Physics Question Regarding Error Analysis

Taken and reformed by Claric1 from a mathematics question by C G Nobbs (1955)
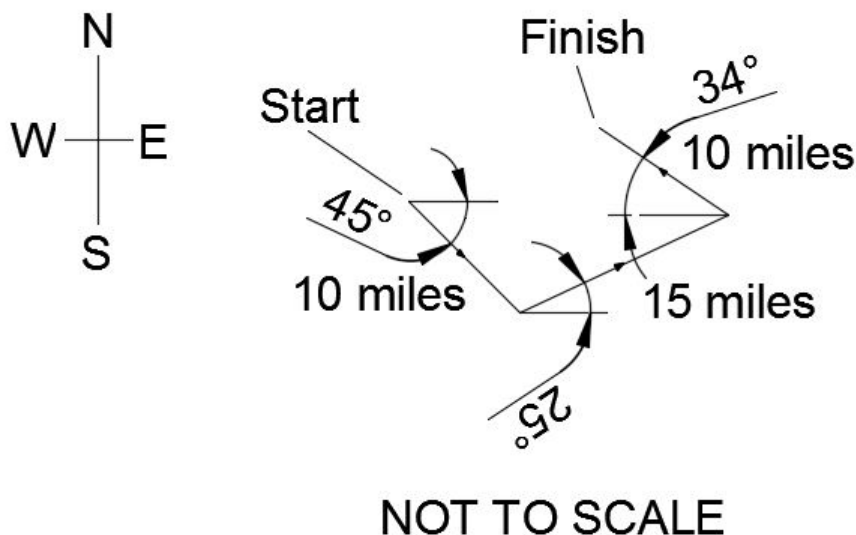
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Figure 1: Vector diagram showing given information from question.

The above shows a non-scaled drawing of the flight of an aeroplane over three parts of the same journey. The angles shown and distances given were measured from a scale drawing in which 1 inch represents 5 miles. The measuring instruments used were a protractor gradated in degrees and ruler gradated in inches and tenths. All measurements taken were given to the nearest tenth of inch or nearest degree such that 2 inch represents 10 miles and 3 inch represents 15 miles. The equilibrium vector is calculated using the following:

Let R_x, R_y and $|R|$ represent the x-component of resultant, y-component of resultant and modulus of resultant respectively, and θ represent angle between component vectors.

$R_x = 10\cos 45^o + 15\cos 25^o - 10cos34^o$

$R_y = -10\sin 45^o + 15\sin 25^o + 10sin34^o$

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

$\theta = \arctan \frac{R_y}{R_x}$

Find the equilibrium vector which gives the distance and compass bearing of the start from the finish.

Calculate also the uncertainty in the resultant if the uncertainty in each measurement taken was:

i) ± 0.1 inches and $\pm 1^o$

ii) ± 0.05 inches and $\pm 0.5^o$