Stopping Distances

A lorry jack-knives across a motorway, blocking all three lanes.

The two nearest cars are, at this moment, level with one another, one travelling at 70mph, the other at 80mph as shown in the diagram:

The following may be useful:

The official Highway Code stopping distance calculations are based on a constant deceleration of \(6.55 \text{ms}^{-2}\).

The Highway Code also assumes a reaction time of \(\frac{2}{3}\) of a second when calculating thinking distances (the distance covered before a driver can react to apply the brakes).

\[
1\text{mph} = 0.45\text{ms}^{-1}
\]

Calculate the gap between the cars and the lorry given that the slower car manages to stop just in time.

Calculate the speed of the 80mph car at the point of impact.
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**Calculate the gap between the cars and the lorry given that the slower car manages to stop just in time.**

**Thinking distance:**

$s =$?

$v = 70\text{mph} = 70 \times 0.45 = 31.5\text{ms}^{-1}$

$t = \frac{2}{3}s$

$v = \frac{s}{t} \Rightarrow 31.5 = \frac{s}{\frac{2}{3}} \Rightarrow s = 21m$

**Braking distance:**

$s =$?

$u = 31.5\text{ms}^{-1}$

$v = 0\text{ms}^{-1}$

$a = -6.55\text{ms}^{-2}$

$t = -s$

**Total distance:**

$21 + 75.7 = 96.7\text{m to 3 s.f.}$

**Calculate the speed of the 80mph car at the point of impact.**

**Thinking distance:**

$s =$?

$v = 80\text{mph} = 80 \times 0.45 = 36\text{ms}^{-1}$

$t = \frac{2}{3}s$

$v = \frac{s}{t} \Rightarrow 36 = \frac{s}{\frac{2}{3}} \Rightarrow s = 24m$

**Braking distance = Total distance – Thinking distance = 96.7 – 24 = 72.7m**

**Final speed:**

$s = 72.7m$

$u = 36\text{ms}^{-1}$

$v =$?

$a = -6.55\text{ms}^{-2}$

$t = -s$

$v^2 = u^2 + 2as \Rightarrow v^2 = 36^2 - 2 \times 6.55 \times 72.7 \Rightarrow v = \sqrt{36^2 - 2 \times 6.55 \times 72.7} = 18.5\text{ms}^{-1} \text{ to 3 s.f. (≈ 40mph)}$