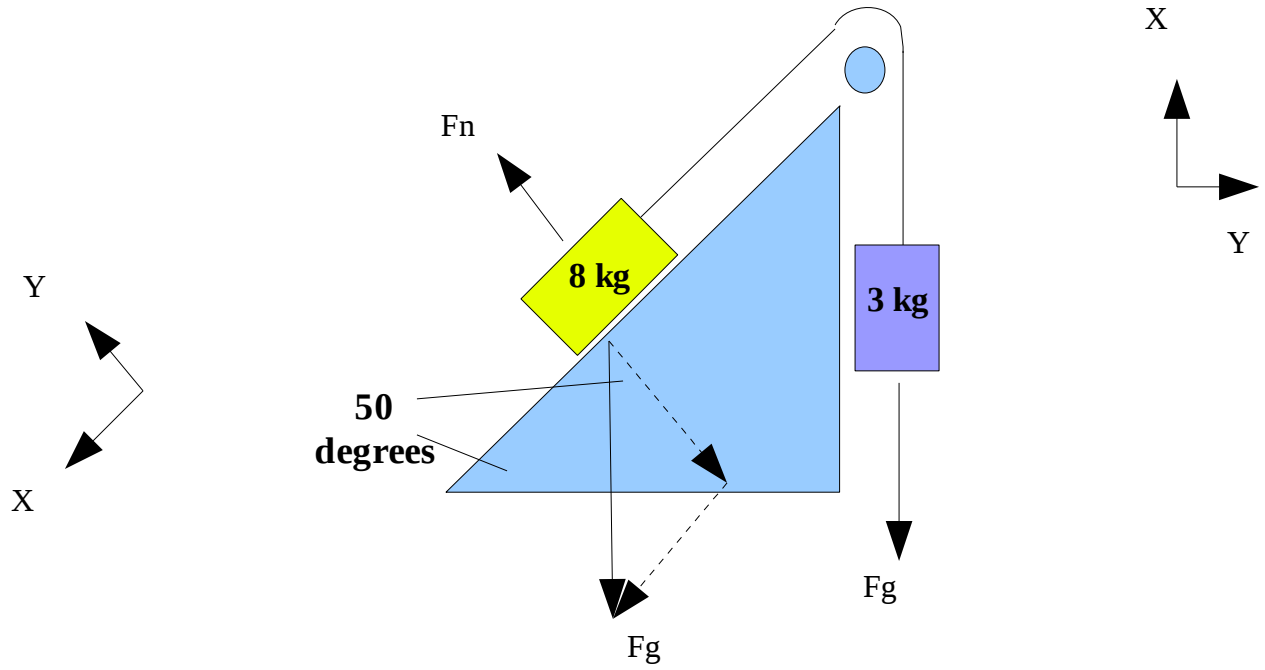
Applying Newton's Laws

System Diagrams

•Used for two or more connected masses

It is often useful to draw system diagrams and remove internal forces to find acceleration of a system.

1. For the following system, determine the acceleration and the tension in the string. Assume zero friction.



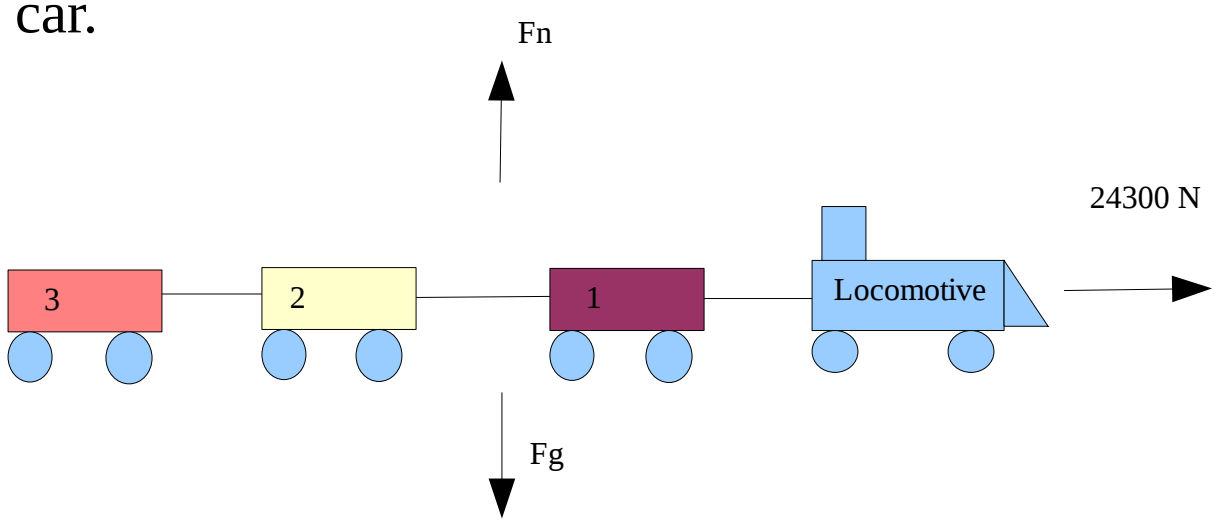
F_{net} = ma, so

$$F_{net(x)} = ma_x \rightarrow (8)(9.8)\sin 50^o - (3)(9.8) = (8+3)a$$

a = 2.8 m/s^2 [counter-clockwise]

2. A locomotive engine ($m = 2.2 \times 10^4$ kg) is pulling three train cars of mass 1.4×10^3 kg, 2.2×10^3 kg and 1.7×10^3 kg respectively (in order, starting from the front). Determine the

a) acceleration of the train.
b) the tension of the coupling between the 1st car and the 2nd car.

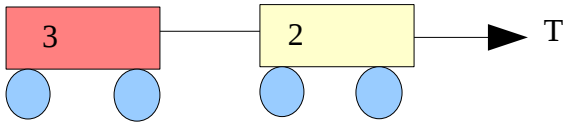


a) $F_{net} = ma$

$24300 = (2.2 \times 10^4 + 1.4 \times 10^3 + 2.2 \times 10^3 + 1.7 \times 10^3)a$

$a = 0.89 \text{ m/s}^2$

b) New FBD:



$F_{net} = ma \rightarrow T = (2.2 \times 10^3 + 1.7 \times 10^3)(0.89)$

$T = 3471\ N$