



Sky divers & Terminal velocity



Air resistance(Drag force)

The opposite force exerted on objects when moving through a fluid(liquid/gas) is called the drag.

Drag force

A white Mercedes-Benz sedan is positioned in a wind tunnel. Blue streamlines represent the airflow over the car, showing how the air flows around the hood, roof, and rear. The car is on a test platform. In the background, a digital display shows wind tunnel parameters: Va: 140,0 km/h, Beta: 0,0 °, 00:00, and 23,0 °C. The tunnel walls are dark and industrial.

Video demonstration

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Drag force.

- The size of the drag force acting on an object depends on its shape and its speed.
- High speed → Large drag
- Large area → Large drag
- The modern cars, high speed trains are designed with streamlined shape and smooth surfaces to reduce the drag force.
- The sizes of drag forces in liquids are much higher than in gases.



Low drag coefficient

Drag coefficient- A measure of how easily an object moves through air

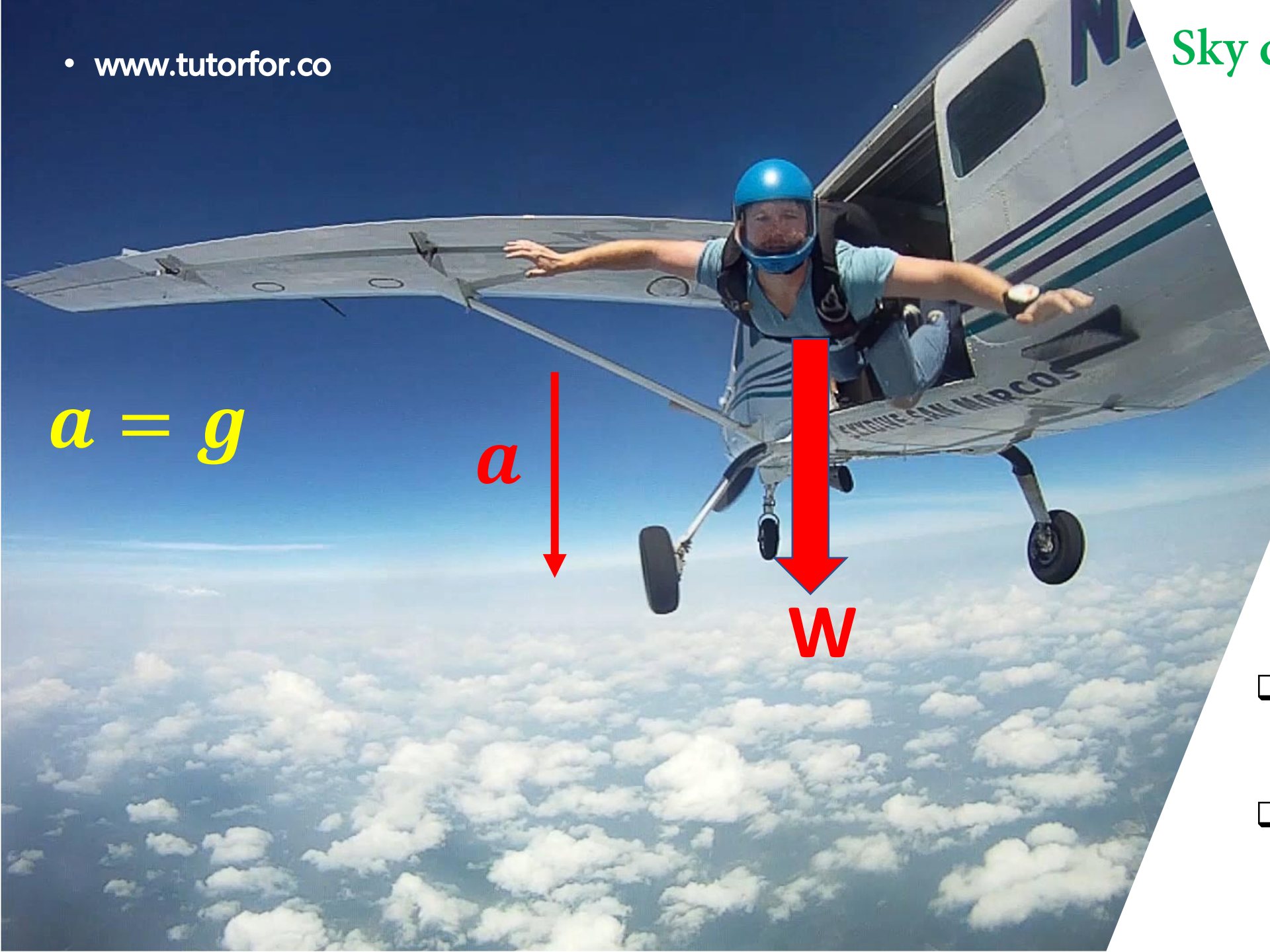


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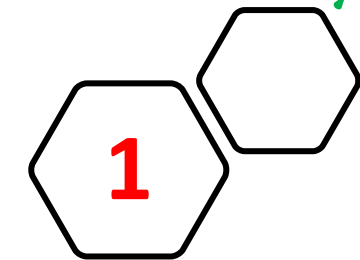
A composite image featuring several skydivers in freefall against a bright, sunlit sky. The skydivers are silhouetted against the light. Below them, a landscape with a large body of water and a town is visible. A large white diamond shape is overlaid in the center, containing red text. The overall scene is dynamic and captures the essence of skydiving.

**Sky divers &
Terminal velocity:
Video
demonstration**

Sky divers & Terminal velocity



$$a = g$$



Just after the jump:

Unbalanced force = Weight
= $W = mg$

↓ $F = ma$
 $mg = ma$
 $g = a$

- The only force acting on the person is his weight.
- The acceleration is equal to the gravitational acceleration ($g = 10 \text{ m/s}^2$)

$$D < W$$

D



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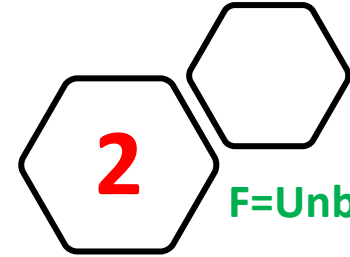
a

$$a < g$$



W

Falling through air:



F=Unbalanced force

F= Weight-Drag

F = W - D



F = ma

ma = W-D

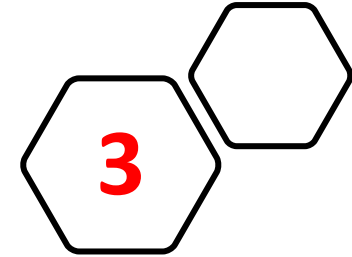
a < g

- The unbalanced force acting on the person is lower than his weight.
- The acceleration is less than gravitational acceleration.

$$D < W$$

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Falling through air:



- Drag increases with the speed. ($D \uparrow$)
- Unbalanced force decreases.

$$F \downarrow = W - D \uparrow$$

- The acceleration decreases when unbalanced force decreases.

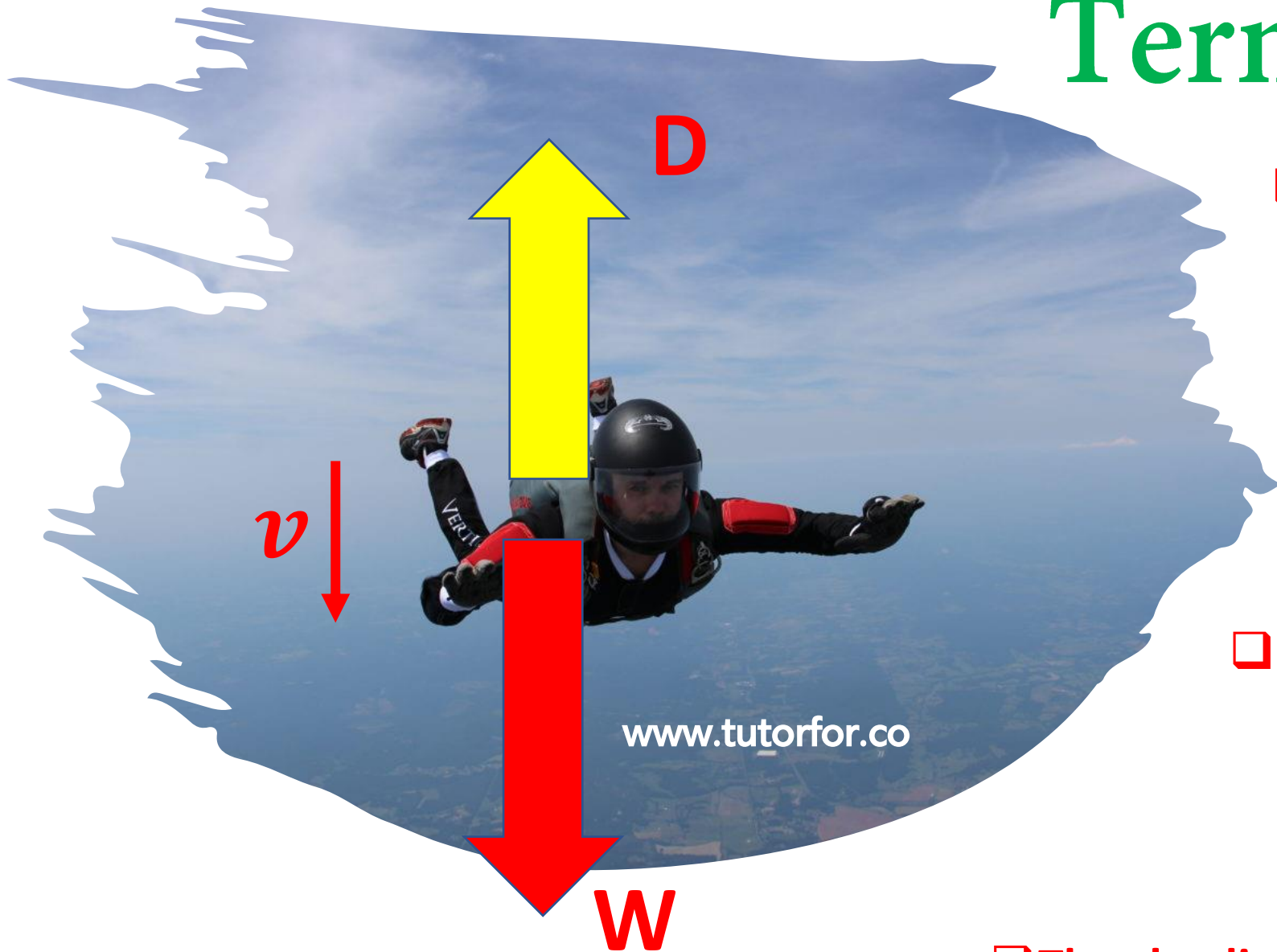
$$F \downarrow = m a \downarrow$$

a

$$a \ll g$$

W

Terminal velocity



- Drag increases with the speed until it balances the weight force.

$$D = W$$

$$F = W - D = 0$$

- The unbalanced force is zero. Hence acceleration is zero.

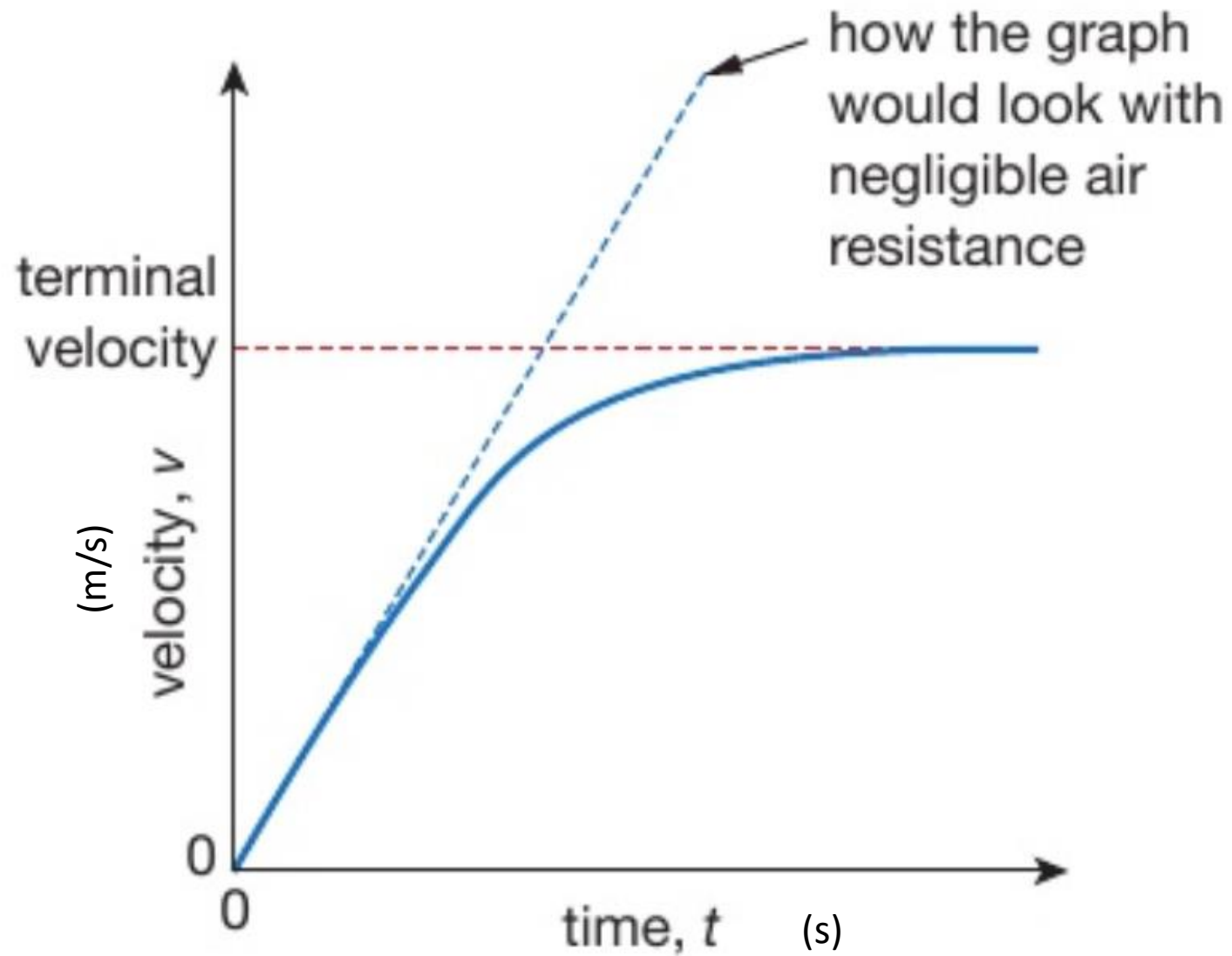
$$a = 0$$

- The sky diver is moving with a constant velocity called terminal velocity.



Velocity-time graph
(Sky diver reaches first
terminal velocity)

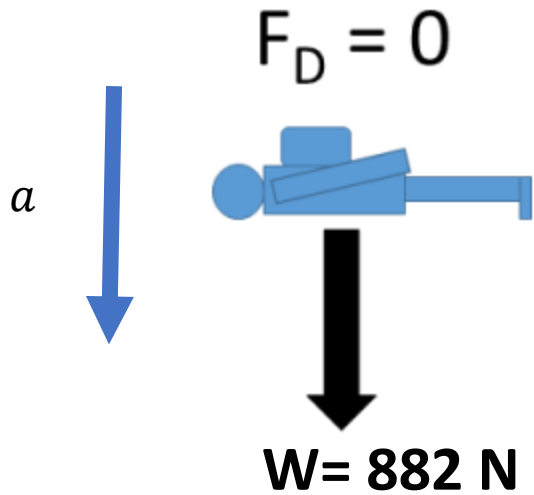
Terminal velocity v-t graph



Concept learning

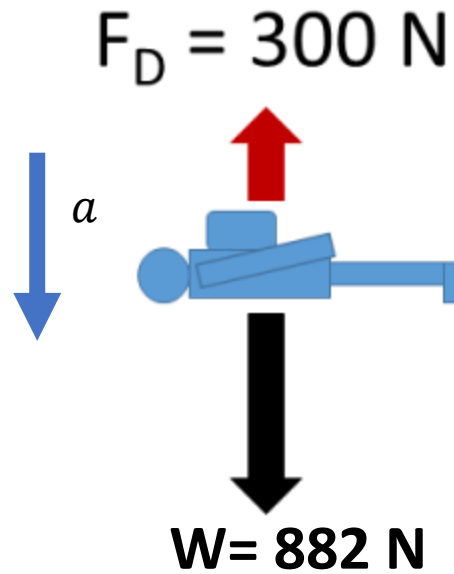
Find the acceleration

1



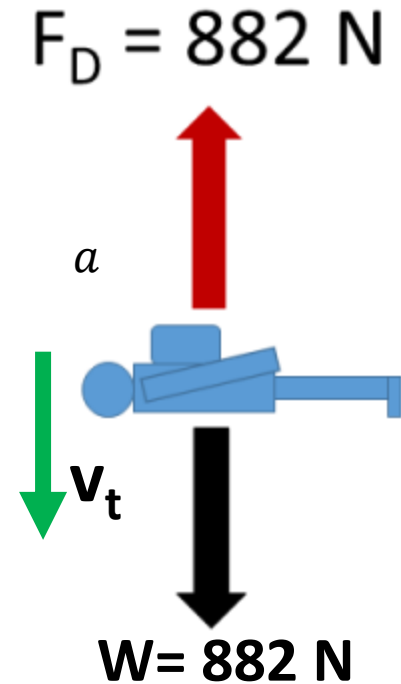
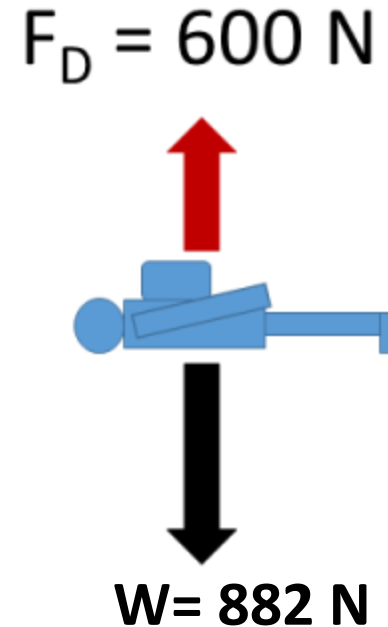
Initially the drag force is zero. The person falling with gravitational acceleration.

2

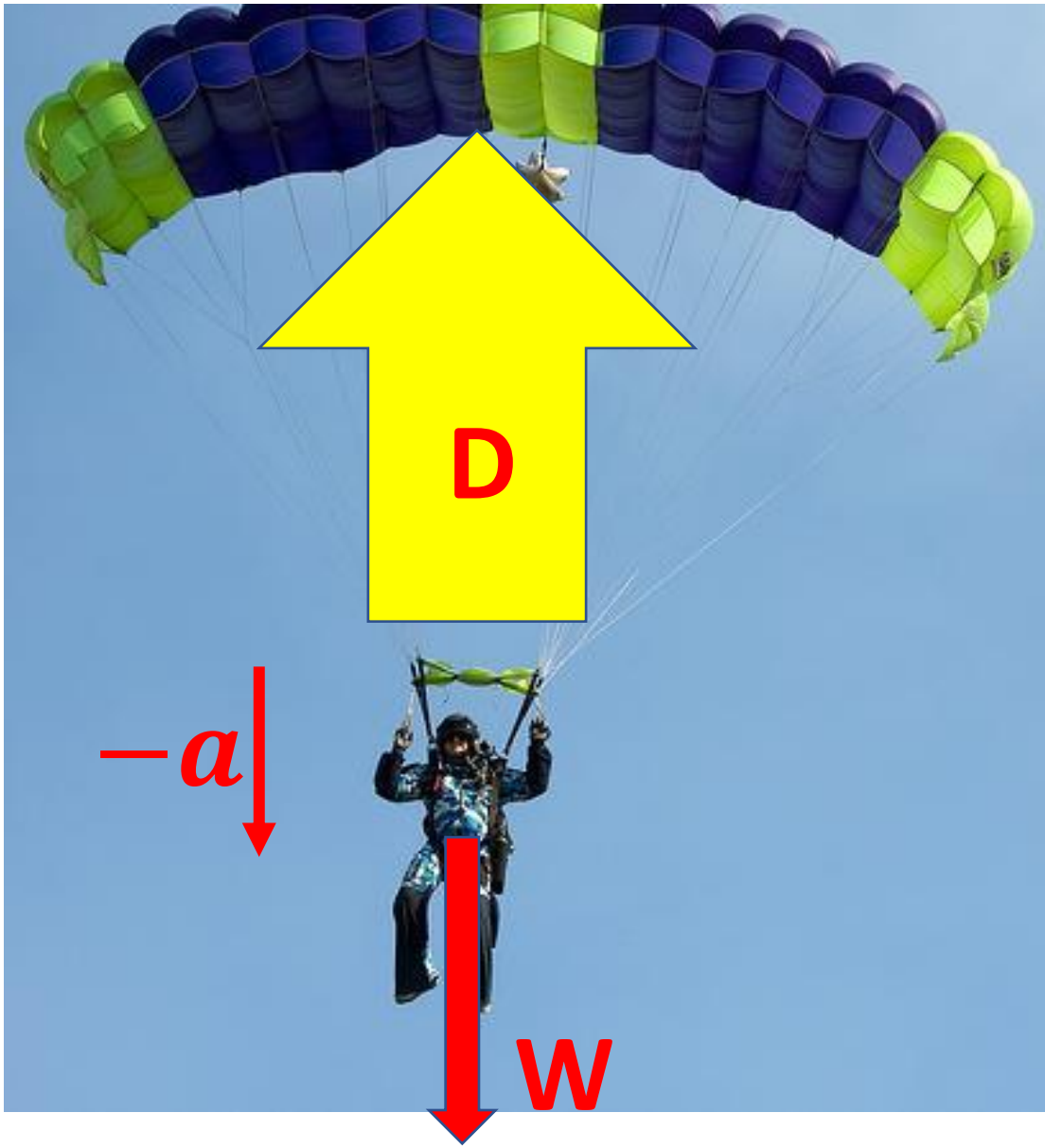


Drag force increases with the speed. The acceleration decreases.

3



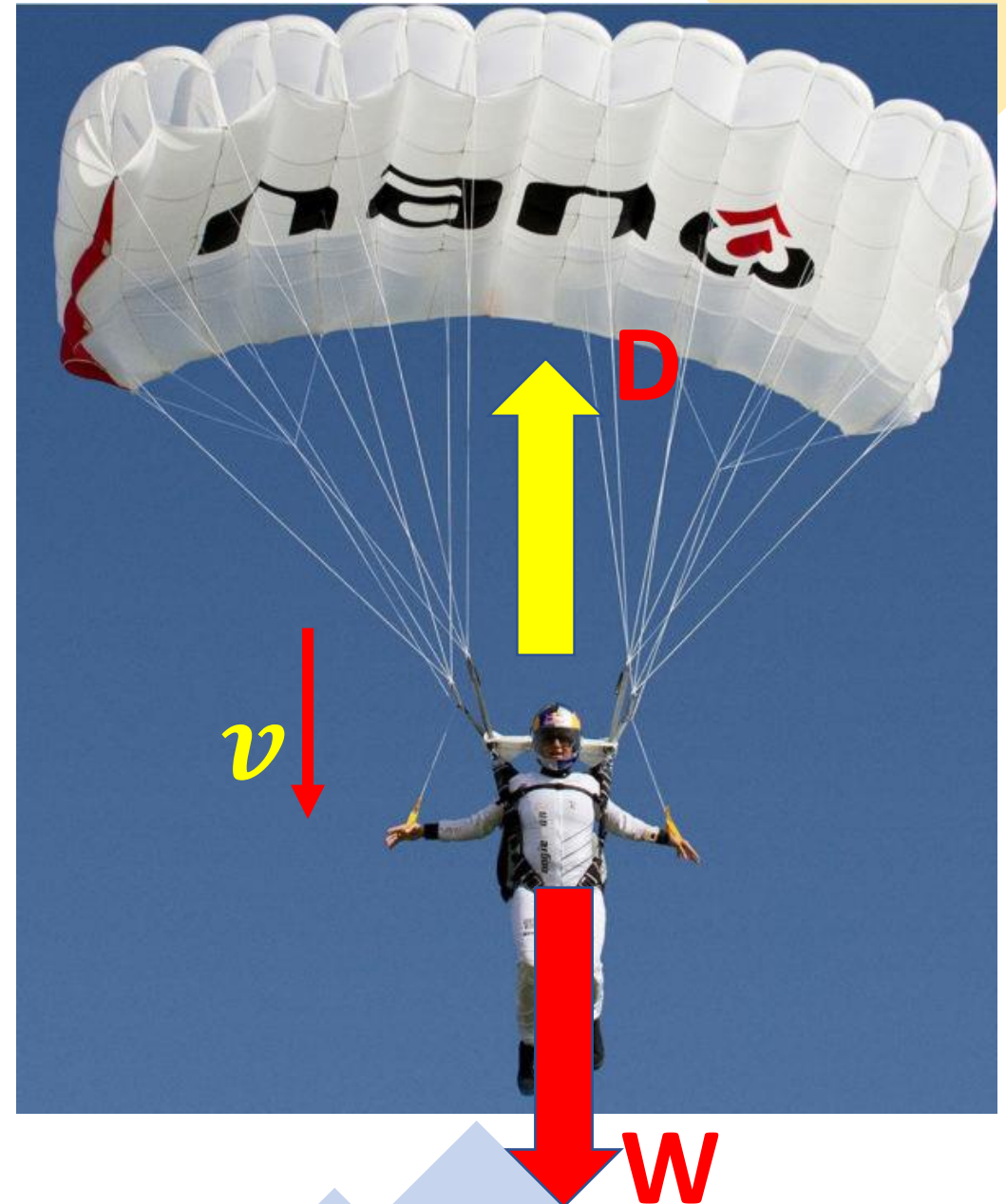
When forces are balanced the person moving down with a steady speed called terminal velocity.



Opens the parachute

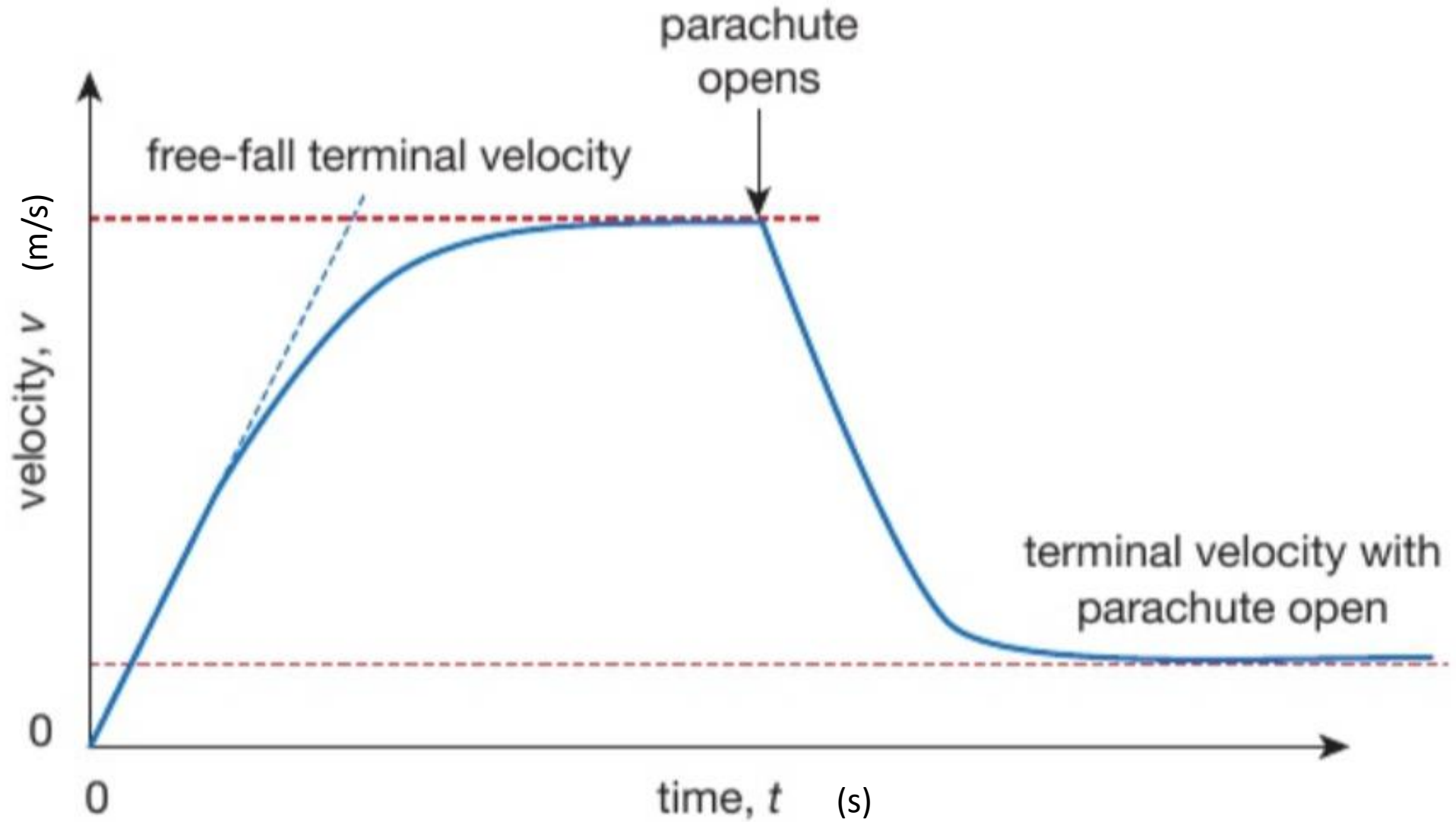
- A large drag force is acting in the upward direction due to the increase of the surface area.
- Unbalanced force is acting upward.
- The person moving downwards with a deceleration.

- Drag force decreases with the speed.
- Drag force decreases until it balances the weight.
- The person comes to a new terminal velocity which is lower than the previous one.





Velocity-time graph of a Sky diver



Next:
Momentum

