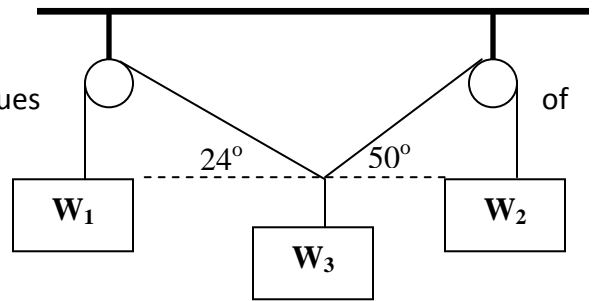


Worksheet 3.1 - Translational Equilibrium

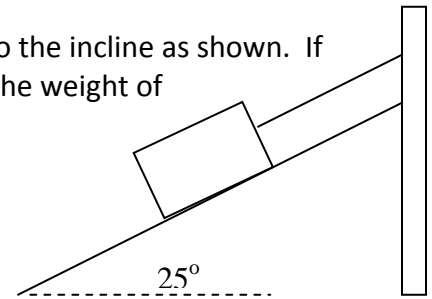
1)  $W_1$ ,  $W_2$  and  $W_3$  are the weights of three objects suspended by pulleys as shown. Assuming the pulleys in this system are frictionless and weightless and that  $W_3 = 12\text{ N}$ , what are the values  $W_1$  and  $W_2$ ?

$(W_1 = 8.0\text{ N}, W_2 = 11.4\text{ N})$



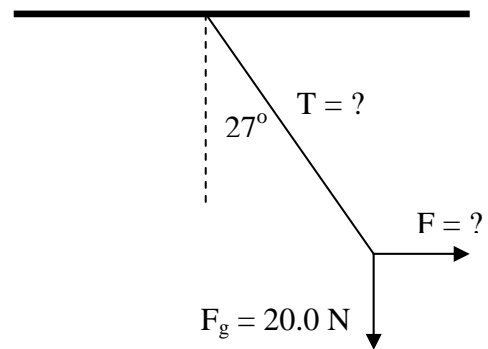
2) An object is suspended on a frictionless inclined plane by a rope parallel to the incline as shown. If the angle of the incline is  $25^\circ$  and the tension in the rope is  $5000\text{ N}$ , what is the weight of the object?

$(1.18 \times 10^4\text{ N})$

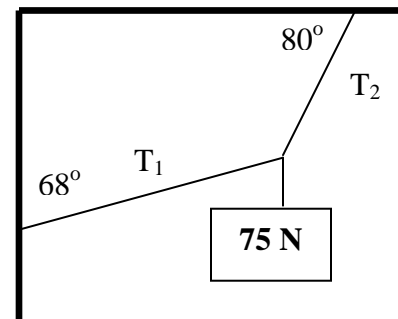


3) A  $20.0\text{ N}$  child sitting on a playground swing is being pushed by her father. When the rope makes an angle of  $27^\circ$  to the vertical what is the force exerted by her father? What is the tension in the rope,  $T$ ?

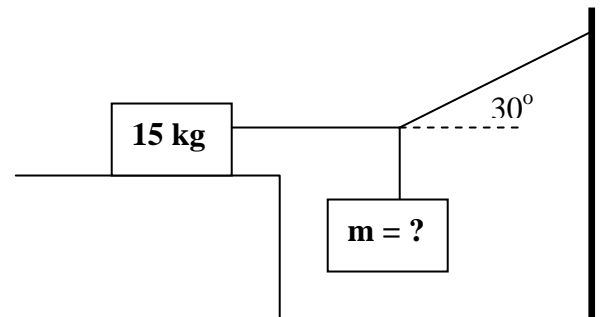
$(F = 10.2\text{ N}, T = 22.4\text{ N})$



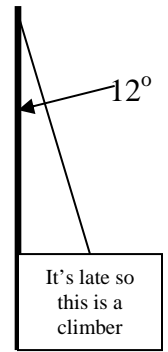
4) Find the tensions  $T_1$  and  $T_2$  in the ropes shown in the diagram.



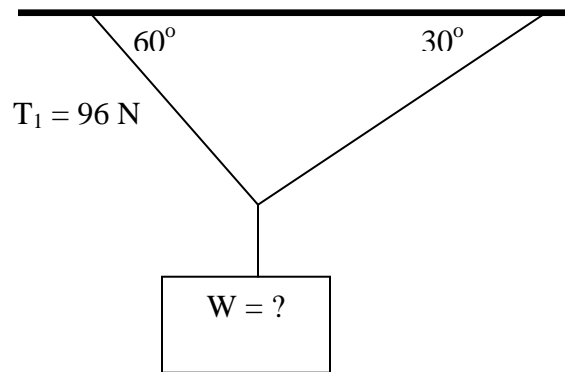
5) A  $15\text{ kg}$  object rests on a table. A cord is attached to this object and also to a wall. Another object is hung from this cord as shown. If the coefficient of friction between the  $15\text{ kg}$  object and the table is  $0.27$ , what is the maximum mass that can be hung, without movement?



6) A 735 N mountain climber is rappelling down the face of a vertical cliff as shown in the diagram. If the rope makes an angle of  $12^\circ$  with the cliff face, what is the tension in the rope?

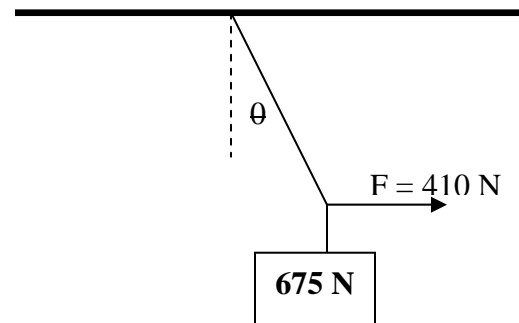


7) Given the following diagram, find  $W$  and  $T_2$ .  
(110 N, 55 N)



8) A 675 N object is pulled horizontally by a force of 410 N as shown. What is the angle,  $\theta$ , between the rope and the vertical?

(31.3°)



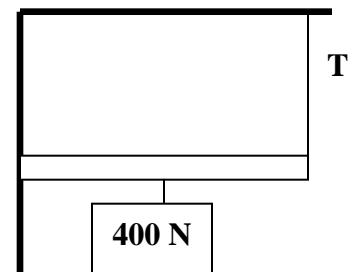
### Worksheet 3.2 - Torque

1) If the torque needed to loosen a lug nut is 45 Nm and you are using a 35 cm wheel wrench, what force do you need to exert perpendicular to the end of the wrench?

(130 N)

2) A beam of negligible mass is attached to a wall by a hinge. Attached to the center of the beam is a 400 N weight. A rope supports the beam as shown in the diagram. What is the tension in the rope?

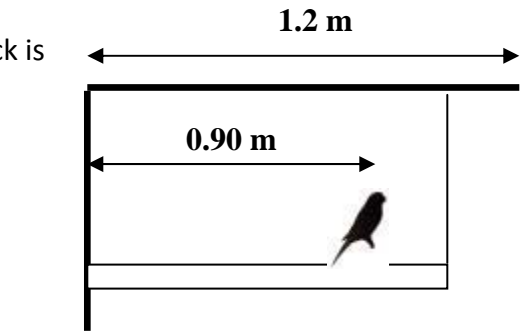
(200 N)



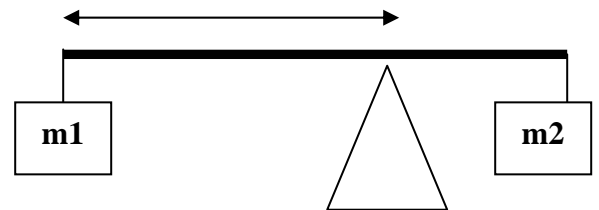
3) Two students sit on either end of a uniform teeter-totter. Student 1 sits 1.10 m from the pivot while Student 2 sits 0.85 m from the pivot. If Student 1 has a mass of 72 kg, what is the mass of Student 2?

(93 kg)

4) A 0.75 kg bird stands on a uniform 1.0 kg stick as shown. The stick is attached to a wall with a hinge and to the ceiling with a rope of negligible mass. What is the tension in the rope?

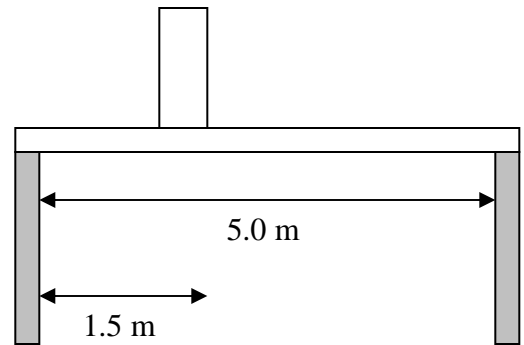


5) Two masses ( $m_1 = 3.00$  kg,  $m_2 = 5.00$  kg) hang from the ends of a metre stick as shown. If the mass of the metre stick is negligible, at what distance from the left of the metre stick should a pivot be placed so that the system will be balanced?



(0.625 m)

6) A 650 N student stands on a 250 N uniform beam that is supported by two supports as shown in the diagram. If the supports are 5.0 m apart and the student stands 1.5 m from the left support:



a) What is the force that the right support exerts on the beam?

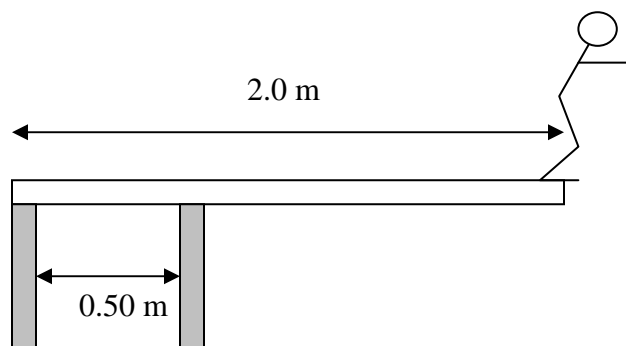
(320 N)

b) What is the force that the left support exerts on the beam?

(580 N)

7) A uniform 400 N diving board is supported at two points as shown in the diagram. If a 75 kg diver stands at the end of the board, what are the forces acting on the each support?

(left support =  $2.61 \times 10^3$  N down , right support =  $3.74 \times 10^3$  N up)

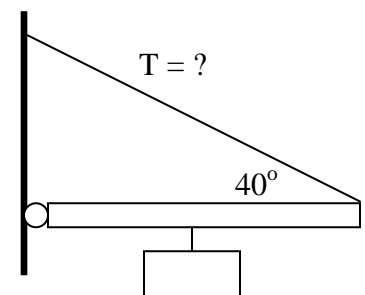


### Worksheet 3.3 – Torque not at $90^\circ$

1) A beam of negligible mass is attached to a wall by means of a hinge. Attached to the centre of the beam is a 400 N weight. A rope also helps to support this beam as shown in the diagram.

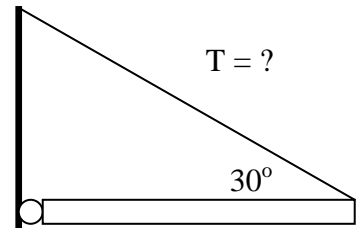
a) What is the tension in the rope? (311 N)

b) What are the vertical and horizontal forces that the wall exerts on the beam? (V: 200 N, H: 238 N)



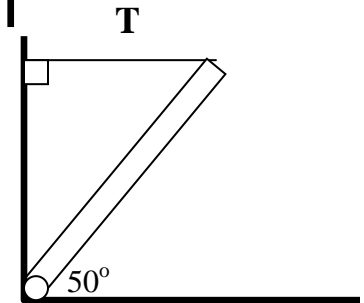
2) Find the tension in the rope supporting the 200 N hinged uniform beam as shown in the diagram.

(200 N)



3) Find the tension in the rope supporting the 200 N hinged uniform beam as shown in the diagram.

(83.9 N)

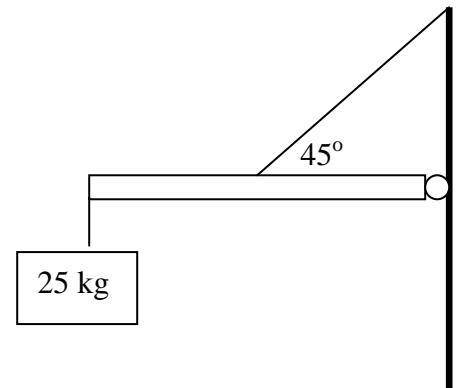


4) A uniform beam (mass = 22 kg) is supported by a cable that is attached to the centre of the beam as shown in the diagram.

a) find the tension in the cable. (1000 N)

b) find the horizontal and vertical forces acting on the hinge.

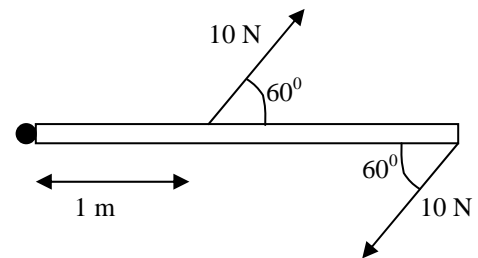
( $F_x = 710 \text{ N}$ ,  $F_y = 240 \text{ N}$ )



5) The diagram below shows the top view of a door that is 2 m wide. Two forces are applied to the door as indicated in the diagram.

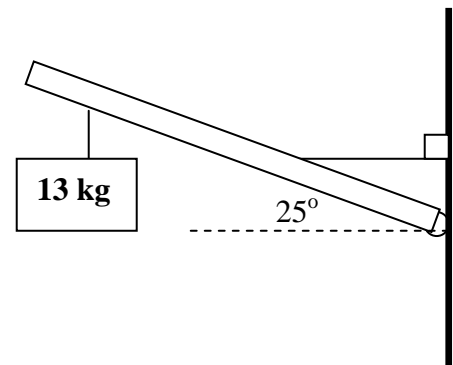
What is the net torque on the door with respect to the hinge?

(8.66 Nm clockwise)



6) A 2.6 m uniform beam (mass of 9.0 kg) is attached to a wall by a hinge and supported by a rope. A 13 kg mass hangs from the beam 2.2 m from the hinge. Find the tension in the rope which is attached to the beam 1.1 m from the wall.

(770 N)



**Bonus** - A uniform ladder of mass 12.5 kg leans against a wall at an angle of  $73^\circ$  to the horizontal. The coefficient of static friction between the ladder and the wall and between the ladder and the ground is 0.76. How heavy of a person can climb all the way to the top of the ladder before the ladder starts to slip?