Answers: Catch-up Problems

1)	Motorcycle	Car
	$v_i = 25.0\,\frac{m}{s}$ $a = 8.00\,\frac{m}{s^2}$ $\Delta t = y$ $\Delta d = x + 50m$ $\Delta d = v_i \Delta t + \frac{1}{2} a(\Delta t)^2$ $x + 50m = (25.0\,\frac{m}{s})y + \frac{1}{2}(8.00\,\frac{m}{s^2})(y)^2$ $x + 50m = (25.0\,\frac{m}{s})y + (4.00\,\frac{m}{s^2})(y)^2$ Substitute "x" from the car $(25.0\,\frac{m}{s})y + 50m = (25.0\,\frac{m}{s})y + (4.00\,\frac{m}{s^2})(y)^2$ $50m = +(4.00\,\frac{m}{s^2})(y)^2$ $(\Delta t)^2 = \frac{50m}{4.00\,\frac{m}{s^2}}$ $\Delta t = 3.5s$ **Ans: 3.5 s**	$v = 25.0\,\frac{m}{s}$ $\Delta t = y$ $\Delta d = x$ $\Delta d = v\Delta t$ $x = (25.0\,\frac{m}{s})y$

2)	1st rock	2nd rock
	$v_i = 21\frac{m}{s}$ $a = -9.8\frac{m}{s^2}$ $\Delta t = x + 3s$ $\Delta d = y$ $\Delta d = v_i \Delta t + \frac{1}{2} a(\Delta t)^2$ $y = (21\frac{m}{s})(x + 3s) + \frac{1}{2}(-9.8\frac{m}{s^2})(x + 3s)^2$ $y = (21\frac{m}{s})x + (21\frac{m}{s})(3s) + (-4.9\frac{m}{s^2})(x^2 + (6s)x + 9s^2)$ $y = (21\frac{m}{s})x + 63m - (4.9\frac{m}{s^2})x^2 - (29.4\frac{m}{s})x - 44.1m$ Substitute "y" from 2nd rock $(21\frac{m}{s})x + (-4.9\frac{m}{s^2})(x)^2 = (21\frac{m}{s})x + 63m - (4.9\frac{m}{s^2})x^2 - (29.4\frac{m}{s})x - 44.1m$ $0 = 63m - (29.4\frac{m}{s})x - 44.1m$ $(29.4\frac{m}{s})x = 63m - 44.1m$ $x = \frac{18.9m}{29.4\frac{m}{s}} = 0.64s$ Find the height $y = (21\frac{m}{s})x + (-4.9\frac{m}{s^2})(x)^2$ $y = (21\frac{m}{s})(0.64s) + (-4.9\frac{m}{s^2})(0.64s)^2$ $y = 11.4m$ **Ans:** ▪ 0.64 s after the second rock was thrown (or 3.64 s after the first one was thrown) ▪ 11 m above the ground	$v_i = 21\frac{m}{s}$ $a = -9.8\frac{m}{s^2}$ $\Delta t = x$ $\Delta d = y$ $\Delta d = v_i \Delta t + \frac{1}{2} a(\Delta t)^2$ $y = (21\frac{m}{s})x + \frac{1}{2}(-9.8\frac{m}{s^2})(x)^2$ $y = (21\frac{m}{s})x + (-4.9\frac{m}{s^2})(x)^2$

3)	**Hot Air balloon**	**Camera**
	$v = 2.03\frac{m}{s}$ $\Delta t = x$ $\Delta d = y - 2.50m$ $\Delta d = v\Delta t$ $y - 2.50m = \left(2.03\frac{m}{s}\right)x$ Substitute "y" from the camera $y - 2.50m = \left(2.03\frac{m}{s}\right)x$ $\left(4.9\frac{m}{s^2}\right)(x)^2 - 2.50m = \left(2.03\frac{m}{s}\right)x$ $0 = -\left(4.9\frac{m}{s^2}\right)(x)^2 + \left(2.03\frac{m}{s}\right)x + 2.50m$ $x = -0.54s$ $x = 0.95s$ It takes 0.95 s. Now find v_i for the camera. $v_f = v_i + a\Delta t$ $v_i = -a\Delta t$ $v_i = -\left(-9.8\frac{m}{s^2}\right)(0.95s)$ $v_i = 9.3\frac{m}{s}$ **Ans: 9.3 m/s**	$v_i = ?$ $a = -9.8\frac{m}{s^2}$ $\Delta t = x$ $\Delta d = y$ $v_f = 0$ $\Delta d = v_f \Delta t - \frac{1}{2}a(\Delta t)^2$ $\Delta d = -\frac{1}{2}a(\Delta t)^2$ $y = -\frac{1}{2}\left(-9.8\frac{m}{s^2}\right)(x)^2$ $y = \left(4.9\frac{m}{s^2}\right)(x)^2$

4)	**Dropped ball**	**Thrown ball**
	$v_i = 0$ $a = -9.8 \frac{m}{s^2}$ $\Delta t = x + 0.600s$ $\Delta d = -8.0m$ $\Delta d = v_f \Delta t - \frac{1}{2} a(\Delta t)^2$ $\Delta d = -\frac{1}{2} a(\Delta t)^2$ $(\Delta t)^2 = \frac{2\Delta d}{a}$ $(\Delta t)^2 = \frac{2(-8.0m)}{\left(-9.8 \frac{m}{s^2}\right)}$ $(\Delta t)^2 = 1.63s^2$ $(x + 0.60s)^2 = 1.63s^2$ $\sqrt{(x + 0.60s)^2} = \sqrt{1.63s^2}$ $x + 0.60s = 1.28s$ $x = 0.68s$ Now find v_I for the second (thrown) rock. $\Delta d = v_i \Delta t + \frac{1}{2} a(\Delta t)^2$ $v_i = \frac{\Delta d - \frac{1}{2} a(\Delta t)^2}{\Delta t}$ $v_i = \frac{-8.0m - \frac{1}{2}\left(9.8 \frac{m}{s^2}\right)(0.68s)^2}{0.68s}$ $v_i = -15 \frac{m}{s}$ **Ans: 15 m/s**	$v_i = ?$ $a = -9.8 \frac{m}{s^2}$ $\Delta t = x$ $\Delta d = -8.0m$

5)	**Tiger**	**Prey**
	$v = 15m/s$ $\Delta t = y$ $\Delta d = x + 75m$ $\Delta d = v\Delta t$ $x + 75m = (15m/s)y$ Substitute "x" from the prey $(8.0m/s)y + 75m = (15m/s)y$ $75m = (7m/s)y$ $y = \frac{75m}{7m/s} = 10.7s$ Find "x" $x = (8m/s)y$ $x = 85.6m$ Find how far the tiger ran: $\Delta d = x + 75m$ $\Delta d = 85.6m + 75m$ $\Delta d = 161m$ **Ans: 161 m**	$v = 8.0m/s$ $\Delta t = y$ $\Delta d = x$ $\Delta d = v\Delta t$ $x = (8m/s)y$

6)	you	Little neighbour
	$v = 8.0m/s$ $\Delta t = y$ $\Delta d = x$ $\Delta d = v\Delta t$ $x = (8.0\frac{m}{s})y$ Make both "x" equal to each other. $(8.0\frac{m}{s})y = (5.0\frac{m}{s})(y + 10s)$ $(8.0\frac{m}{s})y = (5.0\frac{m}{s})y + 50m$ $(3.0\frac{m}{s})y = 50m$ $y = 16.667s$ Find how far you pedaled: $\Delta d = v\Delta t$ $x = (8.0\frac{m}{s})(16.667s) = 133m$ **Ans: 133 m**	$v = 5.0m/s$ $\Delta t = y + 10s$ $\Delta d = x$ $\Delta d = v\Delta t$ $x = (5.0\frac{m}{s})(y + 10s)$

7)	Train 1	Train 2
	$v = 75km/h$ $\Delta t = y$ $\Delta d = x$ $\Delta d = v\Delta t$ $x = (75\frac{km}{h})y$ Substitute "x" from train 1 into "x" from train 2. $450km - (75\frac{km}{h})y = (90\frac{km}{h})y$ $450km = (165\frac{km}{h})y$ $y = 2.727h$ Find the distance from one of the cities: $x = (75\frac{km}{h})y$ $x = (75\frac{km}{h})(2.727h)$ $x = 205km$ **Ans: The trains meet 205 km from city A**	$v = 90km/h$ $\Delta t = y$ $\Delta d = 450km - x$ $\Delta d = v\Delta t$ $450km - x = (90\frac{km}{h})y$

8)	**Cyclist A**	**Cyclist B**
	$v = 8.0 m/s$ $\Delta t = 2400s + 600s = 3000s$ $\Delta d = ?$ $\Delta d = v\Delta t$ $\Delta d = (8.0 m/s)(3000s)$ $\Delta d = 24000m$ The distance between the 2 cities: 24 000 m + 14 400 m = 384000 m =38.4 km **Ans: The cities are 38.4 km apart.** (I know, this wasn't really a catch-up problem…)	$v = 6.0 m/s$ $\Delta t = 2400s$ $\Delta d = ?$ $\Delta d = v\Delta t$ $\Delta d = (6.0 m/s)(2400s)$ $\Delta d = 14400m$