Chapter 1: Understanding Static Forces Tutorial

1. Briefly describe what is a force.
2. What is the meaning of static equilibrium?
3. What do you know about dynamics?
4. State Newton's 3 laws.
5. An object shown in Figure 1.5 has a mass of 100 kg. Find the force Fw acting towards the ground. If a force of 300 N is applied to the object, calculate its acceleration.

as shown,

$\vec{a} = \frac{\vec{F}}{m} = \frac{300}{100} = 3\ m/s^2$ //

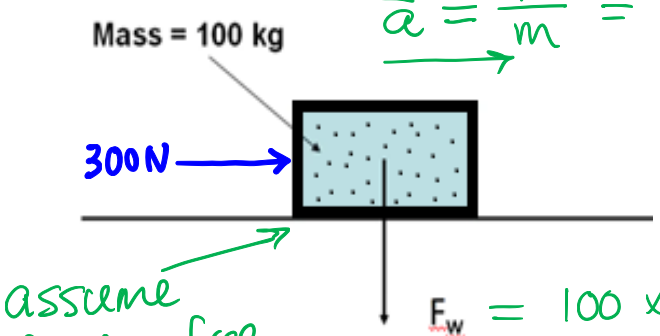


Figure 1.5

6. What is a scalar quantity and what is a vector quantity. List 5 scalars and 5 vectors in the table below.
7. Find the resultant force shown in Figure 1.7. Indicate the direction of the resultant force.

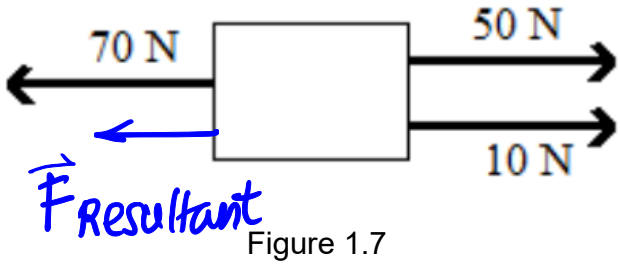
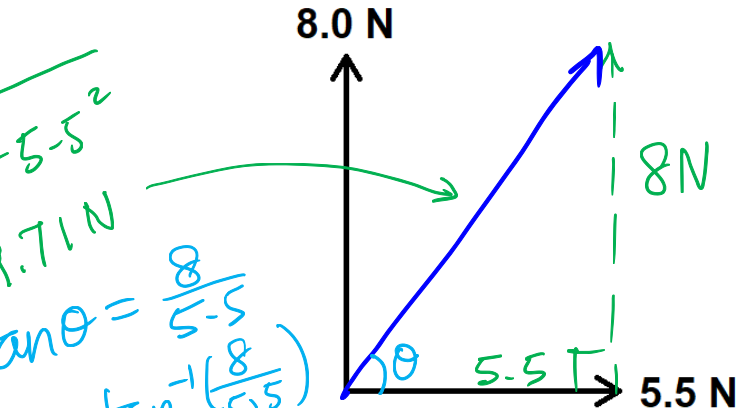


Figure 1.7

= 70 − 50 − 10

= 10N //

8. Find the resultant force for Figure 1.8.



$\sqrt{8^2+5.5^2} = 9.71\,N$

$\tan\theta = \frac{8}{5.5}$

$\theta = \tan^{-1}\left(\frac{8}{5.5}\right) = 55.5°$ //

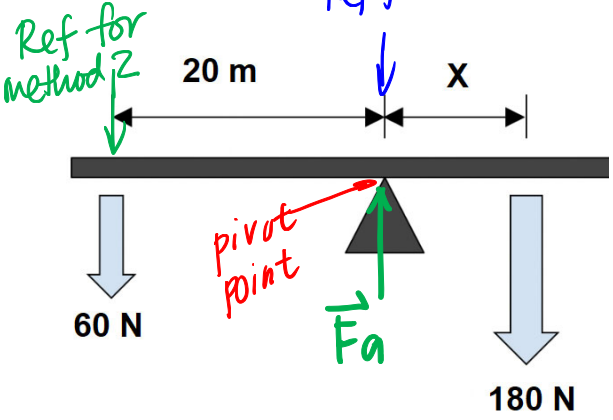
Figure 1.8

The objective of working out using method 2 is to show you that the reference need not be at the pivot point. In fact, it can be anywhere but notice that selecting the pivot as the reference simplifies the working

Method 2

9. Calculate X in m for Figure 1.9.

Ref for method 1



method 1

↻ $180x$

↺ $60 \times 20 = 1200$

$180x = 1200$

$x = 6\frac{2}{3}$ m

or $\simeq 6.67$ m //

↻ $180x(20+x)$

↺ $F_a \times 20$

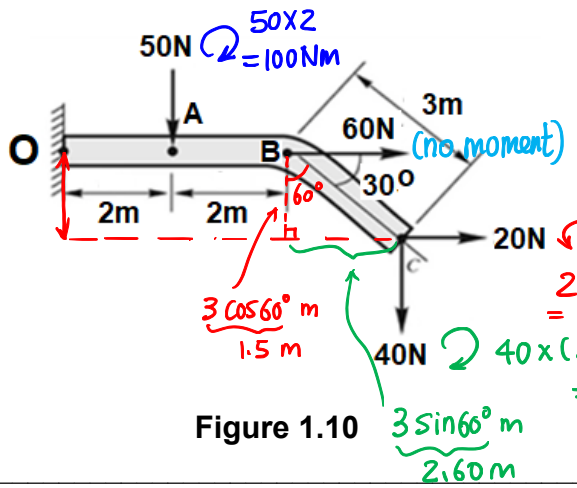
& $F_a = 60 + 180 = 240$ N //

$\therefore 180x(20+x) = 240 \times 20$

$20 + x = 26\frac{2}{3}$

$x = 6\frac{2}{3}$ m //

10. Determine the resultant moment of the four forces acting on the bend rod in the Figure 1.10 about 'O'. Indicate whether the overall resultant is clockwise or anti clockwise.



50N ↻ $50 \times 2 = 100$ Nm

3 cos60° m = 1.5 m

20 × 1.5 = 30 Nm

40N ↻ $40 \times (2+2+2.6) = 264$ Nm //

3 sin60° m = 2.60 m

↻ 100 Nm

↻ 264 Nm

↺ 30 Nm

Resultant ↻ 334 Nm //

Figure 1.10

Q12 $1\,cm = \frac{1}{100}\,m = 0.01\,m$

$\therefore 1\,cm^2 = (0.01)^2\,m^2 = 0.0001\,m^2$ or $10^{-4}\,m^2$

$\therefore 100\,cm^2 = 100 \times 10^{-4}\,m^2$ or $10^{-2}\,m^2$

$\text{Stress} = \frac{200\,N}{10^{-2}\,m^2} = 20000\,\frac{N}{m^2}$ or $20\,\frac{kN}{m^2}$ //

---

11. Briefly describe tension, compression, shear, bending, and torsional forces.

12. Find the stress on a material if the force is 200N and the cross section area is 100 cm^2 .

$\text{Strain} = \frac{0.02\,m}{1\,m} \times 100\% = 2\%$ // Elastic deformation.

13. A 1m long metal bar extended by 2 cm when a tensile force is applied to it. Calculate the strain this bar is subjected to. If this bar returns to 1m when the tensile force is released. What type of deformation has this bar experienced ?

Figure 1.30

14. Sketch the Stress-Strain relationship and indicate clearly where is the elastic stage, plastic stage, Yield point, ultimate tensile point and the break point.

Q15

$\text{Stress} = \frac{500\,N}{2 \times 10^{-4}\,m^2} = 2.5 \times 10^6\,\frac{N}{m^2}$ //

15. A 500 N force is stretching a 1.5 m long metal bar. The bar has a cross sectional area of 2 cm^2 metal bar. Calculate the stress and strain experience by this bar if the bar is 1.55 m now. What is it's Young's modulus ?

$\text{Strain} = \frac{0.05\,m}{1.5\,m} \times 100\% = 3.33\%$ //

$\text{Young's modulus} = \frac{2.5 \times 10^6\,N/m^2}{0.033} = 7.58 \times 10^7\,N/m^2$ //

16. A worker wanted to load a 100 kg of components inside a box on to a lorry. He realised that the box will not slide down if he leaves it on the 30° ramp as shown in Figue1.16. Calculate the forces Fx, Fy and Fz acting on the box.

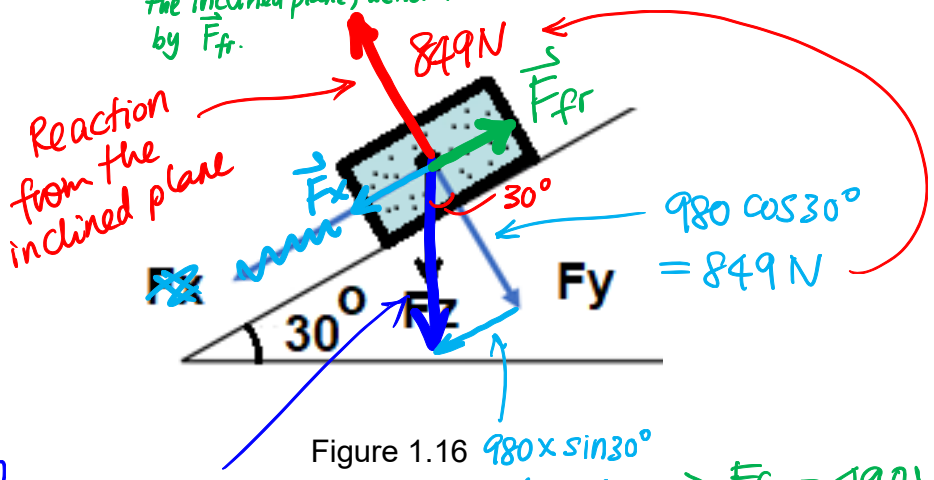


Figure 1.16 $980 \times \sin 30° = 490\,N$ // $\Rightarrow F_{fr} = 490N$ also since the block is not sliding down.

The block is at static equilibrium since it is not moving. That is, there is no net force acting on it.

$100 \times 9.8\,N = 980N$