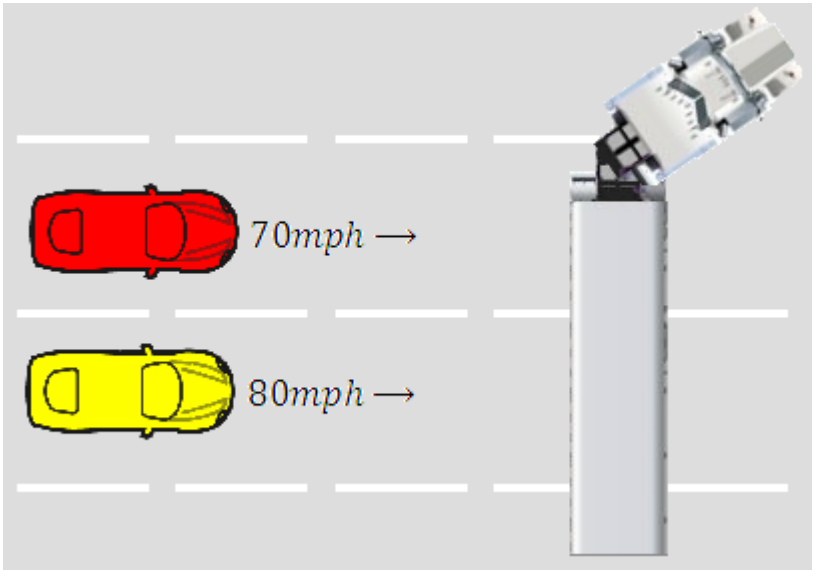
Stopping Distances

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 $\mathbf{6.55ms^{-2}}$.

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).

$$\mathbf{1mph = 0.45ms^{-1}}$$

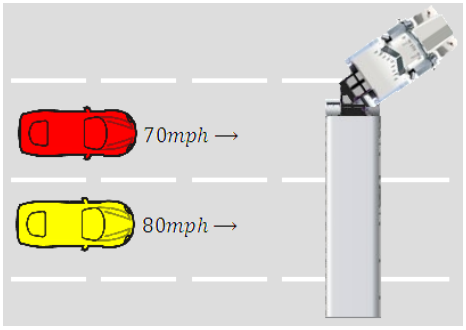
Calculate the gap between the cars and the lorry given that the slower car manages to stop just in time.

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

Stopping Distances - SOLUTIONS

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 $\mathbf{6.55ms^{-2}}$.

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).

$$\mathbf{1mph = 0.45ms^{-1}}$$

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

Thinking distance:
$s =?$
$v = 70mph = 70 \times 0.45 = 31.5ms^{-1}$
$t = \frac{2}{3}s$

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

Braking distance:
$s =?$
$u = 31.5ms^{-1}$
$v = 0ms^{-1}$
$a = -6.55ms^{-2}$
$t = -s$

$$v^2 = u^2 + 2as \implies 0 = 31.5^2 + 2 \times (-6.55)s$$

$$\implies s = \frac{31.5^2}{13.1} = \mathbf{75.7m\ to\ 3\ s.f.}$$

Total distance:

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

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

Thinking distance:
$s =?$
$v = 80mph = 80 \times 0.45 = 36ms^{-1}$
$t = \frac{2}{3}s$

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

$Braking\ distance = Total\ distance - Thinking\ distance = 96.7 - 24 = \mathbf{72.7m}$

Final speed:
$s = 72.7m$
$u = 36ms^{-1}$
$v =?$
$a = -6.55ms^{-2}$
$t = -s$

$$v^2 = u^2 + 2as \implies v^2 = 36^2 - 2 \times 6.55 \times 72.7$$

$$\implies v = \sqrt{36^2 - 2 \times 6.55 \times 72.7} = \mathbf{18.5ms^{-1}\ to\ 3\ s.f.}\ (\approx 40mph)$$