1.2 - Equations of Motion - Answers

1. Method 1: Find the area underneath the line.

$$LW + \frac{1}{2}bh = (10\,m/s)(10s) + \frac{1}{2}(10s)(10\,m/s) = 150\,m$$

Method 2: Find equation of line & integrate

$$v = t + 10\,m/s \qquad \int_{t=0s}^{t=10s} t + 10\,m/s = \frac{1}{2}t^2 + 10t \Big|_{t=0s}^{t=10s} = \frac{1}{2}(10)^2 + 10(10) = 150m$$

2. $a = ?$
$\Delta d = 10\,km = 10\,000\,m$
$\Delta t = 1800s$
$v_2 = 0\,m/s$

$$\Delta d = v_2 \Delta t - \frac{1}{2}a\Delta t^2 \Rightarrow a = -2\left[\frac{\Delta d - v_2 \Delta t}{\Delta t^2}\right]$$

$$a = -2\left(\frac{(10000m) - (0)(1800s)}{(1800s)^2}\right)$$

$$a = -6.2 \times 10^{-3}\,m/s^2$$

3. $a = -0.200\,m/s^2\,[E]$
$v_1 = 15.0\,m/s\,[E]$
$v_2 = 0$
$\Delta d = ?$

$$v_2^2 = v_1^2 + 2a\Delta d \Rightarrow \Delta d = \frac{v_2^2 - v_1^2}{2a}$$

$$\Delta d = \frac{0 - (15.0\,m/s)^2}{2(-0.200\,m/s^2)}$$

$$\Delta d = 562\,m\,[E]$$

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4. $\Delta d_{c2} = 100 - \Delta d_{c1}$ ① For car 2

$v_{c1} = 0.050\ m/s$

$v_{ic2} = 0\ m/s$

$a_{c2} = 1.0\ m/s^2$

$\Delta t = ?$

$\Delta d_{c2} = v_{ic2}\Delta t + \frac{1}{2}a_{c2}\Delta t^2$ ②

Sub ① into ②

$$100 - d_{c1} = v_{ic2}\Delta t + \tfrac{1}{2}a_{c2}\Delta t^2$$

But $\Delta d_{c1} = v_{c1}\Delta t$

$$\therefore \quad 1.00 - v_{c1}\Delta t = v_{ic2}\Delta t + \tfrac{1}{2}a_{c2}\Delta t^2$$

$$\tfrac{1}{2}a_{c2}\Delta t^2 + v_{ic2}\Delta t + v_{c1}\Delta t - 1.00 = 0$$

$$\tfrac{1}{2}(1.00\ m/s^2)\Delta t^2 + (0)\Delta t + (0.050\ m/s)\Delta t - 1.00\ m = 0$$

$$\Delta t = \frac{-0.050 \pm \sqrt{(0.050)^2 - 4(0.500)(-1.00\ m)}}{2(0.500)}$$

$\Delta t = 1.365\ s$

$= 1.4\ s$

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5. up = +ve
$v_1 = 49.0\ m/s$
$\Delta d = 78.4\ m$
$a = -9.81\ m/s^2$
$\Delta t = ?$

$$\Delta d = v_1 \Delta t + \frac{1}{2} a \Delta t^2$$

$$78.4\ m = (49.0\ m/s)\Delta t + \frac{1}{2}(-9.81\ m/s^2)\Delta t^2$$

$$-4.905\,\Delta t^2 + 49.0\,\Delta t - 78.4 = 0$$

Quadratic formula!

$$\Delta t = \frac{-49.0 \pm \sqrt{(49.0)^2 - 4(-4.905)(-78.4)}}{2(-4.905)}$$

$$\Delta t = 7.99\ s$$

6. down = +ve
$\Delta d = 40.0\ m$
$v_1 = 4.00\ m/s$
$a = 9.81\ m/s^2$
$v_2 = ?$

$$v_2^2 = v_1^2 + 2a\Delta d$$

$$v_2 = \sqrt{(4.00\ m/s)^2 + 2(9.81\ m/s^2)(40.0\ m)}$$

$$v_2 = 28.3\ m/s$$