Sky divers & Terminal velocity

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Air resistance(Drag force)

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

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Drag force

Video demonstration

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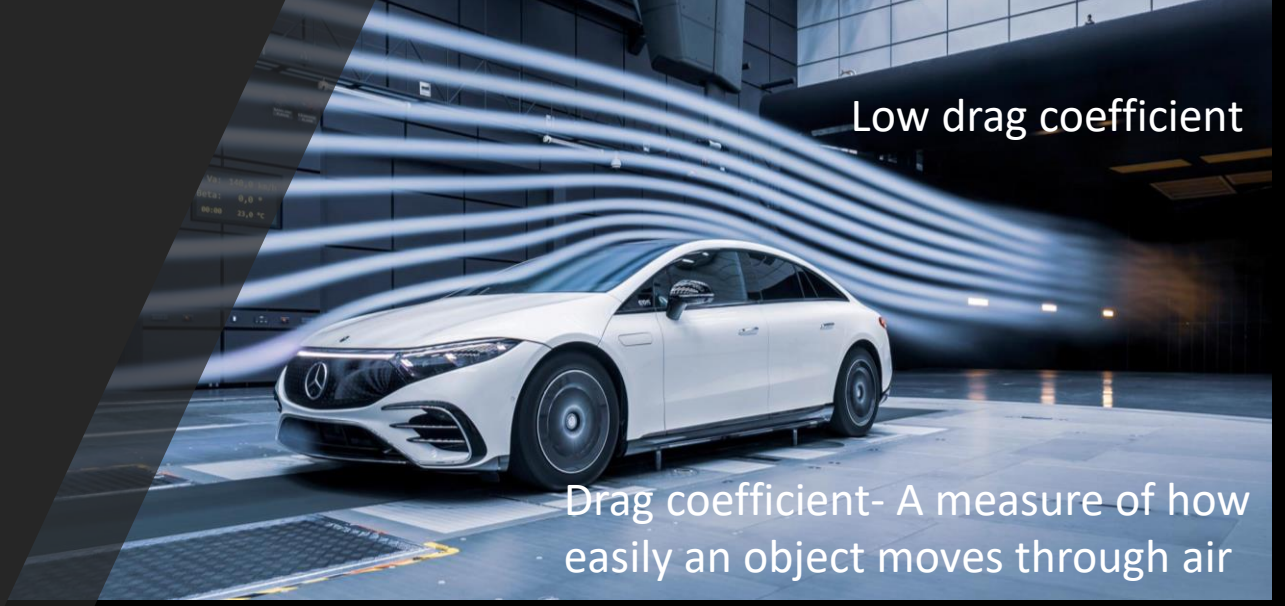
Drag force.

- The size of the drag force acting on an object depends on its shape and its speed.

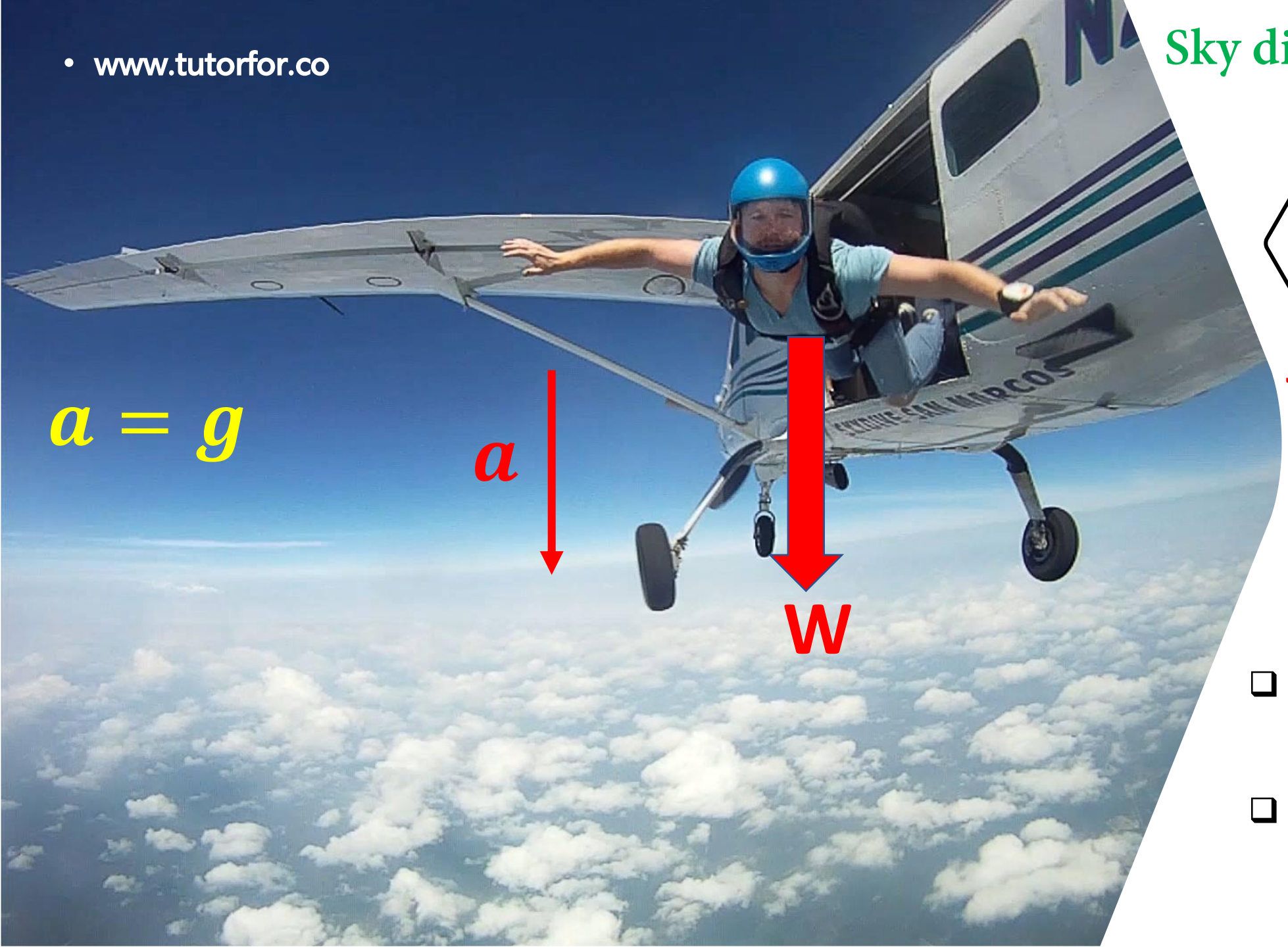
- High speed→ Large drag
- Large area→ Large drag

- 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.



Sky divers & Terminal velocity: Video demonstration



Sky divers & Terminal velocity

1

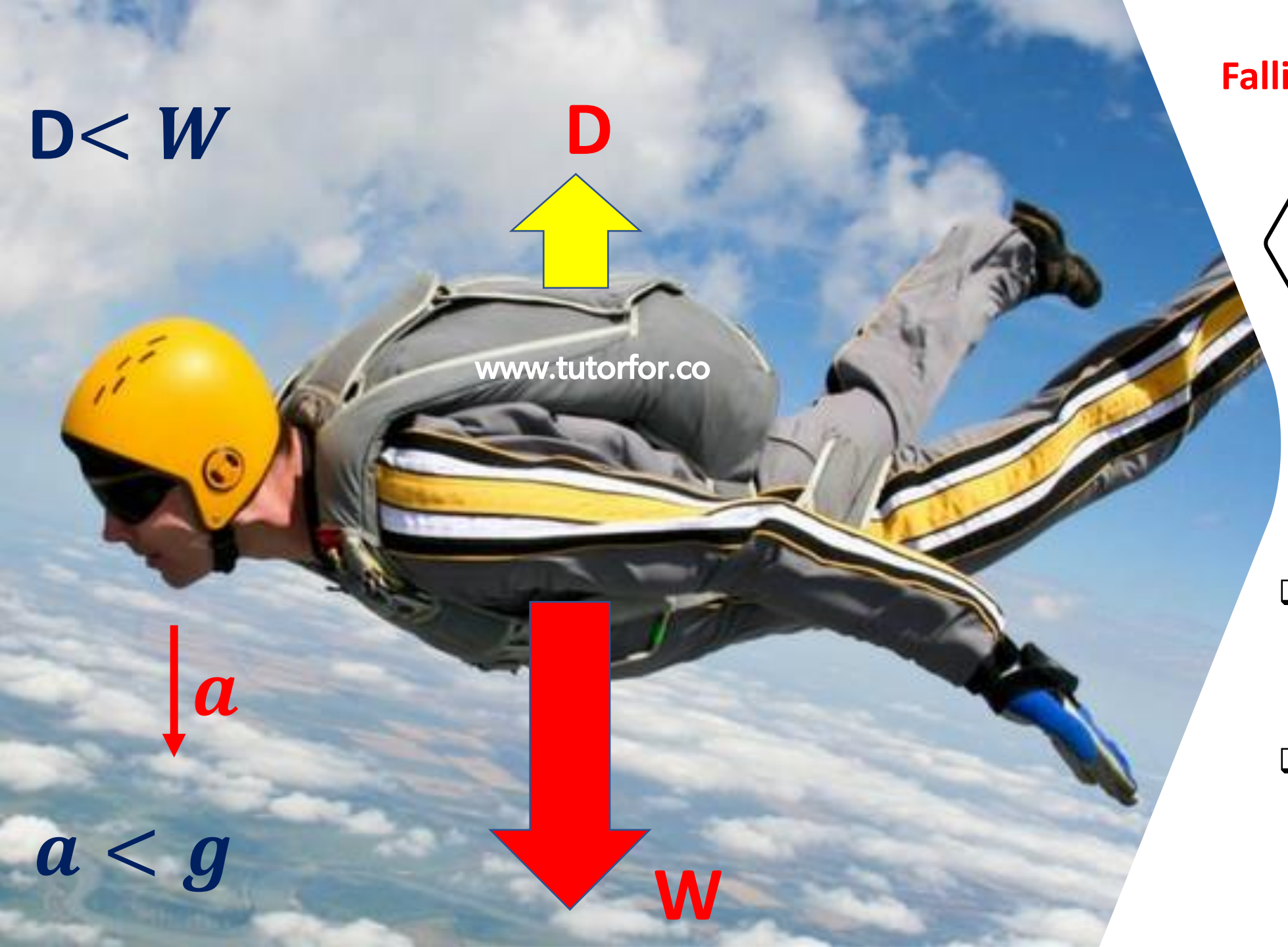
Just after the jump:

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 m/s^2)



Falling through air:

2

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:

3

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

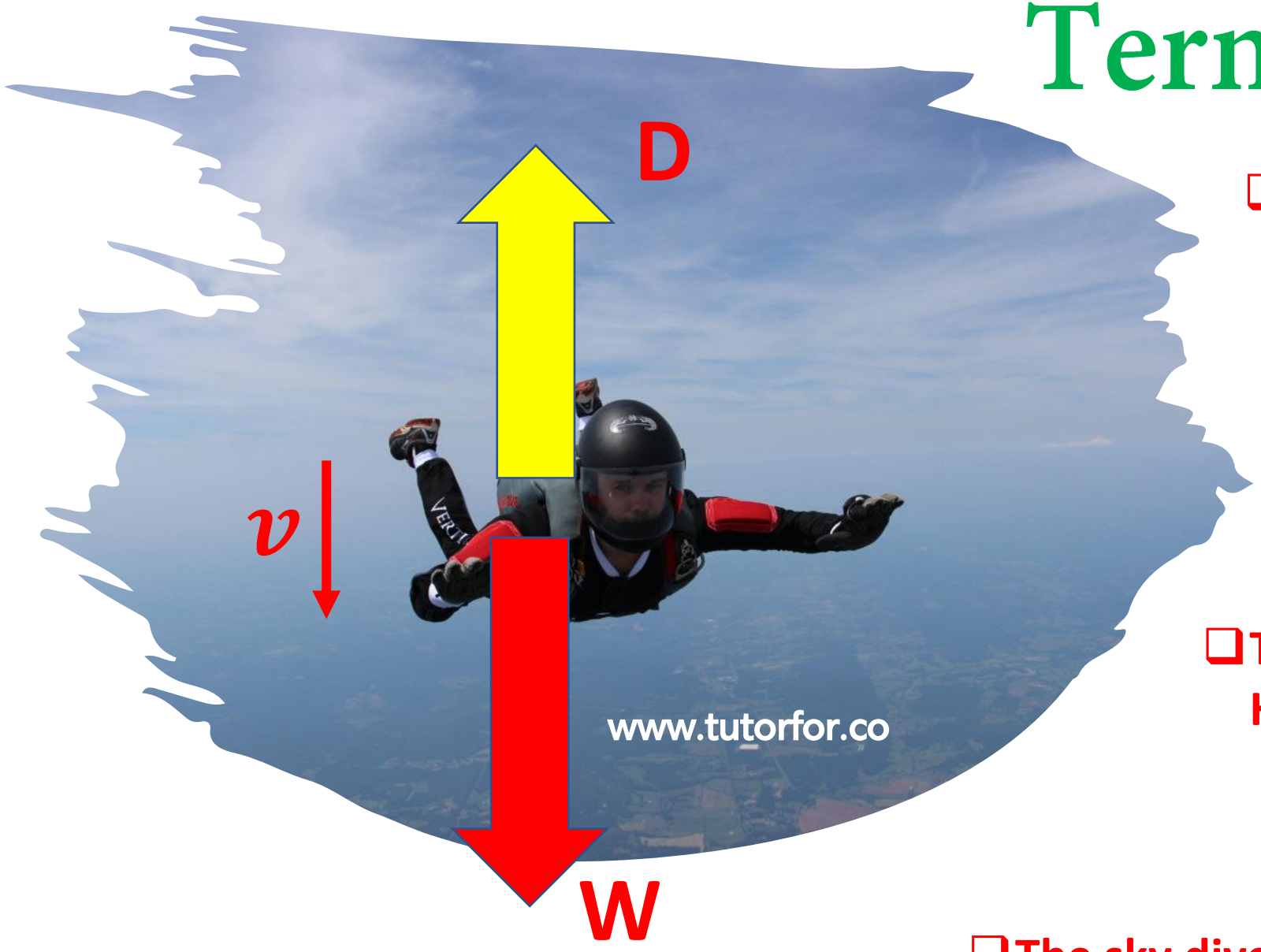
$$F\downarrow = W - D\uparrow$$

- The acceleration decreases when unbalanced force decreases.

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

$a \ll g$

Terminal velocity



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

$$D = W$$

$$F = W - D = 0$$

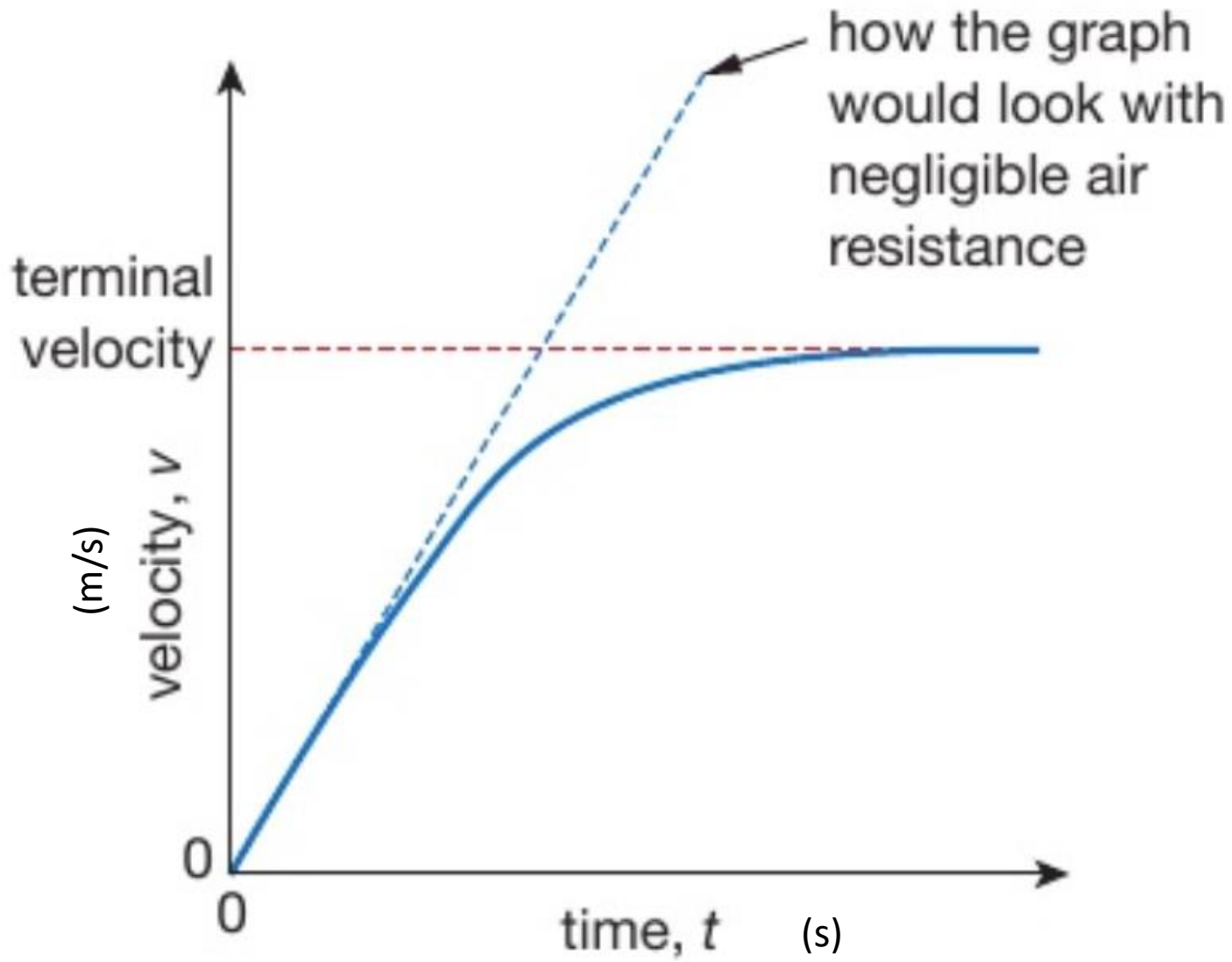
- The unbalanced force is zero. Hence acceleration is zero.

$$a = 0$$

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

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

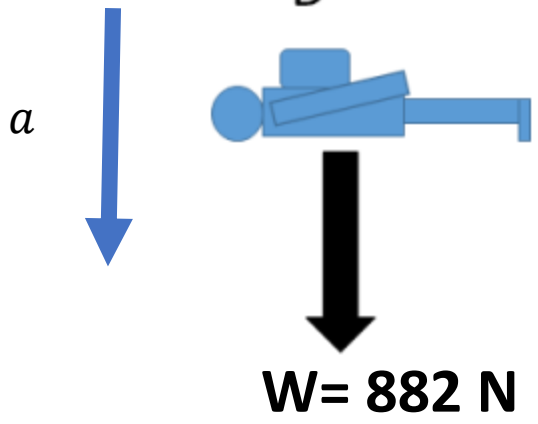
Terminal velocity v-t graph



Concept learning

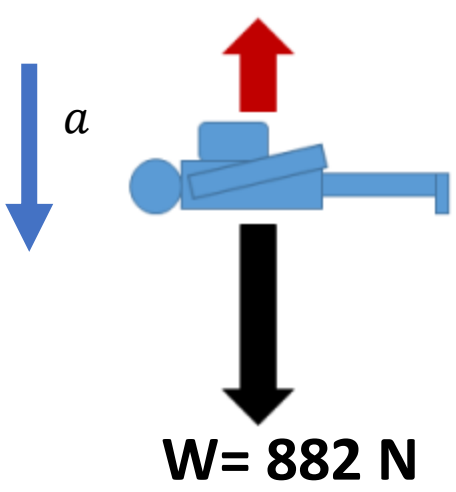
Find the acceleration

1



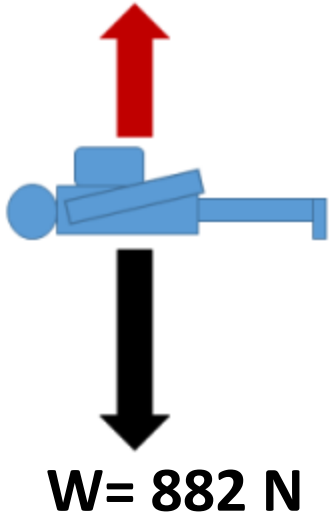
Initially the drag force is zero. The person falling with gravitational acceleration.

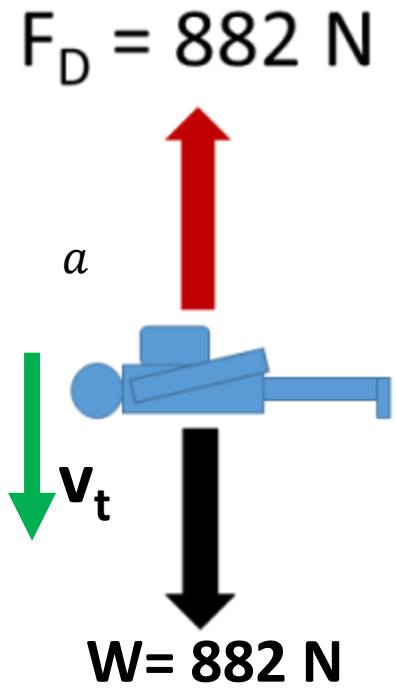
2



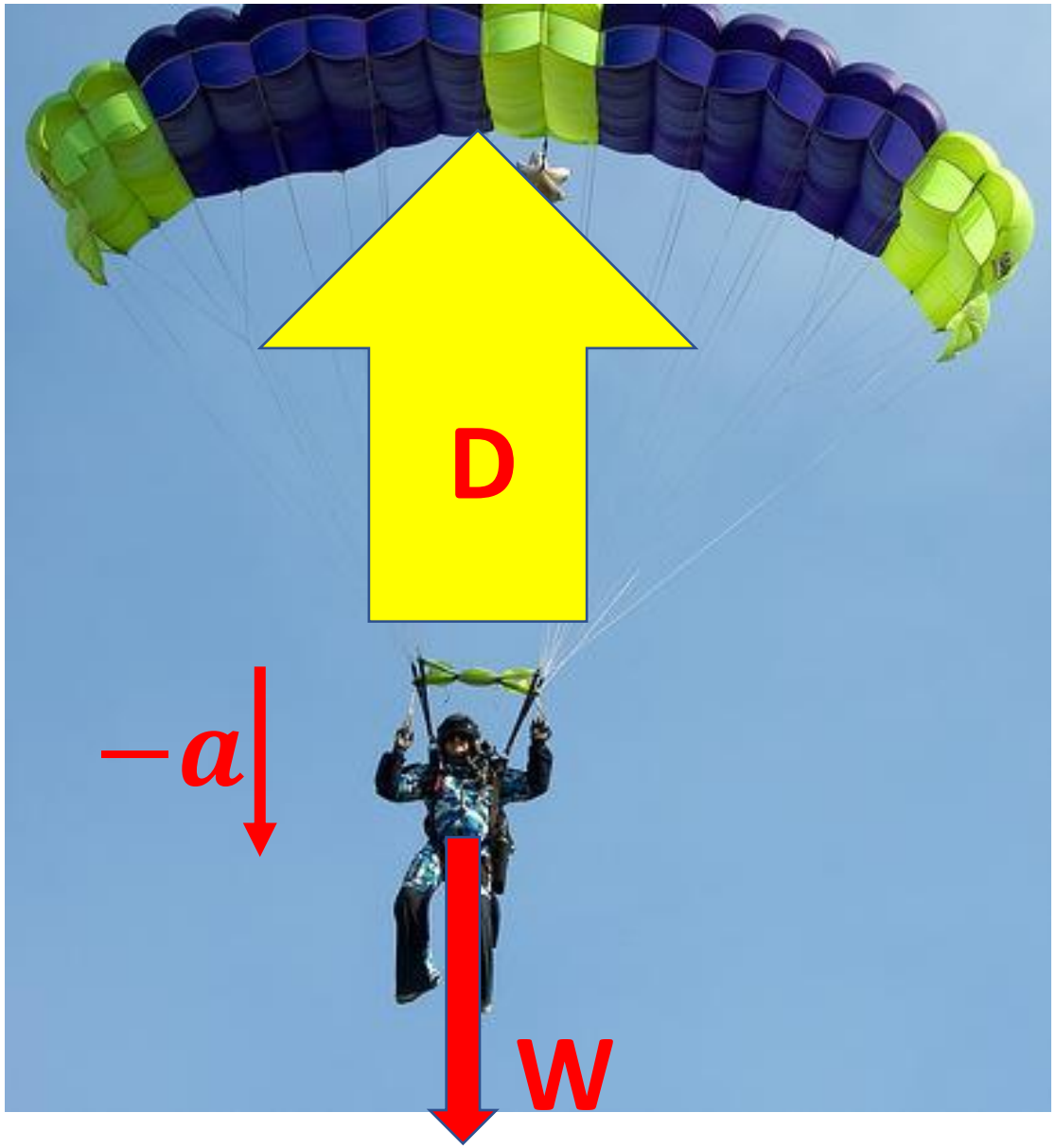
Drag force increases with the speed. The acceleration decreases.

3





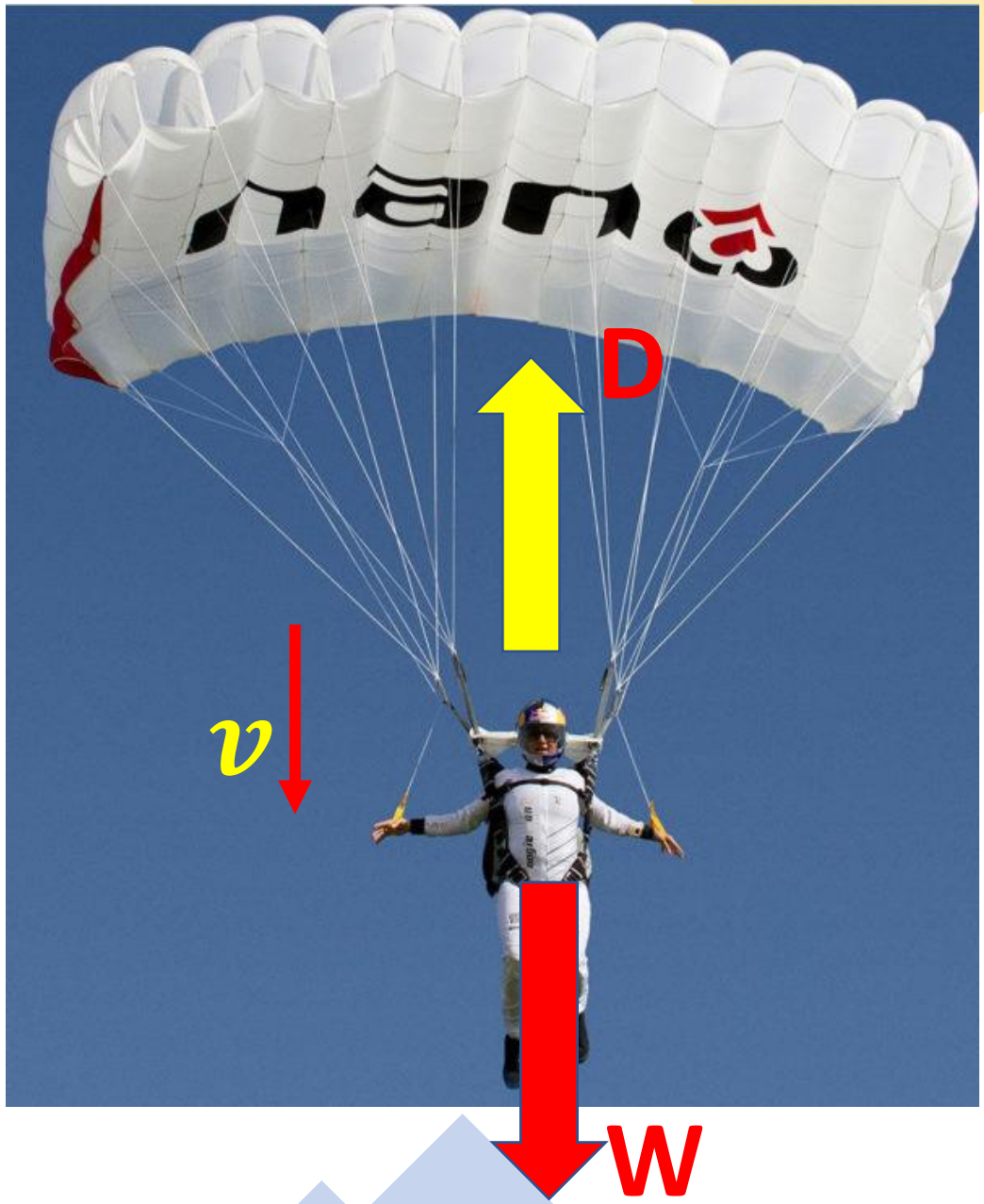
When forces are balanced the person moving down with a steady speed called terminal velocity.



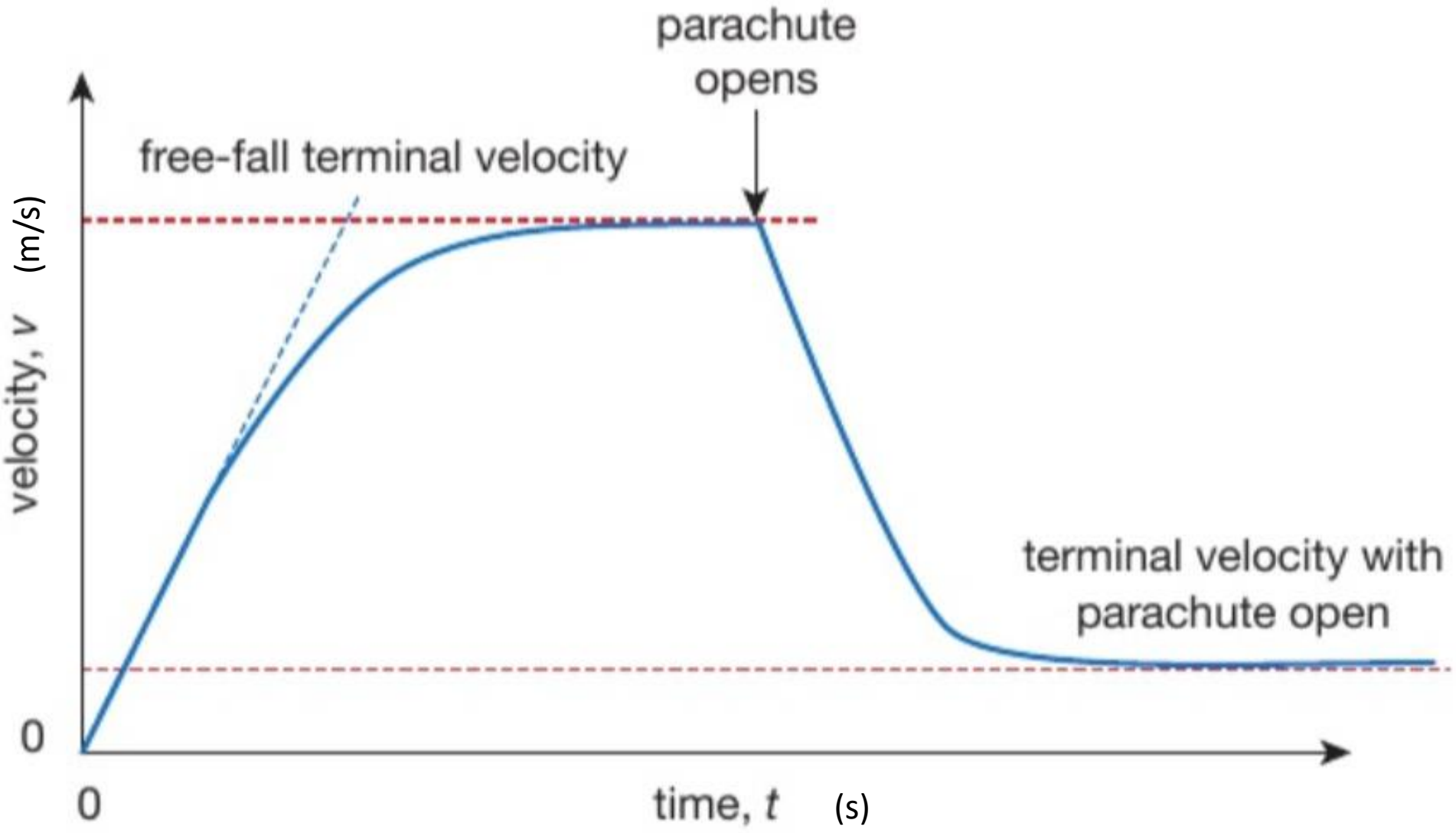
Opens the parachute

- 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