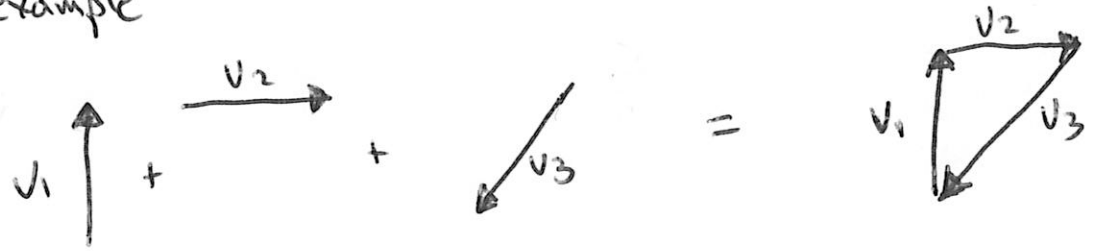
Equilibrium problems can be solved in two ways:

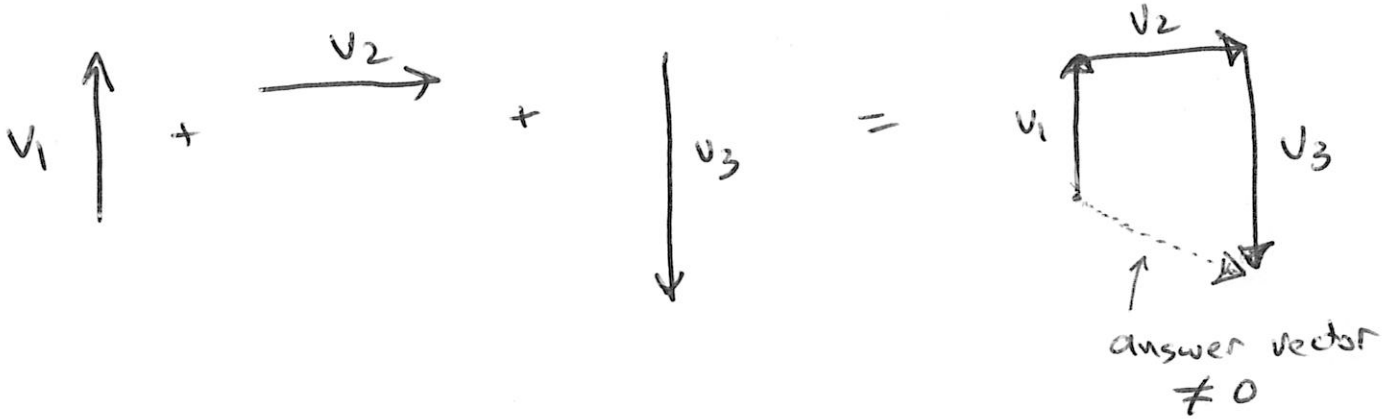
1) Graphical Method

three vectors will sum up to zero
if they make an enclosed triangle

example



these vectors do not sum up to zero



You can solve your triangles with SineLaw and Cosine Law or SOH CAH TOA if your triangle is a right triangle. Remember each vector will have a magnitude and a direction (angle)

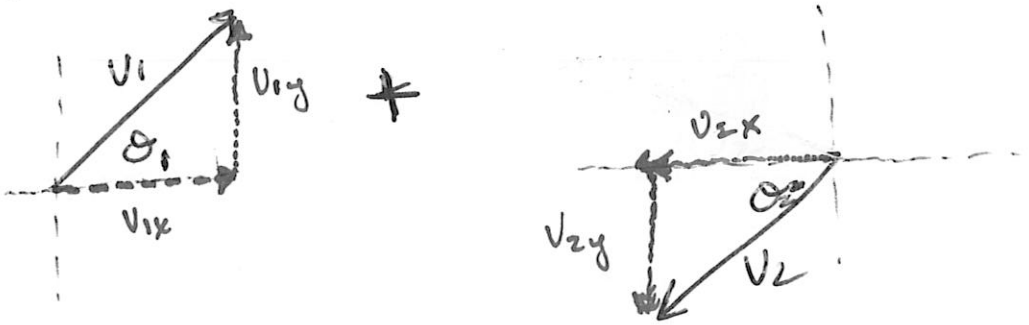
2) Component method

Break all vectors down into x-components and y-components

The sum of all X-components = 0
The sum of all Y-components = 0

This will generate 2 equations that will allow you to solve for the answer

example



so [X] $V_1 \cos\theta_1 = V_2 \cos\theta_2$

[Y] $V_1 \sin\theta_1 = V_2 \sin\theta_2$

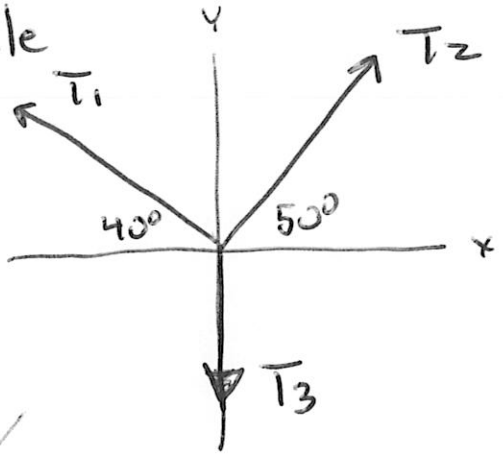
↑ Two equations means you can solve for 2 unknowns

either V_1 V_2 θ_1 or θ_2

Graphical Method Solutions

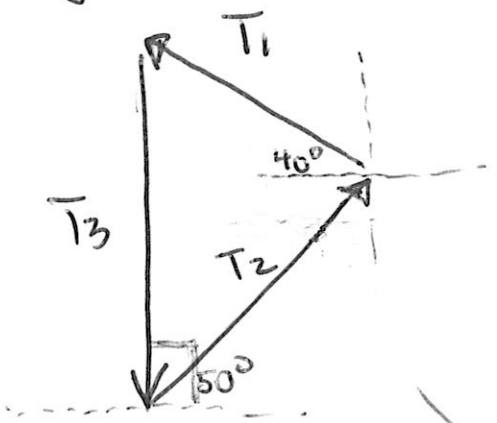
Some Applications of Newtons Laws

1 a) This diagram is very useful because it allows us to see the three vectors that make up the triangle



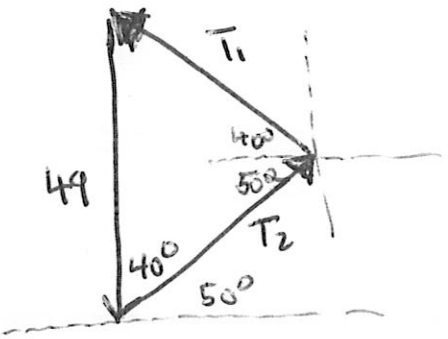
$(T_3 = mg)$

Now make a large triangle from this (this can be tricky because you don't know how long T_1, T_2 or T_3 may be)

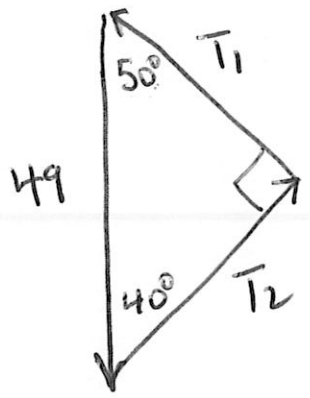


— $T_3 = mg$ so $T_3 = 5(9.8)$
$= 49\ N$

— angles inside a triangle add up to 180°



Working out all the inside angles gives



Since this has produced a right-angle triangle you can use SOH CAH TOA and $a^2+b^2=c^2$ to solve.

CAH $\quad \cos 50^\circ = \dfrac{T_1}{49} \longrightarrow T_1 = (49)\cos 50^\circ$

$= 31\ N$

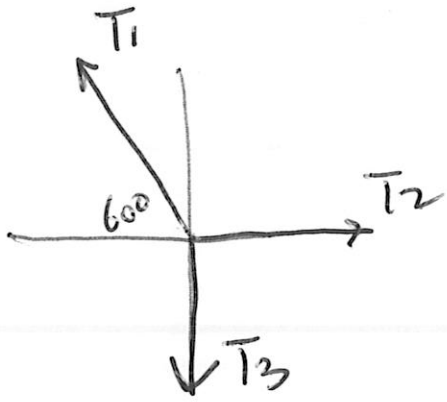
SOH $\quad \sin 50^\circ = \dfrac{T_2}{49} \longrightarrow T_2 = (49)\sin 50^\circ$

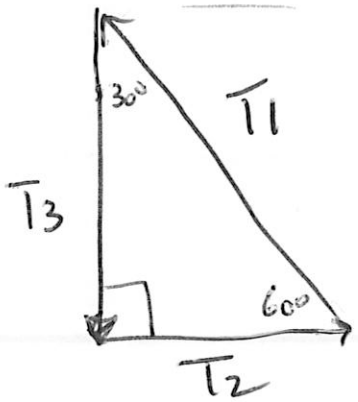
$= 38\ N$

So $T_1 = 31\ N$, $T_2 = 38\ N$, $T_3 = 49\ N$ or $T_1 = 30\ N$, $T_2 = 40\ N$, $T_3 = 50\ N$

This is not a sig. fig question so 1 or 2 sigs figs seems to match the question → 3 or more sig figs though would be too much!

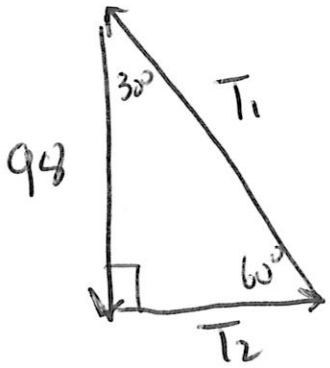
b)





$T_3 = mg$
$= 10(9.8)$
$= 98\ N$

Pick an angle to work from – either 30° or 60°



CAH $\quad \cos 30° = \frac{98}{T_1} \rightarrow T_1 = \frac{98}{\cos 30°}$

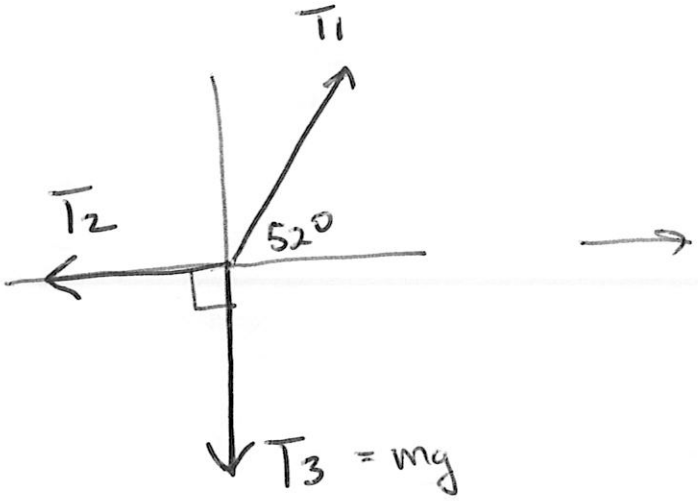
$= 113\ N$

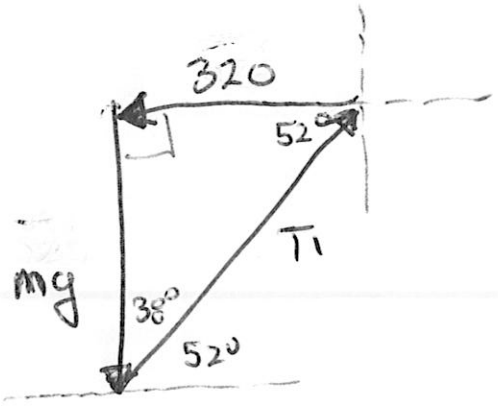
TOA $\quad \tan 30° = \frac{T_2}{98} \rightarrow T_2 = 98(\tan 30°)$

$= 56.6\ N$

So $T_1 = 110\ N$ $T_2 = 57\ N$
and $T_3 = 98\ N$

2.





- No need to solve for T_1
- work from either angle (52° or 38°) to generate equations

TOA

$$\tan 52^\circ = \frac{mg}{320}$$

$$mg = 320(\tan 52^\circ)$$

$$9.8(m) = 409.6$$

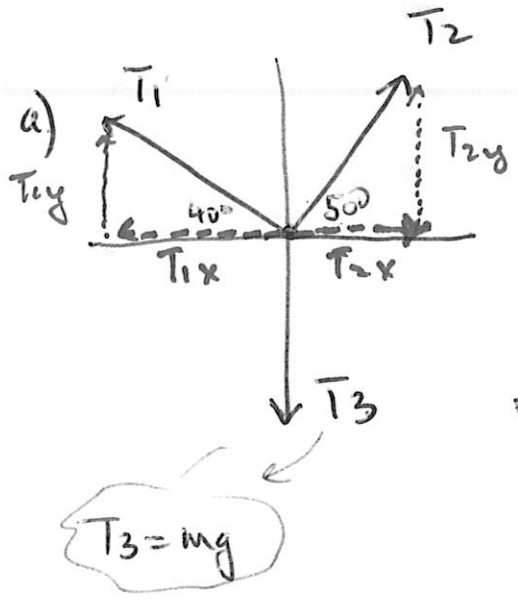
$$m = 41.7$$

So Mass = 42 kg

Component Method Solutions

1 (a) only

1 a)



This drawing also allows us to see the components (X and Y) for T_1, T_2 and T_3

So [X] $T_1 \cos 40^\circ = T_2 \cos 50^\circ$

[Y] $T_1 \sin 40^\circ + T_2 \sin 50^\circ = T_3$

Each equation has 2 unknowns so you will have to rearrange one equation and substitute it into the other

[X] $T_2 = \dfrac{T_1 \cos 40^\circ}{\cos 50^\circ}$

$T_2 = 1.19\, T_1$

sub

$T_1(\sin 40^\circ) + 1.19\, T_1(\sin 50^\circ) = mg$

$0.643\, T_1 + 0.911\, T_1 = 49$

$1.554\, T_1 = 49$

$T_1 = 31.5$

$T_2 = 1.19\, T_1$

$= 1.19\,(31.5)$

$= 37.5$

So $T_1 = 31$ N $T_2 = 38$ N $T_3 = 49$ N

or $T_1 = 30$ N $T_2 = 40$ N $T_3 = 50$ N