

# BACCALAURÉAT-Session 2015

## Epreuve de Discipline Non Linguistique

### Mathématiques/Anglais

#### How does a parachute work?



A parachute is used extensively to break the fall from an aircraft or higher altitudes. Owing to its large surface area it helps to slow down the descent rate of the person or object, thus resulting in a safe landing.

➤ **Before the parachute opens**

1. When a skydiver jumps out of a plane, he accelerates due to the force of gravity pulling him down. As he speeds up, the upward air resistance force increases. He carries on accelerating as long as the air resistance is less than his weight.
2. Eventually, he reaches his terminal speed when the air resistance and weight become equal.

➤ **After the parachute opens**

3. When the parachute opens it has a large surface area which increases the air resistance. This causes the parachutist to slow down.
4. As the parachutist slows down, his air resistance decreases until eventually it equals the downward force of gravity on him (his weight). Once again the two forces balance and he falls at terminal speed. This time it's a much slower terminal speed than before.

Source: adapted from <http://www.bbc.co.uk/education/guides/zff82hv/revision/1>

#### Questions:

1. The following graph represents the velocity  $v$  (in  $\text{m}\cdot\text{s}^{-1}$ ) of a skydiver who at first is in free fall, and then deploys a parachute.

Identify and justify each of the four steps mentioned in the text above. What happens when  $t$  equals 0?

2. *Part of the graph after parachute deployment*

Let  $v(t)$  be the vertical downward velocity of the skydiver in  $\text{m}\cdot\text{s}^{-1}$ . According to the laws of physics, we can assume that  $v(t) = 50.2e^{-1.5t} + 4.8$  ( $t =$  time in seconds;  $t \geq 0$ ).

- a) What is the initial velocity of the parachute (in  $\text{km}\cdot\text{h}^{-1}$ )?
- b) Justify the variations of the function  $v$  and compute the terminal velocity of the parachute.

c) If we consider that it is safe to land when the velocity is smaller than  $6 \text{ m}\cdot\text{s}^{-1}$ , at what instant does the skydiver reach this speed?

3°) Parachuting is not the same as paragliding (parapente): can you explain why?

