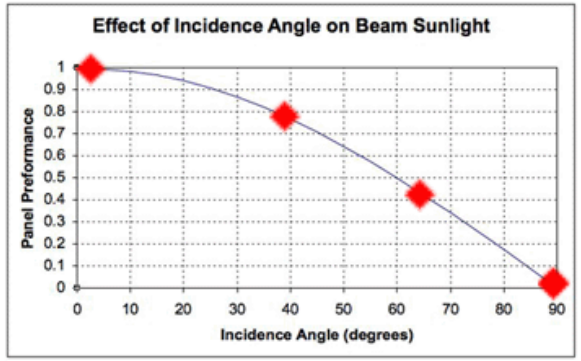
Incidence angle

Electric


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

Electric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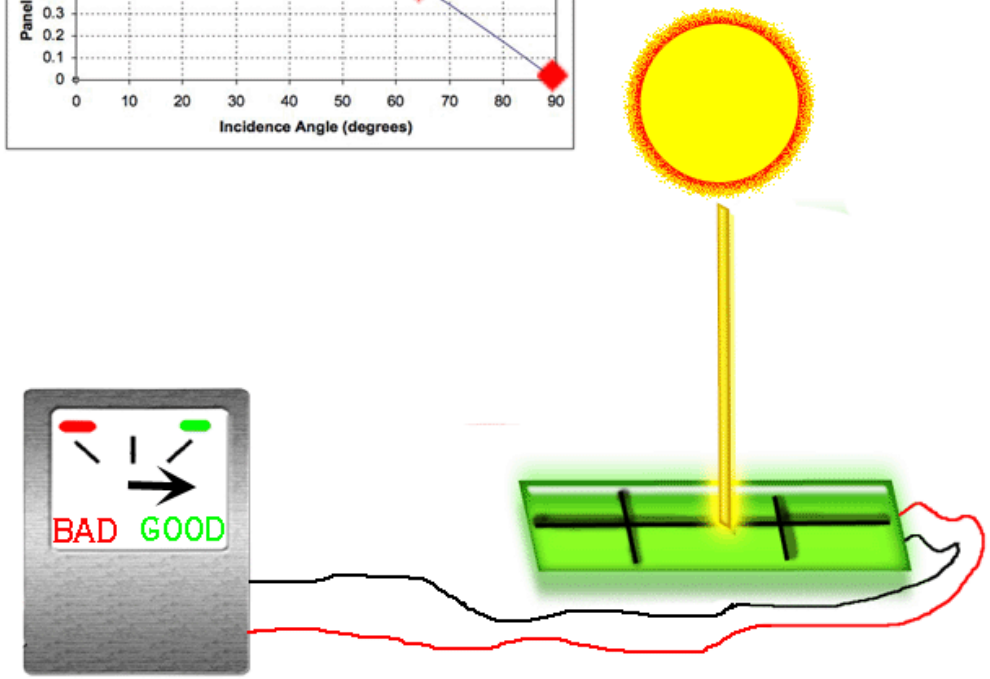
Incidence Angle (degrees)


BAD
GOOD

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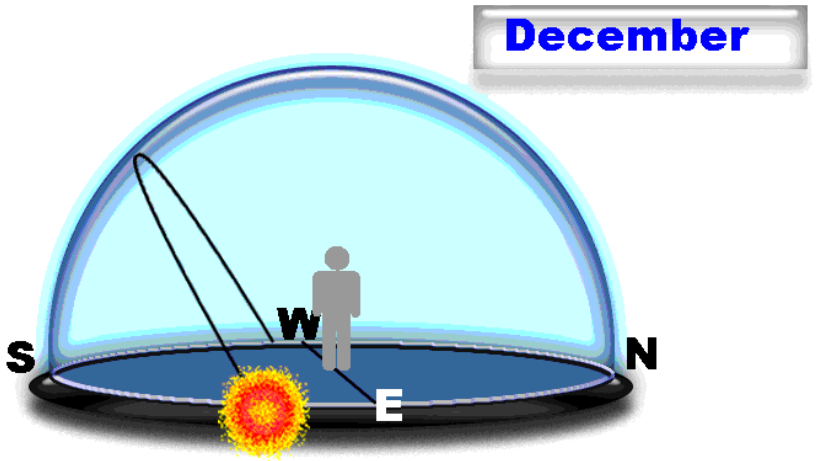
Where is sun?



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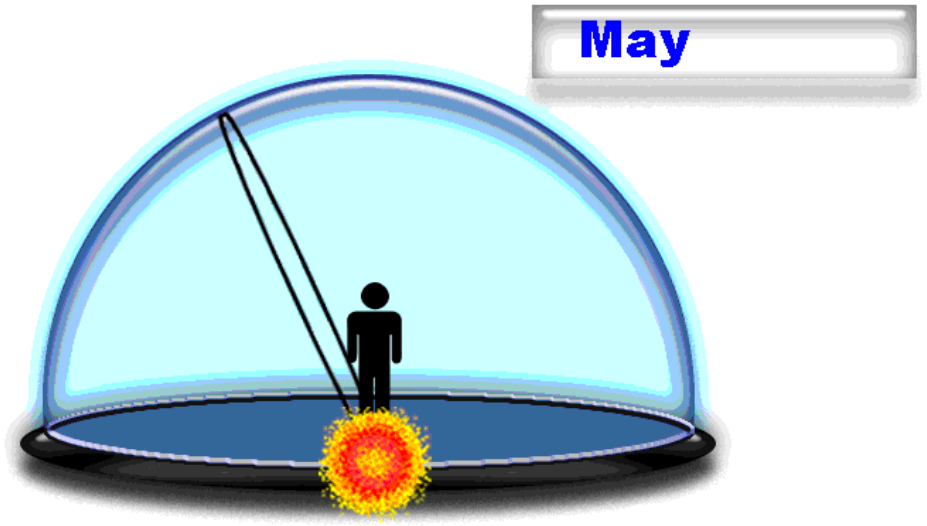
Where is sun?



On May 20, the sun will rise to around 70 degrees at noon (1 p.m.).

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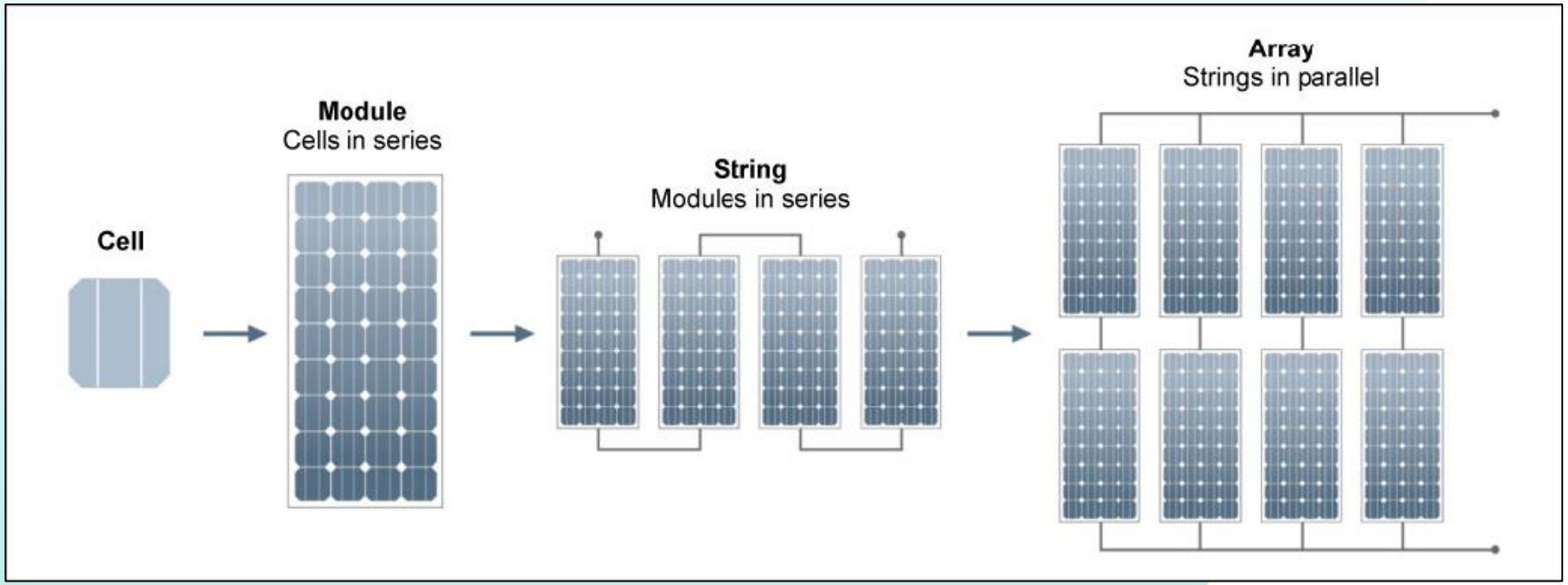
Solar panel connection



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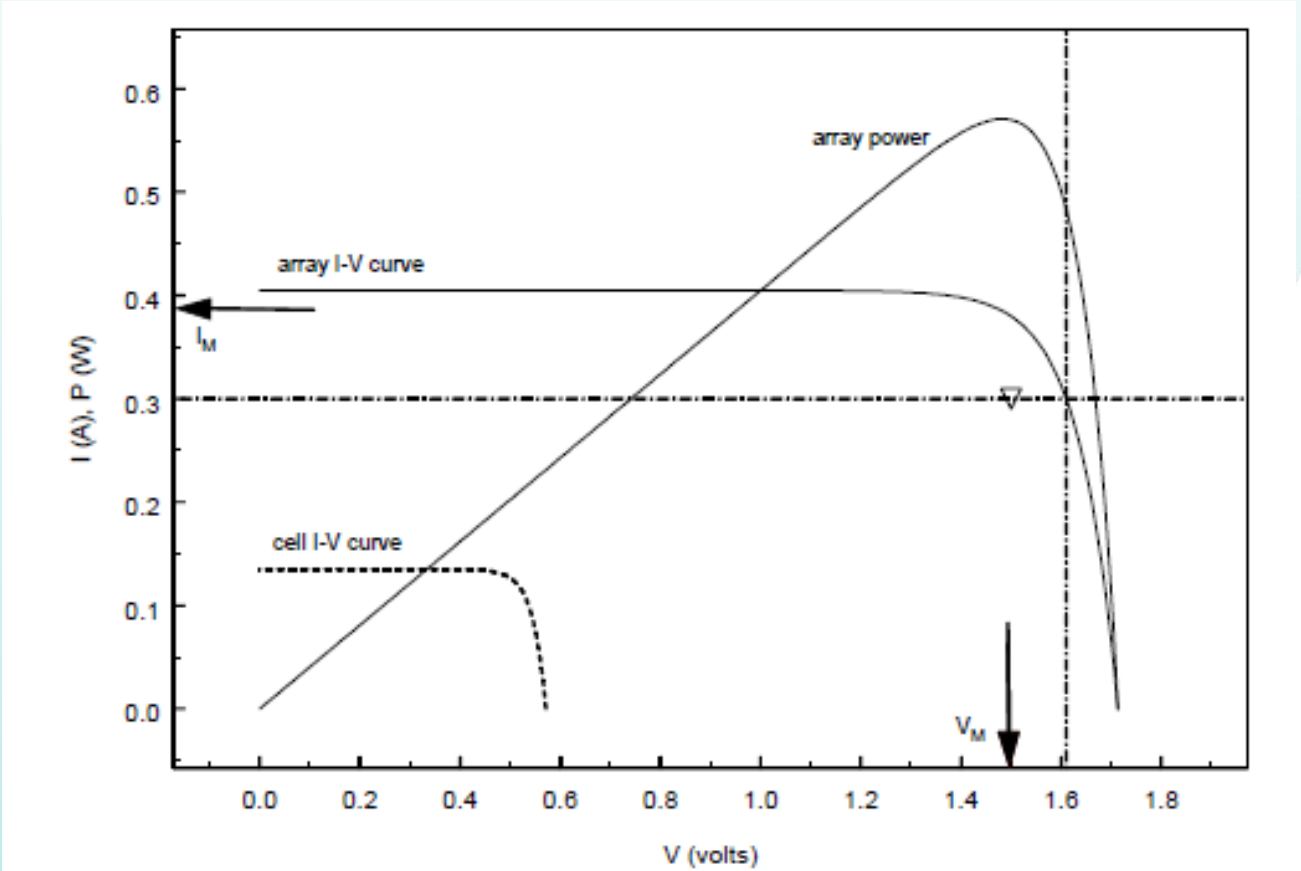
Solar panel V-I characteristic curve



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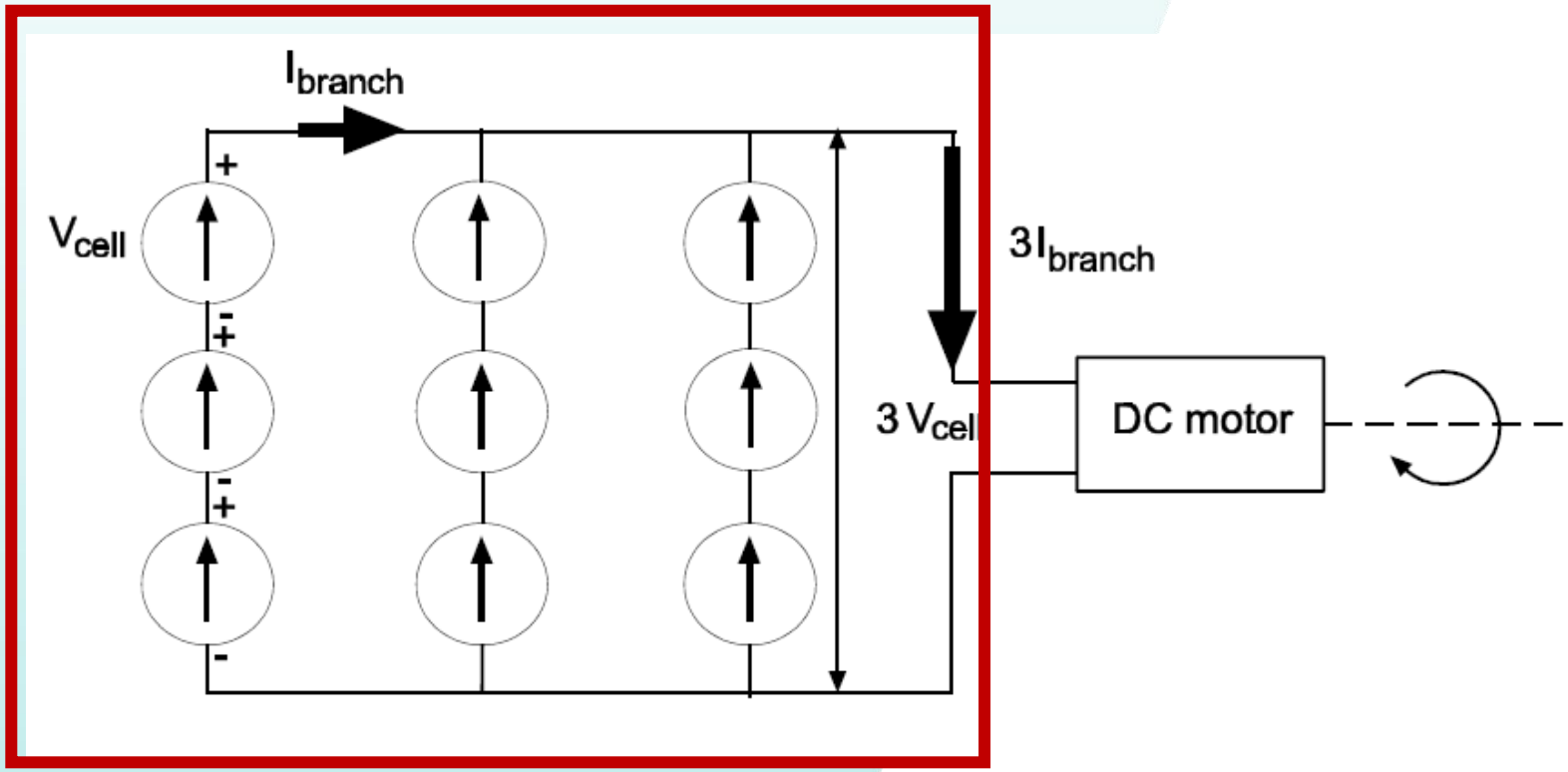
Example

- Calculate the power output of this solar panel array.



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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

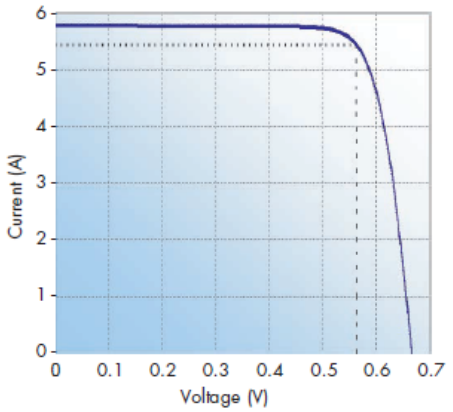
- High efficiency reduces module assembly and system installation costs
- Uniform front appearance - no contact grid
- Back contact design simplifies circuit assembly
- Lower temperature coefficient improves energy delivery

PACKAGING

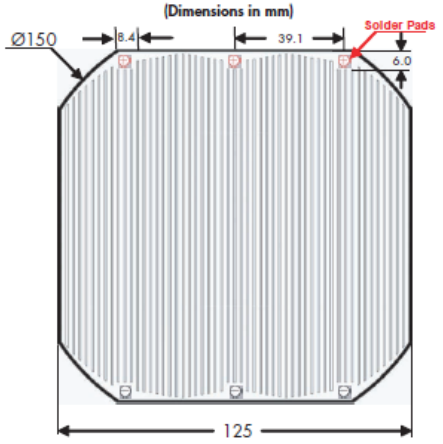
- Cells are packed in boxes of 1000 each; grouped in shrink-wrapped stacks of 50 with interleaving
- Twelve boxes are packed in a water-resistant "Master Carton" containing 12,000 cells suitable for air transportation

Document#: 70-0006 RevOd

A-300 CELL PERFORMANCE - TYPICAL I-V CURVE



CELL BACKSIDE VIEW
(Dimensions in mm)



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1.877.786.0123 Email: sales@sunpowercorp.com www.sunpowercorp.com
A Subsidiary of Cypress Semiconductor

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Example

Voltage of the solar panel array:

➢1 series:

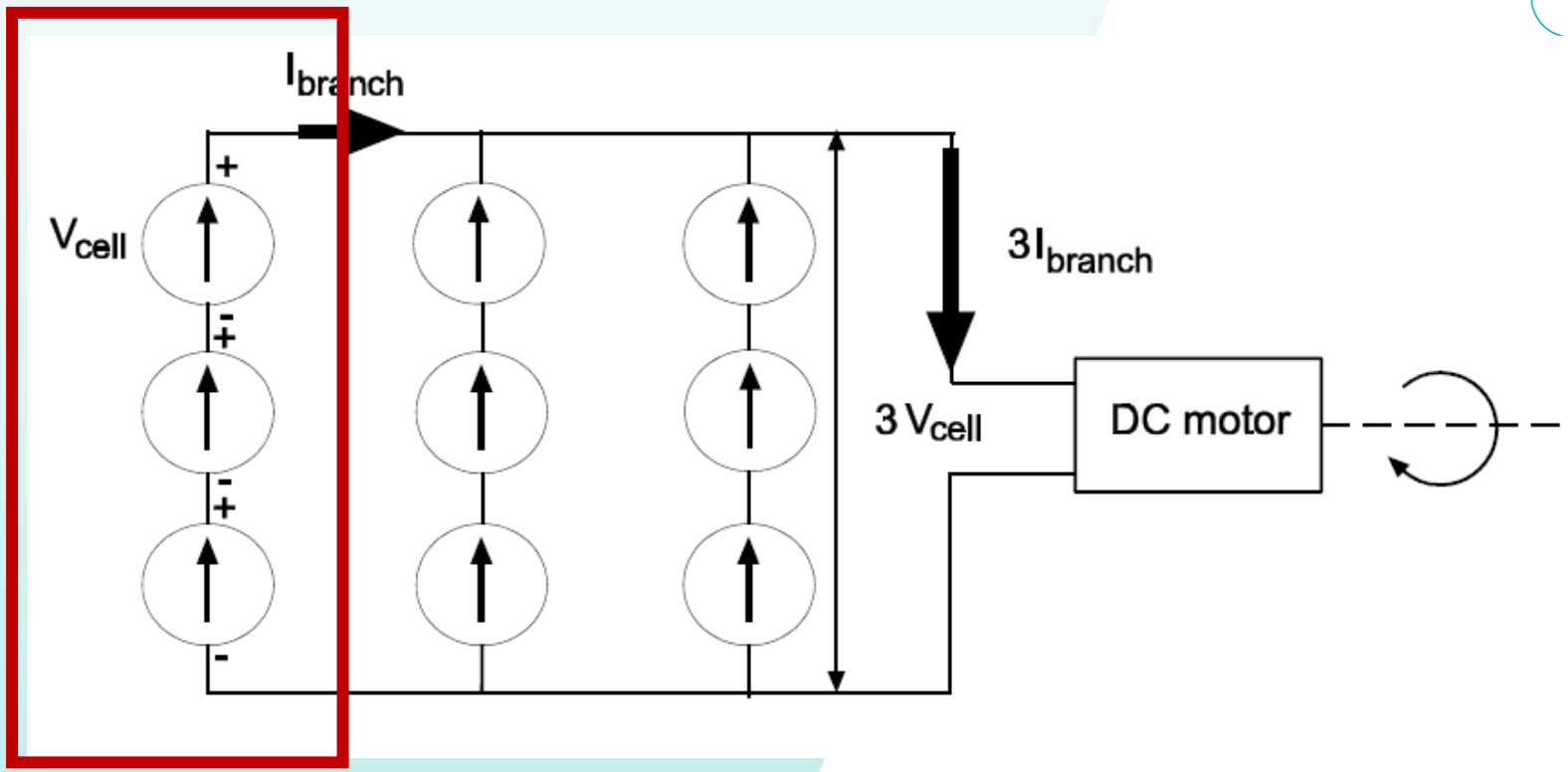
1 cell voltage:

= 0.5V

3 cell on 1 series:

= 3 x 0.5 V

=1.5 V



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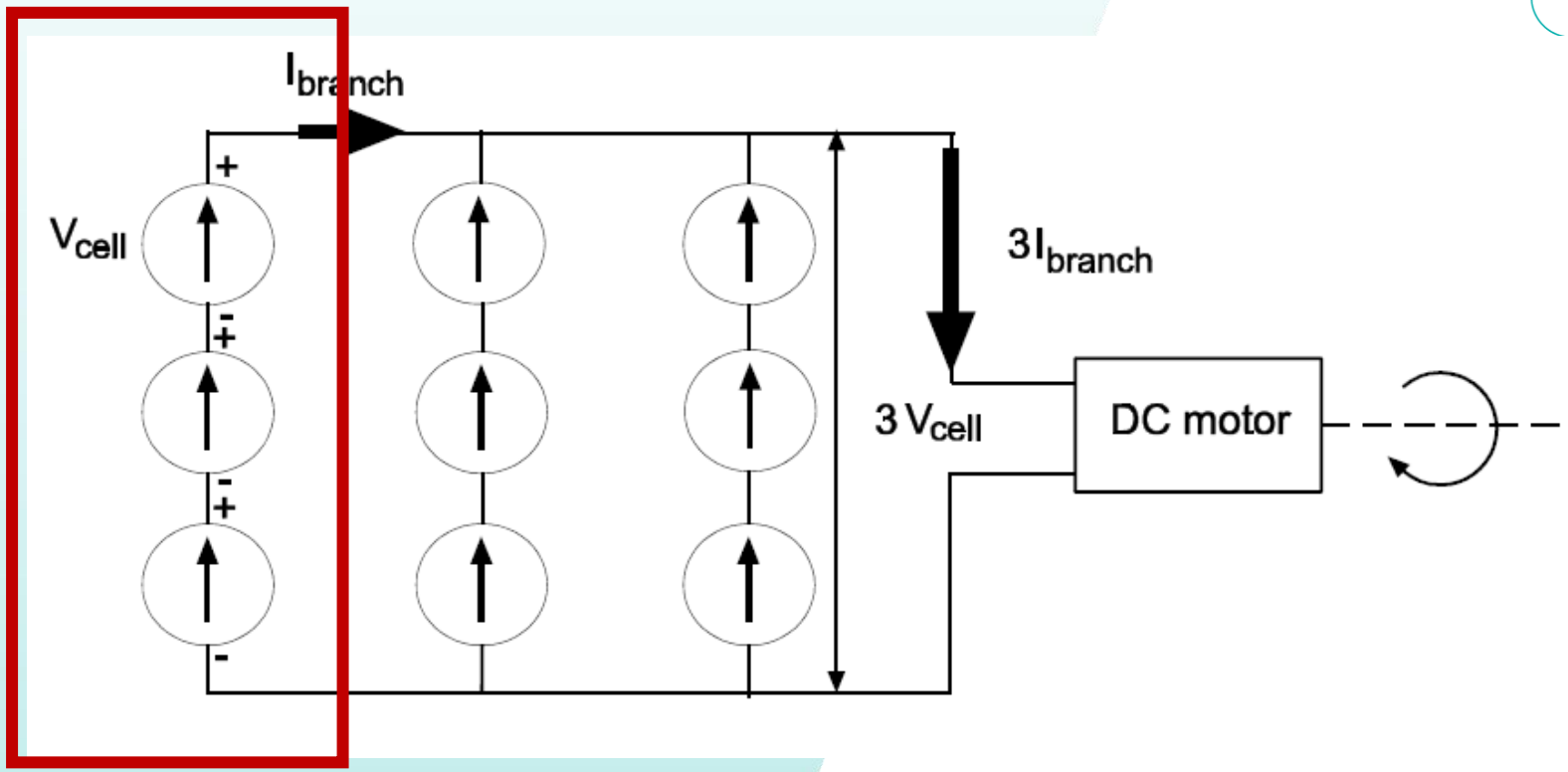
Example

Solar panel current:

- 3 parallels:

= 5 x 3 A

=15 A



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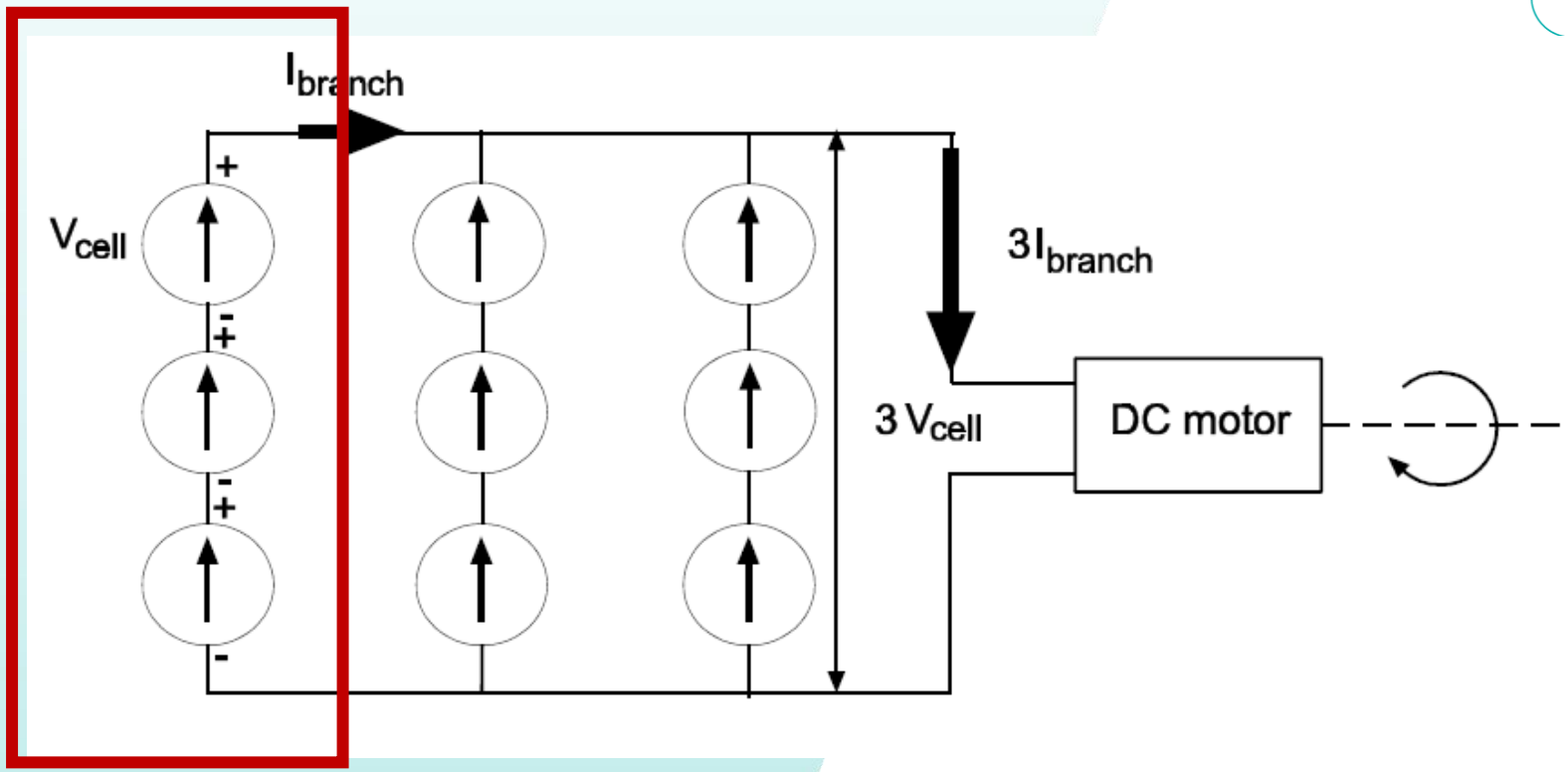
Example

Solar panel power:

- Voltage x Current

= 1.5 x 15

= 22.5 W



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It's time to take action: Design your solar car and get the parts you need!

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

Key questions

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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End