Score: 21.5/25. Great job!

Jayden Del Mar

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

b. $100\ \frac{\text{km}}{\text{hr}} \cdot \frac{1000\ \text{m}}{\text{km}} \cdot \frac{\text{hr}}{3600\ \text{s}} = \boxed{27.77\ \frac{\text{m}}{\text{s}}}$ (-1)

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

$a = 10 \cos 15 = 9.659\hat{i}$ → $\boxed{x = 9.659\hat{i} + 2.588\hat{j}}$ m

$b = 10 \sin 15 = 2.588\hat{j}$

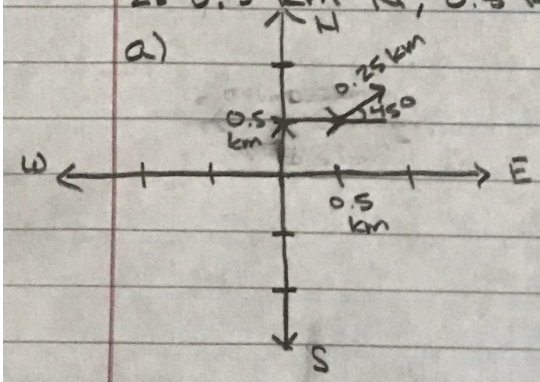
2. 20 m, 135° x-axis

$a = 20 \cos 135 = -14.142\hat{i}$ → $\boxed{x = -14.142\hat{i} + 14.142\hat{j}}$ m

$b = 20 \sin 135 = 14.142\hat{j}$

2. 0.5 km N, 0.5 km E, 0.25 km 45° NE

a)



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

$c = \sqrt{0.676^2 + 0.676^2}$

$\boxed{= 0.956\ \text{km}}$

b) 0.25 km, 45° x-axis → 0.5 + 0.176 = 0.676

$a = 0.25 \cos 45 = 0.176\hat{i}$

$b = 0.25 \sin 45 = 0.176\hat{j}$

$\boxed{x_f = 0.676\hat{i} + 0.676\hat{j}}$ km

4 Motion Along a Straight Line

1. $x(t) = -1.0 - 4.0t$ m

a. $x(-2) = -1 - 4(-2) = 7$ m

$x(2) = -1 - 4(2) = -9$ m

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

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

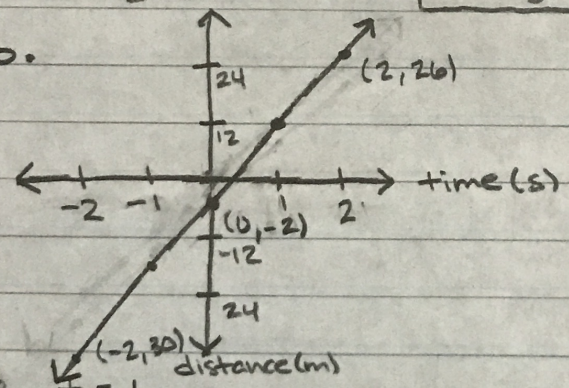
2. $x(t) = -2t + 7t^2$

a. $x(0) = -2(0) + 7(0)^2 = 0$

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

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

b.



$v(t) = 14t - 2$

Well done!

c. $t = 1$

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

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

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

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

(-0.5) the units are m/s^2

3. $5.0\ m/s^2$, starts at rest $V_i = 0\ m/s$

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

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

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

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

(-1) The sprinter is accelerating in this phase, so the kinematic equation does not apply to this situation.

c. 100 m sprint, continues 10 m/s

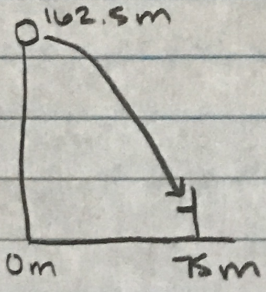
$100 - 20 = \frac{80\ m}{10\ m/s} = 8\ s + 2s = \boxed{10\ s}$

(This would have been right given part (b))

5 Motion in Two and Three Dimensions

1. 162.5 m above, 75 m horizontal

a.



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

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

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

(-1) Remember that velocity in the horizontal direction is constant, not accelerating. Only the vertical component of velocity is changing

2. 45° x-axis, 40 m/s

a. $R = \frac{V_0^2 \sin(2\theta_0)}{g} = \frac{(40)^2 \sin(2(45))}{9.81} = \boxed{163.098 \text{ m}}$

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

6 Forces

1.

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

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

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

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

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

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

$\rightarrow 6.82 = 49(a)$

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

Well done!