Given the following forces. (1)

$\vec{A} = 2.45\ N \angle 30^\circ$

$\vec{B} = 4.91\ N \angle 120^\circ$

$\vec{C} = 0.981\ N \angle 135^\circ$

Find:

Part I

$\vec{R} = \vec{A} + \vec{B} + \vec{C}$ graphically.

Part II

$\vec{R} = \vec{A} + \vec{B} + \vec{C}$ mathematically (components)

Part III

Calculate the percent difference.

Part IV

Find Vector $\vec{E}$

such that

$\vec{A} + \vec{B} + \vec{C} + \vec{E} = 0$

Part I Graphical Representation

Scale 1.5cm ≡ 1.0N

* This is the scale I am using for this example. Your scale is given in the lab manual

$$|\vec{A}| = 2.45N \times \frac{1.5cm}{1.0N} = 3.675N = 3.7cm \text{ (2 sig figs)}$$

$|\vec{B}| = 7.4$ cm (2 sig figs)

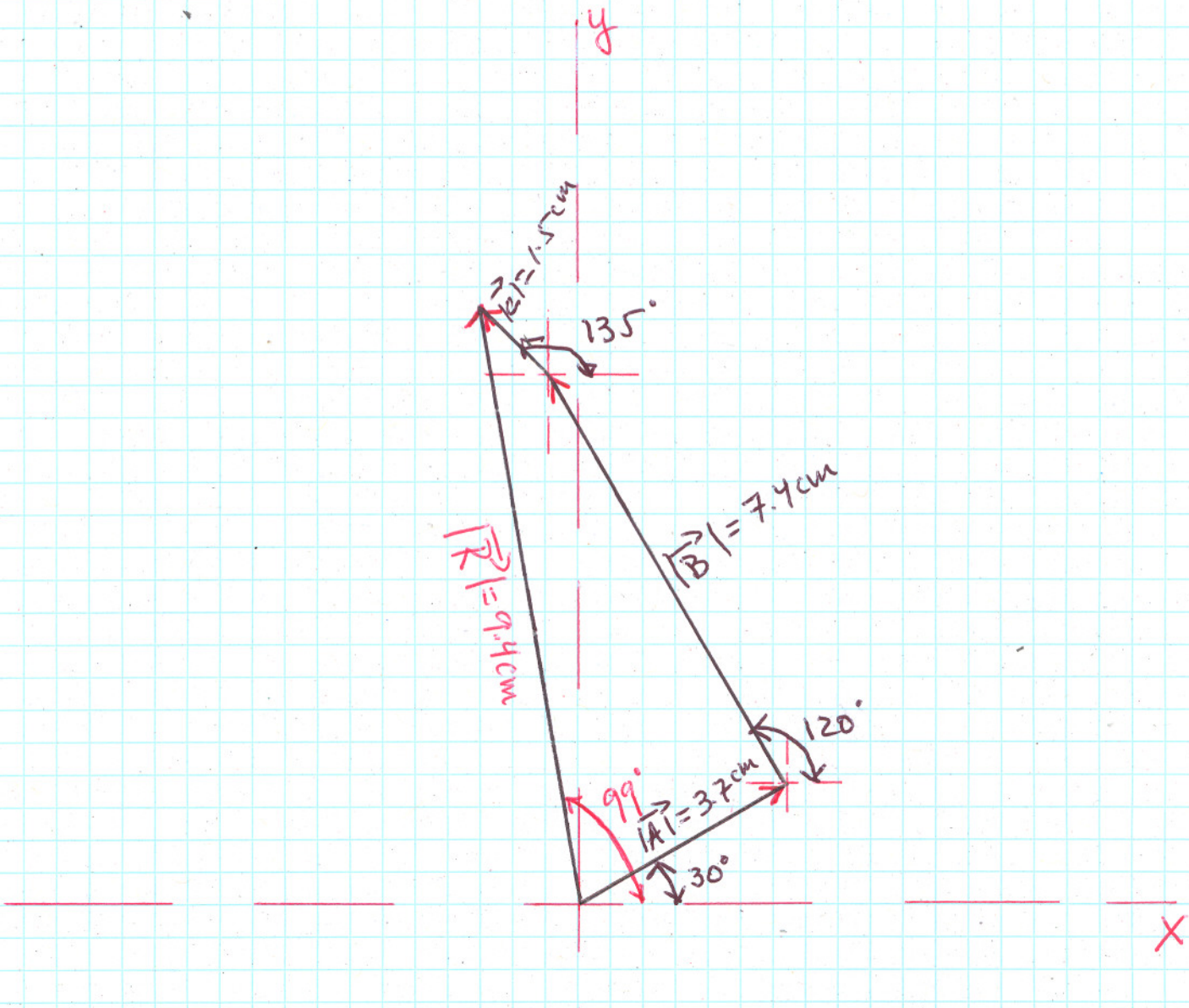
$|\vec{C}| = 1.5$ cm (2 sig figs)

Vectors values to graph

$\vec{A} = 3.7cm \text{ @ } 30^\circ$

$\vec{B} = 7.4cm \text{ @ } 120^\circ$

$\vec{C} = 1.5cm \text{ @ } 135^\circ$



$$|\vec{R}| = 9.4\text{cm} \times \frac{1.0\text{N}}{1.5\text{cm}}$$

$$|\vec{R}| = 6.3\text{N}$$

$$\theta_R = 99°$$

$$\vec{R}_{\text{graph}} = 6.3\text{N} \text{ @ } 99°$$

Part II Components

* All forces values must be in Newtons

Do not use centimeters for the following calculations.

Σ X components.

$$\vec{R_x} = \vec{A_x} + \vec{B_x} + \vec{C_x}$$

$$\vec{R_x} = (2.45N \cos 30^\circ) + (4.91N \cos 120^\circ) + (0.981 \cos 135^\circ)$$

(3 SF, 2 SF, 3 SF, 3 SF, 3 SF, 3 SF)

$$\vec{R_x} = 2.12N + (-2.46N) + (-0.694N)$$

(2.1N (2 SF))

$$\vec{R_x} = -1.034N = -1.0N \text{ (2 SF)}$$

Σ y components.

$$\vec{R_y} = \vec{A_y} + \vec{B_y} + \vec{C_y}$$

$$\vec{R_y} = (2.45N \sin 30) + (4.91N \sin 120^\circ) + (0.981 \sin 135)$$

$$\vec{R_y} = 1.225N + (4.252N) + (0.694N)$$

(1.2 (2 SF), 4.25 (3 SF), 0.694 (3 SF))

$$\vec{R_y} = +6.171N = +6.2N \text{ (2 sig figs)}$$

Part II cont..

$$|\vec{R}| = \sqrt{R_x^2 + R_y^2}$$

$$|\vec{R}| = \sqrt{(-1.0N)^2 + (6.2N)^2}$$

$$|\vec{R}| = 6.28N$$

$$|\vec{R}| = 6.3N \quad (2SF)$$

$$\theta_M = \tan^{-1}\left(\frac{\vec{R_y}}{\vec{R_x}}\right)$$

$(-x, +y)$ (II Quadrant)

$$\theta_M = \tan^{-1}\left(\frac{6.2N}{-1.0N}\right) = -80.84^\circ = -81^\circ \quad (2SF)$$

$$\theta_M = -81^\circ + 180^\circ = 99^\circ$$ (angle must be measured from +x axis)

$$R_{meth} = 6.3N \angle 99^\circ$$

Part III

Percent difference

(a) $\%\ \text{diff}\ |\vec{R}| = \dfrac{\left||\vec{R}|_g - |\vec{R}|_M\right|}{\left(\dfrac{|\vec{R}|_g + |\vec{R}|_M}{2}\right)} \times 100\%$

$\%\ \text{diff}\ |\vec{R}| = \dfrac{|6.3N - 6.3N|}{\left(\dfrac{6.3N + 6.3N}{2}\right)} \times 100\%$

$$\boxed{\%\ \text{diff}\ |\vec{R}| = 0.0\%}$$

(b) $\%\ \text{diff}\ \theta = \dfrac{|\theta_g - \theta_M|}{\dfrac{\theta_g + \theta_M}{2}} \times 100\%$

$\%\ \text{diff}\ \theta = \dfrac{|99 - 99|}{\left(\dfrac{99+99}{2}\right)} \times 100\%$

$$\boxed{\%\ \text{diff}\ \theta = 0.\%}$$

Part IV

Equilibrium Force

$$\vec{A}+\vec{B}+\vec{C}+\vec{E}=0$$

$$\vec{E} = -\vec{A}-\vec{B}-\vec{C}$$

$$\vec{E} = -(\vec{A}+\vec{B}+\vec{C})$$

$$\vec{E} = -\vec{R}_{avg.}$$

$$|\vec{R}|_{avg} = \frac{|\vec{R}_G| + |\vec{R}_M|}{2}$$

$$|\vec{R}|_{avg} = \frac{6.3N + 6.3N}{2} = \overbrace{\frac{12.6\,N}{2}}^{3SF} = 6.30N$$

$$\theta_{avg} = \frac{\theta_g + \theta_M}{2}$$

$$\theta_{avg} = \frac{99+99}{2} = \overbrace{\frac{198}{2}}^{3SF} = 99.\cancel{0}$$

Protractor does not allow for extra digit.

$$\vec{E} = 6.30N \angle (99+180)$$

$$\boxed{\vec{E} = 6.30N \angle 279^\circ}$$