Even more catch-up problems - Answers

1) **Falling Stone** ↓+

$v_i = 0$

$a = 9.8\ m/s^2$

$\Delta d = x$

$\Delta t = y + 2.0s$

Thrown Stone ↓+

$v_i = 30.0\ m/s$

$a = 9.8\ m/s^2$

$\Delta d = x$

$\Delta t = y$

① $\Delta d = \cancel{v_i \Delta t} + \frac{1}{2} a(\Delta t)^2$

$x = \frac{1}{2}(9.8 \frac{m}{s^2})(y+2.0s)^2$

$x = 4.9 \frac{m}{s^2}(y^2 + 4.0s\,y + 4.0s^2)$

$x = 4.9 \frac{m}{s^2} y^2 + (4.9 \frac{m}{s^2})(4.0s\,y) + 4.9 \frac{m}{s^2}(4.0s^2)$

$\Delta d = v_i \Delta t + \frac{1}{2} a(\Delta t)^2$

$x = 30.0 \frac{m}{s} y + \frac{1}{2}(9.8 \frac{m}{s^2}) y^2$

$x = 30.0 \frac{m}{s} y + 4.9 \frac{m}{s^2} y^2$

Set $x = x$

$\cancel{4.9 \frac{m}{s^2} y^2} + 19.6 \frac{m}{s} y + 19.6 m = 30.0 \frac{m}{s} y + \cancel{4.9 \frac{m^2}{s^2} y^2}$

$19.6 \frac{m}{s} y + 19.6 m = 30.0 \frac{m}{s} y$

$19.6 m = 30.0 \frac{m}{s} y - 19.6 \frac{m}{s} y$

$19.6 m = 10.4 \frac{m}{s} y$

$y = \frac{19.6 \cancel{m}}{10.4 \frac{\cancel{m}}{s}} \quad m \times \frac{s}{\cancel{m}}$

$y = 1.88 s$

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② $\Delta d = \cancel{v_i \Delta t}^{0} + \frac{1}{2} a (\Delta t)^2$ for stone falling

$\Delta d = \frac{1}{2} (9.8 \frac{m}{s^2})(y + 2.0s)^2$

$= \frac{1}{2} (9.8 \frac{m}{s^2})(1.88s + 2.0s)^2$

$= 74 m$

2) **Car A**

$a = 1.0 m/s^2$

$v_i = 0$

$\Delta d = x$

$\Delta t = y$

Car B

$v = 8.0 m/s$

$\Delta d = x$

$\Delta d = y$

① $\Delta d = \cancel{v_i \Delta t}^{0} + \frac{1}{2} a (\Delta t)^2$

$\Delta d = \frac{1}{2} a (\Delta t)^2$

$x = \frac{1}{2} (1.0 \frac{m}{s^2})(y)^2$

$0.5 \frac{m}{s^2} y^2 = 8.0 \frac{m}{s} y$

$y = \frac{8.0 \frac{m}{s}}{0.5 \frac{m}{s^2}}$

$y = 16 s$

$\Delta d = v \Delta t$

$x = 8.0 \frac{m}{s} y$

② $\Delta d = \frac{1}{2} a (\Delta t)^2$

$= \frac{1}{2} (1.0 \frac{m}{s^2})(16s)^2$

$= 128 m$

3) **Man**

$v = 6.0\ m/s$

$\Delta d = x + 25\ m$

$\Delta t = y$

$\Delta d = v\,\Delta t$

$x + 25\ m = 6.0\frac{m}{s}\,y$

Bus

$v_i = 0$

$a = 0.5\ m/s^2$

$\Delta d = x$

$\Delta t = y$

$\Delta d = \cancel{v_i \Delta t}^{0} + \frac{1}{2}a(\Delta t)^2$

$x = \frac{1}{2}(0.5\frac{m}{s^2})y^2$

$x = 0.25\frac{m}{s^2}y^2$

① $0.25\frac{m}{s^2}y^2 + 25\ m = 6.0\frac{m}{s}y$

$0 = 0.25\frac{m}{s^2}y^2 + 6.0\frac{m}{s}y - 25\ m$

quadratic!

$$y = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-(6.0\frac{m}{s}) \pm \sqrt{(6.0\ m/s)^2 - 4(-0.25\frac{m}{s^2})(-25\ m)}}{2(-0.25\frac{m}{s^2})}$$

$$= \frac{-6.0\frac{m}{s} \pm \sqrt{11\frac{m^2}{s^2}}}{-0.5\frac{m}{s^2}}$$

$y = 5.37\ s$

or

$y = 18.6\ s$ ← this is when the bus will catch up to the man later!

② $\Delta d = v\,\Delta t$

$= (6.0\frac{m}{s})(5.37\ s)$

$= 32\ m$