1. Let d = trip distance = 4000 miles

t = time of trip + time until next trip (for average, that's pertinent)

$= 1$ week $= 7$ days $= 7 \times 24$

$= 168$ hours

$$\bar{v} = \frac{d}{t} = \frac{4000}{168} = 23.8 \text{ mph (not MKS)}$$

1 mph = how many meters/second?

$\Rightarrow$ Google says 0.447 meters/second

$1 \text{ mile} = 5280 \text{ ft} \simeq 5280 \cdot 30 \text{ cm} \simeq 1.58 \cdot 10^5 \text{ cm}$

$\simeq 1.58 \cdot 10^3 \text{ m}$ ($1.61 \cdot 10^3$ more accurate)

$1 \text{ hour} = 60 \text{ minutes} = 60 \cdot 60 \text{ s} = 3.6 \cdot 10^3 \text{ s}$

$$1 \frac{\text{mile}}{\text{hour}} = \frac{1.61 \cdot 10^3}{3.6 \cdot 10^3} \simeq \frac{1.61}{3.6} = 0.447 \text{ m/s} \checkmark$$

$$\boxed{\bar{v} = 23.8 \text{ mph} = 10.6 \text{ m/s}}$$

speed of airplane not needed for average, which includes all of the physicist's time on the ground.

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2. $x = 9.75 + 1.5t^3$

(a) $t_1 = 2\text{s}$ $\quad t_2 = 3\text{s}$

$x_1 = x(t_1) = 9.75 + 1.5 \cdot 2^3 = 9.75 + 1.5 \cdot 8 =$

$9.75 + 12 = 21.75 \text{ cm}$

$$x_2 = x(t_2) = 9.75 + 1.5\cdot 3^3 = 9.75 + 1.5\cdot 27$$
$$= 9.75 + 40.5 = 50.25 \text{ cm}$$

$$\bar{v} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{50.25 - 21.75}{3 - 2} = 28.5 \ \frac{\text{cm}}{\text{s}}$$

$$\boxed{\bar{v} = 0.285 \ \text{m/s}}$$

(b) $v = \dot{x} = 0 + 3\cdot 1.5\cdot t^2 = 4.5t^2$

$t = 2s$, $\quad v(2s) = 4.5\cdot 2^2 = 4.5\cdot 4$

$$\boxed{v(2s) = 18 \ \text{cm/s} = 0.18 \ \text{m/s}}$$

(c) $\boxed{v(3s) = 4.5\cdot 3^2 = 4.5\cdot 9 = 40.5 \ \text{cm/s} = 0.405 \ \text{m/s}}$

(d) $\boxed{v(2.5s) = 4.5\cdot 2.5^2 = 4.5\cdot 6.25 = 28.125 \ \frac{\text{cm}}{\text{s}} = 0.281 \ \text{m/s}}$

(e) Need to find t_{mid}, where

$$x(t_{mid}) = \frac{1}{2}(x_1 + x_2)$$

$$x(t) = A + Dt^3 \qquad A = 9.75 \text{ cm}$$
$$D = 1.5 \ \text{cm/s}^3$$

so
$$A + Dt_{mid}^3 = \frac{1}{2}(x_1 + x_2)$$
$$Dt_{mid}^3 = \frac{1}{2}(x_1 + x_2) - A$$
$$t_{mid}^3 = \frac{\frac{1}{2}(x_1 + x_2) - A}{D}$$

$$t_{mid} = \left[\frac{\frac{1}{2}(x_1 + x_2) - A}{D}\right]^{1/3} = \left[\frac{\frac{1}{2}(21.75 + 50.25) - 9.75 \text{ cm}}{1.5 \ \frac{\text{cm}}{\text{s}^3}}\right]^{1/3} = 2.60 \text{ s}$$

$$V(t_{mid}) = 3Dt_{mid}^2 = 3 \cdot 1.5 \cdot (2.60)^2$$

$$\boxed{V(t_{mid}) = 30.3 \ \frac{cm}{s} = 0.303 \ m/s}$$

3.

t_1 (s)	t_2 (s)	$t_2 - t_1$ (s)	$\bar{V}$ (m/s)	s (m)
0	2	2	4	8
2	10	8	8	64
10	12	2	6	12
12	16	4	4	16
		16 s		100 m

sum

Total Distance is 100 meters

4. V is linearly decreasing

$$\boxed{a = \frac{V_2 - V_1}{t_2 - t_1} = \frac{4-8}{12-10} = \frac{-4}{2} = -2 \ m/s^2}$$

5. (a) When $V(t) = 0$.

$$x(t) = Bt - Dt^3$$

$B = 9.00 \ cm/s$

$D = 0.75 \ cm/s^3$

$$V(t) = \dot{x}(t) = B - 3Dt_0^2 = 0$$

$$B = 3Dt_0^2$$

$$t_0^2 = \frac{B}{3D}, \quad t_0 = \pm\sqrt{\frac{B}{3D}}$$

but, assume $t > 0$, so

$$\boxed{t_0 = +\sqrt{\frac{B}{3D}}} = \sqrt{\frac{9.00\ \text{cm/s}}{3(0.75\ \text{cm/s}^3)}} = \sqrt{4\ s^2}$$

$$\boxed{t_0 = 2\ s}$$

(b) $x(t_0) = Bt_0 - Dt_0^3$

$$= B\cdot\sqrt{\frac{B}{3D}} - D\left(\sqrt{\frac{B}{3D}}\right)^3 = \sqrt{\frac{B}{3D}}\left(B - \cancel{D}\frac{B}{3\cancel{D}}\right)$$

$$= \frac{2}{3}B\sqrt{\frac{B}{3D}} = \frac{2}{3}Bt_0$$

$$\boxed{x(t_0) = \frac{2}{3}Bt_0}$$

$$= \frac{2}{\cancel{3}}\cdot\left(\cancel{9}^{\,3}\frac{\text{cm}}{s}\right)\cdot 2s$$

$$\boxed{x(t_0) = 12\ \text{cm} = 0.12\ \text{m}}$$

(c) $a(t_0) = \dot{v}(t_0) = \ddot{x}(t_0) = \boxed{-6Dt_0}$

$$= -6\cdot 0.75\left(\frac{\text{cm}}{s^3}\right)(2\ s)$$

$$\boxed{a(t_0) = -9\ \frac{\text{cm}}{s^2} = -0.09\ \text{m/s}^2}$$

(d) for $0 < t < 12s$, $v(t) = B - 3Dt^2 > 0$

$t = t_0 = 12s \quad v(t_0) = 0$

$12s < t$ the $-3Dt^2$ takes over,

$\boxed{\text{so } v(t) < 0, \text{ and spot moves toward left}}$

(e) When $x(t) = Bt - Dt^3 = 0 = t(B - Dt^2) = 0$

$t = 0$ or $B - Dt^2 = 0 \Rightarrow \boxed{t = +\sqrt{\frac{B}{D}} = \sqrt{\frac{9.00\ \text{cm/s}}{0.75\ \text{cm/s}^3}} = \sqrt{12 s^2} = 2\sqrt{3}\,s}$

TOPS.

6. (a) $v = v_0 + at \qquad v_0 = 0$

$$v = at = c \times \frac{1}{10}$$

* correction

$$t = \frac{c}{a \cdot 10} = \frac{3.0 \cdot 10^8\ m/s}{9.8 \cdot 10\ m/s^2} s = 3.06 \cdot 10^6\ s$$

$$= 0.097 \text{ years} = 35.43 \text{ days}$$

(b) $x = \cancel{x_0} + \cancel{v_0 t} + \frac{1}{2}at^2$

0 0

$$x = \frac{1}{2}at^2 = \frac{1}{2} \cdot 9.8\ \frac{m}{s^2} \cdot (3.06 \cdot 10^6\ s)^2$$

$$= 4.59 \cdot 10^{13}\ m = 0.049 \text{ light-years}$$

7. In this case, easiest to use

$$v^2 = v_0^2 + 2a(x - x_0)$$

final velocity $v = 0$

unknown initial velocity

$a = 32\ \frac{ft}{s^2} = 9.8\ \frac{m}{s^2}$

$x - x_0 = 19.2\ ft = 5.85\ m$

$$v_0 = \sqrt{2a(x-x_0)} = \sqrt{2 \cdot 9.8 \cdot 5.85}$$

$$v_0 = 10.7\ m/s = 23.9\ mph < 30\ mph$$

NOT SPEEDING