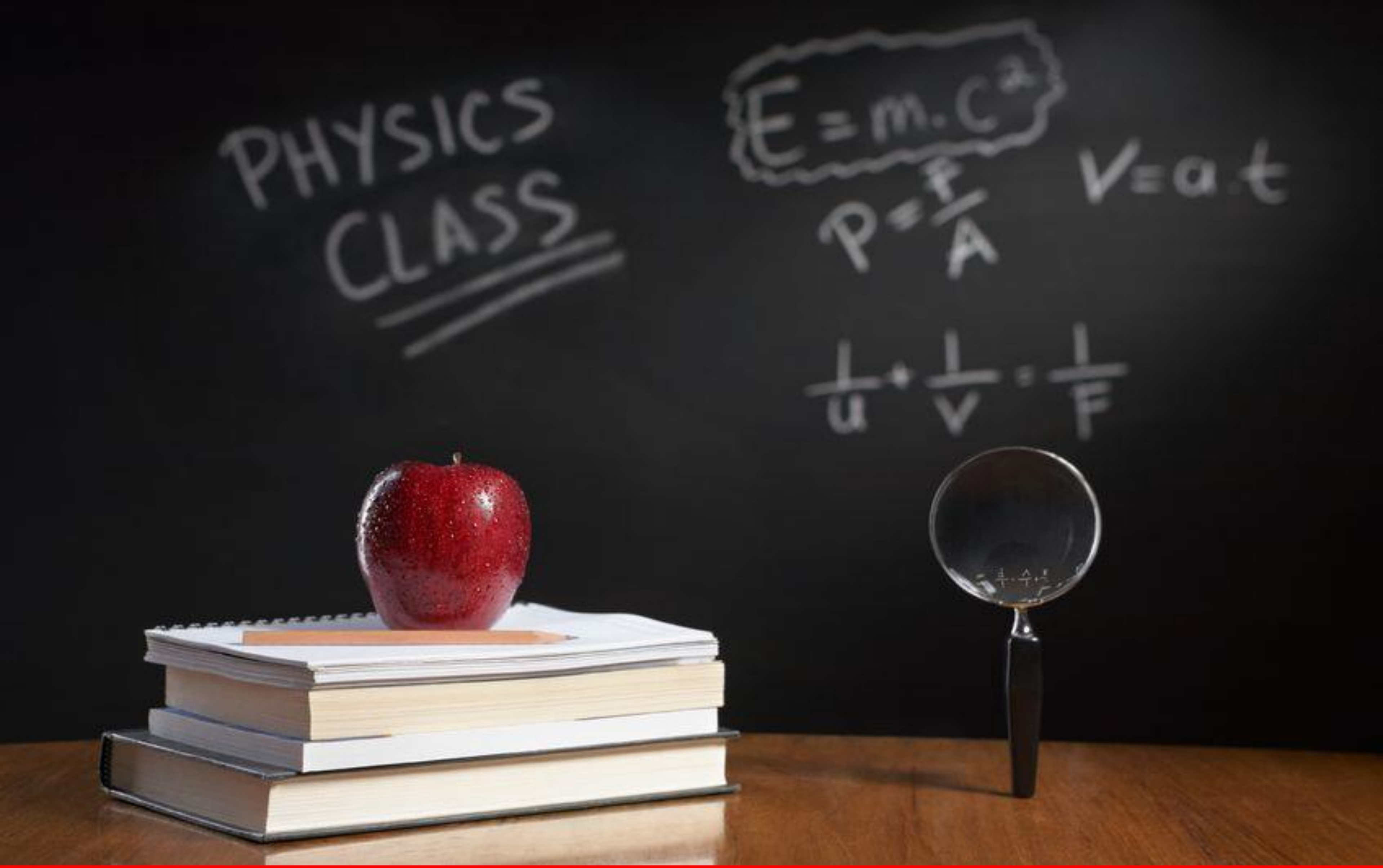
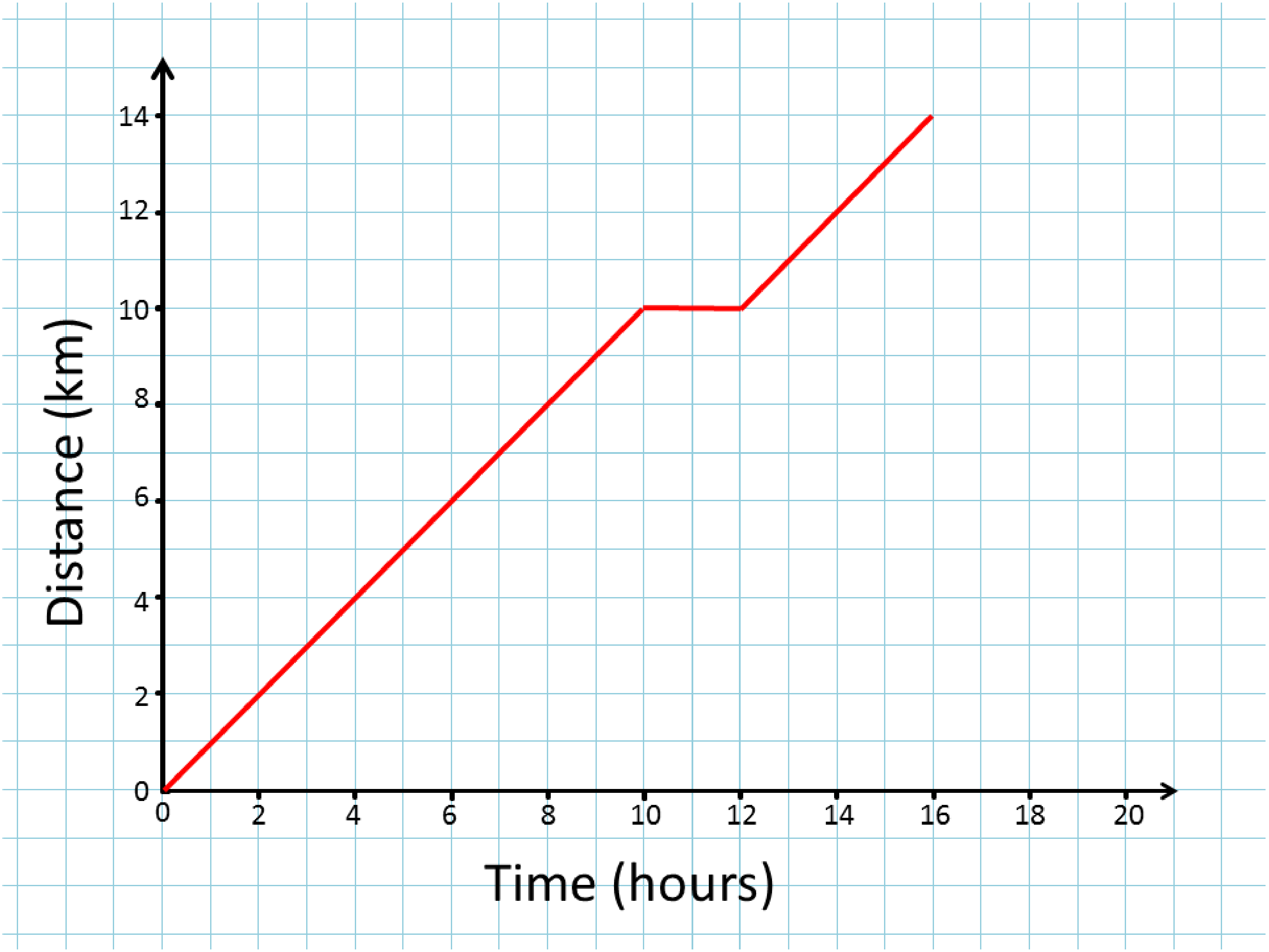
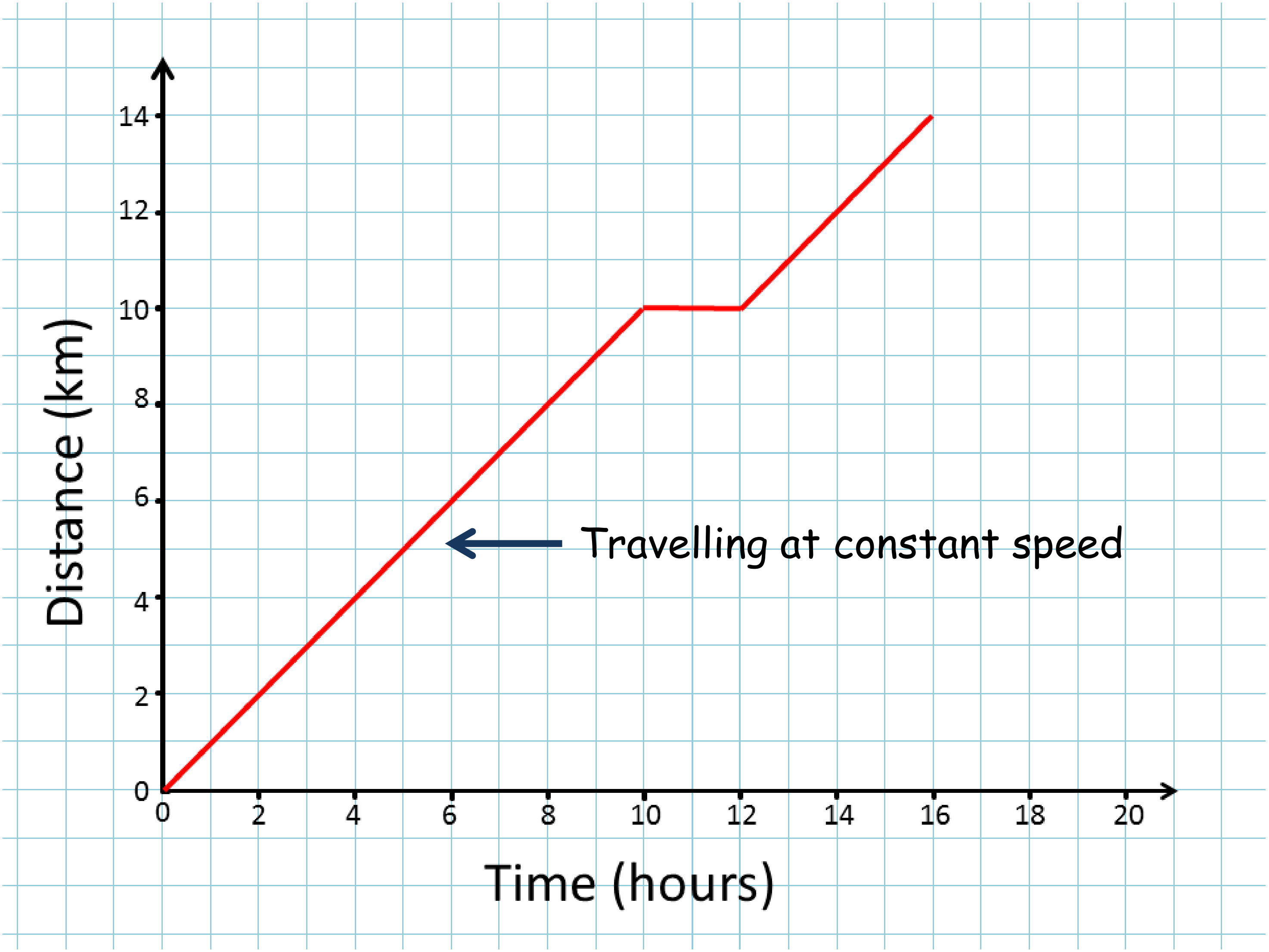



# Motion graphs

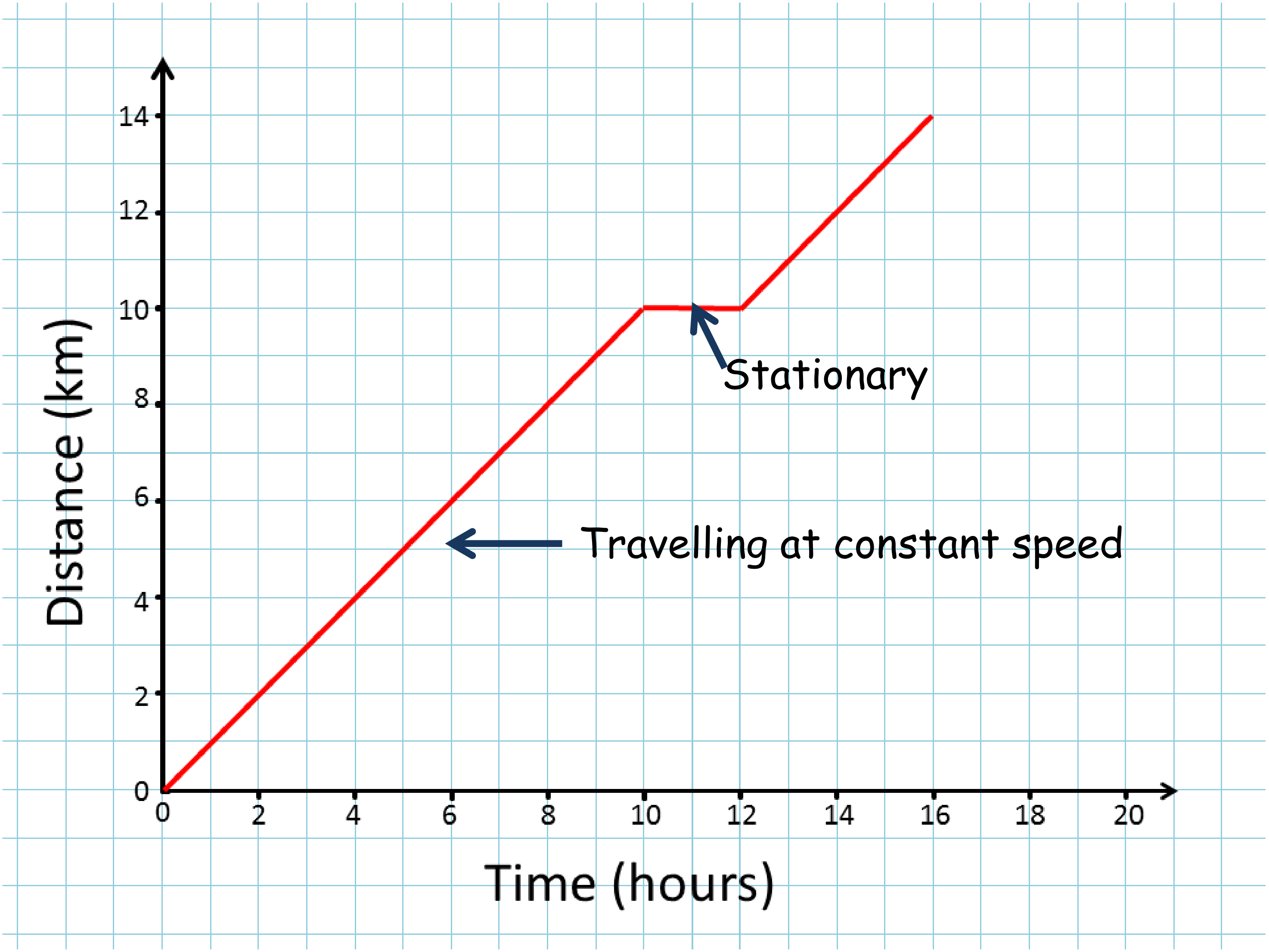
# Motion graphs



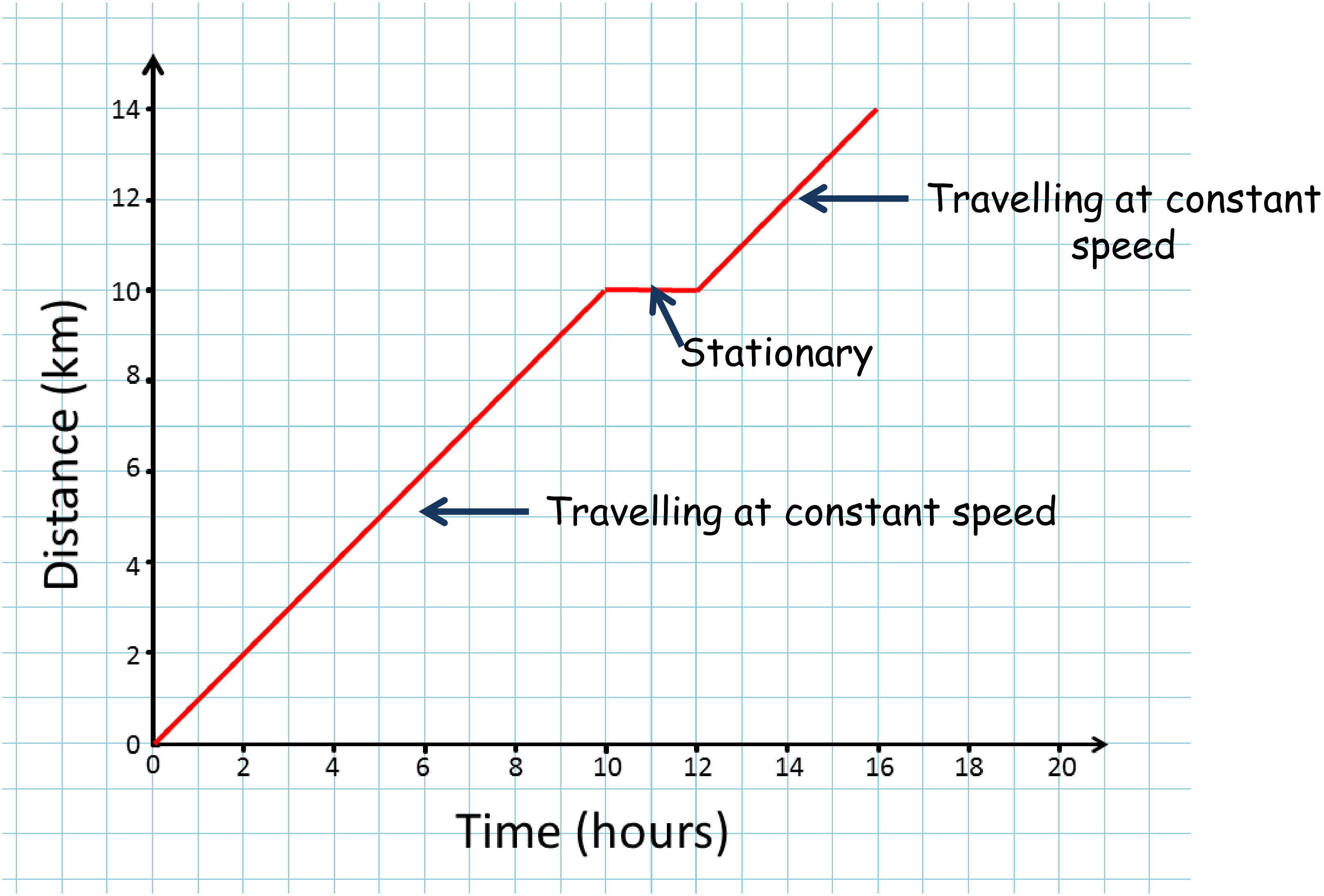
Distance (km)
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Time (hours)



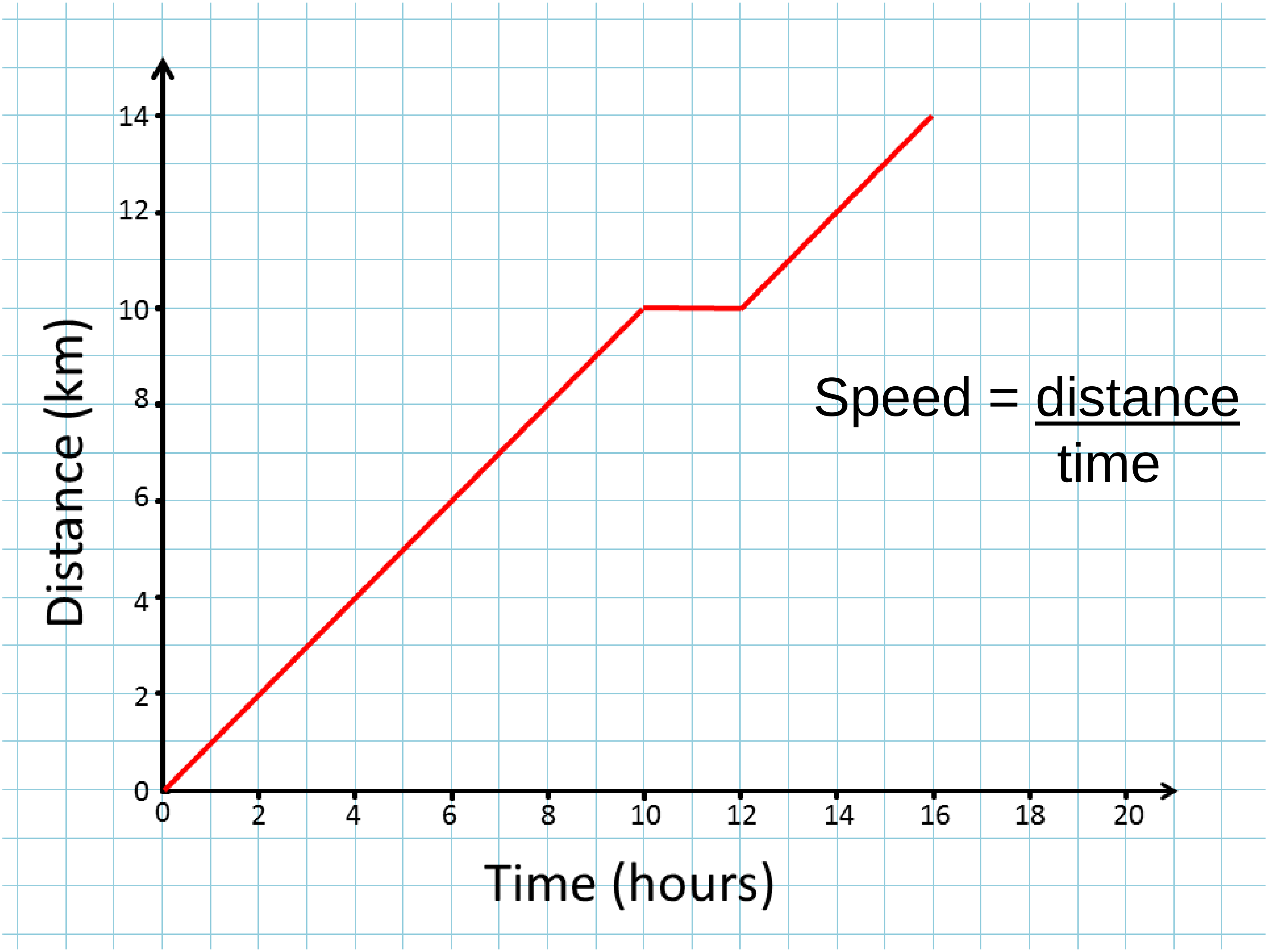
Distance (km)
0
2
4
6
8
10
12
14
0
2
4
6
8
10
12
14
16
18
20
Time (hours)
Travelling at constant speed



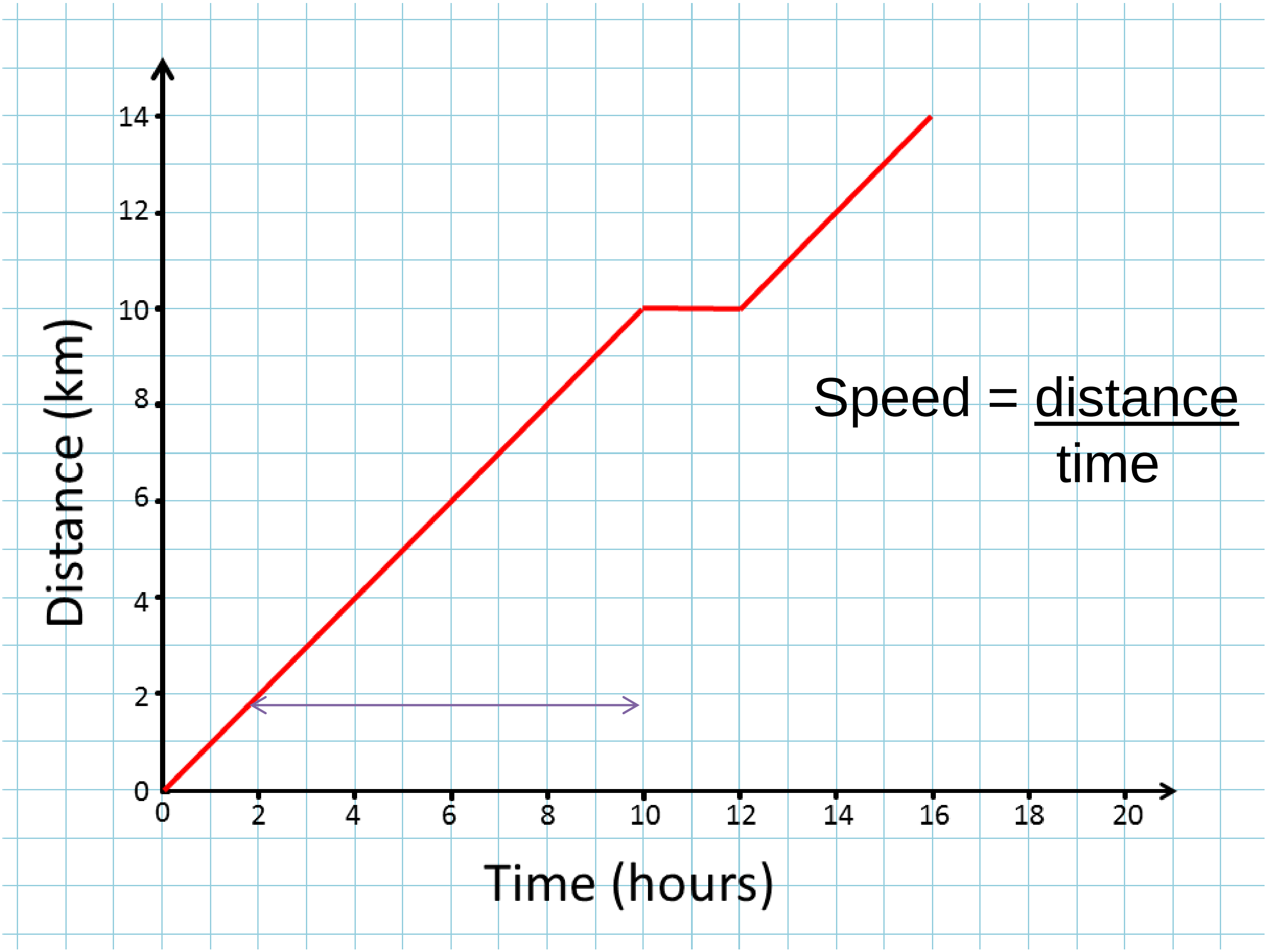
Distance (km)
14
12
10
8
6
4
2
0
Stationary
Travelling at constant speed
0
2
4
6
8
10
12
14
16
18
20
Time (hours)

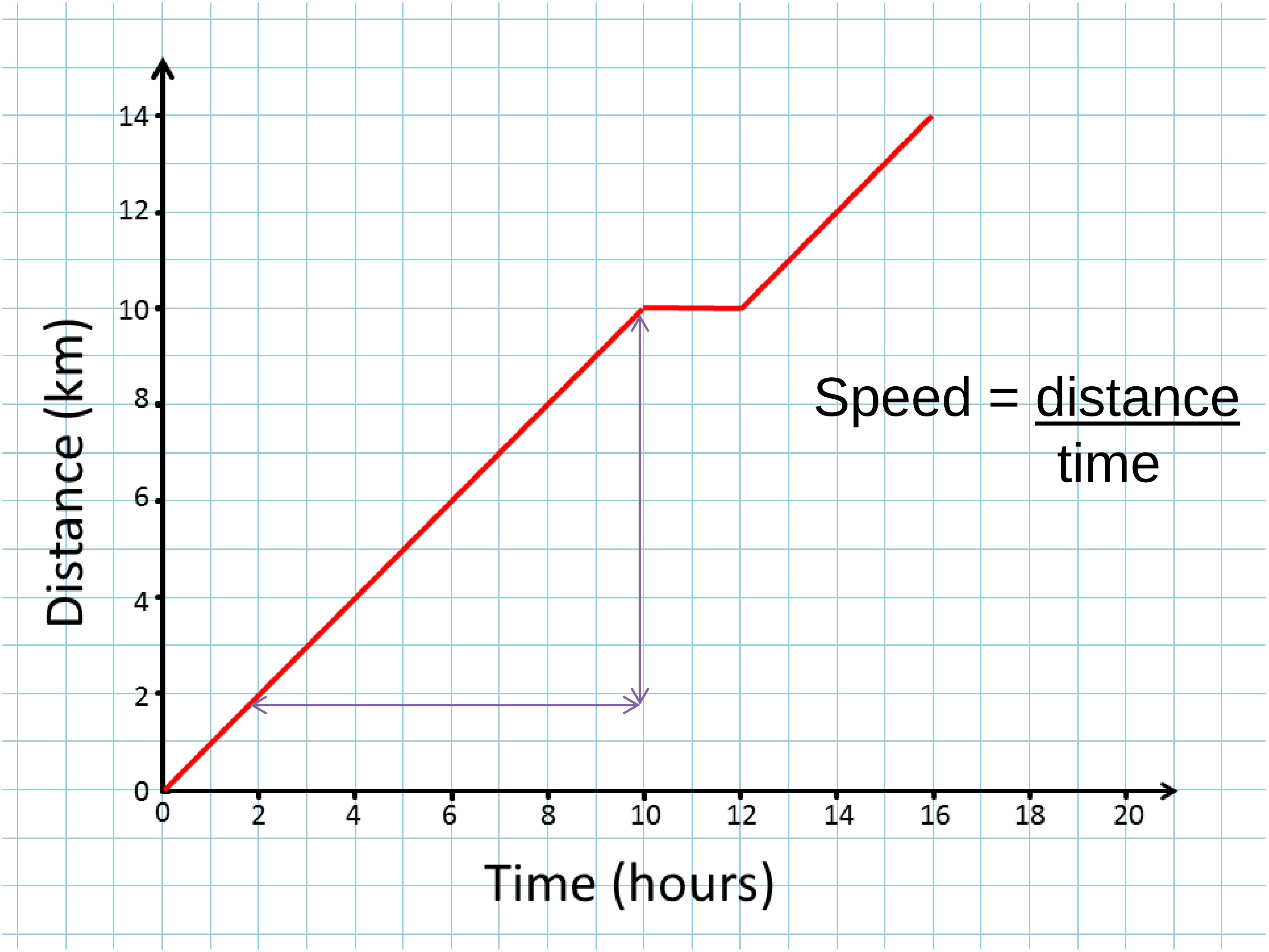


Distance (km)
0
2
4
6
8
10
12
14
Time (hours)
0
2
4
6
8
10
12
14
16
18
20
Travelling at constant speed
Stationary
Travelling at constant speed

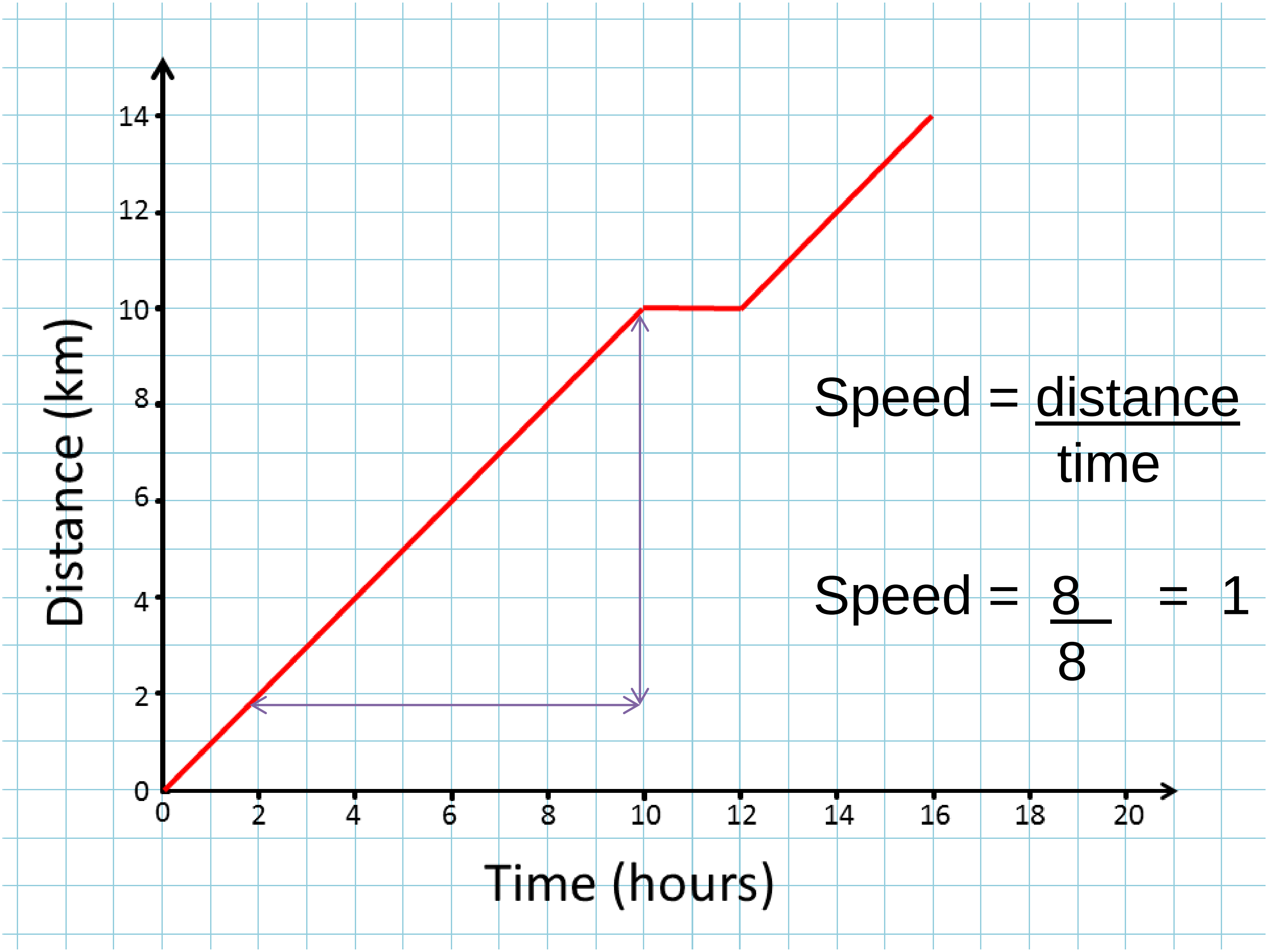


Distance (km)
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Time (hours)
Speed = distance / time


Distance (km)
0
2
4
6
8
10
12
14
Time (hours)
0
2
4
6
8
10
12
14
16
18
20
Speed = distance
time



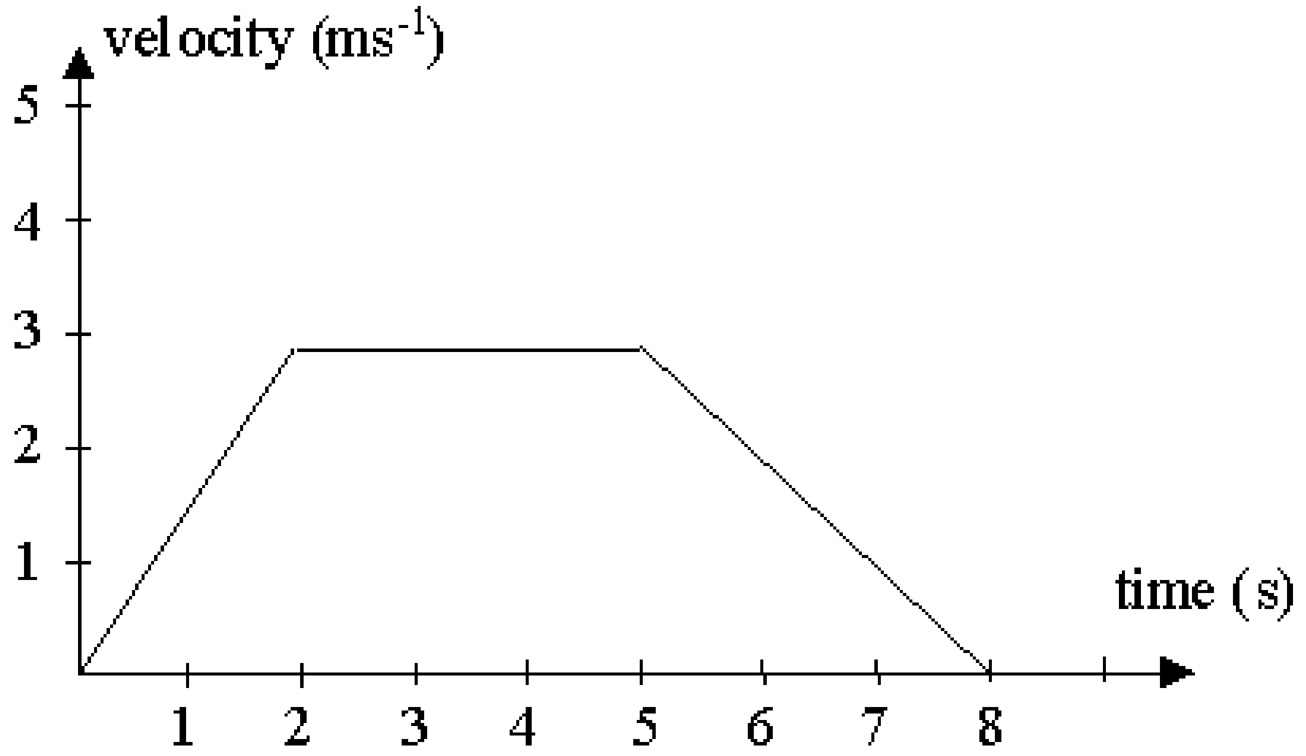
Distance (km)
Time (hours)
0
2
4
6
8
10
12
14
16
18
20
Speed = distance / time



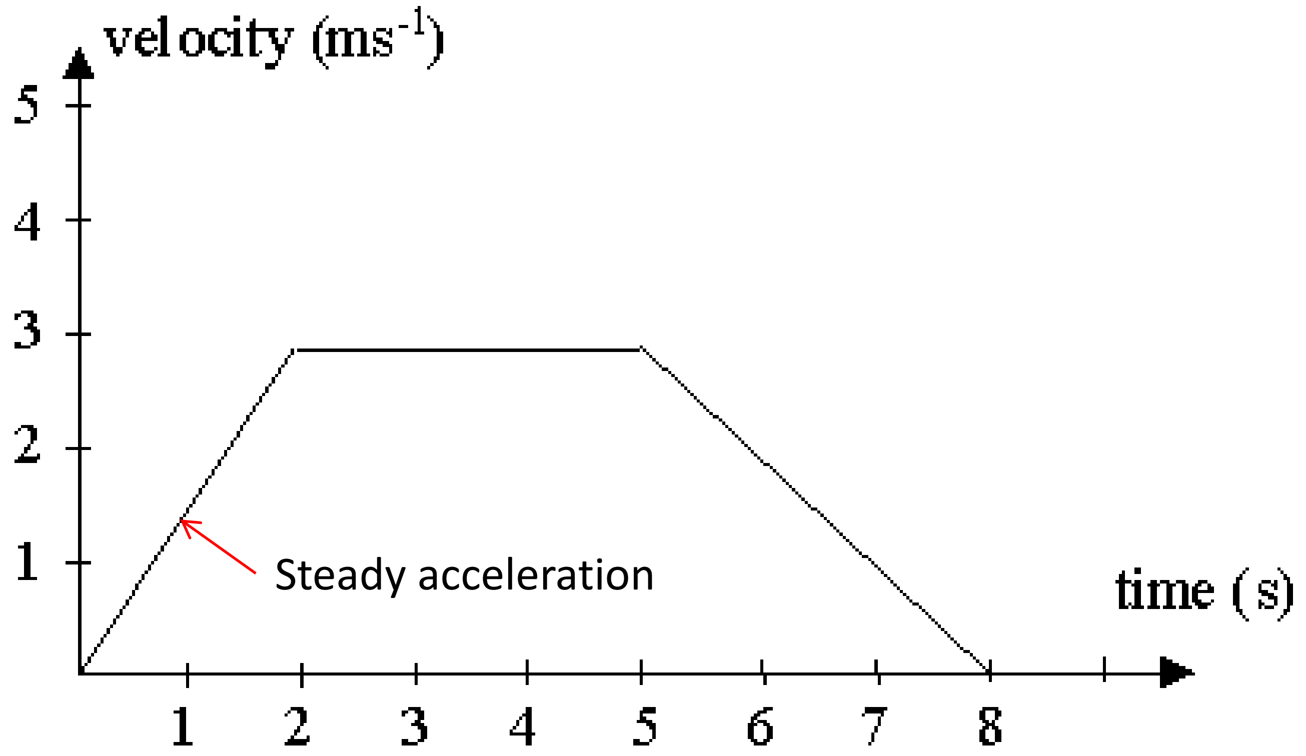

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{Speed} = \frac{8}{8} = 1 \text{ km/h}$$

# Acceleration from velocity : time graph



# Acceleration from velocity : time graph



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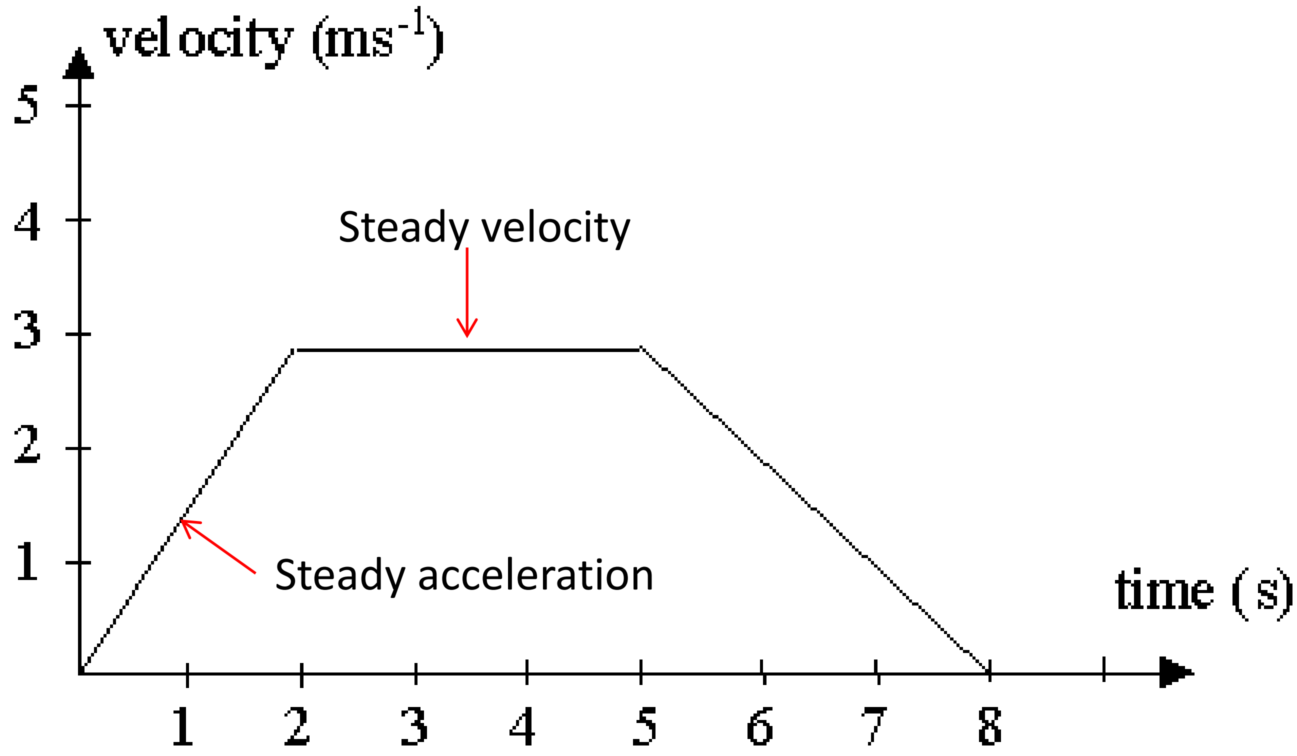

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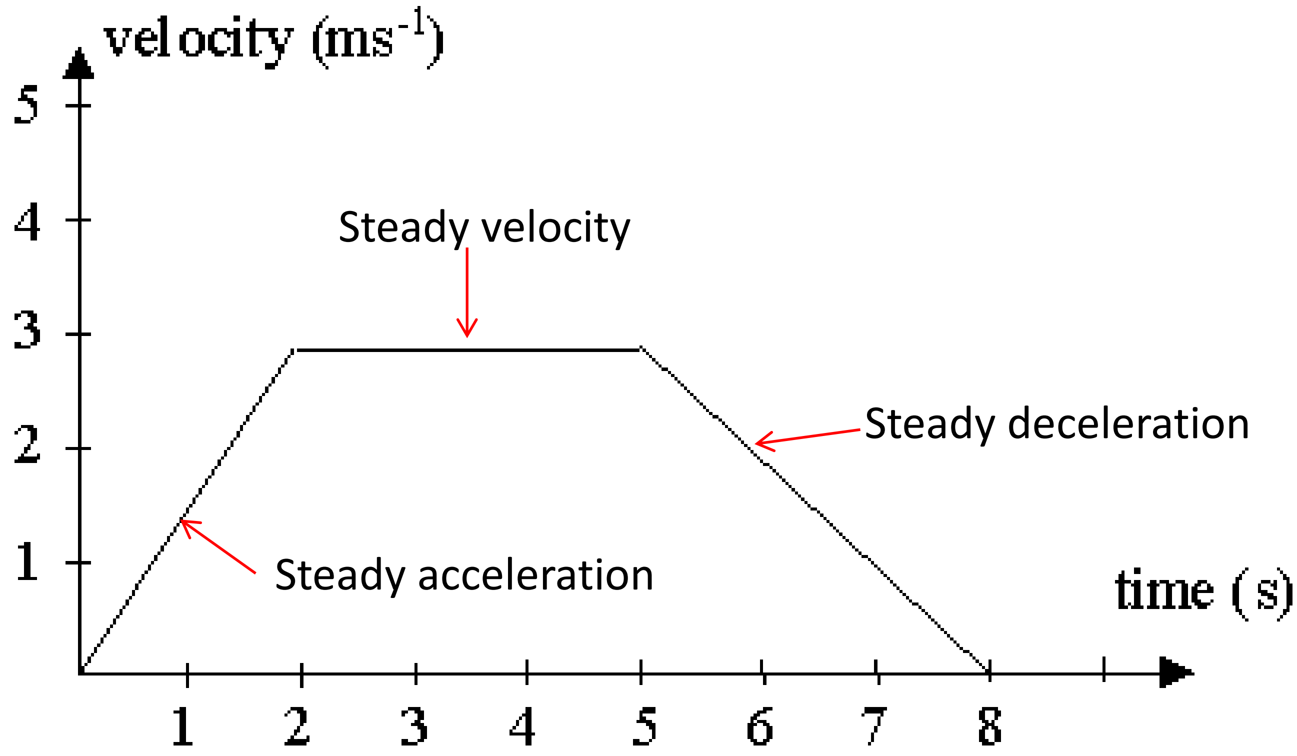
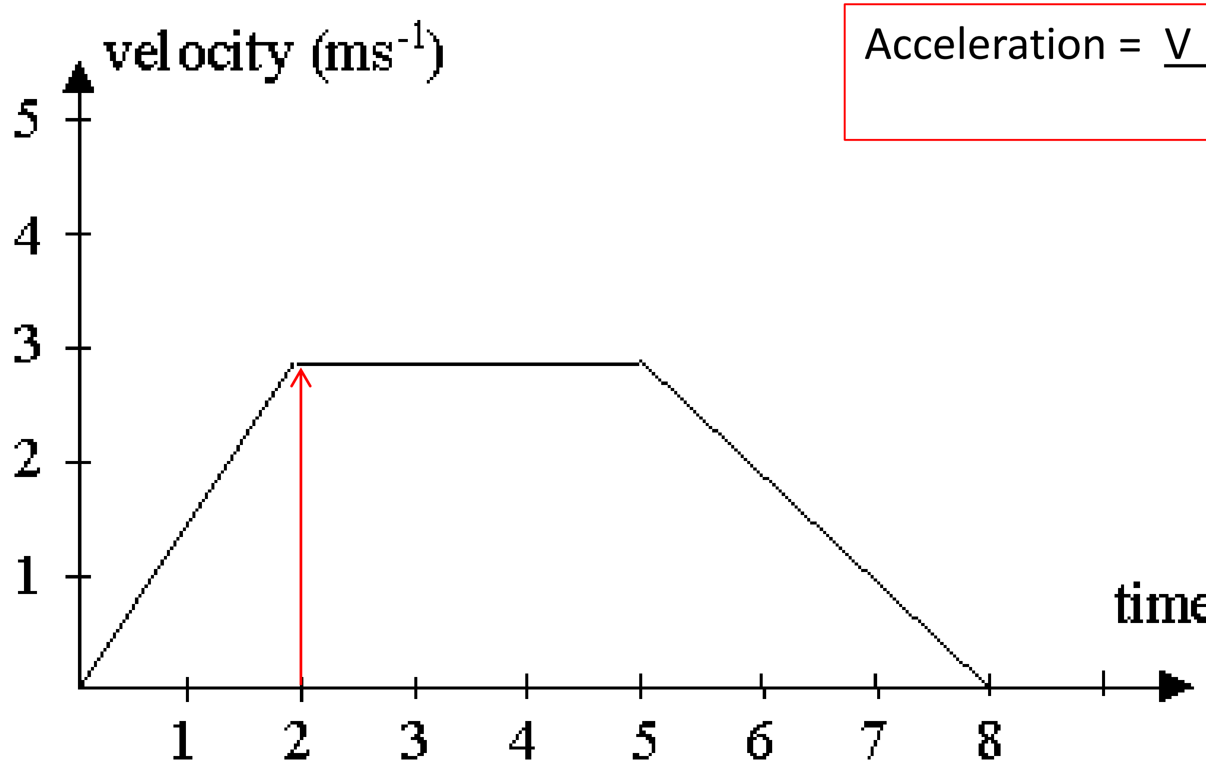


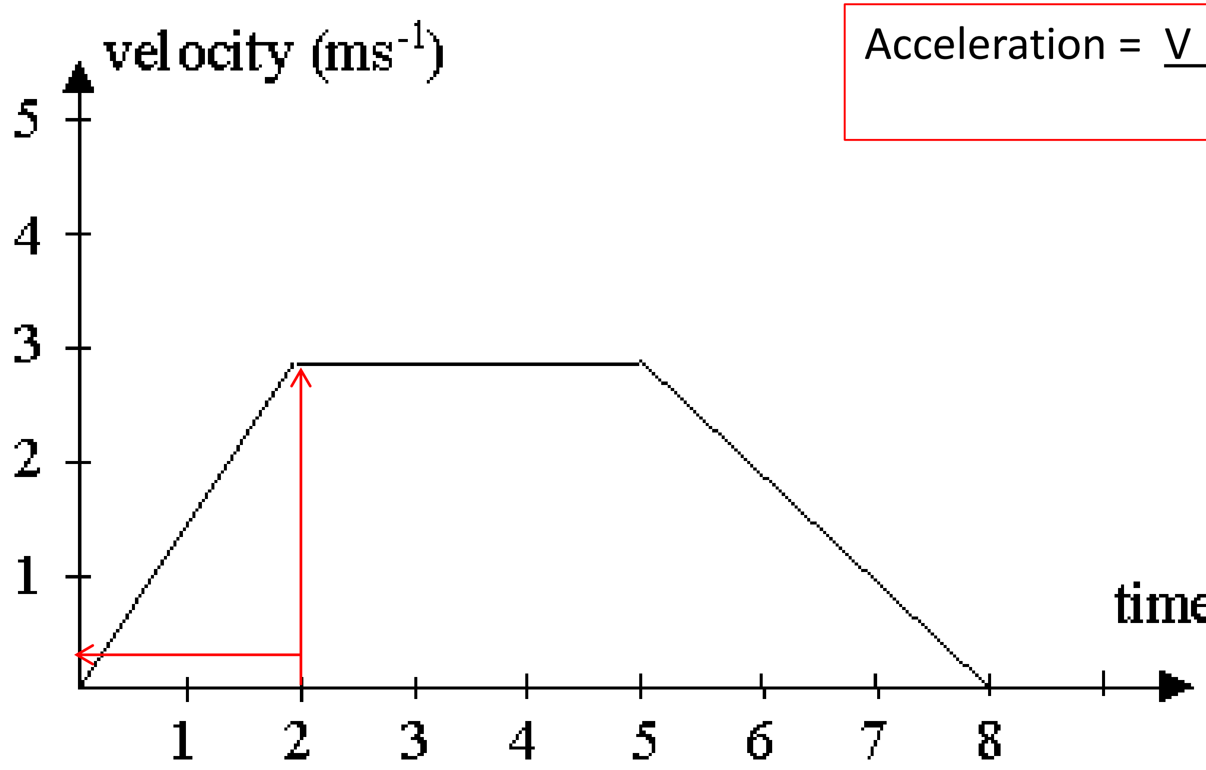
# Acceleration from velocity : time graph



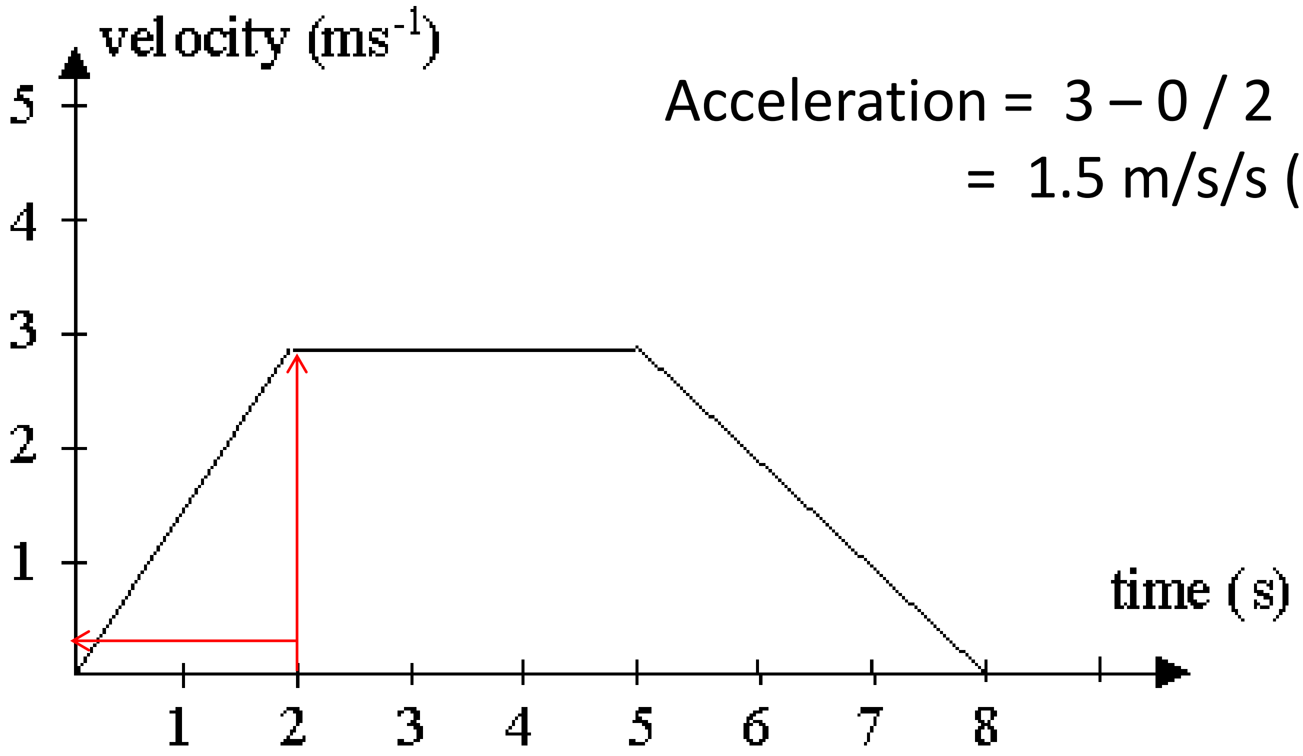

Acceleration = $\frac{V - U}{t}$

# Acceleration from velocity : time graph

Acceleration = $\frac{V - U}{t}$



# Acceleration from velocity : time graph

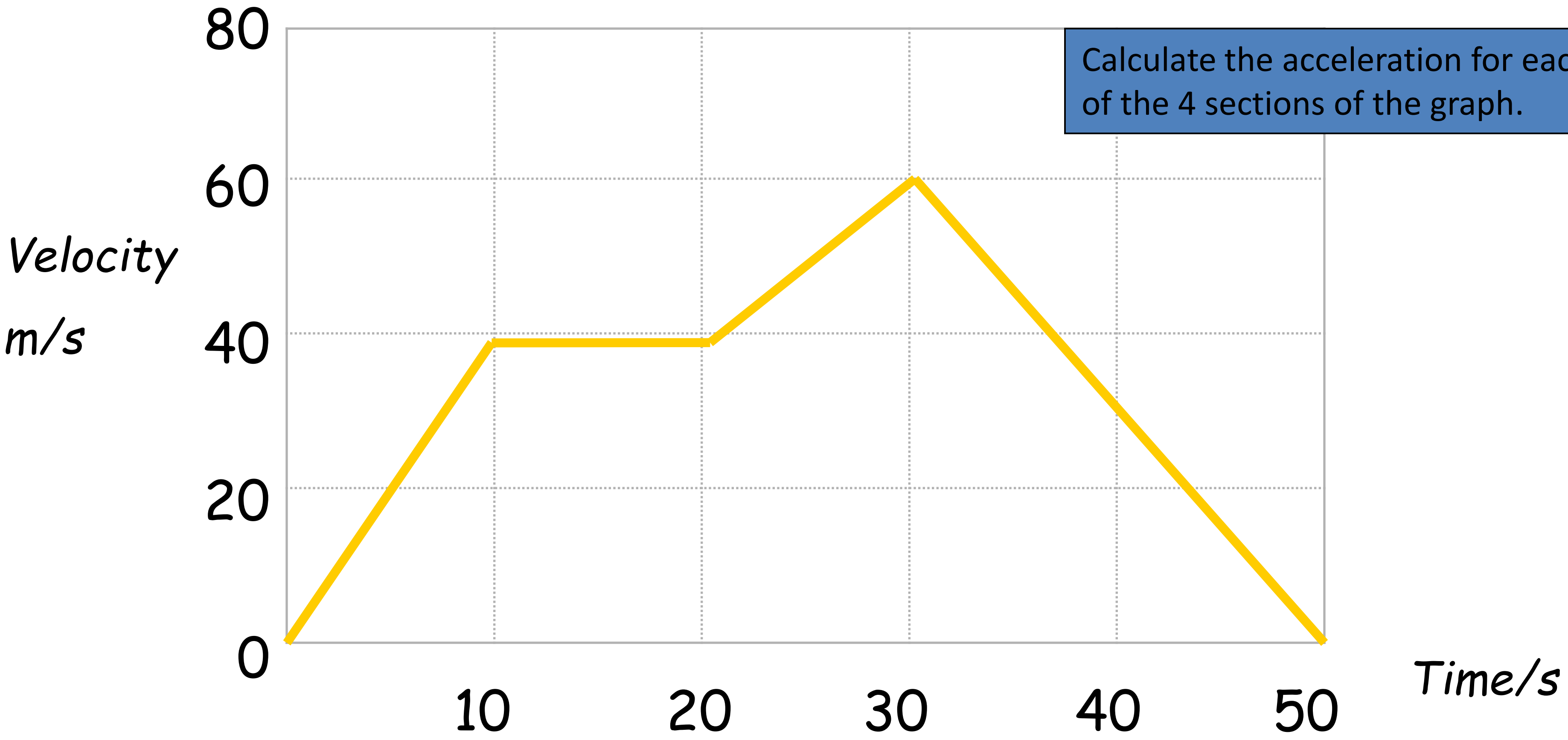



Acceleration = 3 – 0 / 2

= 1.5 m/s/s (m.s$^{-2}$)

# Velocity-time graphs

Acceleration can be calculated by the gradient of a velocity:time graph. (Remember gradient is the difference up divided by the difference across)




Calculate the acceleration for each of the 4 sections of the graph.

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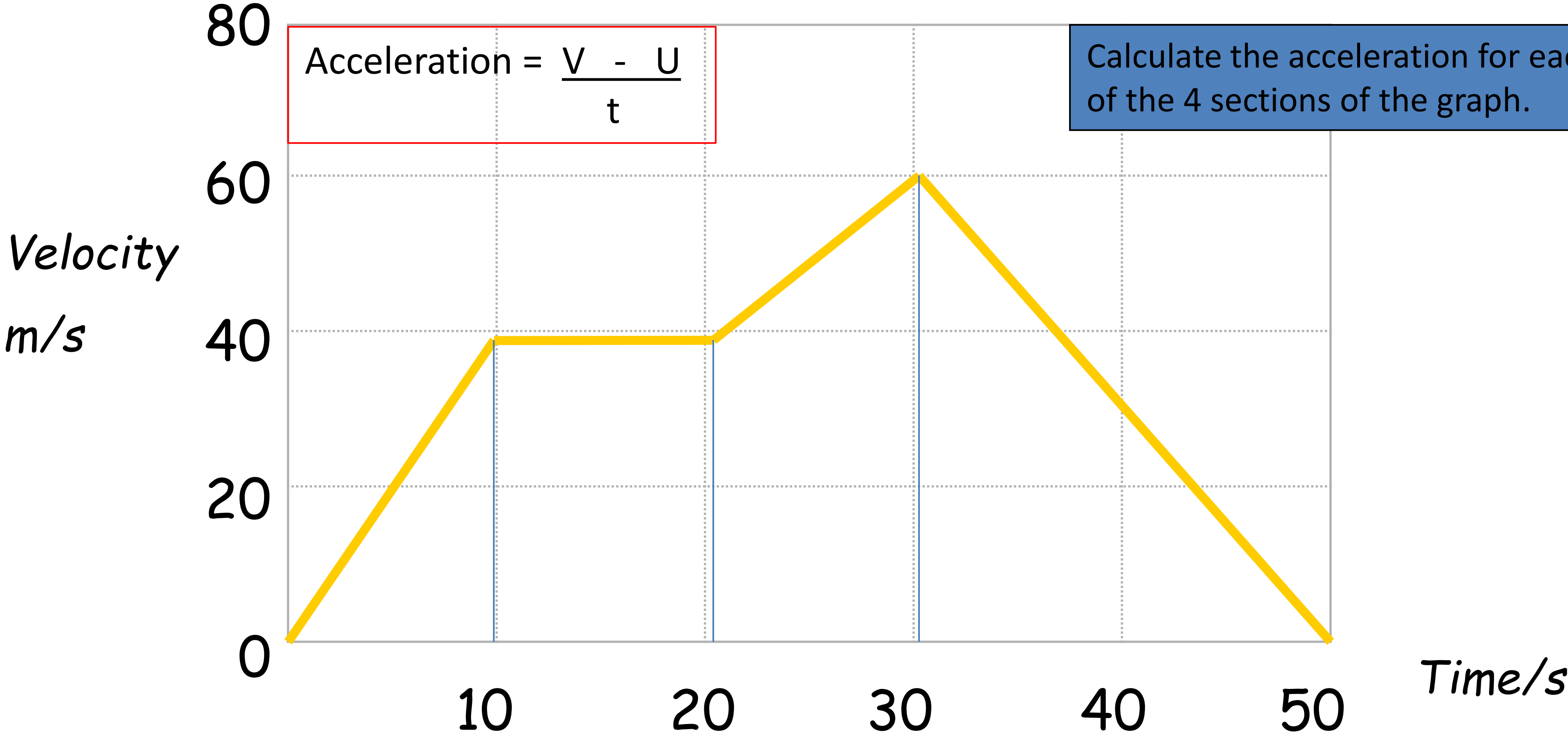
Acceleration = $\frac{V - U}{t}$

Calculate the acceleration for each of the 4 sections of the graph.



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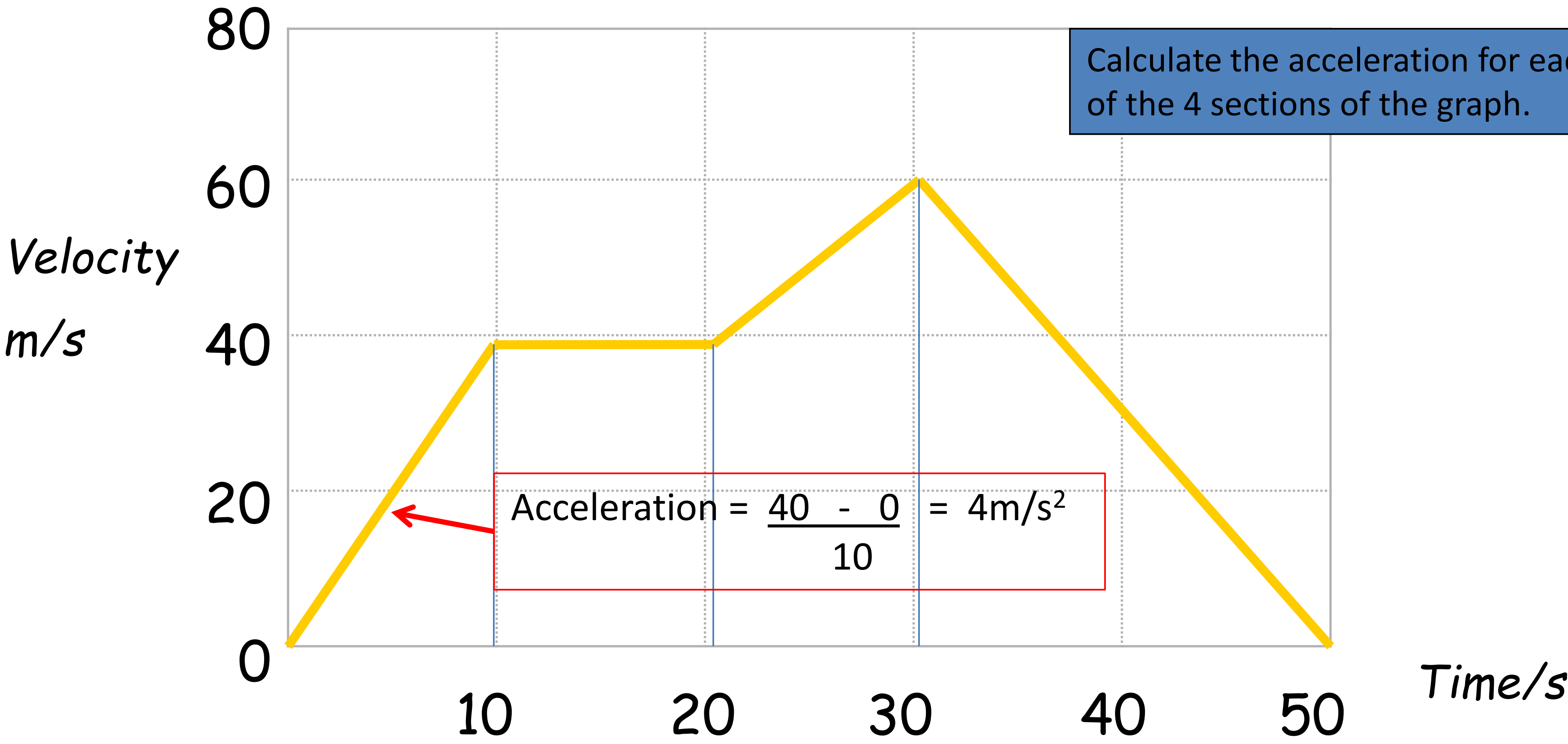

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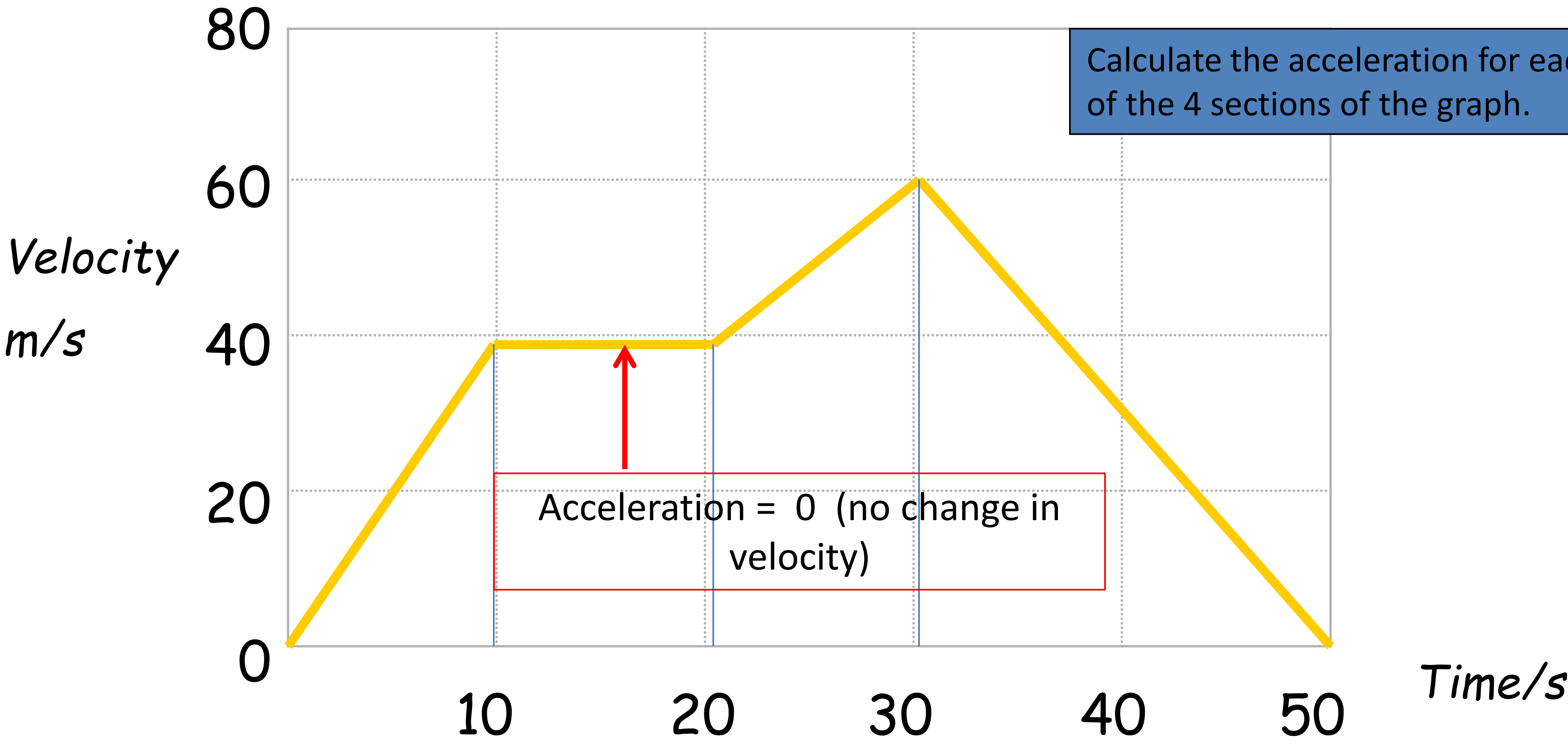

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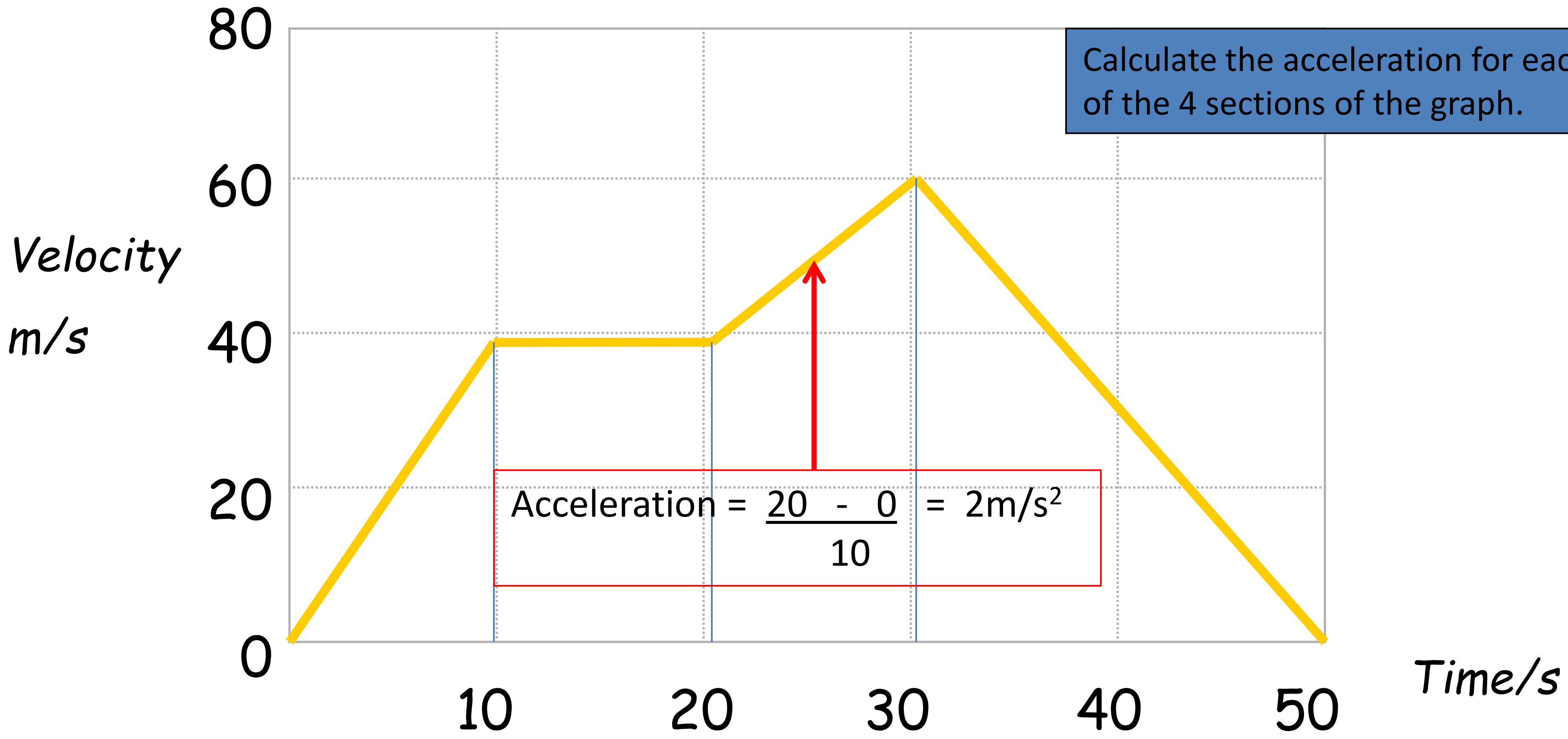

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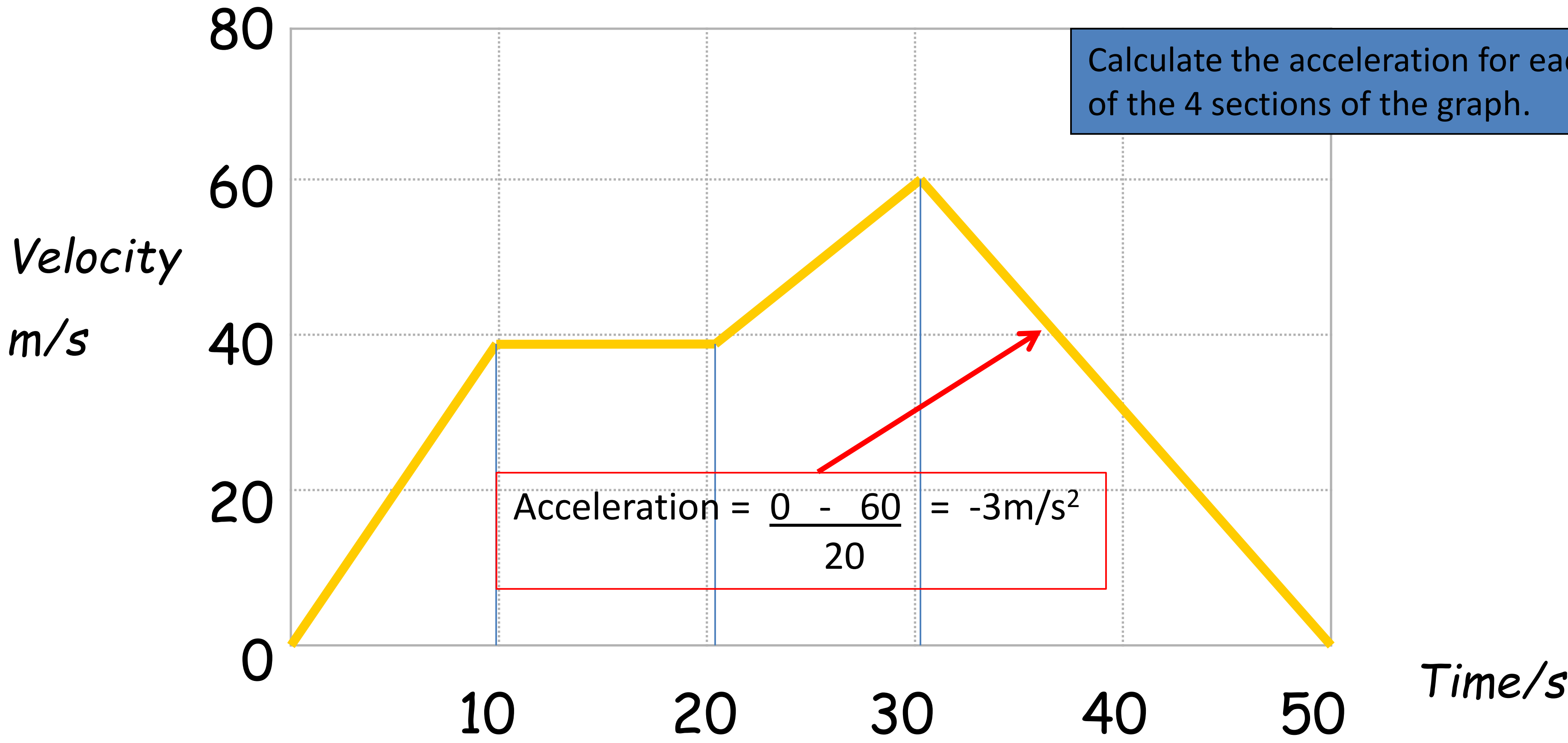
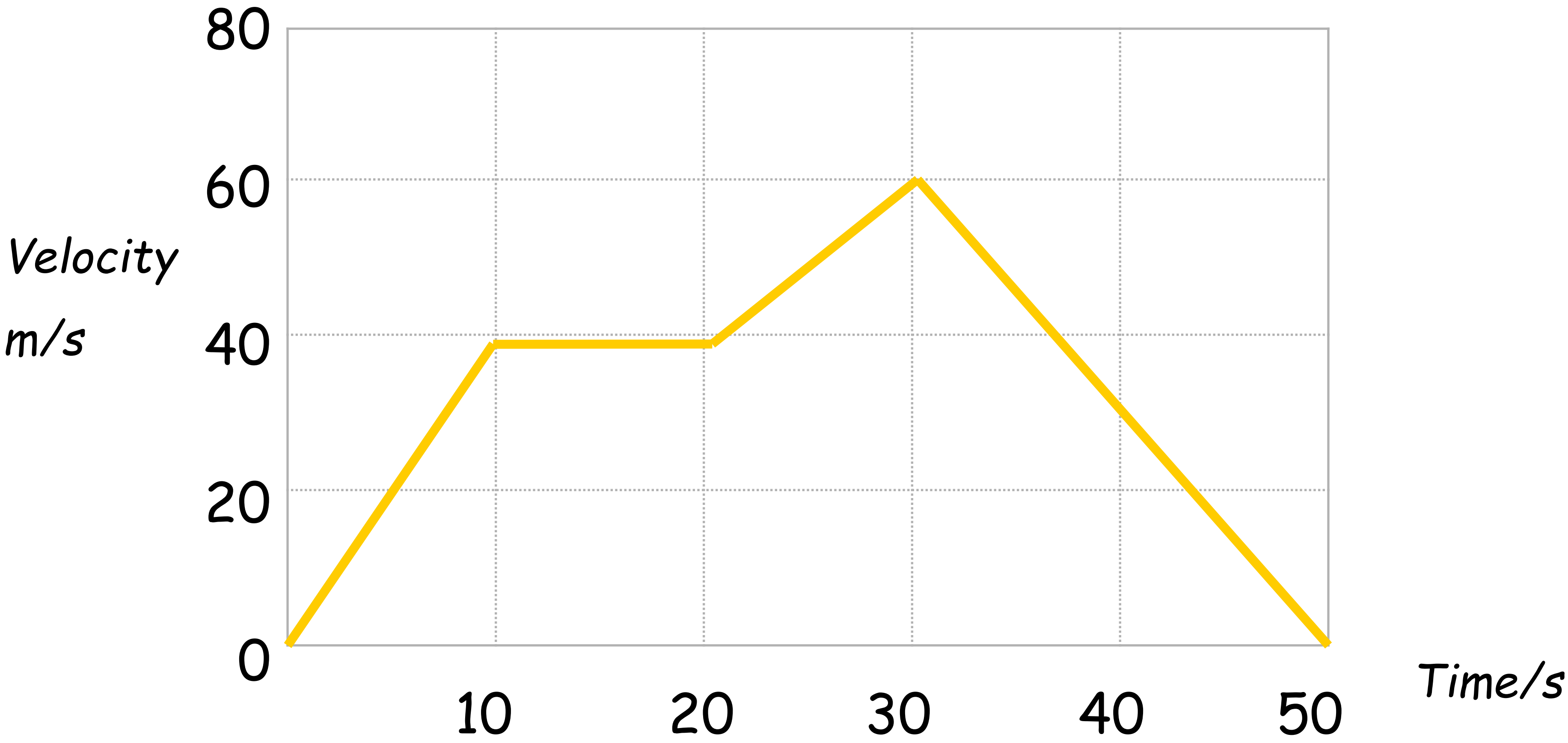



$$\text{Acceleration} = \frac{0 - 60}{20} = -3\,\text{m/s}^2$$

# Velocity-time graphs

On a velocity – time (or speed – time) graph, the area under the line is numerically equal to the distance travelled.



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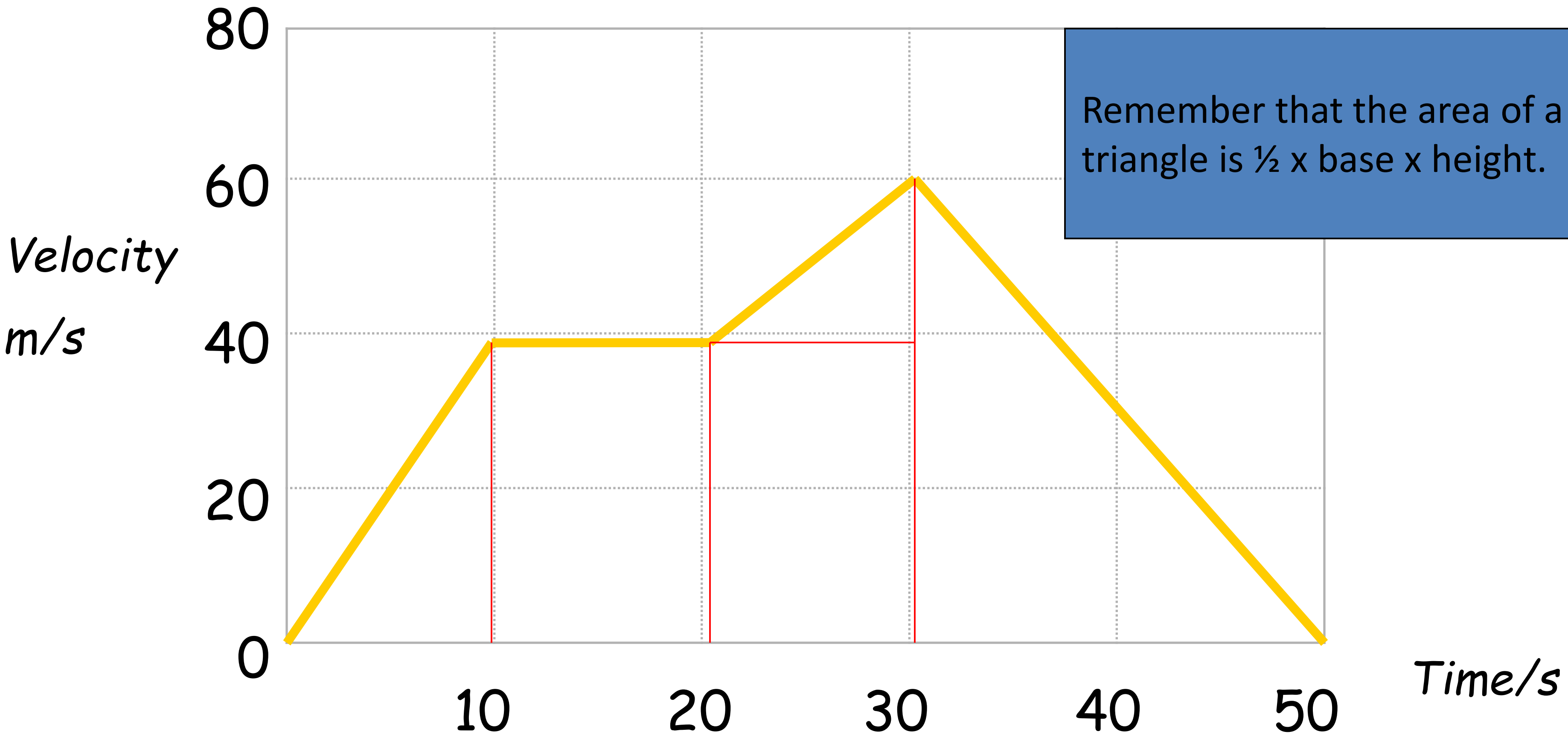


Remember that the area of a triangle is ½ x base x height.

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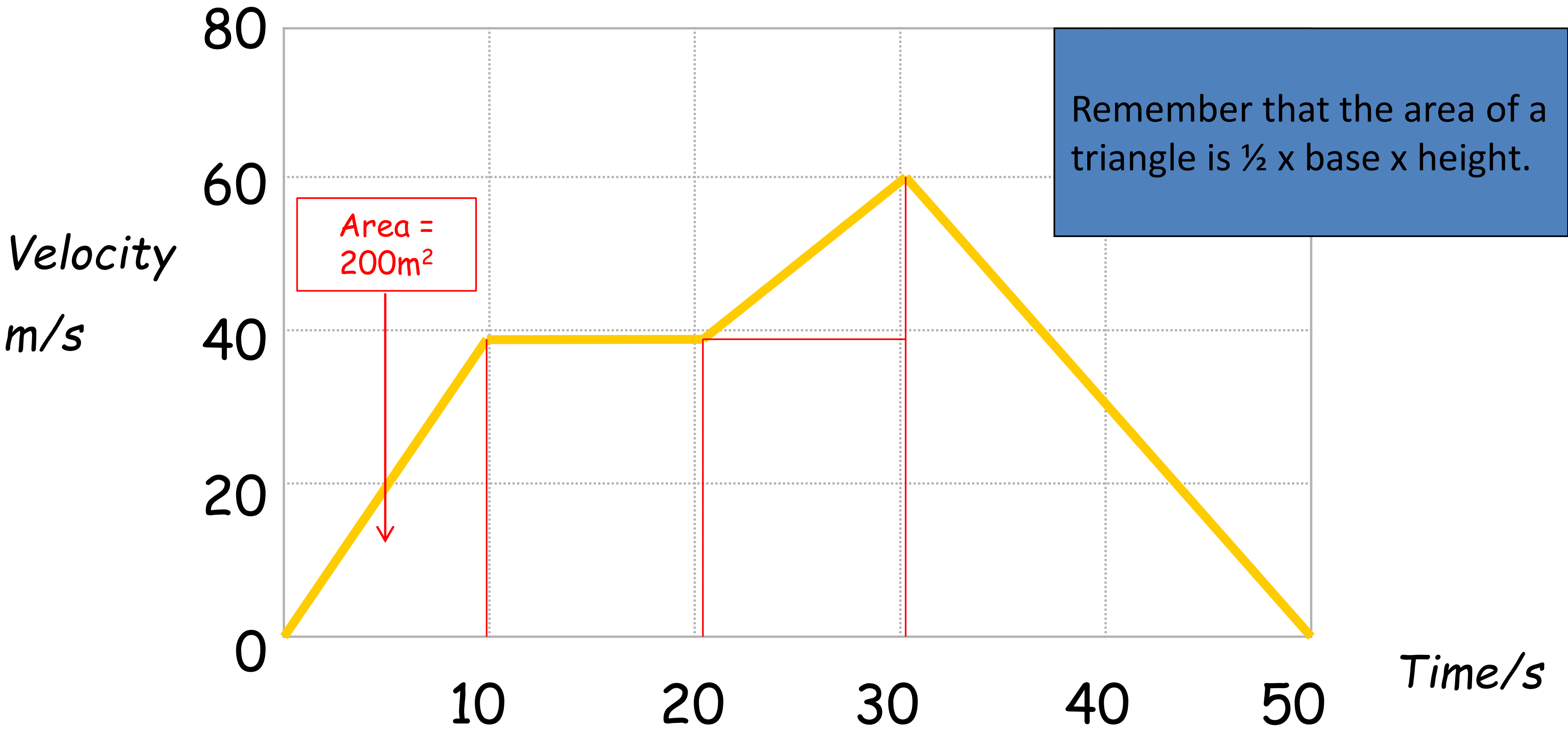


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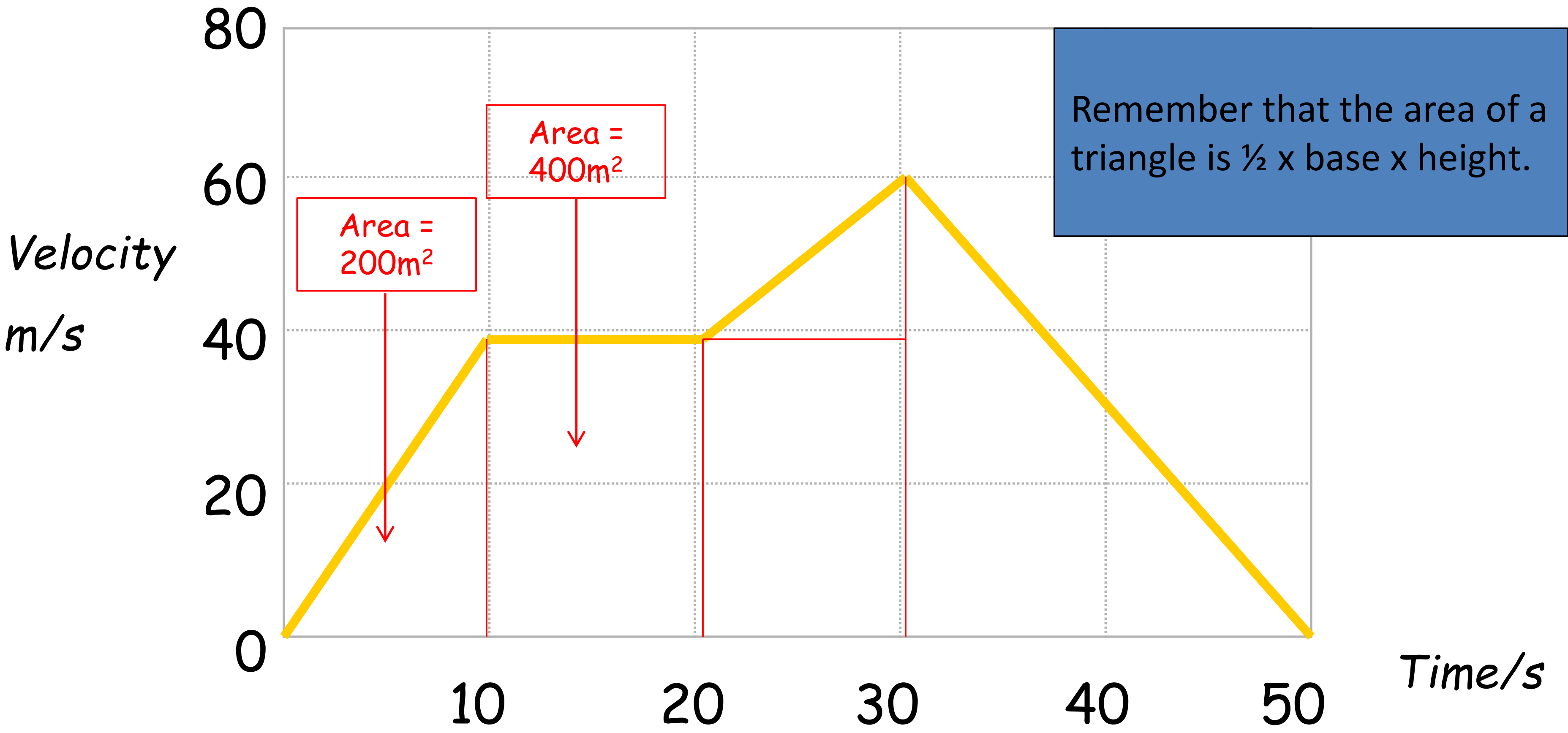


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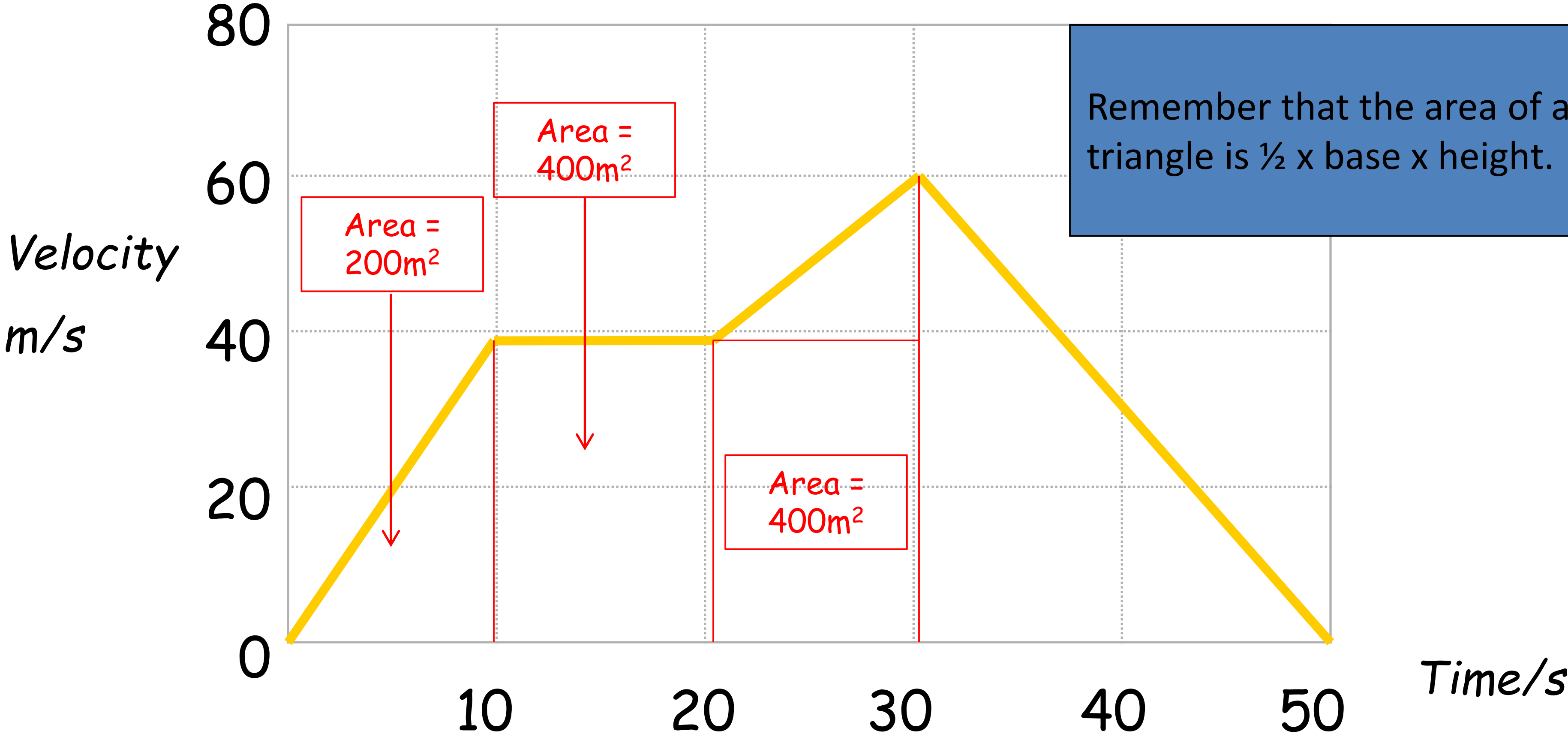


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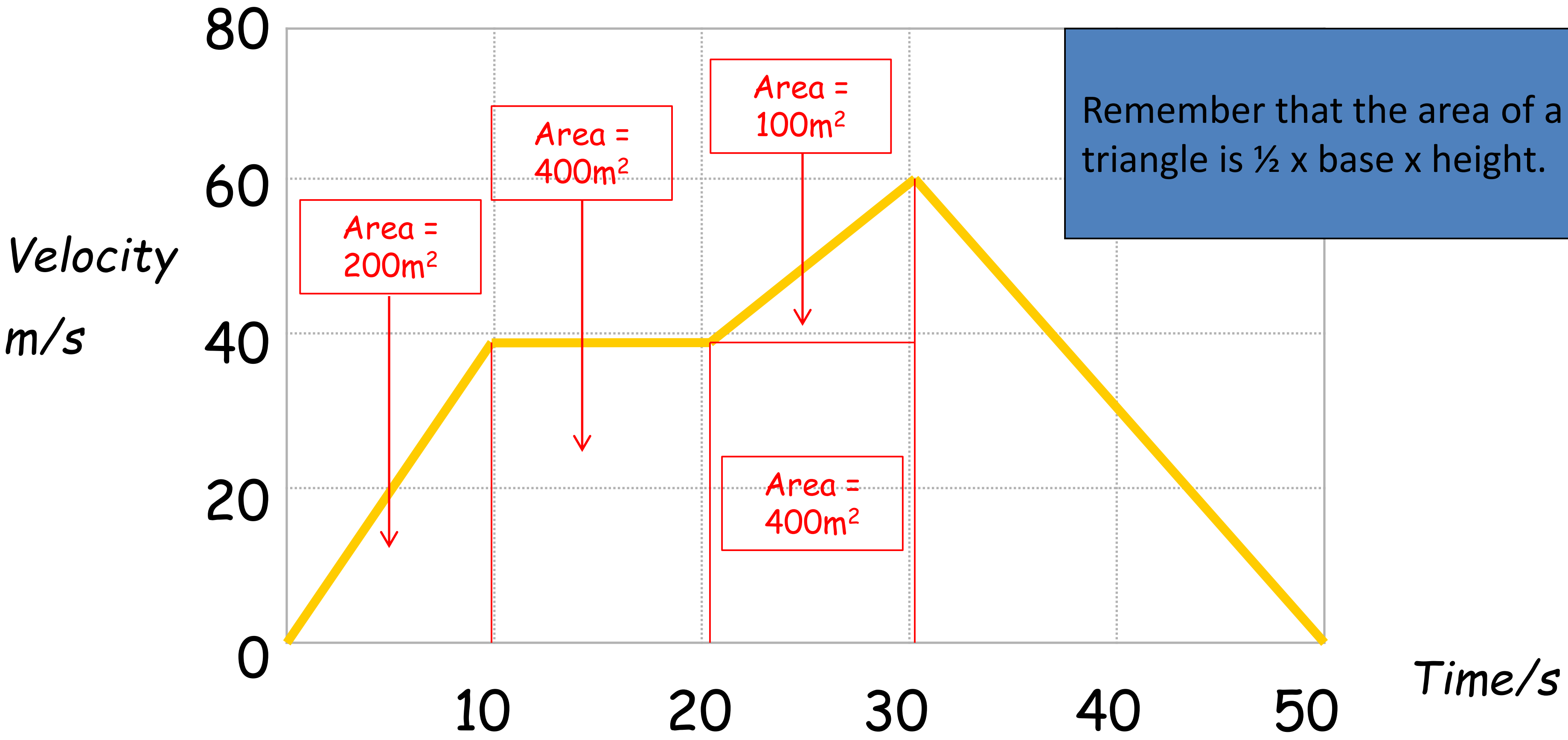


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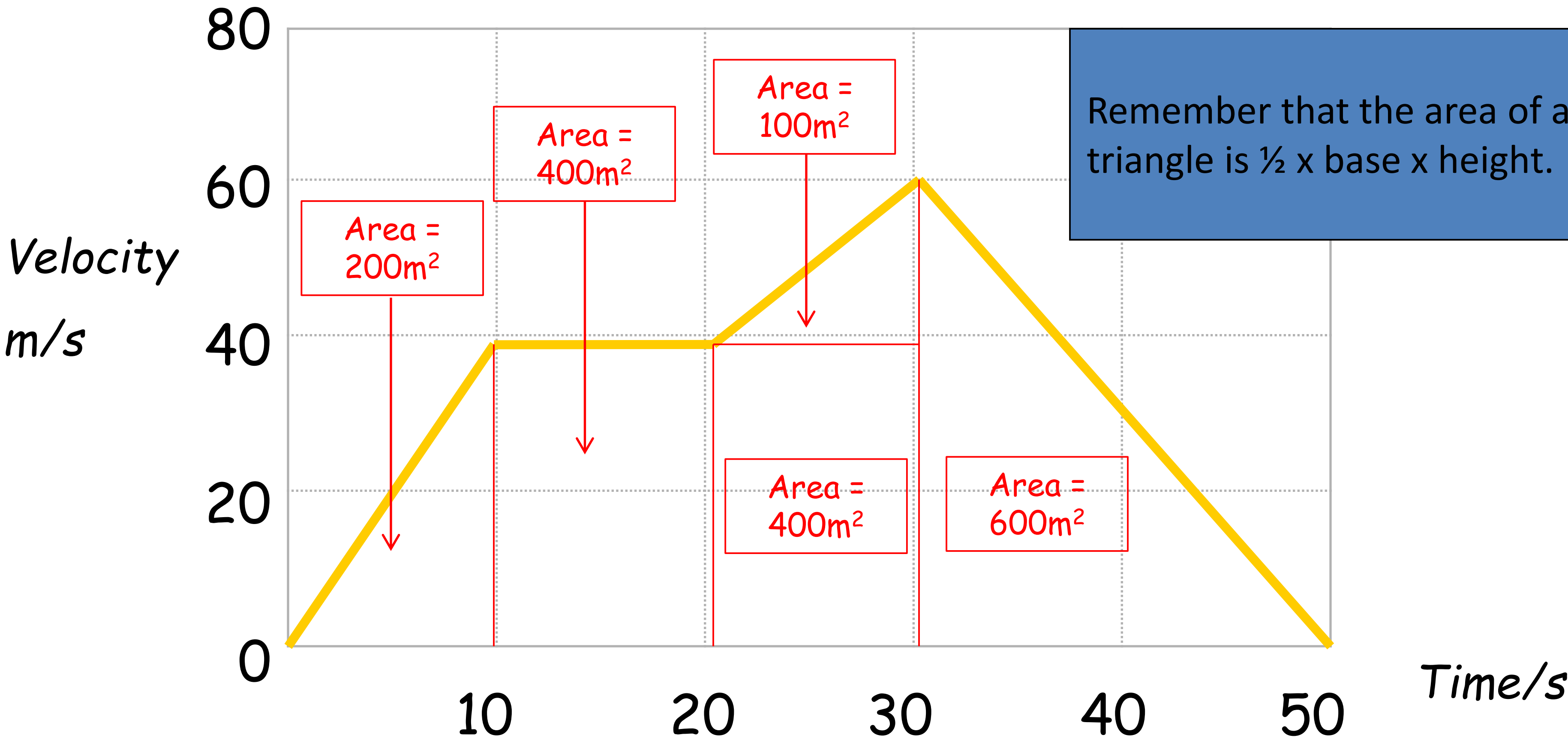


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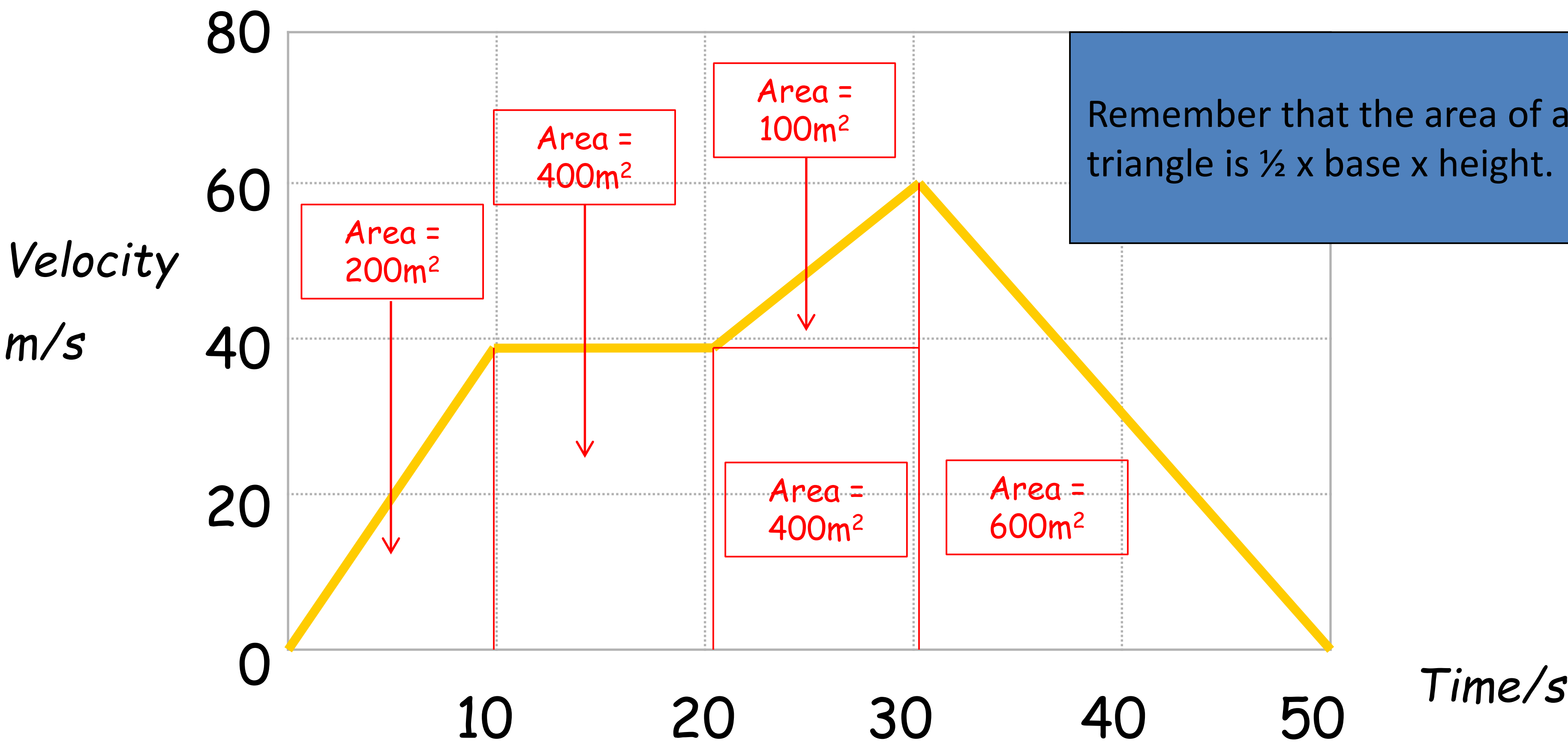
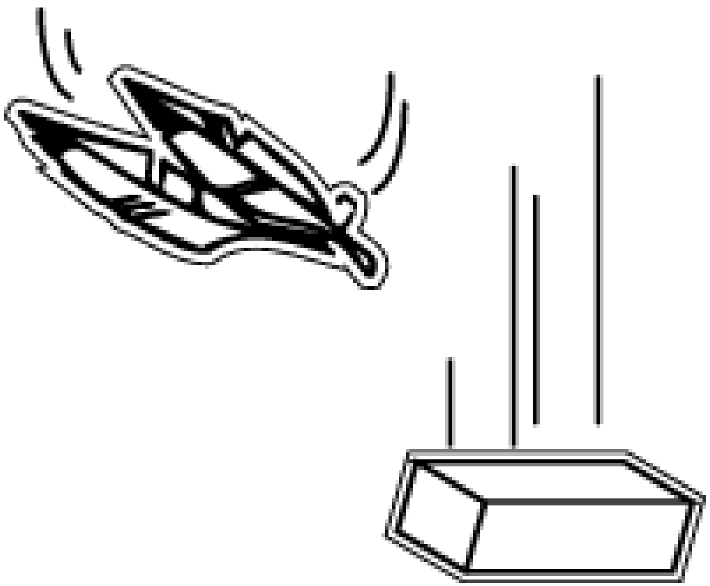



Remember that the area of a triangle is ½ x base x height.

The total distance travelled = 200 + 400 + 400 + 100 + 600 = 1700m

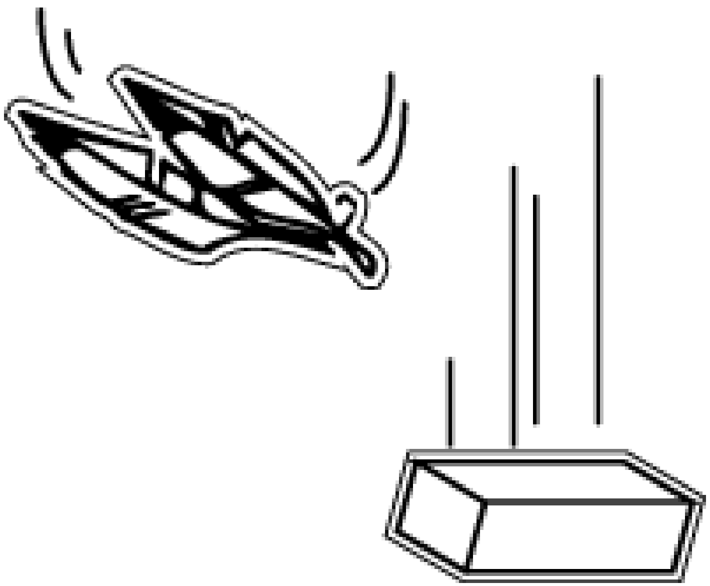
# Free fall

# Acceleration of free fall (g)



Which object will hit the ground first?

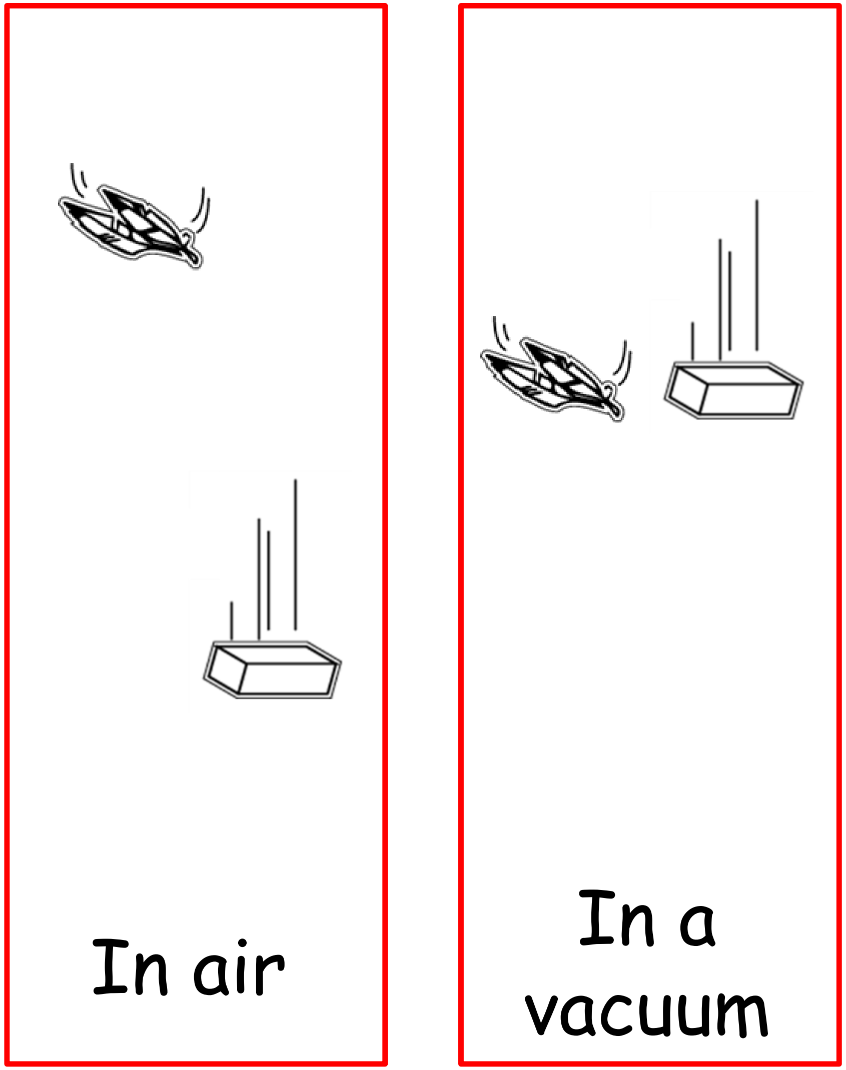
# Acceleration of free fall (g)



Which object will hit the ground first?

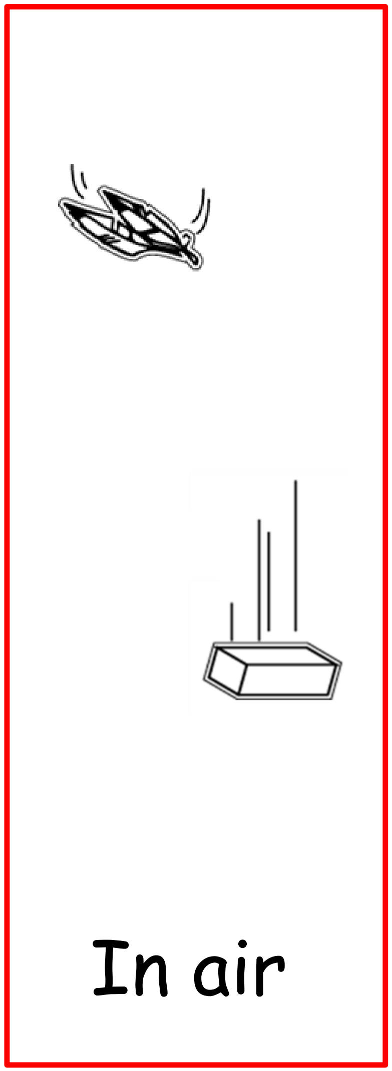
Obviously the brick (because the feather is slowed much more by the air)

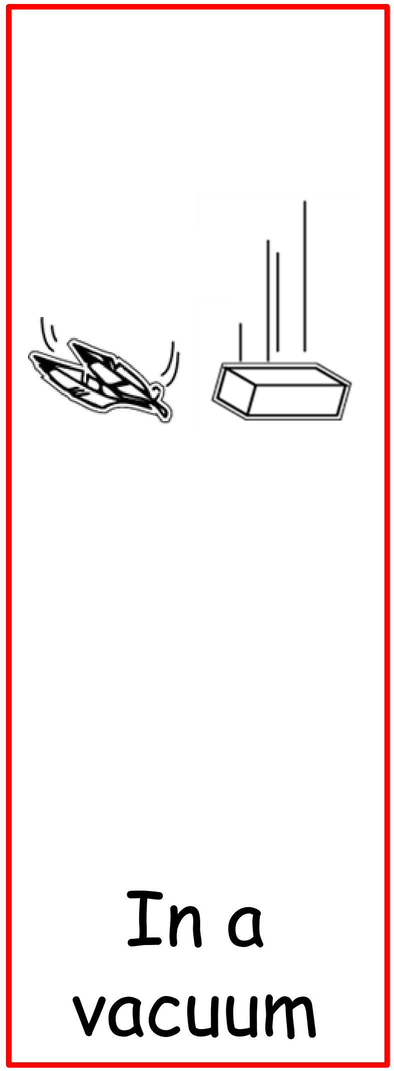
# Acceleration of free fall (g)




No air resistance, objects both fall with the same downward acceleration.

# Acceleration of free fall (g)



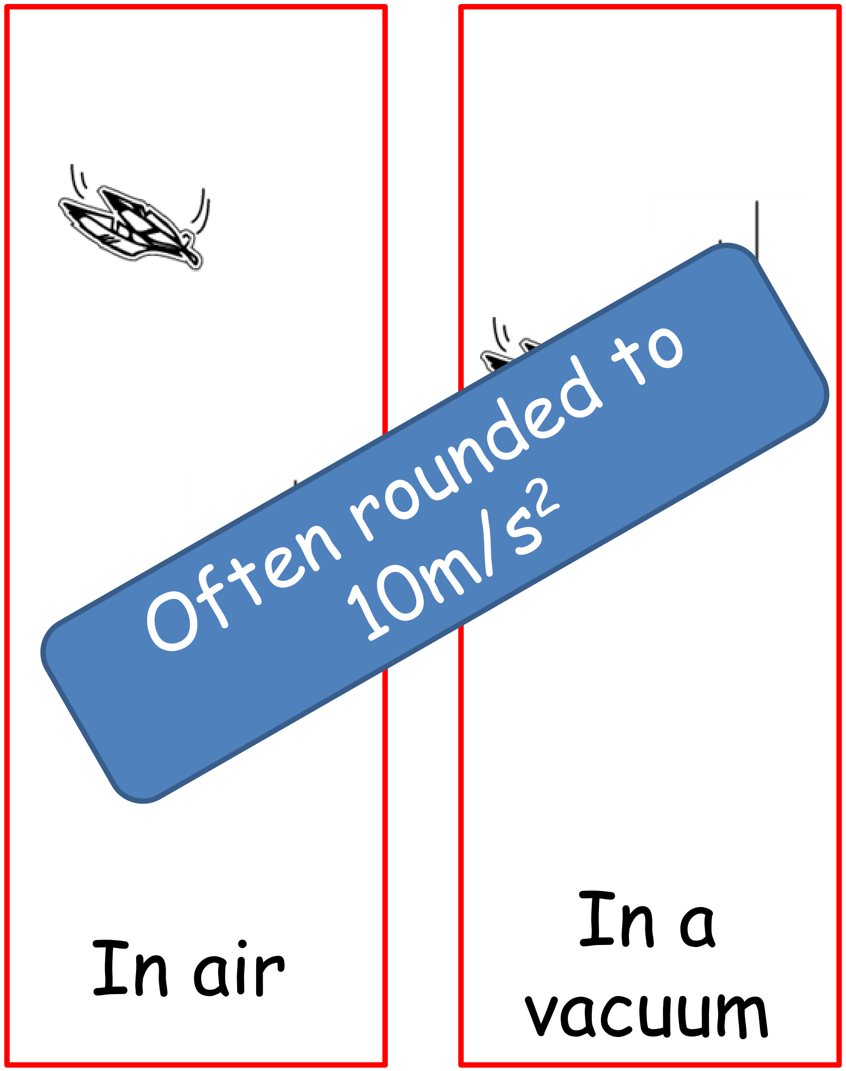




No air resistance, objects both fall with the same downward acceleration.

Acceleration of free fall = $9.8 m/s^2$

Given the symbol 'g'

# Acceleration of free fall (g)




Often rounded to $10m/s^2$

No air resistance, objects both fall with the same downward acceleration.

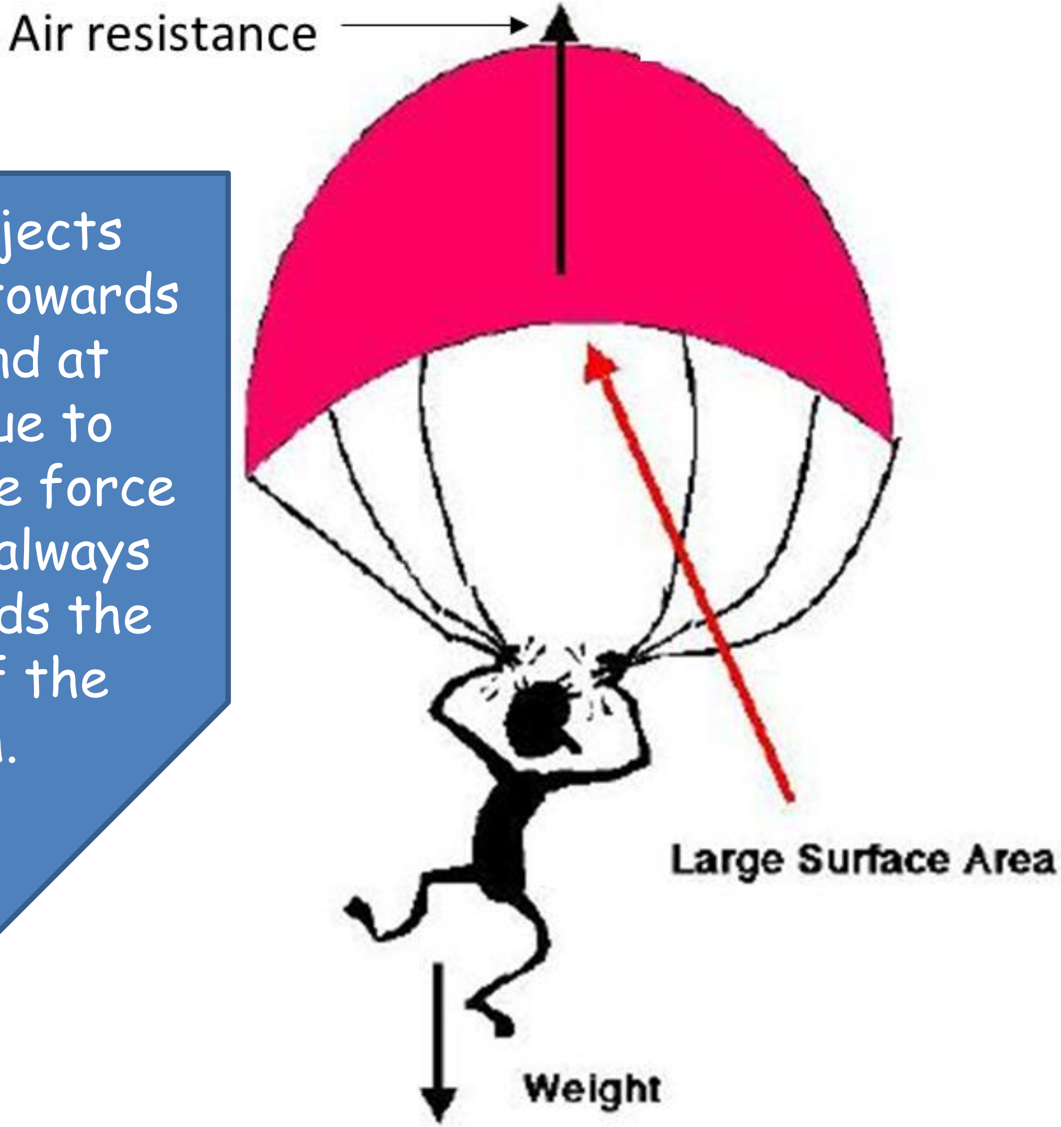
Acceleration of free fall = $9.8m/s^2$

Given the symbol 'g'

# Acceleration and gravity

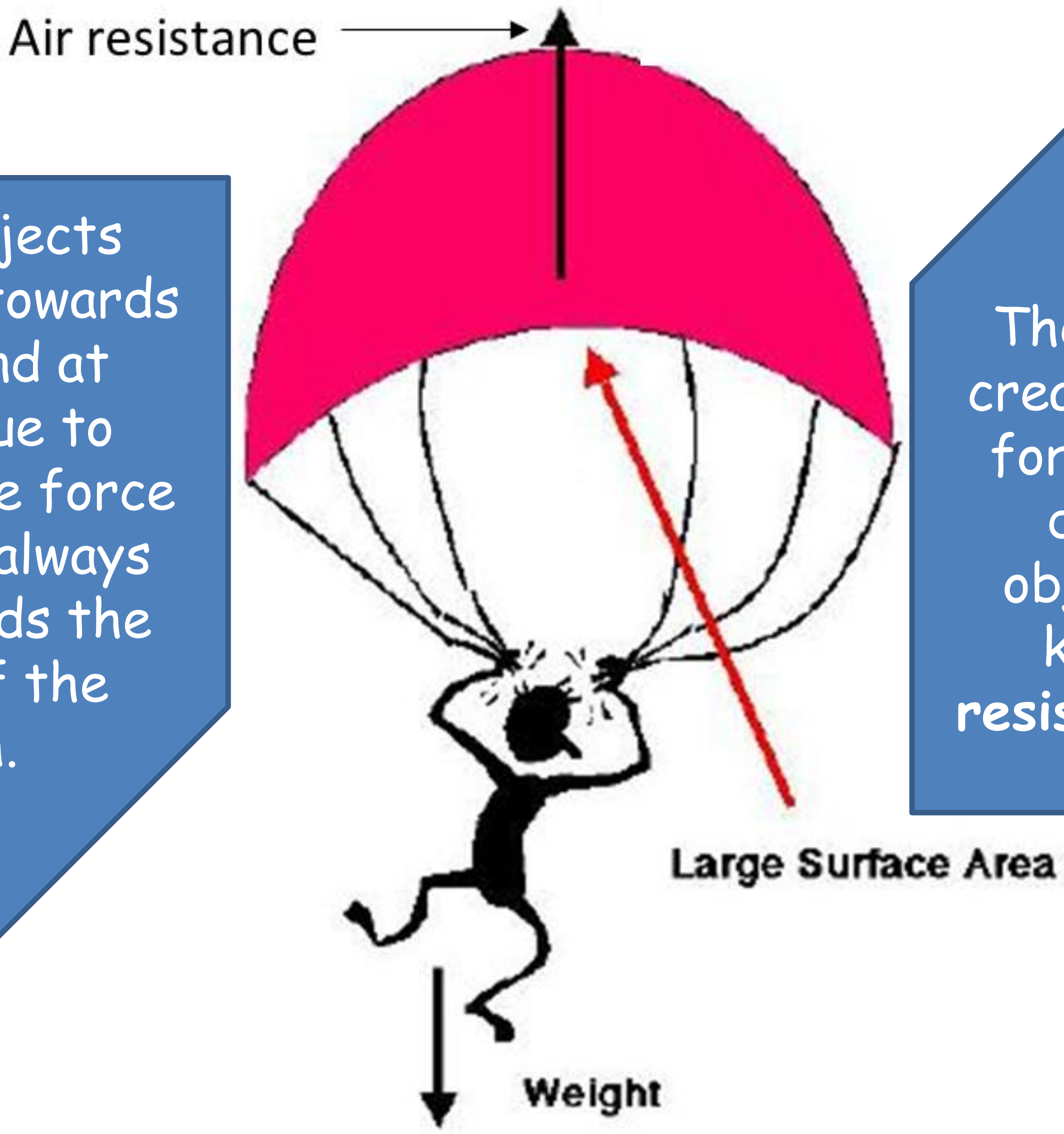
# Acceleration and gravity

Falling objects accelerate towards the ground at $10 m/s^2$ due to gravity. The force of gravity always acts towards the centre of the Earth.



# Acceleration and gravity

Falling objects accelerate towards the ground at 10m/s$^2$ due to gravity. The force of gravity always acts towards the centre of the Earth.




The atmosphere creates an upward force that slows down falling objects. This is known as **air resistance** or **drag**.

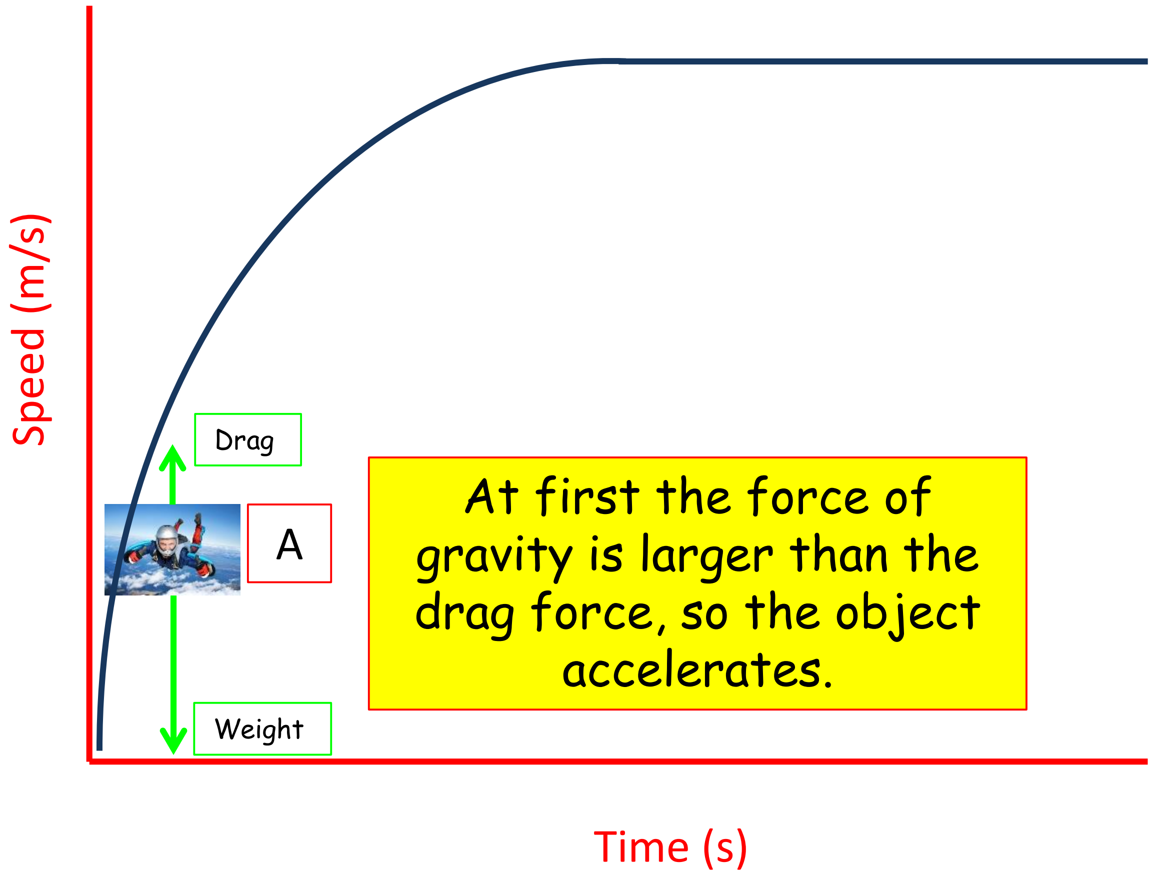
# Acceleration and gravity

Falling objects accelerate towards the ground at 10m/s$^2$ due to gravity. The force of gravity always acts towards the centre of the Earth.


The atmosphere creates an upward force that slows down falling objects. This is known as **air resistance** or **drag**.

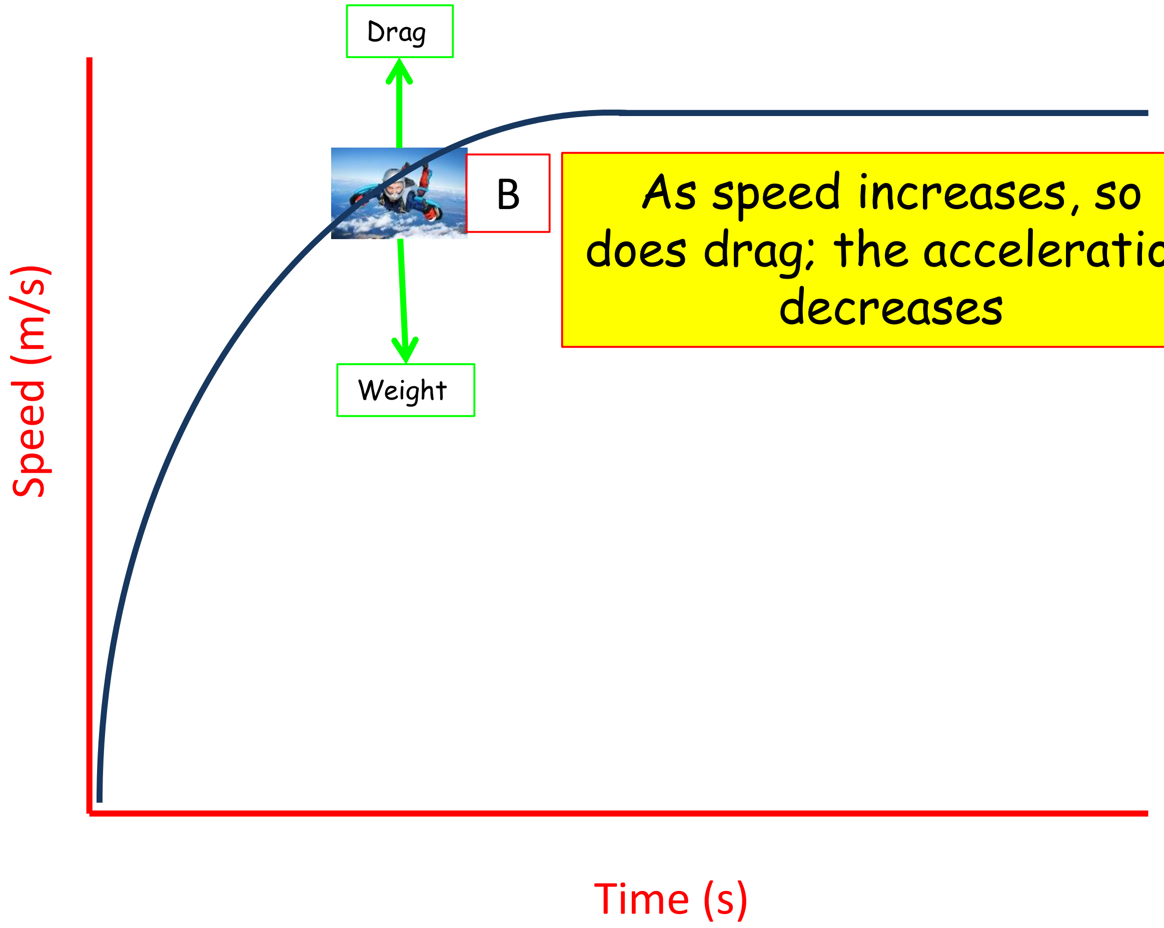
The larger the surface area of the object, the larger the drag force

# Acceleration and gravity



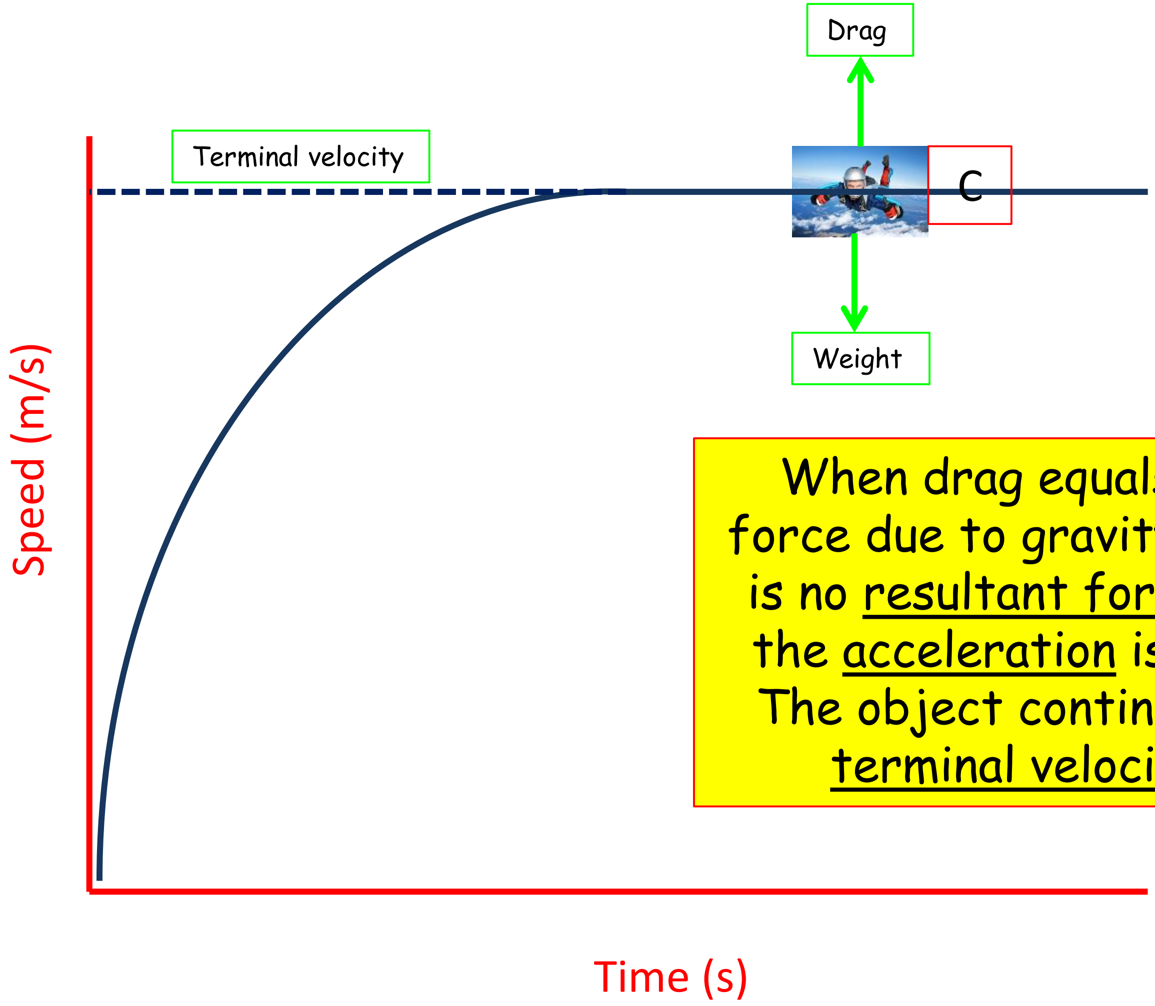

At first the force of gravity is larger than the drag force, so the object accelerates.

# Acceleration and gravity




As speed increases, so does drag; the acceleration decreases

# Acceleration and gravity




When drag equals the force due to gravity there is no resultant force and the acceleration is zero. The object continues at terminal velocity.

# LEARNING OBJECTIVES

| 1.2 Motion | |
|---|---|
| **Core**<br>• Define speed and calculate average speed from total time / total distance<br>• Plot and interpret a speed-time graph or a distance- time graph<br>• Recognise from the shape of a speed-time graph when a body is<br>– at rest<br>– moving with constant speed<br>– moving with changing speed<br>• Calculate the area under a speed-time graph to work out the distance travelled for motion with constant acceleration<br>• Demonstrate understanding that acceleration and deceleration are related to changing speed including qualitative analysis of the gradient of a speed-time graph<br>• State that the acceleration of free fall for a body near to the Earth is constant | **Supplement**<br>• Distinguish between speed and velocity<br>• Define and calculate acceleration using time taken change of velocity<br>• Calculate speed from the gradient of a distance-time graph<br>• Calculate acceleration from the gradient of a speed-time graph<br>• Recognise linear motion for which the acceleration is constant<br>• Recognise motion for which the acceleration is not constant<br>• Understand deceleration as a negative acceleration<br>• Describe qualitatively the motion of bodies falling in a uniform gravitational field with and without air resistance (including reference to terminal velocity) |