

Midterm 1

2 Estimations and Unit Analysis

1. 1.5 s later, 0.5 km away

$$a. \frac{0.5 \text{ km}}{1.5 \text{ s}} \cdot \frac{1000 \text{ m}}{\text{km}} = \frac{500 \text{ m}}{1.5 \text{ s}} = \boxed{333.33 \frac{\text{m}}{\text{s}}}$$

$$b. \frac{0.5 \text{ km}}{1.5 \text{ s}} \cdot \frac{3600 \text{ s}}{\text{hr}} = \frac{1800 \text{ km}}{1.5 \text{ hr}} = \boxed{1200 \frac{\text{km}}{\text{hr}}}$$

2.

$$a. 0.25 \frac{\text{m}^3}{\text{m}} \cdot \left(\frac{100 \text{ cm}}{\text{m}} \right)^3 = \boxed{250,000 \frac{\text{cm}^3}{\text{m}}}$$

$$b. 100 \frac{\text{km}}{\text{hr}} \cdot \frac{1000 \text{ m}}{\text{km}} \cdot \frac{\text{hr}}{3600 \text{ s}} = \boxed{27.77 \frac{\text{m}}{\text{s}}}$$

$$c. 2 \frac{\text{kg} \cdot \text{m}}{\text{s}^2} \cdot \frac{\text{g}}{1000 \text{ kg}} \cdot \frac{100 \text{ cm}}{\text{m}} \cdot \left(\frac{\text{s}}{1000 \text{ ms}} \right)^2 = \boxed{2 \times 10^{-7} \frac{\text{g} \cdot \text{cm}}{\text{ms}^2}}$$

3 Vectors

1. 10 m, 15° x-axis

$$a = 10 \cos 15 = 9.659 \uparrow \rightarrow \boxed{x = 9.659 \uparrow + 2.588 \uparrow} \text{ m}$$

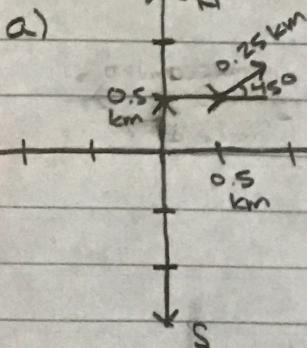
$$b = 10 \sin 15 = 2.588 \uparrow$$

2. 20 m, 135° x-axis

$$a = 20 \cos 135 = -14.142 \uparrow \rightarrow \boxed{x = -14.142 \uparrow + 14.142 \uparrow} \text{ m}$$

$$b = 20 \sin 135 = 14.142 \uparrow$$

2. 0.5 km N, 0.5 km E, 0.25 km 45° NE



$$c) 0.676^2 + 0.676^2 = c^2$$

$$\begin{aligned} c &= \sqrt{0.676^2 + 0.676^2} \\ &= 0.956 \text{ km} \end{aligned}$$

$$b) 0.25 \text{ km}, 45^\circ \text{ x-axis} \rightarrow 0.5 + 0.176 = 0.676$$

$$a = 0.25 \cos 45 = 0.176 \uparrow$$

$$b = 0.25 \sin 45 = 0.176 \uparrow$$

$$\boxed{x_f = 0.676 \uparrow + 0.176 \uparrow} \text{ km}$$

4 Motion Along a Straight Line

$$1. x(t) = -1.0 - 4.0t \text{ m}$$

$$\text{a. } x(-2) = -1 - 4(-2) = 7 \text{ m}$$

$$x(2) = -1 - 4(2) = -9 \text{ m}$$

$$x(2) - x(-2) \rightarrow -9 - (7) = \boxed{-16 \text{ m}}$$

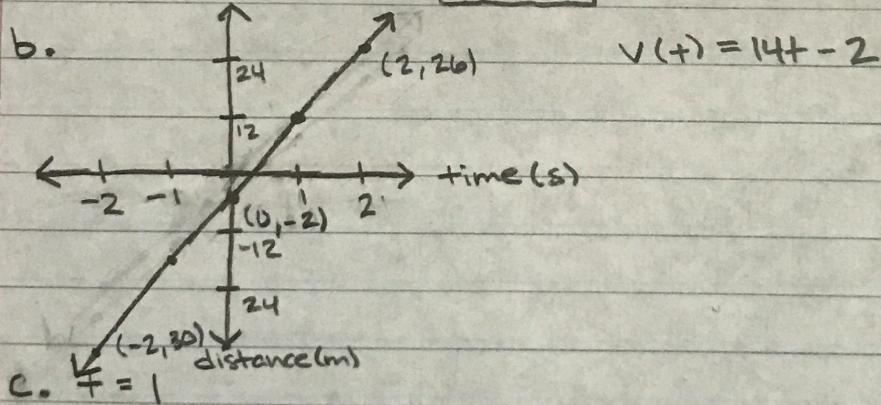
$$\text{b. } \frac{-16 \text{ m}}{2 - (-2) \text{ s}} = \frac{-16 \text{ m}}{4 \text{ s}} = \boxed{-4 \frac{\text{m}}{\text{s}}}$$

$$2. x(t) = -2t + 7t^2$$

$$\text{a. } x(0) = -2(0) + 7(0)^2 = 0$$

$$x(2) = -2(2) + 7(2)^2 = -4 + 28 = 24$$

$$v = \frac{24 - 0}{2 - 0} = \frac{24}{2} = \boxed{12 \frac{\text{m}}{\text{s}}}$$



$$v(t) = \frac{d}{dt} x(t) = \frac{d}{dt} (-2t + 7t^2) = -2 + 2(7)t = 14t - 2$$

$$v(1) = 14(1) - 2 = 14 - 2 = \boxed{12 \frac{\text{m}}{\text{s}}}$$

$$\text{d. } a(t) = \frac{d}{dt} v(t) = \frac{d}{dt} (14t - 2) = 14$$

$$a(1) = \boxed{14 \frac{\text{m}}{\text{s}}}$$

3. 5.0 m/s^2 , starts at rest $v_i = 0 \text{ m/s}$

a. $v(t) = v_i + a(t)$

$$10 \frac{\text{m}}{\text{s}} = 0 + 5 \frac{\text{m}}{\text{s}^2} (t) \rightarrow t = \frac{10}{5} = 2 \text{ s}$$

b. $x(t) = x_i + v(t)t$

$$x(2) = 0 + 10 \frac{\text{m}}{\text{s}} (2 \text{ s}) = 20 \text{ m}$$

c. 100 m sprint, continues 10 m/s

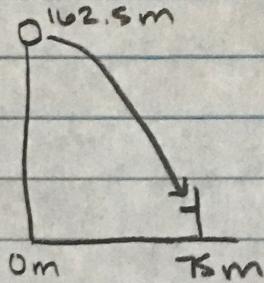
$$100 - 20 = 80 \text{ m} = 8 \text{ s} + 2 \text{ s} = 10 \text{ s}$$

10 m/s

5 Motion in Two and Three Dimensions

1. 162.5 m above, 75 m horizontal

a.



b. $a = 9.81 \text{ m/s}^2$

$$v^2 = v_i^2 + 2a\Delta x = 0 + 2(9.81)(75) \rightarrow v^2 = 1471.5$$

$$\rightarrow v = 38.36 \text{ m/s}$$

2. 45° x-axis, 40 m/s

$$a. R = \frac{V_0^2 \sin(2\theta)}{g} = \frac{(40)^2 \sin(2 \cdot 45)}{9.81} = 163.098 \text{ m}$$

$$b. T_{\text{tot}} = \frac{2V_0 \sin(\theta_0)}{g} = \frac{2(40) \sin(45)}{9.81} = 5.766 \text{ s}$$

6 Forces

1.

$$F_1 \rightarrow x = 10 \cos 45 = 7.07 \text{ N}, y = 10 \sin 45 = 7.07 \text{ N}$$

$$F_2 \rightarrow x = 8 \cos 30 = 6.92 \text{ N}, y = 8 \sin 30 = -4 \text{ N}$$

$$R \rightarrow x = 13.99 \text{ N}, y = 3.07 \text{ N}$$

$$R = \sqrt{13.99^2 + 3.07^2} = 14.32 \text{ N}$$

$$\tan \theta = \frac{3.07}{13.99} \rightarrow \theta = 12.37^\circ$$

$$F_{\text{net}} = ma = 14.32 - 7.5 = 49(a)$$

$$\rightarrow 6.82 = 49(a)$$

$$\rightarrow a = 0.139 \frac{\text{m}}{\text{s}^2}$$