How can I swim faster?

大力D

多練水

增大浮力

泳式好

有好教練

高大：手掌/脚掌大

穿高科技泳衣

食補品

Coach Chan Mee Lee

Simple Math

In general,

Distance (m) = Speed (m/sec) x Time (sec)

$$\text{Time (sec)} = \frac{\text{Distance(m)}}{\text{Speed (m/sec)}}$$

In swimming,

Speed (m/sec) = Stroke Length (m/stroke) x Stroke Rate (stroke/sec)

Therefore,

$$\text{Time (sec)} = \frac{\text{Distance (m)}}{\text{Stroke Length (m/stroke) x Stroke Rate (stroke/sec)}}$$

* Note: m = meter, sec = second

Example

What is the time of swimming a 50 meters Freestyle at stroke rate of 1.5 stroke per second and stroke length of 1 meter per stroke?

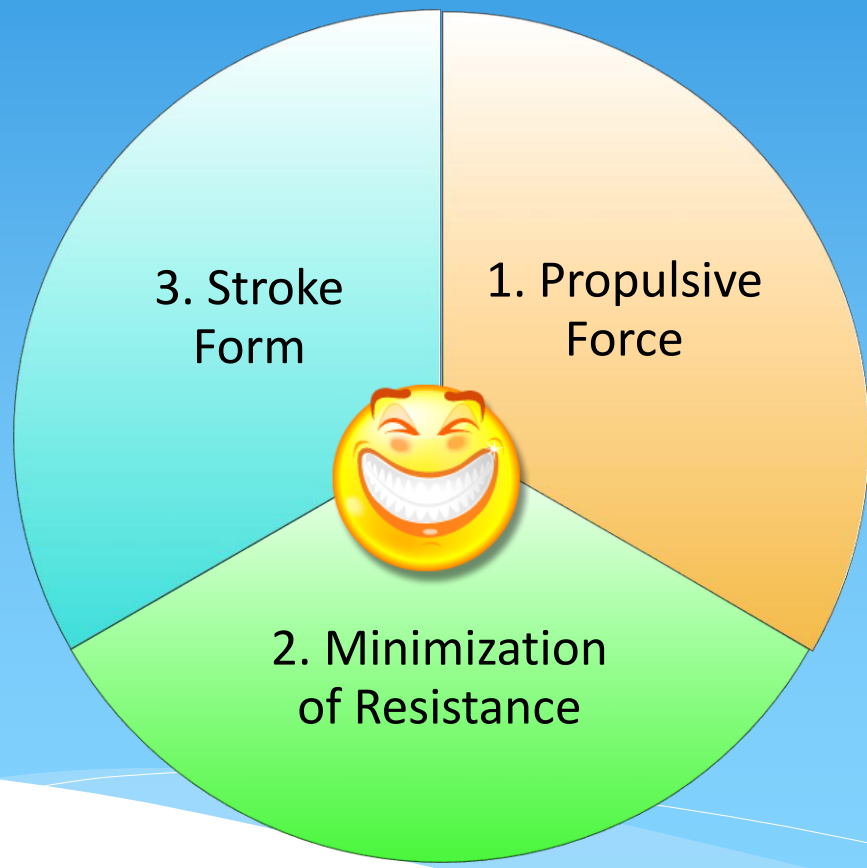
Hint: $Time\ (second) = \frac{Distance}{Stroke\ Length\left(\frac{m}{stroke}\right) \times Stroke\ Rate\left(\frac{stroke}{second}\right)}$

$$Time\ (second) = \frac{50\ m}{\left(\frac{1m}{stroke}\right) \times \left(\frac{1.5\ stroke}{second}\right)}$$

Ans = 33.33 seconds

Key to Increase Speed

Speed (m/sec) = Stroke Length (m/stroke) x Stroke Rate (stroke/sec)



Newton's First Law

- *A body acted on by no net force moves with constant velocity (which may be zero) and zero acceleration.*

That means, an object will always continue moving at its current speed and in its current direction until some force causes its speed or direction to change.

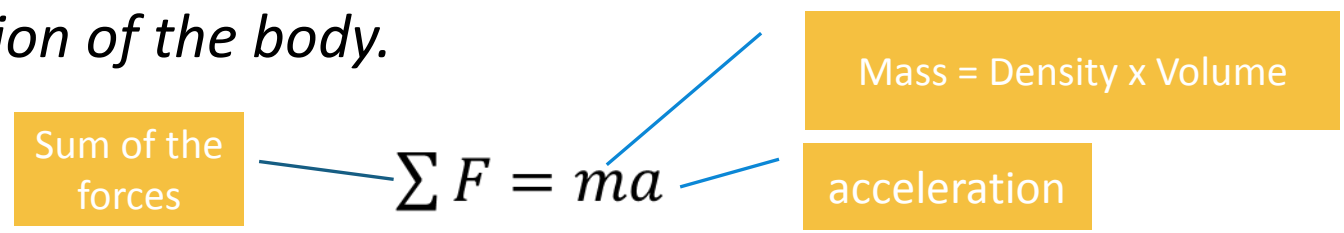
An object that is not in motion (velocity = zero), which will remain at rest until some force causes it to move.

If Newton is right, how come after a swimmer push off from the wall, one will slow down and eventually come to a stop?

Ans: DRAG!

Newton's Second Law

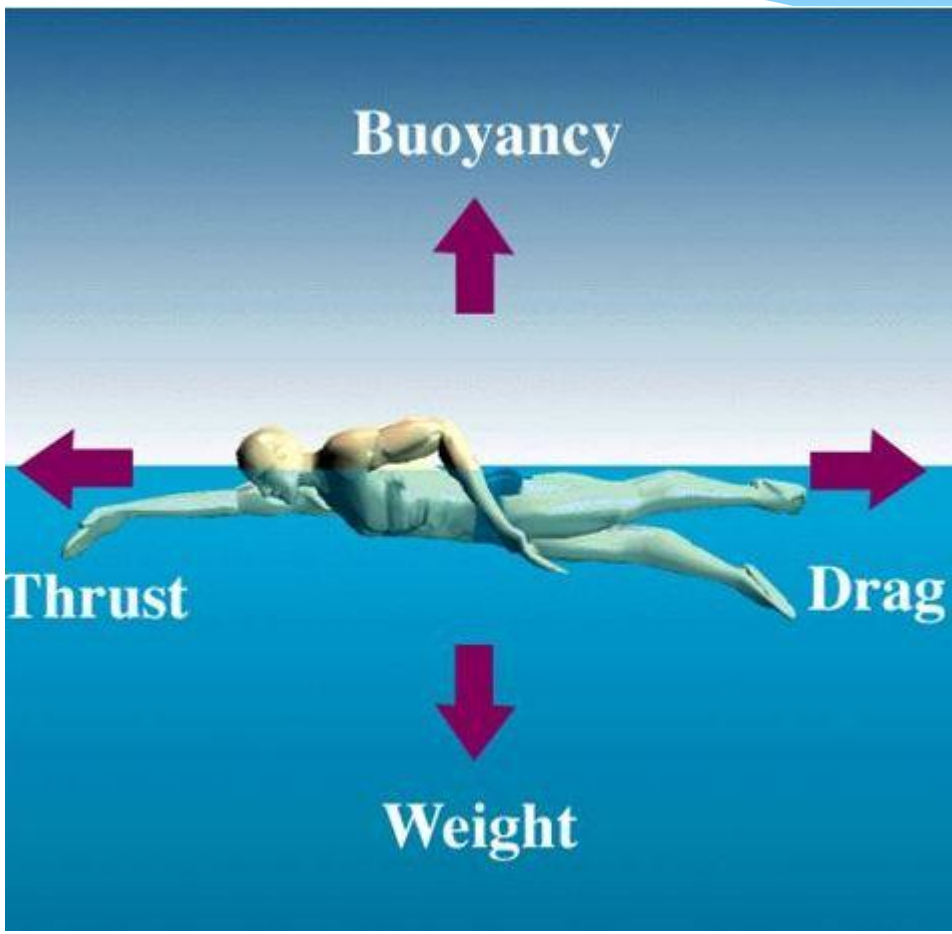
- *If a net external force acts on a body, the body accelerates. The direction of acceleration is the same as the direction of the net force. The net force vector is equal to the mass of the body times the acceleration of the body.*



Therefore,

$$a = \frac{\sum F}{m}$$

Free Body Diagram of A Swimmer



Source: Cislunar Aerospace, Inc.

$$\sum F = F_{thrust} - F_{drag} = ma$$

Since $\sum F = ma$,

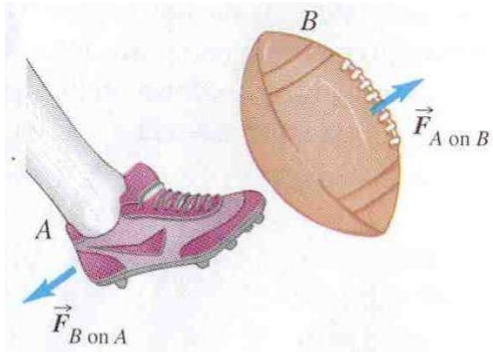
1. If $\sum F = 0$, a= 0. It means constant velocity and zero acceleration.
2. If $\sum F \geq 0$, a= +. It means you are accelerating.
3. If $\sum F \leq 0$, a= - . It means you are decelerating.

Newton's Third Law of Motion

- *If body A exerts a force on body B (an "action"), then body B exerts a force on body A (a "reaction"). These two forces have the same magnitude but are opposite in direction. These two forces act on different bodies.*

Apply to swimming,

$$F_{\text{swimmer on water}} = -F_{\text{water on swimmer}}$$



4–18 If body A exerts a force $\vec{F}_{A \text{ on } B}$ on body B, then body B exerts a force $\vec{F}_{B \text{ on } A}$ on body A that is equal in magnitude and opposite in direction: $\vec{F}_{A \text{ on } B} = -\vec{F}_{B \text{ on } A}$.

Propulsive force (F_{thrust})

- Increase muscular force

  Muscular Strength: Endurance and Power

  Muscle mass

- Increase flexibility

  Maximize range of motion, esp. shoulders and ankles joints.

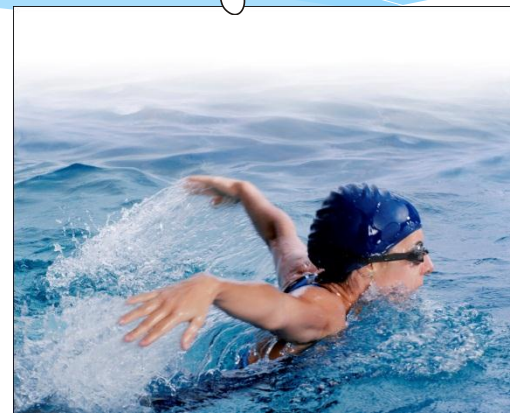
  Stiffness in joints = energy inefficiency

- Stroke coordination

Resistance Force (F_{Drag})

Types of Drag

1. *Pressure/ Form drag (F_p),
2. Surface/ Friction drag (F_s) and
3. *Wave drag (F_w)



Total Drag (F_{Drag}) a swimmer encounters

$$F_{Drag} = F_p + F_s + F_w$$

Minimization of Resistance

- Decrease of drag & turbulence
  - Decrease body cross-sectional area
  - Body alignment- Leg and hip sinking disturbed streamlined
  - Streamline body position (front & back, left and right), including head position.

Streamline

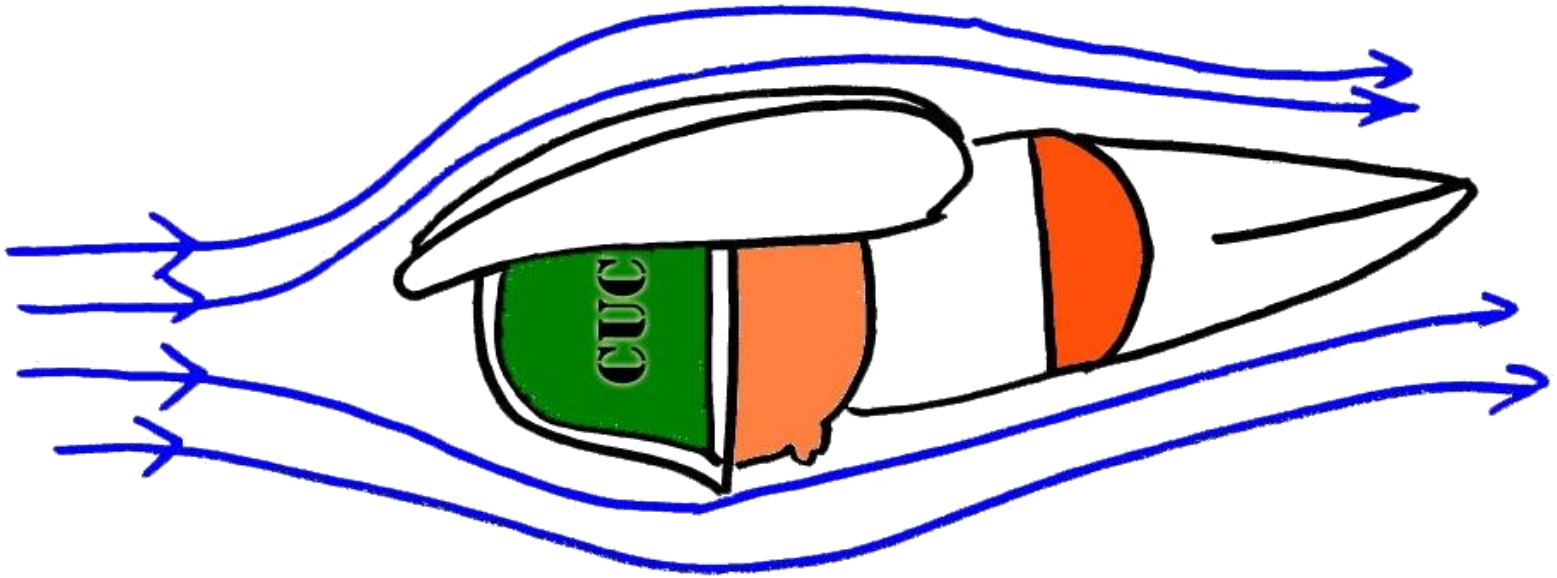
Ian Thorpe testing in the wind tunnel
Source: http://www.swim.ee/adidas

Streamline

Ian Thorpe testing in the water
Source: http://www.swim.ee/adidas

Natalie Coughlin
Source: http://swimtelligence.blogspot.com

Streamline



Minimization of Resistance (cont'd)

15 meters underwater kicks

* History

Denis Pankratov

- **Russian Butterfly swimmer**
- **1996 Summer Olympics in Atlanta, Georgia, USA**
- **100 Bu- 1st lap more than 25 m underwater, 2nd 15 m**

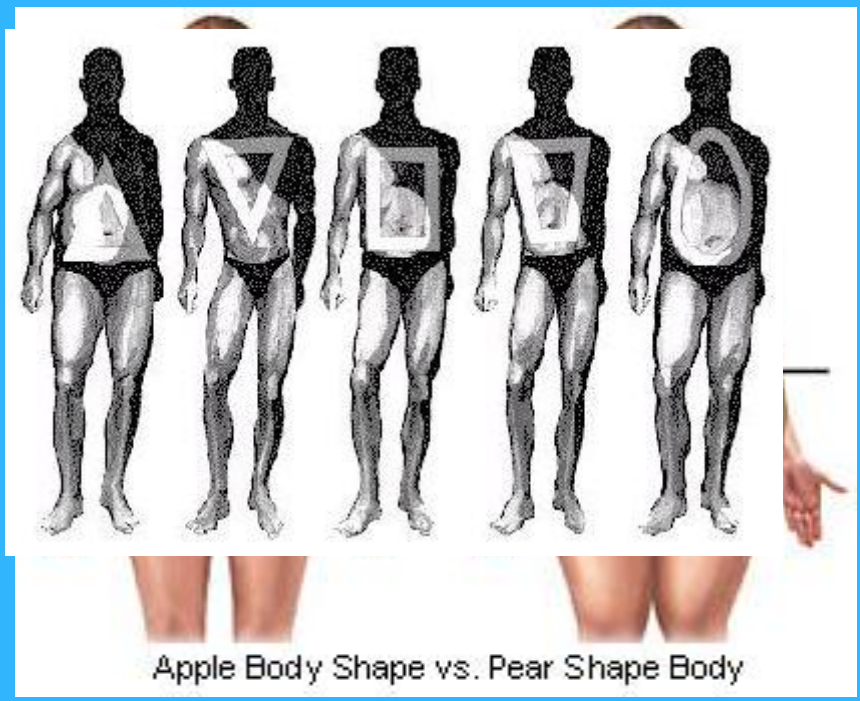
* FINA rule changed

  Swimming not more than 15 meters after the start and each turn.

Stroke form-

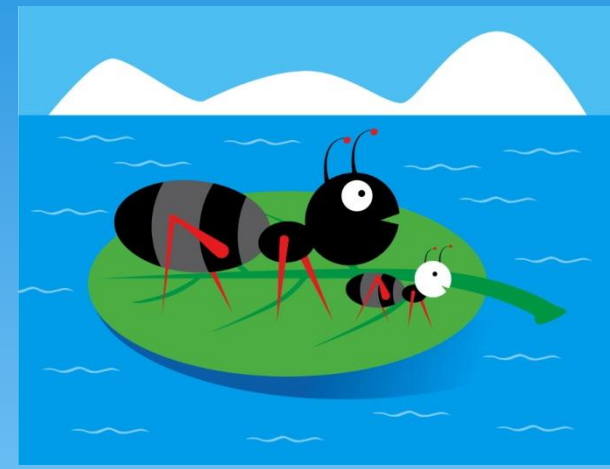
Individual differences (variation between individuals)

- Physique



Stroke form (cont'd)

- Density
  - Water=1.0 g/cm^3
  - Ocean Water= 1.03 g/cm^3
  - Dead Sea = 1.24 g/cm^3
  - Body Fat= 0.9 g/cm^3
  - Muscle= 1.06 g/cm^3
  - Human body: 0.9-1.0 g/cm^3



- Learning ability
  - The **Eagerness** to change
  - **Seriousness** in performing drills
  - ~~Practice makes perfect~~

Perfect practice makes perfect

Sports Technology

Hi-Tech swimsuits claim to

- decrease surface drag
- decrease pressure drag

V-shaped ridges pattern - mixing/ redirect flow pattern to decrease pressure differential

- Increase muscle compression
- Increase buoyancy - less drag

E.g. Speedo FastSkin, Arean X-Glide, Adidas JetConcept

FINA Rules By-Laws

* **BL 8.2** In swimming competitions the competitor must wear only one swimsuit in one or two pieces. No additional items, like arm bands or leg bands shall be regarded as parts of a swimsuit.
* **BL 8.3** From January 1, 2010 swimwear for men shall not extend above the navel nor below the knee, and for women, shall not cover the neck, extend past the shoulder, nor shall extend below knee. All swimsuits shall be made from textile materials.

FINA Requirements for Swimwear

Swimsuits criteria:

Material:

- Flexibility: the material shall be flexible and soft folding.
- Regular flat material: The material shall be regular and flat. The material shall not form outstanding shapes or structures, such as scales.
- Thickness: The material used shall have a maximum thickness of 0.8mm.
- Buoyancy: The swimsuit shall not have a buoyancy effect above 0.5 Newton measured after application of vacuum.
- Permeability: material(s) used must have at any point a permeability value of more than 80 litres/meter^2/second.

Construction:

- External stimulation or influence: swimsuits which include any system providing external stimulation or influence of any type, including pain reduction, chemical/medical substance release, electro-stimulation etc. are prohibited.

Caps and goggles criteria:

- Independent item: the cap shall not be attached to the swimsuit or goggles nor be in continuity therewith (no "hood" or "mask" effect).

Sports Technology

Design of swimming pool

- Anti-waves swimming lanes
- 10 lanes with gutter placed at the same level of water
- Location of water outlet and inlet

References

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Questions?

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