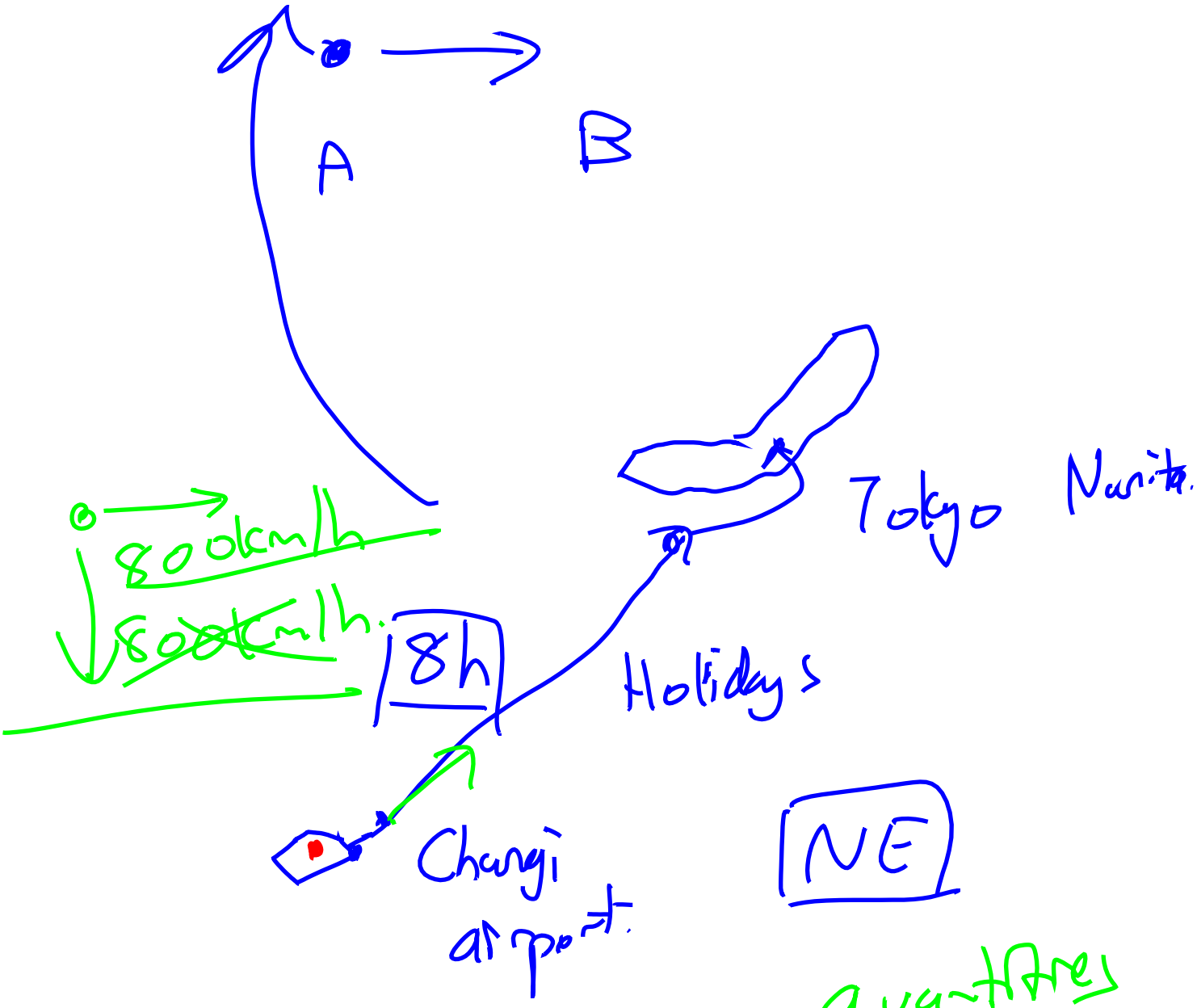
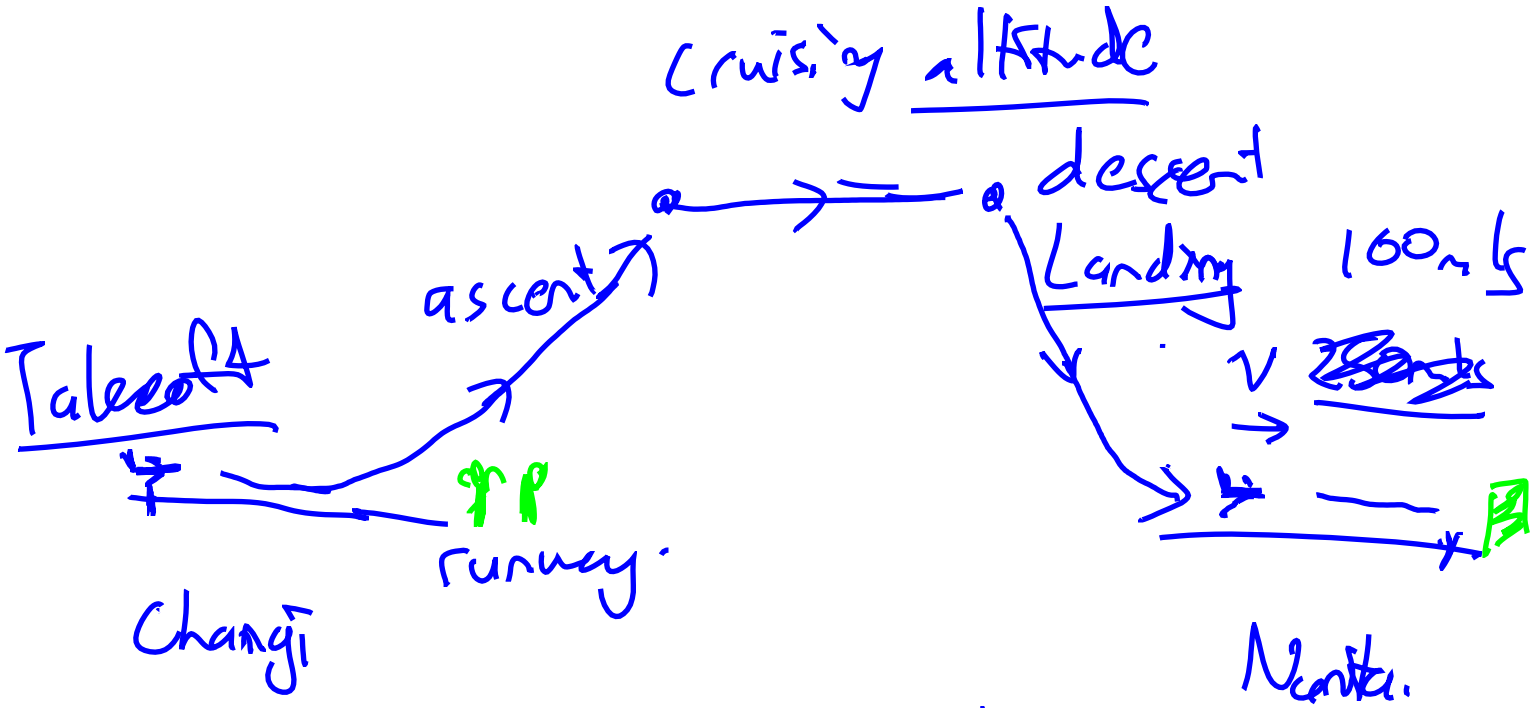
Kinematics



Vectors = Quantities w/ magnitude & direction.

quantities



How long does your runway need to be?

Cruising

roughly constant speed. v

A → B

3500km

3500 km

700 km/h

− 800 km/h

displacement.

$s = v t$

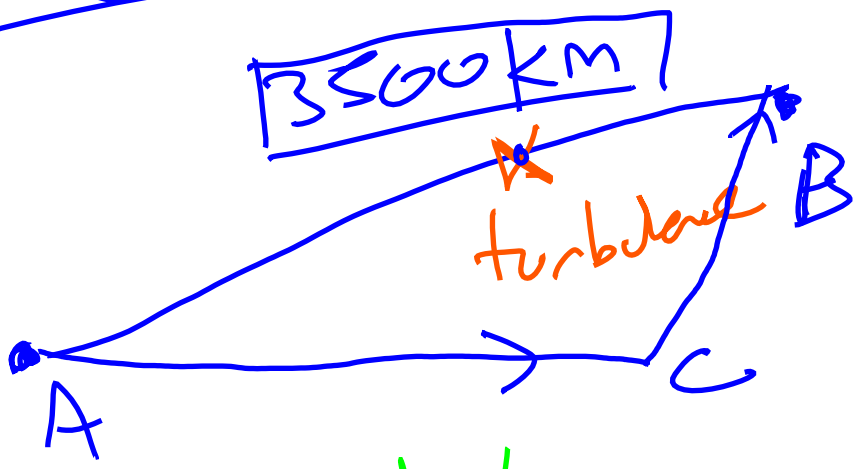
velocity.

$$v = \frac{\text{distance}}{\text{time}}$$

$$\text{time} = \frac{\text{distance}}{v}$$

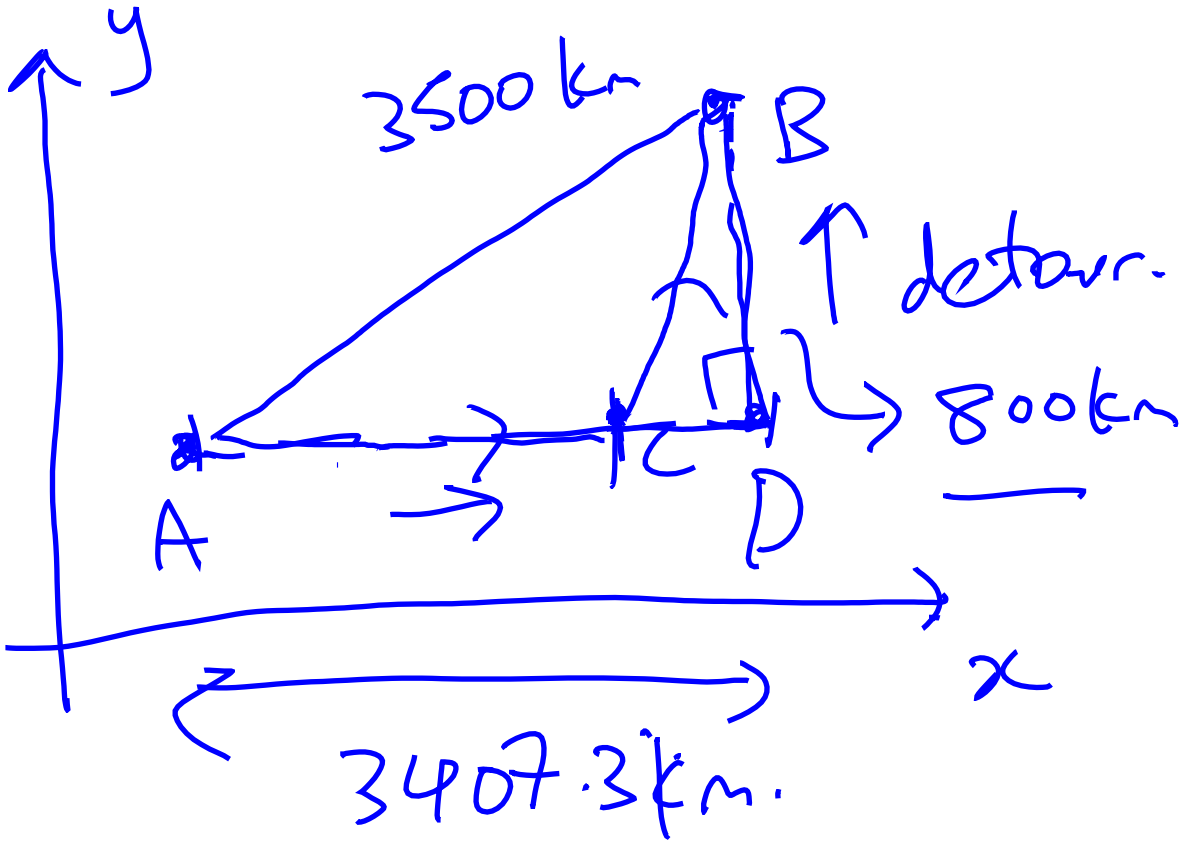
$$= \frac{3500\,(\text{km})}{700\,(\text{km/h})} = 5\,\text{h}$$

cruising at



detour.

Direction becomes imp.



$$AD = \sqrt{3500^2 - 800^2}$$

$$= 3407.3 \text{ km}$$

5 sf.

$$AC = 3000 \text{ km}.$$

$$BC = \sqrt{407.3^2 + 800^2}$$

$$BC \text{ (km)} = \left(\sqrt{805,929}\right) \text{km}.$$

$$= 897.7 \text{ km}.$$

$AC + BC$

$= 3000 + 897.7$ km

$= 3897.7$ km

extra time taken

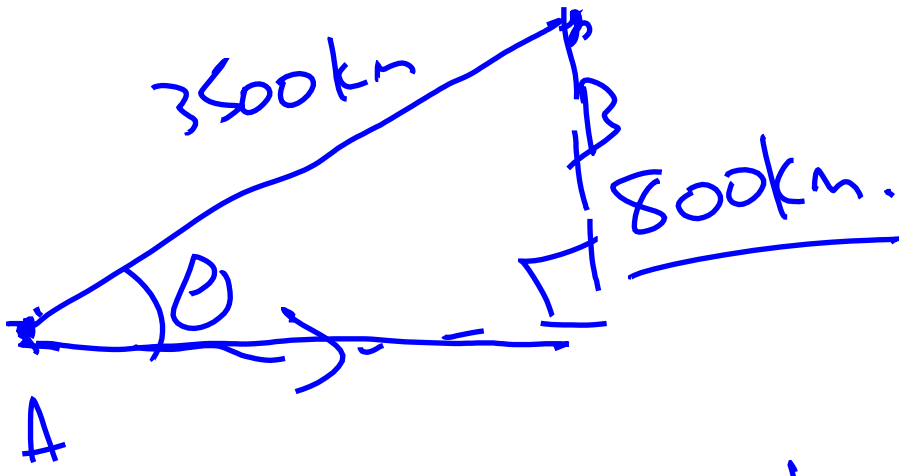
$= \frac{3897.7 - 3500}{700 \text{ km/h}}$

$= 0.568 \text{ h}$

$= 34.1 \text{ min}$

Detour example

↳ took ~ 1/2 hr longer to get from A to B.



What is displacement from A to B?

method 1 of rcp vectors.

3500 km.

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$= \frac{800}{3500}$$

$$\theta = \arcsin\left(\frac{800}{3500}\right)$$

$$\sin^{-1}\left(\frac{800}{3500}\right)$$

$$\theta = 0.2306 \text{ rad}$$

w.r.t

+ve x dir

θ is also

13.2°.

---

method 2: use "coordinates"

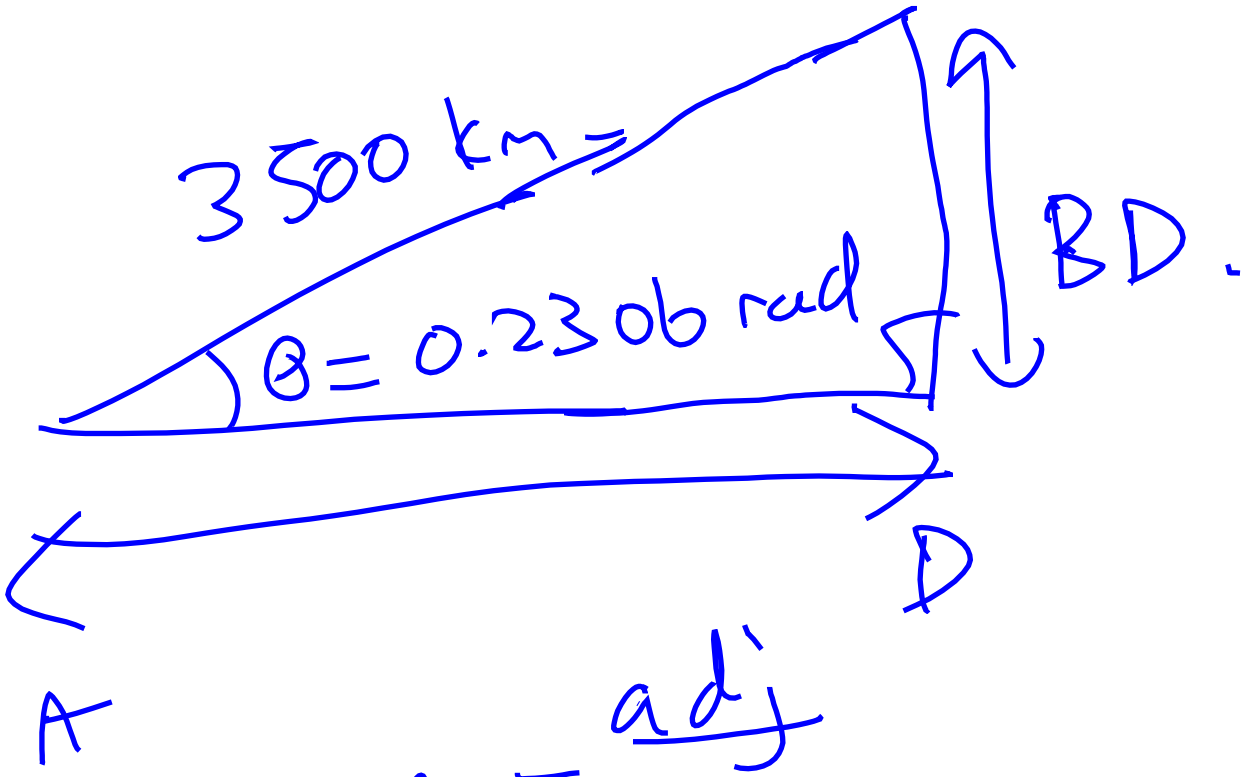
In 2D.

$$\vec{S} = \begin{bmatrix} S_x \\ S_y \end{bmatrix}$$

where

$S_x = 3407.3$ km

$S_y = 800$ km.



$$\cos\theta = \frac{\text{adj}}{\text{hyp.}}$$

$$AD = 3500 \times \cos\theta$$

$$= 3500 \times \cos(0.2306 \text{ rad})$$

$$= \underline{3407.3 \text{ km.}}$$

$$BD = 3500 \times \sin(0.2306 \text{ rad})$$

$$= 800 \text{ km}$$