Example 11.5

The table below gives the values of distance travelled by a car at various time intervals during the initial running

Time, t(s)	5	6	7	8	9
Distance travelled, $s(t)$ (km)	10.0	14.5	19.5	25.5	32.0

Estimate velocity at time $t = 5$, $t = 7$ and $t = 9$.

We know that velocity is given by the first derivative of $s(t)$. At $t = 5$, we use the three-point forward difference formula (11.17).

$$v(t) = \frac{-3s(t) + 4s(t+h) - s(t+2h)}{2h}$$

Then

$$v(5) = \frac{-3(10) + 4(14.5) - 19.5}{2(1)}$$

$$= 4.25 \text{ km/s}$$

At $t = 7$, we use the central difference formulae (11.19). Therefore,

$$v(7) = \frac{s(8) - s(6)}{2h}$$

$$= \frac{25.5 - 14.5}{2} = 5.5 \text{ km/s}$$

At $t = 9$, we use the backward-difference formulae (11.18)

$$v(9) = \frac{3s(9) - 4s(8) + s(7)}{2h}$$

$$= \frac{3(32) - 4(25.5) + 19.5}{2}$$

$$= 6.75 \text{ km/s}$$

Higher-order Derivatives