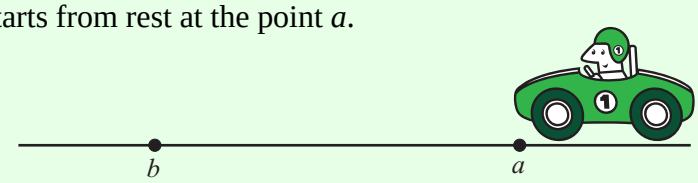
# Differentiation & Functions (Q 6, 7 & 8, Paper 1)

## Lesson No. 9: Rates of Change

**2007**

7 (c) A car starts from rest at the point $a$.




The distance of the car from $a$, after $t$ seconds, is given by

$$s = 2t^2 + 2t$$

where $s$ is in metres.

(i) Find the speed of the car after 2 seconds.

(ii) Find the acceleration of the car.

(iii) The distance from $a$ to the point $b$ is 24 metres. After how many seconds does the car reach the point $b$?

**2006**

7 (c) A missile is fired straight up in the air. The height, $h$ metres, of the missile above the firing position is given by

$$h = t(200 - 5t)$$

where $t$ is the time in seconds from the instant the missile was fired.

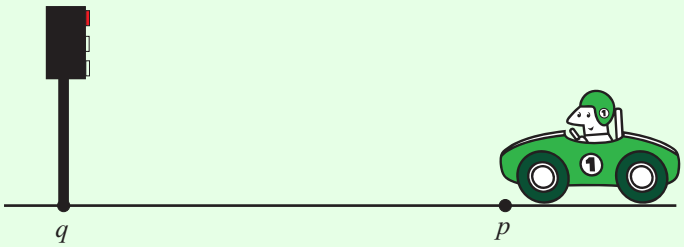
(i) Find the speed of the missile after 10 seconds.

(ii) Find the acceleration of the missile.

(iii) One second before reaching its greatest possible height, the missile strikes a target. Find the height of the target.

**2005**

7 (c) A car begins to slow down at $p$ in order to stop at a red traffic light at $q$.




The distance of the car from $p$, after $t$ seconds, is given by

$$s = 12t - \tfrac{3}{2}t^2$$

where $s$ is in metres.

(i) Find the speed of the car as it passes $p$.

(ii) Find the time taken to stop.

(iii) The car stops exactly at $q$. Find the distance from $p$ to $q$.

**2004**

7 (c) A jet is moving along an airport runway. At the instant it passes a marker it begins to accelerate for take-off. From the time the jet passes the marker, its distance from the marker is given by

$$s = 2t^2 + 3t,$$

where $s$ is in metres and $t$ is in seconds.

(i) Find the speed of the jet at the instant it passes the marker ($t = 0$).

(ii) The jet has to reach a speed of 83 metres per second to take off. After how many seconds will the jet reach this speed?

(iii) How far is the jet from the marker at that time?

(iv) Find the acceleration of the jet.

**2003**

7 (c) A train is travelling along a track. Suddenly, the brakes are applied. From the time the brakes are applied ($t = 0$ seconds), the distance travelled by the train, in metres, is given by

$$s = 30t - \tfrac{1}{4}t^2.$$

(i) What is speed of the train at the moment the brakes are applied?

(ii) How many seconds does it take for the train to come to rest?

(iii) How far does the train travel in that time?

**2002**

7 (c) A marble rolls along the top of a table. It starts to move at $t = 0$ seconds.
The distance that it has travelled at $t$ seconds is given by

$$s = 14t - t^2$$

where $s$ is in centimetres.

(i) What distance has the marble travelled when $t = 2$ seconds?

(ii) What is the speed of the marble when $t = 5$ seconds?

(iii) When is the speed of the marble equal to zero?

(iv) What is the acceleration of the marble?

**2001**

7 (c) Two fireworks were fired straight up in the air at $t = 0$ seconds.
The height, $h$ metres, which each firework reached above the ground $t$ seconds after it was fired is given by

$$h = 80t - 5t^2.$$

The first firework exploded 5 seconds after it was fired.

(i) At what height was the first firework when it exploded?

(ii) At what speed was the first firework travelling when it exploded?

The second firework failed to explode and it fell back to the ground.

(iii) After how many seconds did the second firework reach its maximum height?

**2000**

7 (c) A car, starting at $t = 0$ seconds, travels a distance of $s$ metres in $t$ seconds where

$$s = 30t - \tfrac{9}{4}t^2.$$

(i) Find the speed of the car after 2 seconds.

(ii) After how many seconds is the speed of the car equal to zero?

(iii) Find the distance travelled by the car up to the time its speed is zero.

**1999**

7 (c) The speed, $v$, in metres per second, of a body after $t$ seconds is given by

$$v = 3t(4 - t).$$

(i) Find the acceleration at each of the two instants when the speed is 9 metres per second.

(ii) Find the speed at the instant when the acceleration is zero.

**1998**

7 (c) The volume of water, $V$, in $\text{cm}^3$, that remains in a leaking tank after $t$ seconds is given by

$$V = 45000 - 300t + 0.5t^2.$$

(i) After how many seconds will the tank be empty?

(ii) Find the rate of change of the volume with respect to $t$ when $t = 50$ seconds.

**1997**

7 (c) The distance $s$ metres of an object from a fixed point at $t$ seconds is given by

$$s = \frac{t+1}{t+3}.$$

(i) At what time is the object 0.75 m from a fixed point?

(ii) What is the speed of the object, in terms of $t$, at $t$ seconds?

(iii) After how many seconds will the speed of the object be less than 0.02 m/s?

**1996**

7 (c) A stone is dropped from a height of 80 metres. Its height $h$ metres above the ground after $t$ seconds is given by

$$h = 80 - t^2.$$

Find

(i) its speed after $t$ seconds

(ii) its speed after 2.5 seconds

(iii) the time it takes to fall the first 14.4 metres.

**ANSWERS**

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|---|---|---|---|---|---|
| **2007** | 7 | (c) (i) $10\ \text{ms}^{-1}$ | (ii) $4\ \text{ms}^{-2}$ | (iii) 3 s | |
| **2006** | 7 | (c) (i) $100\ \text{ms}^{-1}$ | (ii) $-10\ \text{ms}^{-2}$ | (iii) 1995 m | |
| **2005** | 7 | (c) (i) $12\ \text{ms}^{-1}$ | (ii) 4 s | (iii) 24 m | |
| **2004** | 7 | (c) (i) $3\ \text{ms}^{-1}$ | (ii) 20 s | (iii) 860 m | (iv) $4\ \text{ms}^{-2}$ |
| **2003** | 7 | (c) (i) $30\ \text{ms}^{-1}$ | (ii) 60 s | (iii) 900 m | |
| **2002** | 7 | (c) (i) 24 cm | (ii) $4\ \text{cms}^{-1}$ | (iii) 7 s | (iv) $-2\ \text{cms}^{-2}$ |
| **2001** | **7** | (c) (i) 275 m | (ii) $30\ \text{ms}^{-1}$ | (iii) 8 s | |
| **2000** | **7** | (c) (i) $21\ \text{ms}^{-1}$ | (ii) $\frac{20}{3}$ s | (iii) 100 m | |
| **1999** | 7 | (c) (i) $6\ \text{ms}^{-2}, -6\ \text{ms}^{-2}$ | (ii) $12\ \text{ms}^{-1}$ | | |
| **1998** | 7 | (c) (i) 300 s | (ii) $-250\ \text{cm}^3/\text{s}$ | | |
| **1997** | 7 | (c) (i) 5 seconds | (ii) $\frac{2}{(t+3)^2}$ | (iii) 7 seconds | |
| **1996** | 7 | (c) (i) $-2t\ \text{ms}^{-1}$ | (ii) $-5\ \text{ms}^{-1}$ | (iii) 8.1 s | |