Kinematic Equations

1) $\Delta t = 2\text{hr } 20\text{min}$
$= 2.33\text{ hr}$
$d = 200\text{km}$
$v = \frac{d}{\Delta t}$
$= \frac{200\text{km}}{2.33\text{hr}}$
$= 85.7\text{ km/h}$

2) $\vec{v}_1 = 0\text{m/s [F]}$
$\vec{v}_2 = 5\text{m/s [F]}$
$\vec{d} = 2\text{m [F]}$
$\Delta t = ?$
$\vec{d} = \left(\frac{\vec{v}_1 + \vec{v}_2}{2}\right)\Delta t$
$\Delta t = \frac{2\vec{d}}{\vec{v}_1 + \vec{v}_2}$
$= \frac{2(2\text{m})}{0+5}$
$= 0.8\text{s}$
$\therefore \Delta t = 0.8\text{s}$

3) $\vec{v}_1 = 0\text{m/s [F]}$
$\vec{v}_2 = 8\text{m/s [F]}$
$\vec{d} = 10\text{m [F]}$
$\vec{a} = \frac{\vec{v}_2^2 - \vec{v}_1^2}{2\vec{d}}$
$\vec{a} = \frac{\vec{v}_2^2 - \vec{v}_1^2}{2\vec{d}}$
$= \frac{(8\text{m/s})^2 - (0\text{m/s})^2}{2(10\text{m})}$
$= 3.2\text{m/s}^2\text{ [F]}$
$\therefore \vec{a} = 3.2\text{ m/s}^2\text{ [F]}$

4) $\vec{a} = 3\text{m/s}^2\text{[F]}$
$\Delta t = 5\text{s}$
$\vec{v}_1 = 4\text{m/s [F]}$
$\vec{v}_2 = ?$
$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$
$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$
$= (4\text{m/s}) + (3\text{m/s}^2)(5\text{s})$
$= 19\text{m/s [F]}$
$\therefore \vec{v}_2 = 19\text{m/s [F]}$

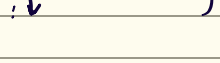
5) $\vec{a} = -8\text{m/s}^2\text{[F]}$
$\vec{v}_1 = 20\text{m/s [F]}$
$\vec{v}_2 = 0\text{m/s [F]}$
$\Delta t = ?$
$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$
$\Delta t = \frac{\vec{v}_2 - \vec{v}_1}{\vec{a}}$
$= \frac{0\text{m/s} - 20\text{m/s}}{-8\text{m/s}^2}$
$= 2.5\text{s}$
$\therefore \Delta t = 2.5\text{s}$

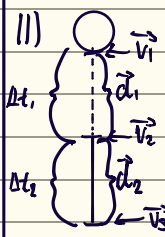
6) $\vec{d} = 2\text{m [down]}$
$\vec{a} = 9.8\text{m/s}^2\text{ [down]}$
$\vec{v}_1 = 0\text{m/s [down]}$
$\vec{v}_2 = ?$
$\vec{d} = \frac{\vec{v}_2^2 - \vec{v}_1^2}{2\vec{a}}$
$\vec{v}_2 = \sqrt{\vec{v}_1^2 + 2\vec{a}\vec{d}}$
$= 6.26\text{m/s [down]}$

7) $\vec{v}_1 = 24\text{m/s [E]}$
$\vec{a} = -5\text{m/s}^2\text{[E]}$
$\Delta t = 3\text{s}$
$\vec{v}_2 = ?$
$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$
$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$
$= 24\text{m/s [E]} + (-5\text{m/s}^2\text{[E]})(3\text{s})$
$= 9\text{m/s [E]}$
$\therefore \vec{v}_2 = 9\text{m/s [E]}$

8) $\vec{v}_1 = 10\text{m/s [down]}$
$\Delta t = 0.2\text{s}$
$\vec{v}_2 = -8\text{m/s [down]}$
$\vec{a} = ?$
$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$
$= \frac{-8\text{m/s} - 10\text{m/s}}{0.2}$
$= -90\text{m/s}^2\text{ [down]}$
$= 90\text{m/s}^2\text{ [up]}$
$\therefore \vec{a} = 90\text{m/s}^2\text{ [up]}$

9) $\vec{v}_1 = 54\text{km/h [F]} = 15\text{m/s [F]}$
$\vec{a} = -7\text{m/s}^2\text{ [F]}$
$\vec{d} = 20\text{m [F]}$ (must be less than this value)
$\vec{v}_2 = 0\text{m/s}$
$\vec{d} = ?$
$\vec{d} = \frac{\vec{v}_2^2 - \vec{v}_1^2}{2\vec{a}}$
$= \frac{(0\text{m/s})^2 - (15\text{m/s})^2}{2(-7\text{m/s}^2)}$
$= 16.07\text{m}$
$\therefore \vec{d} < 20\text{m}$
$\therefore$ the car can stop in time.

10) $\Delta t = 1.5\text{s}$ (half because  counting this point)
$\vec{a} = -9.8\text{m/s}^2\text{ [up]}$
$\vec{v}_2 = 0\text{m/s}$
$\vec{v}_1 = ?$
$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$
$\vec{v}_1 = \vec{v}_2 - \vec{a}\Delta t$
$= (0) - (-9.8\text{m/s}^2)(1.5\text{s})$
$= 14.72\text{ m/s [up]}$
$\therefore \vec{v}_1 = 14.72\text{ m/s [up]}$

11) 

$\vec{a} = 9.81\text{ m/s}^2\text{ [down]}$
$\Delta t_2 = 0.2\text{s}$
$\Delta \vec{d}_2 = 2\text{m [down]}$
$\vec{v}_1 = 0$

$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t_1}$
$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t_1$
$= \vec{a}\Delta t_1$
$\vec{a} = \frac{\vec{v}_3 - \vec{v}_2}{\Delta t_2}$
$\vec{v}_3 = \vec{v}_2 + \vec{a}\Delta t_2$
$= \vec{a}\Delta t_1 + \vec{a}\Delta t_2$
$\vec{d} = \left(\frac{\vec{v}_2 + \vec{v}_3}{2}\right)\Delta t_2$
$= \left(\frac{\vec{a}\Delta t_1 + \vec{a}\Delta t_1 + \vec{a}\Delta t_2}{2}\right)\Delta t_2$
$= \left(\frac{2\vec{a}\Delta t_1 + \vec{a}\Delta t_2}{2}\right)\Delta t_2$
$2\text{m} = \left(\frac{2\vec{a}\Delta t_1 + \vec{a}\Delta t_2}{2}\right)(0.2\text{s})$
$20\text{m/s} = 2\vec{a}\Delta t_1 + \vec{a}\Delta t_2$
$18.038 = 2\vec{a}\Delta t_1$
$\Delta t_1 = 0.92\text{s}$
$\vec{v}_2 = \vec{a}\Delta t_1$
$= (9.81\text{m/s}^2)(0.92\text{s})$
$= 9.0[9\text{m/s [down]}]$
$\vec{d} = \left(\frac{\vec{v}_1 + \vec{v}_2}{2}\right)\Delta t_1$
$= \left(\frac{9.019\text{m/s}}{2}\right)(0.92\text{s})$
$= 4.15\text{m [down]}$
$\therefore \vec{d} = 4.15\text{ m [down]}.$