L05 - Horizontally Accelerated Motion

Kinematics Equations - "What we know"

1. For each of the following sample questions, write down "what we know".
2. Circle the equation you would use to solve this question.
3. **Don't solve the question**... I didn't leave room for that. ☺

Q1: A stationary runner accelerates to 3m/s [E] in only 4 seconds. What is the runner's acceleration?

$a = \frac{v_f - v_i}{t}$ $d = \left(\frac{v_f + v_i}{2}\right)t$ $d = v_i t + \frac{1}{2}at^2$ $v_f^2 = v_i^2 + 2ad$ $d = v_f t - \frac{1}{2}at^2$

$\vec{v}_i = 0 m/s [E]$

$\vec{v}_f = 3 m/s [E]$

$t = 4 s$

$a = ?$

Use $\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$

Q2: A man was jogging at 1.2m/s [E] when a rabid squirrel started to chase him. He accelerated to 2.6m/s [E] in 0.8 seconds. What was his displacement during this time?

$a = \frac{v_f - v_i}{t}$ $d = \left(\frac{v_f + v_i}{2}\right)t$ $d = v_i t + \frac{1}{2}at^2$ $v_f^2 = v_i^2 + 2ad$ $d = v_f t - \frac{1}{2}at^2$

$\vec{v}_i = 1.2 m/s [E]$

$\vec{v}_f = 2.6 m/s [E]$

$t = 0.8 s$

$\Delta \vec{d} = ?$

Q3: A stationary puppy accelerated at 2m/s² [E], reaching a velocity of 3.6m/s [E]. How much distance did it take the puppy to get up to speed?

$a = \frac{v_f - v_i}{t}$ $d = \left(\frac{v_f + v_i}{2}\right)t$ $d = v_i t + \frac{1}{2}at^2$ $v_f^2 = v_i^2 + 2ad$ $d = v_f t - \frac{1}{2}at^2$

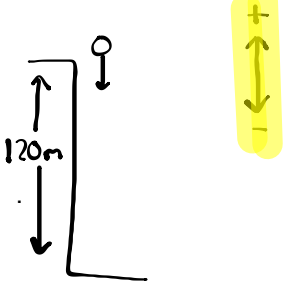
$\vec{v}_i = 0 m/s [E]$ $\Delta \vec{d} = ?$

$\vec{a} = 2 m/s^2 [E]$

$\vec{v}_f = 3.6 m/s [E]$

Q4: A penny is dropped off a building that is 120m high. The acceleration due to gravity is 9.81m/s². How long does it take the penny to reach the ground?

$a = \frac{v_f - v_i}{t}$ $d = \left(\frac{v_f + v_i}{2}\right)t$ $d = v_i t + \frac{1}{2}at^2$ $v_f^2 = v_i^2 + 2ad$ $d = v_f t - \frac{1}{2}at^2$



$\vec{v}_i = 0 m/s [up]$

$\Delta \vec{d} = 120 m [down]$ or $-120 m [up]$

$\vec{a} = 9.81 m/s^2 [d]$ or $-9.81 m/s^2 [up]$

$t = ?$

Unit 1 – Kinematics

$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$ $\quad \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$ $\quad \Delta \vec{d} = \vec{d}_f - \vec{d}_i$

$a = \frac{v_f - v_i}{t}$ $\quad d = \left(\frac{v_f + v_i}{2}\right)t$ $\quad d = v_i t + \frac{1}{2}at^2$ $\quad v_f{}^2 = v_i{}^2 + 2ad$ $\quad d = v_f t - \frac{1}{2}at^2$

Kinematics Equations - Solving for each variable.

$a = \frac{(v_f - v_i)}{t}$

$\cdot t \quad \cdot t$

$at = v_f - v_i$

$5 = \frac{(v_f - 4)}{3}$ BEDMAS ←

$\cdot 3 \quad \cdot 3$

$15 = (v_f - 4)$

$15 = v_f - 4$

$+4 \quad +4$

$\boxed{19 = v_f}$

Practice Questions

Pg 47, Practice Problems #1-2

① $\vec{v}_i = 6\,m/s\ [E]$

$\vec{a} = 4\,m/s^2\ [E]$

$t = ?$

$\vec{v}_f = 36\,m/s\ [E]$

$a = \frac{\Delta v}{\Delta t}$

$4 = \frac{(36-6)}{t}$

$4 = \frac{30}{t}$

$\cdot t \quad \cdot t$

$4t = 30$

$\div 4 \quad \div 4$

$\boxed{t = 7.5\,s}$

---

② $\vec{v}_i = \frac{20\,km}{h}\ [N] \times \frac{1000\,m}{1\,km} \times \frac{1\,h}{3600\,s} = 5.\overline{5}\,m/s\ (N)$

$\vec{a} = 1.5\,m/s^2$

$t = 9.3\,s$

$\vec{v}_f = ?$

$a = \frac{v_f - v_i}{t}$

$1.5 = \frac{v_f - 5.\overline{5}}{9.3}$

$13.95 = v_f - 5.\overline{5}$

$\vec{v}_f = 19.50\overline{5}\,m/s\ (N)$

$= 70.22\,kph$

Unit 1 – Kinematics

$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$ $\quad \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$ $\quad \Delta \vec{d} = \vec{d}_f - \vec{d}_i$

$a = \frac{v_f - v_i}{t}$ $\quad d = \left(\frac{v_f + v_i}{2}\right)t$ $\quad d = v_i t + \frac{1}{2}at^2$ $\quad v_f{}^2 = v_i{}^2 + 2ad$ $\quad d = v_f t - \frac{1}{2}at^2$

Kinematics Equations – Solving for each variable.

$d = \left(\frac{v_f + v_i}{2}\right)t$

$\div t \qquad \div t$

$\frac{d}{t} = \frac{v_f + v_i}{2}$

$\cdot 2 \qquad \cdot 2$

$\frac{2d}{t} = v_f + v_i$

$100 = \left(\frac{v_f + 20}{2}\right)5$

$\div 5 \qquad \div 5$

$20 = \frac{(v_f + 20)}{2}$

$\cdot 2 \qquad \cdot 2$

$40 = v_f + 20$

$-20 \qquad -20$

$\boxed{20 = v_f}$

Practice Questions

Pg 48, Practice Problems #1-2

① $\vec{v}_i = 16\text{m/s [S]}$

$\vec{v}_f = 4\text{m/s [S]}$

$t = 4\text{s}$

$\Delta \vec{d} = ?$

$d = \left(\frac{v_f + v_i}{2}\right)t$

$d = \left(\frac{4 + 16}{2}\right)4$

$= \left(\frac{20}{2}\right)4$

$= (10)4$

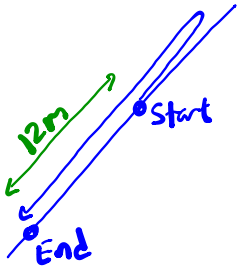
$= 40\text{m [S]}$

$\vec{v}_i = 3\text{m/s [uphill]}$

$t = 4\text{s}$

$\vec{v}_f = -9\text{ m/s [uphill]}$

$d = ?$



$d = \left(\frac{v_f + v_i}{2}\right)t$

$= \left(\frac{-9 + 3}{2}\right)(4)$

$= (-3)(4)$

$= -12\text{m [uphill]}$

$= 12\text{m [downhill]}$

Unit 1 – Kinematics

$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$ $\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$ $\Delta \vec{d} = \vec{d}_f - \vec{d}_i$

$a = \frac{v_f - v_i}{t}$ $d = \left(\frac{v_f + v_i}{2}\right)t$ $d = v_i t + \frac{1}{2}at^2$ $v_f{}^2 = v_i{}^2 + 2ad$ $d = v_f t - \frac{1}{2}at^2$

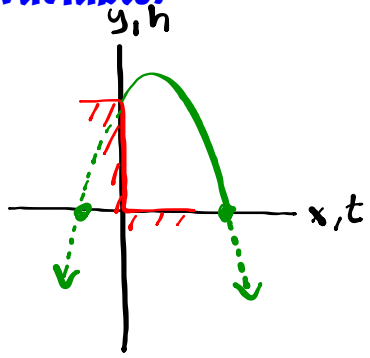
Kinematics Equations - Solving for each variable.

$d = v_i t + \frac{1}{2}at^2$

Quadratic Formula

$ax^2 + bx + c = 0$

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



$0 = 5t + \frac{1}{2}(-9.81)t^2$

$0 = 5t - 4.905t^2$

$\div t \quad \div t \quad \div t$

$0 = 5 - 4.905t$

$-5 = 0t + \frac{1}{2}(-9.81)t^2$

$-5 = -4.905t^2$

Practice Questions

Pg 50, Practice Problems #1-2

① $\vec{v}_i = 3\ m/s\ [downhill]$

$\vec{a} = 4\ m/s^2\ [dh]$

$t = 5s$

$\Delta \vec{d} = ?$

$d = v_i t + \frac{1}{2}at^2$

$d = (3)(5) + \frac{1}{2}(4)(5)^2$

$= 15 + 50$

$= 65m\ [dh]$

---

② $\vec{v}_i = \frac{100km}{h} = 27.\bar{7}\ m/s\ [forward]$

$\vec{a} = -0.8\ m/s^2\ [f]$

$t = 60s$

$\Delta \vec{d} = ?$

$d = v_i t + \frac{1}{2}at^2$

$= (27.\bar{7})(60) + \frac{1}{2}(-0.8)(60)^2$

$= 1666.\bar{6} - 1440$

$= 226.\bar{6}\ m\ [f]$

$= 2.2\bar{6} \times 10^2\ m\ [f]$

$\approx 2.3 \times 10^2\ m\ [f]$

Unit 1 – Kinematics

$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$ $\quad \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$ $\quad \Delta \vec{d} = \vec{d}_f - \vec{d}_i$

$a = \frac{v_f - v_i}{t}$ $\quad d = \left(\frac{v_f + v_i}{2}\right)t$ $\quad d = v_i t + \frac{1}{2}at^2$ $\quad v_f{}^2 = v_i{}^2 + 2ad$ $\quad d = v_f t - \frac{1}{2}at^2$

Kinematics Equations – Solving for each variable.

$v_f{}^2 = v_i{}^2 + 2ad$

$d = \cancel{v_f^{\,0}}\,t - \frac{1}{2}at^2$

$d = -\frac{1}{2}(-2.41379\ldots)(29)^2$

$d = 1015\,m\,[f]$

Practice Questions

Pg 52, Practice Problems #1-2

① $\vec{v}_i = 70\,m/s\,[f]$

$\vec{v}_f = 0\,m/s\,[f]$

$t = 29\,s$

(A) $a = ?$

(B) $d = ?$

(A) $a = \frac{v_f - v_i}{t}$

$a = \frac{0 - 70}{29}$

$\vec{a} = -2.41379\,m/s^2\,[f]$

(B-1) $d = \left(\frac{v_f + v_i}{2}\right)t$

$d = \left(\frac{0 + 70}{2}\right)(29)$

$d = 1015\,m\,[f]$

(B-2) $d = v_i t + \frac{1}{2}at^2$

$= (70)(29) + \frac{1}{2}(-2.41\ldots)(29)^2$

$= 2030 - 1015$

$= 1015\,m\,[f]$

---

② $\vec{v}_i = 50\,kph = 13.\bar{8}\,m/s\,[f]$

$\vec{v}_f = 100\,kph = 27.\bar{7}\,m/s\,[f]$

$\vec{a} = 3.8\,m/s^2\,[f]$

$\vec{d} = ?$

$v_f{}^2 = v_i{}^2 + 2ad$

$(27.\bar{7})^2 = (13.\bar{8})^2 + 2(3.8)d$

$771.605 = 192.901 + 7.6d$

$-192.901 \quad -192.901$

$578.704 = 7.6d$

$\div 7.6 \quad \div 7.6$

$\Delta \vec{d} = 76.145\,m\,[f]$

Unit 1 – Kinematics

$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$ $\quad \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$ $\quad \Delta \vec{d} = \vec{d}_f - \vec{d}_i$

$a = \frac{v_f - v_i}{t}$ $\quad d = \left(\frac{v_f + v_i}{2}\right)t$ $\quad d = v_i t + \frac{1}{2}at^2$ $\quad {v_f}^2 = {v_i}^2 + 2ad$ $\quad d = v_f t - \frac{1}{2}at^2$

Kinematics Equations – Solving for each variable.

$$d = v_f t - \frac{1}{2}at^2$$

Practice Questions

Pg 51, Practice Problems #1-2