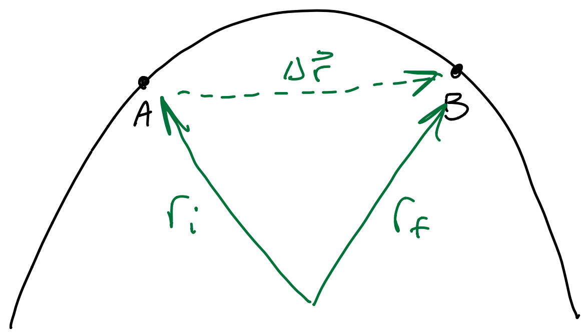
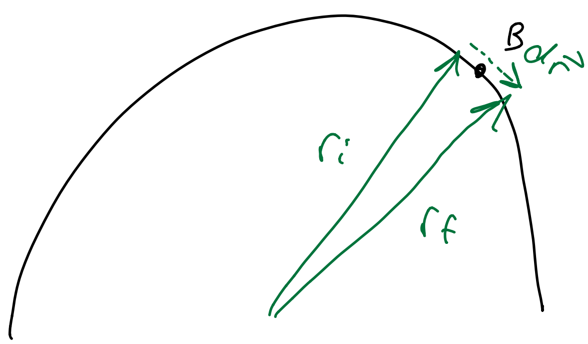
1.

a)



$\vec{v}_{avg} = \frac{\Delta \vec{r}}{\Delta t}$, arrow a is best

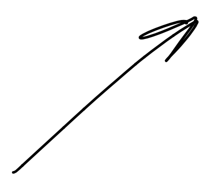
b)



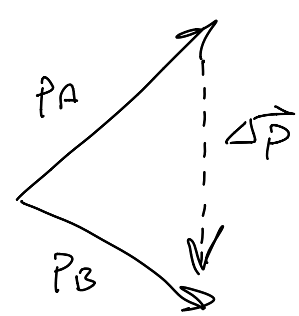
h is best

c) b is best

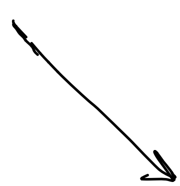
d) $\vec{p}_A$:



$\vec{p}_B - \vec{p}_A$ =



$\vec{p}_B$:



g is best

e) $\vec{p}$ is changing, so yes

2. a) 1, 2, 5

b) 1, 2, 3, 4, 5

c) 1, 4, 5, 6, 7, 8

d) 1, 2, 5

3. $\Delta \vec{p} = \vec{F}_{net} \Delta t$

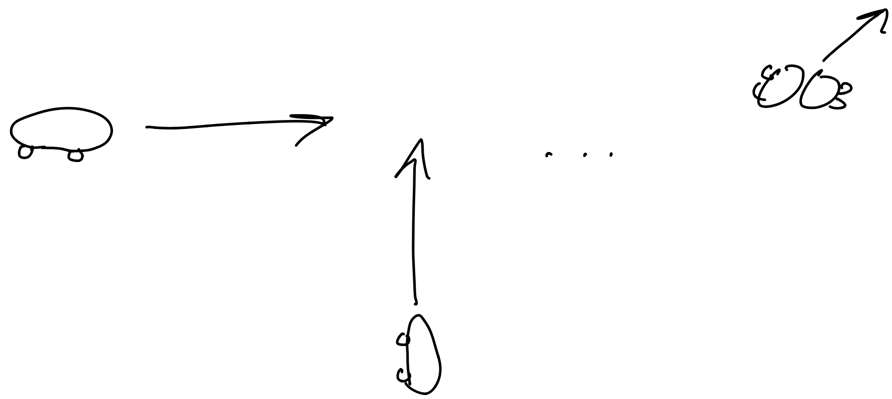
$= (2\times10^{7} N)(30 s)$

$\Delta p = 6\times10^{8} N\cdot s$

$v = \dfrac{6\times10^{8} N\cdot s}{1.5\times10^{6} kg} = 400 \frac{m}{s}$

$\boxed{v = 400 \frac{m}{s}}$

4.



a)

system: both cars

surr: None

$$\Delta \vec{p}_{sys} + \Delta \vec{p}_{surr} = \vec{0}$$

$$\Delta \vec{p}_{sys} = \vec{0}$$

$$\vec{p}_i = m_1 \langle 20, 0 \rangle + m_2 \langle 0, 18 \rangle$$ pi=<22000, 27,000>

$$\vec{p}_f = (m_1 + m_2)\vec{v}_f$$

$$\vec{p}_f - \vec{p}_i = 0$$

$$\vec{p}_f = \vec{p}_i$$

$$\vec{v}_f = \frac{m_1}{m_1+m_2}\langle 20, 0 \rangle + \frac{m_2}{m_1+m_2}\langle 0, 18 \rangle$$

$$= \langle 8.46, 0, 0 \rangle \frac{m}{s} + \langle 0, 10.38, 0 \rangle \frac{m}{s}$$

$$\vec{v}_f = \langle 8.46, 10.38 \rangle \frac{m}{s}$$

b) $\hat{v} = \frac{1}{|\vec{v}_f|} \vec{v}_f$

$= \frac{1}{13.39} \langle 8.46, 10.38 \rangle$

$\hat{v} = \langle 0.63, 0.78 \rangle$

$\hat{v} = \langle \cos\theta_x, \cos\theta_y \rangle$

$\cos\theta_x = 0.63$

$\boxed{\theta_x = 50.95°}$

5.

$\vec{p}_f = \vec{p}_i + \vec{F}\Delta t$

$\vec{p}_i = \langle 0.6kg \cdot 3.5 m/s, 0, 0 \rangle$

$\vec{p}_i = \langle 2.1, 0, 0 \rangle \frac{kg\,m}{s}$

$\vec{F} = \langle 0, 0, -F_z \rangle$

$\vec{p}_f = \langle 2.1, 0, -F_z\Delta t \rangle$

$p_i = 2.1$

$$\hat{p}_f = \frac{1}{\sqrt{p_i^2 + F_z^2 \Delta t^2}} \langle p_i, 0, -F_z \Delta t \rangle$$

$$\cos\theta_x = \cos(24°) = \frac{p_i}{\sqrt{p_i^2 + F_z^2 \Delta t^2}}$$

$$\left(\sqrt{p_i^2 + F_z^2 \Delta t^2}\right) \cos\theta = p_i$$

$$p_i^2 + F_z^2 \Delta t^2 = \frac{p_i^2}{\cos^2\theta}$$

$$F_z^2 \Delta t^2 = p_i^2 \left(\frac{1}{\cos^2\theta} - 1\right)$$

$$F_z = \sqrt{\frac{p_i^2}{\Delta t^2}\left(\frac{1}{\cos^2\theta} - 1\right)}$$

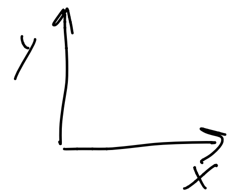
467 N

$$F_z = \cancel{322}\ N$$

-467 N

$$\vec{F}_z = \langle 0, 0, -\cancel{322} \rangle\ N$$

6. $\Delta\vec{p} = \vec{F}\Delta t$



$p_x = p_i - (50N)(2s)$

$p_x = -100 \ Ns$

$V = \dfrac{-100}{(54+10)} = -1.56$

$\vec{V} = \langle -1.56, 0, 0 \rangle$

b) sys = astro + extinguisher
surr = None

$\Delta\vec{p}_{sys} = \vec{0}$

$\vec{p}_i = \langle -100, 0, 0 \rangle \ \frac{kg\ m}{s}$

$\vec{p}_f = \vec{p}_{ext} + \vec{p}_{ast}$

$= 10\,kg \langle -15, 0, 0 \rangle + \vec{p}_{ast}$

$\Delta p = 0 \implies p_f = p_i$

$-100 \ kg\frac{m}{s} = -150 \ \frac{kg\ m}{s} + \vec{p}_{ast}$

$p_{ast} = 50 \frac{kg\,m}{s}$

$v = \frac{50}{54} \frac{kg\,m/s}{kg} = 0.93 \frac{m}{s}$

$v = 0.93\ m/s$, toward the ship

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7. What is $|\vec{v}_i|$ on Earth?

$x(t) = x_i + v_i \cos\theta\, t$

$y(t) = y_i + v_i \sin\theta\, t - \frac{1}{2} g t^2$

$x_i = y_i = 0$

$\Delta x = 200\ m = v_i \cos\theta\, t$

find t

$y(t) = 0 = v_i \sin\theta\, t - \frac{1}{2} g t^2$

$t \left(v_i \sin\theta - \frac{1}{2} g t \right) = 0$

$t \neq 0$

$v_i \sin\theta - \frac{1}{2} g t = 0$

$\frac{2}{g} v_i \sin\theta = t$

$$\Delta x = v_i \cos\theta \, t$$

$$= v_i \cos\theta \left(\frac{2}{g} v_i \sin\theta\right) = \Delta x$$

$$\frac{2 v_i^2}{g} \cos\theta \sin\theta = \Delta x$$

$$v_i^2 = \frac{g}{2} \frac{\Delta x}{\cos\theta \sin\theta}$$

$$= \left(\frac{9.8}{2}\right) \frac{200}{0.433}$$

$$v_i = 47.6 \ \frac{m}{s}$$

Next, what is g_{mars}?

$$g_m = \frac{G M_{mars}}{R_{mars}^2}$$

$$= \frac{(6.7 \times 10^{-11})(7.3 \times 10^{22})}{(1740 \times 10^3)^2}$$

$$g_m = 1.6 \ \frac{N}{kg}$$

on mars:

$$\frac{2}{g} v_i \sin\theta = t$$

$$\left(\frac{2}{1.6}\right)(47.6)\left(\frac{1}{2}\right) = 29.45 \text{ s}$$

$$\Delta x = v_i \cos\theta \, t$$

$$= (47.6)(0.866)(29.54)$$

$$\boxed{\Delta x = 1217.7 \text{ m}}$$

Bad rounding: 1214.5 m is better