PHYS 2311 Ch. 3 HW

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Problem 1.

$$\Delta\vec{r} = \vec{r}_f - \vec{r}_i$$

$$\vec{v}_1 = -245\hat{i} + 0\hat{j}$$

$$\vec{v}_2 = 118\cos 225\hat{i} + 118\cos 225\hat{j}$$

$$\vec{v}_2 = -83.4\hat{i} - 83.4\hat{j}$$

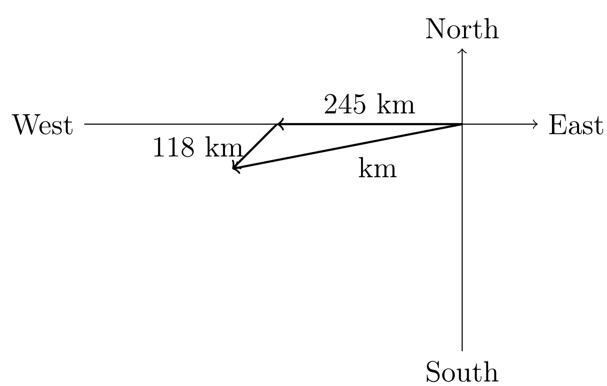
$$\vec{v}_1 + \vec{v}_2 = (v_{1x} + v_{2x})\hat{i} + (v_{1y} + v_{2y})\hat{j}$$

$$\vec{v}_1 + \vec{v}_2 = (-245 - 83.4)\hat{i} + (0 - 83.4)\hat{j} = -328\hat{i} - 83.4\hat{j}$$

$$|\vec{R}| = \sqrt{(-328)^2 + (-83.4)^2} = \boxed{339\,\text{km}}$$

$$\theta = \arctan\left(\frac{A_y}{A_x}\right)$$

$$\theta = \arctan\left(\frac{-328}{-83.4}\right) = \boxed{14.3^\circ \text{ south of west}}$$



Problem 3.

$$|\vec{R}| = \sqrt{(9.40)^2 + (-6.80)^2} = \boxed{11.6\,\text{units}}$$

$$\theta = \arctan\left(\frac{-6.80}{9.40}\right) = \boxed{-35.9^\circ}$$

Problem 6.

(a)

$$\vec{v}_1 = 6.2\hat{\imath} + 0\hat{\jmath}$$
$$\vec{v}_2 = 8.1\cos 55\hat{\imath} + 8.1\sin 55\hat{\jmath}$$
$$\vec{v}_2 = 4.646\hat{\imath} + 6.635\hat{\jmath}$$

(b)

$$\vec{v}_1 + \vec{v}_2 = (v_{1x} + v_{2x})\hat{\imath} + (v_{1y} + v_{2y})\hat{\jmath}$$
$$(6.2 + 4.646)\hat{\imath} + (0 + 6.635)\hat{\jmath} = 10.85\hat{\imath} + 6.64\hat{\jmath}$$
$$\vec{R} = 10.85\hat{\imath} + 6.64\hat{\jmath}$$
$$R = |\vec{R}| = \sqrt{10.85^2 + 6.64^2} = \boxed{12.72\,\text{units}}$$
$$\theta = \arctan\left(\frac{6.64}{10.85}\right) = \boxed{31.48^\circ}$$

Problem 7.

(a)

$$\vec{C} = \vec{A} + \vec{B}$$
$$\vec{C} = 6.8\hat{\imath} - 5.5\hat{\imath}$$
$$\vec{C} = 1.3\hat{\imath} \text{ units in } +\text{x direction}$$

(b)

$$\vec{C} = \vec{A} - \vec{B}$$
$$\vec{C} = 6.8\hat{\imath} - (-5.5\hat{\imath})$$
$$\vec{C} = 12.3\hat{\imath} \text{ units in } +\text{x direction}$$

(c)

$$\vec{C} = \vec{B} - \vec{A}$$
$$\vec{C} = -5.5\hat{\imath} - 6.8\hat{\imath}$$
$$\vec{C} = -12.3\hat{\imath} \text{ units in -x direction}$$

Problem 10.

(a)

$$\vec{A} = 42.0 \cos 28\hat{\imath} + 42.0 \sin 28.0\hat{\jmath}.$$

$$\vec{A} = 37.1\hat{\imath} + 19.7\hat{\jmath}.$$

$$\vec{B} = -29.7 \cos 56.0\hat{\imath} + 29.7 \sin 56.0\hat{\jmath}.$$

$$\vec{B} = -16.6\hat{\imath} + 24.6\hat{\jmath}.$$

$$\vec{C} = 31.0 \cos 90 - 31.0 \sin 90.$$

$$\vec{C} = 0\hat{\imath} - 31.0\hat{\jmath}.$$

$$\vec{A} + \vec{B} + \vec{C}.$$

$$(\vec{A}_x + \vec{B}_x + \vec{C}_x)\hat{\imath} + (\vec{A}_y + \vec{B}_y + \vec{C}_y)\hat{\jmath}.$$

$$(37.1 - 16.6 + 0)\hat{\imath} + (19.7 + 24.6 - 31.0)\hat{\jmath}.$$

$$\boxed{20.5\hat{\imath} + 13.3\hat{\jmath}}.$$

(b)

$$|\vec{R}| = \sqrt{(20.5)^2 + (13.3)^2} = \boxed{24.4\,\text{units}}.$$

$$\theta = \arctan(\frac{13.3}{20.5}) = \boxed{33.0^\circ}.$$

Problem 11.

(a)

$$\vec{B} - \vec{A}.$$

$$(-16.6 - 37.1)\hat{\imath} + (24.6 - 19.7)\hat{\jmath}.$$

$$-53.7\hat{\imath} + 4.9\hat{\jmath}.$$

$$|\vec{R}| = \sqrt{(-53.7)^2 + (4.9)^2} = \boxed{53.9\,\text{units}}.$$

$$\theta = \arctan\left(\frac{4.9}{-53.9}\right) = 180 - 5.2 = \boxed{174.8^\circ}.$$

(b)

$$\vec{A} - \vec{B}.$$

$$(37.1 - (-16.6))\hat{\imath} + (19.7 - 24.6)\hat{\jmath}.$$

$$53.7\hat{\imath} - 4.9\hat{\jmath}.$$

$$|\vec{R}| = \sqrt{(53.7)^2 + (-4.9)^2} = \boxed{53.9\,\text{units}}.$$

$$\theta = \arctan\left(\frac{-4.9}{53.9}\right) = 360 - 5.2 = \boxed{354.8^\circ}.$$

(c) They are the opposites of each other, exactly 180° apart.

Problem 19.

$$\vec{r} = (9.60t\hat{i} + 6.45\hat{j} - 1.50t^2\hat{k}).$$

$$\vec{v} = \left(\frac{\mathrm{d}}{\mathrm{dt}}(9.60t)\hat{i} + \frac{\mathrm{d}}{\mathrm{dt}}(6.45)\hat{j} - \frac{\mathrm{d}}{\mathrm{dt}}(1.50t^2)\hat{k}\right).$$

$$\vec{v} = \boxed{(9.60\hat{i} + 0\hat{j} - 3t\hat{k})\mathrm{m/s}}.$$

$$\vec{a} = \left(\frac{\mathrm{d}}{\mathrm{dt}}(9.60)\hat{i} + 0\hat{j} - \frac{\mathrm{d}}{\mathrm{dt}}(3t)\hat{k}\right).$$

$$\vec{a} = \boxed{(0\hat{i} + 0\hat{j} - 3\hat{k})\mathrm{m/s^2}}.$$

Problem 20.

$$\Delta\vec{r} = \vec{r}_f - \vec{r}_i.$$

$$= (9.60(3.00)\hat{i} + 6.45\hat{j} - 1.50(3.00)^2\hat{k}) - (9.60\hat{i} + 6.45\hat{j} - 1.50\hat{k}).$$

$$= (28.8\hat{i} + 6.45\hat{j} - 13.5\hat{k}) - (9.60\hat{i} + 6.45\hat{j} - 1.50\hat{k}).$$

$$= (19.2\hat{i} - 12.0\hat{k}).$$

$$|\vec{R}| = \sqrt{(19.2)^2 + (-12.0)^2} = 22.6\,\mathrm{m}.$$

$$\vec{v}_{avg} = \frac{\Delta\vec{r}}{\Delta t} = \frac{22.6}{3.00 - 1.00} = \boxed{11.3\,\mathrm{m/s}}.$$

$$\vec{v}_{inst} = (9.60\hat{i} - 3t\hat{k}).$$

$$= (9.60\hat{i} - 3(2.00)\hat{k}).$$

$$= 9.60\hat{i} - 6\hat{k}.$$

$$\sqrt{(9.60)^2 + (-6)^2} = \boxed{11.3\,\mathrm{m/s}}.$$

Problem 23.

(a)

$$\vec{a} = 1.80\cos 330\hat{i} + 1.80\sin 330\hat{j}.$$

$$= 1.56\hat{i} - 0.90\hat{j}.$$

$$\boxed{-0.90\,\mathrm{m/s^2}\hat{\mathrm{j}}}.$$

(b)

$$\vec{r}_f = \vec{r}_i + \vec{v}_i t + \frac{1}{2}\vec{a}t^2.$$

$$0 = 125 + \frac{1}{2}(-0.90)t^2.$$

$$-125 = -0.45t^2.$$

$$\sqrt{\frac{-125}{-0.45}} = t = \boxed{16.7\,\mathrm{s}}.$$

Problem 24.

$$S_{avg} = \frac{11.5}{5.5} = \boxed{2.09\,\mathrm{km/h}}$$

$$\vec{A} = 8.0\hat{\imath} + 0.85\hat{\jmath}.$$

$$A = \sqrt{(8.0)^2 + (0.85)^2} = 8.05km = \Delta r.$$

$$v_{avg} = \frac{\Delta r}{\Delta t} = \frac{8.05}{5.5} = \boxed{1.46\,\mathrm{km/h}}.$$

$$\theta = \arctan\left(\frac{0.85}{8.0}\right) = \boxed{6.06^\circ}.$$

Problem 32.

$$x(t) = x_i + v_i t.$$

$$x(t) = 3.0t.$$

$$y(t) = y_i + v_i t - \frac{g}{2}t^2.$$

$$y(t) = 7.5 - \frac{g}{2}t^2 = 0.$$

$$\sqrt{\frac{7.5}{\frac{g}{2}}} = t = 1.24\,\mathrm{s}.$$

$$x(1.24) = 3.0(1.24) = \boxed{3.71\,\mathrm{m}}.$$

Problem 33.

$$y_f = y_i + v_i t - \frac{g}{2}t^2.$$

$$0 = y_i - \frac{g}{2}(3.5)^2.$$

$$y_i = \frac{g}{2}(3.5)^2 = \boxed{60\,\text{m}}.$$

$$x_f = x_i + v_i t.$$

$$x_f = (2.5)(3.5) = \boxed{8.8\,\text{m}}.$$

Problem 37.

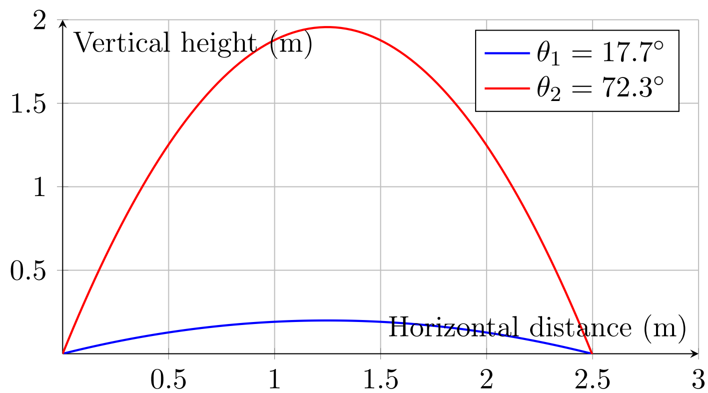
$$R = \frac{v_i^2 \sin(2\theta)}{g}.$$

$$2.5 = \frac{(6.5)^2 \sin(2\theta)}{9.80}.$$

$$\theta = \frac{35.4}{2} = \boxed{17.7^\circ}.$$

$$90 - 17.7 = \boxed{72.3^\circ}.$$

There is a flat angle and a steep angle from which the water hose can spray at and reach the same place. Algebraically, the arcsin function will usually give two answers.



Problem 38.

$$t_{up} = 1.7s, t_{down} = 1.7s.$$

$$v_f = v_i - g t_{up}.$$

$$0 = v_i - (9.80)(1.7).$$

$$v_i = 16.7\,\text{m/s}.$$

$$R_{max} = \frac{v_i^2 \sin(2(45))}{g}.$$

$$R_{max} = \frac{(16.7)^2 \sin(2(45))}{9.80} = \boxed{28.5\,\text{m}}.$$

Problem 39.

(a)

$$\vec{v}_{iy} = v_i \sin\theta = 38.8 \sin(42.2) = 26.06\,\mathrm{m/s}.$$

$$v_f^2 = v_i^2 + 2g(y_f - y_i).$$

$$y_f = \frac{v_i^2}{2g} = \frac{(26.06)^2}{2(9.80)} = \boxed{34.7\,\mathrm{m}}.$$

(b)

$$v_f = v_i + gt_{up}.$$

$$t_{up} = \frac{v_f - v_i}{g}.$$

$$t = 2t_{up} = \frac{2(v_f - v_i)}{g} = \frac{2(v_i)}{g} = \frac{2(26.06)}{9.80} = \boxed{5.32\,\mathrm{s}}.$$

(c)

$$v_{ix} = v_i \cos\theta = 38.8 \cos 42.2 = 28.74\,\mathrm{m/s}.$$

$$R = v_{ix}t.$$

$$R = (28.74)(5.32) = \boxed{152.9\,\mathrm{m}}$$

(d)

$$t = 1.50\,\mathrm{s}.$$

$$v_y = v_{iy} - gt.$$

$$v_y = (26.06) - (9.80)(1.50) = 11.36\,\mathrm{m/s}.$$

$$v_x = v_{0x}.$$

$$v = \sqrt{v_x^2 + v_y^2}.$$

$$v = \sqrt{(28.74)^2 + (11.36)^2} = \boxed{30.91\,\mathrm{m/s}}.$$