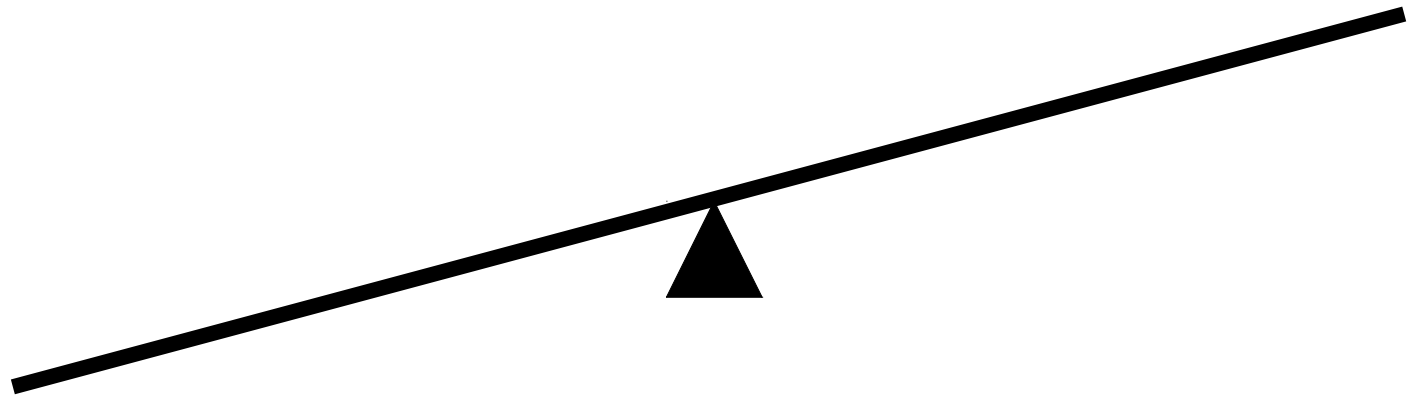


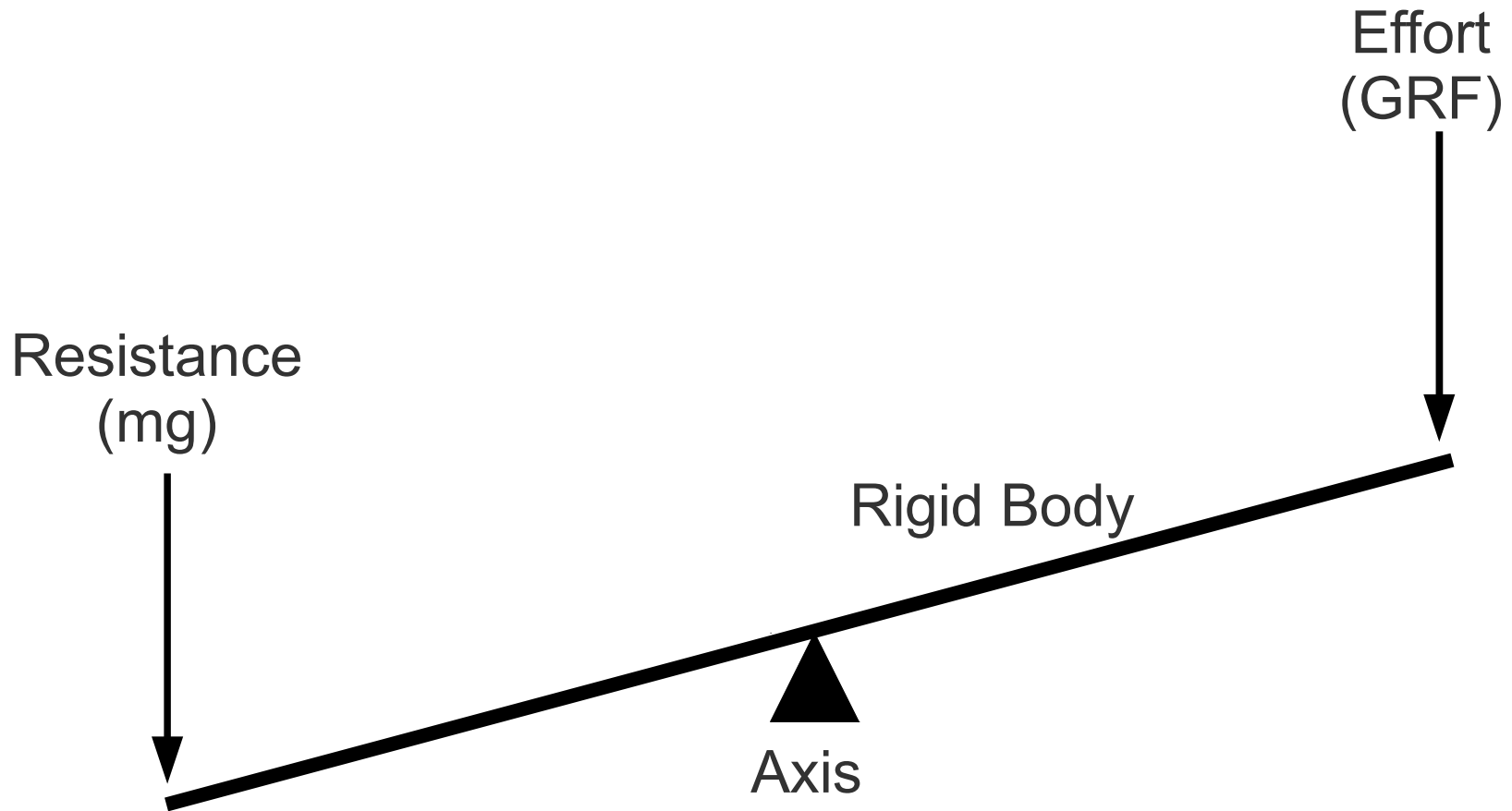
Levers continued!



# Lever

A rigid body acted upon at two different points by opposing forces\*

# Components of a Lever



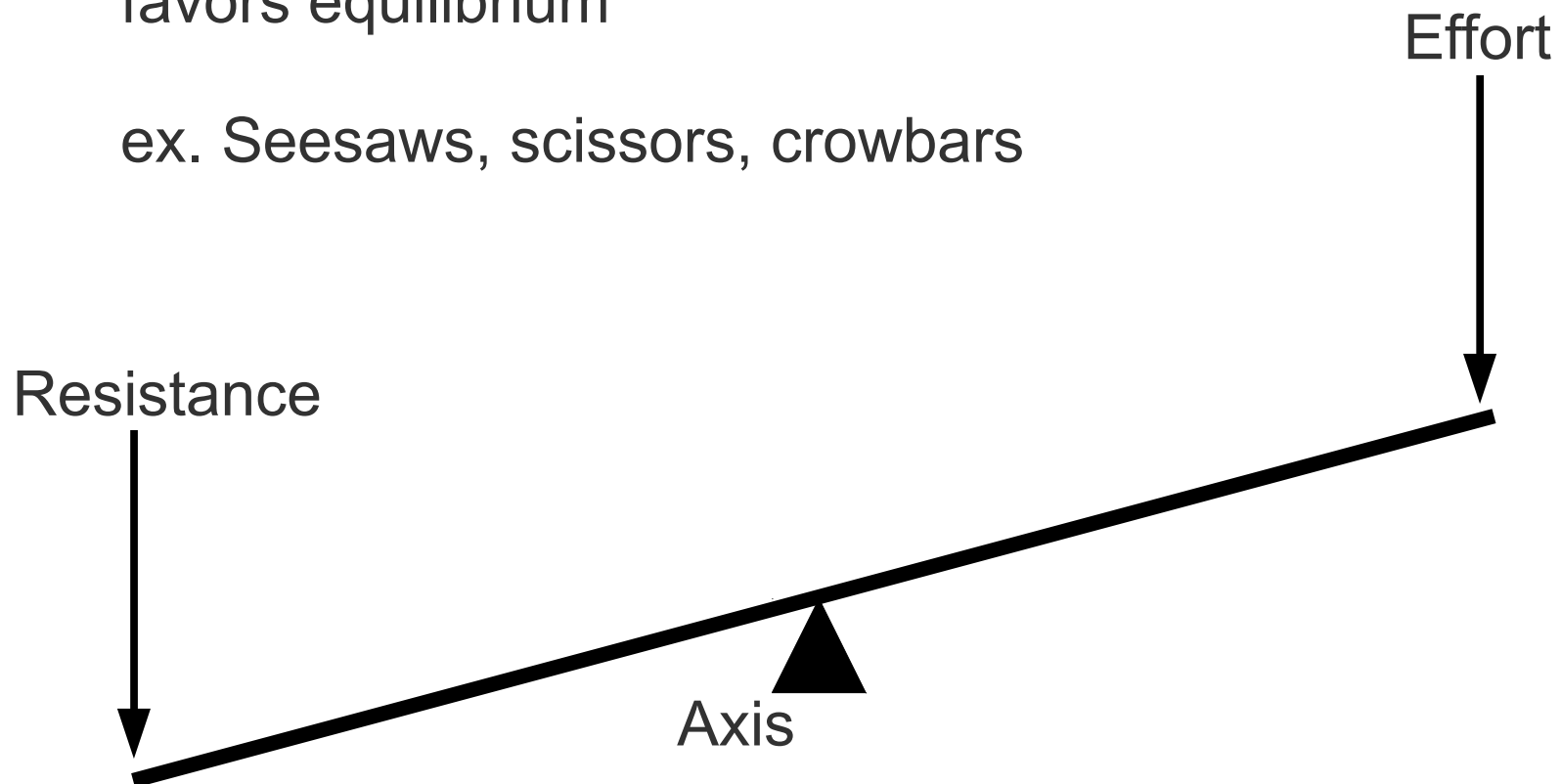
# 3 Classes of Levers

## First-Class:

Axis between effort force and resistance force

favors equilibrium

ex. Seesaws, scissors, crowbars



\*Roberts and Falkenburg, 1992

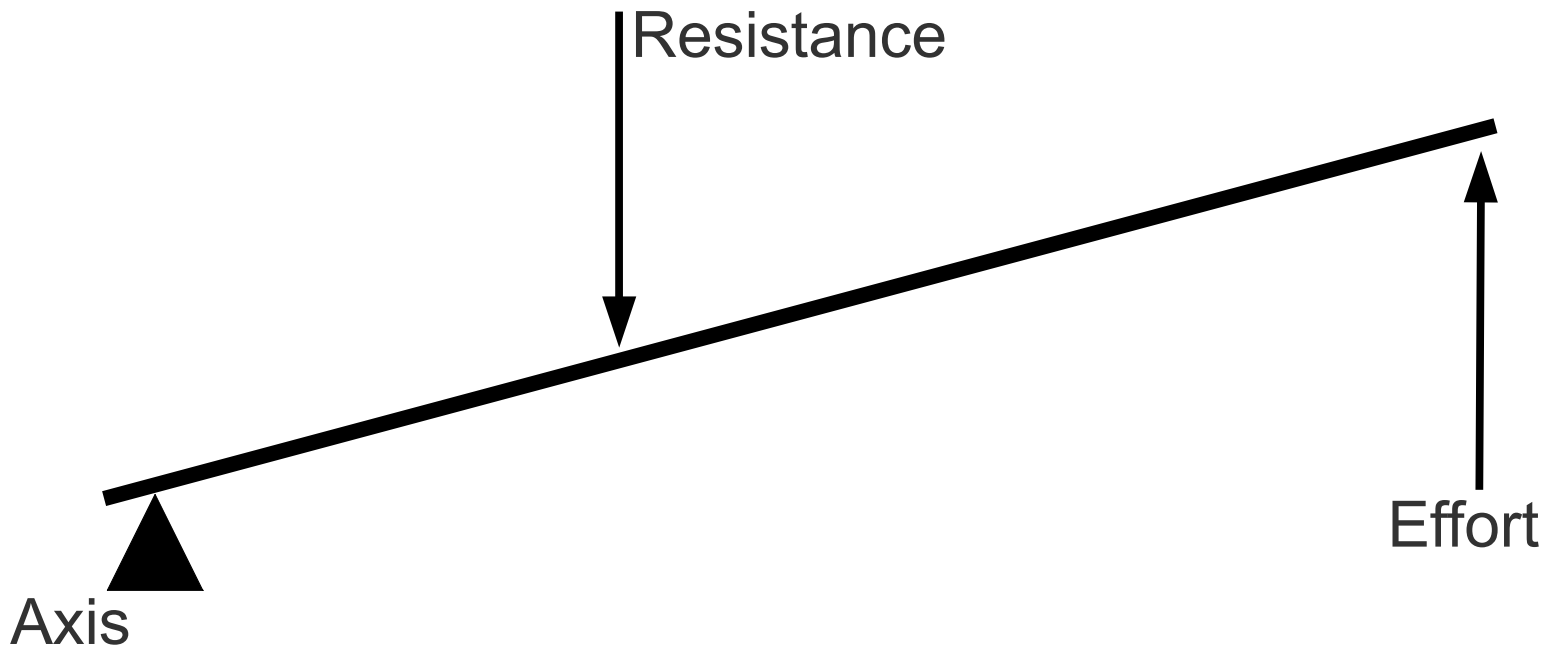
# 3 Classes of Levers

## **Second-Class:**

resistance force between force of effort and axis

favors the effort

ex. Wheelbarrows, nutcrackers



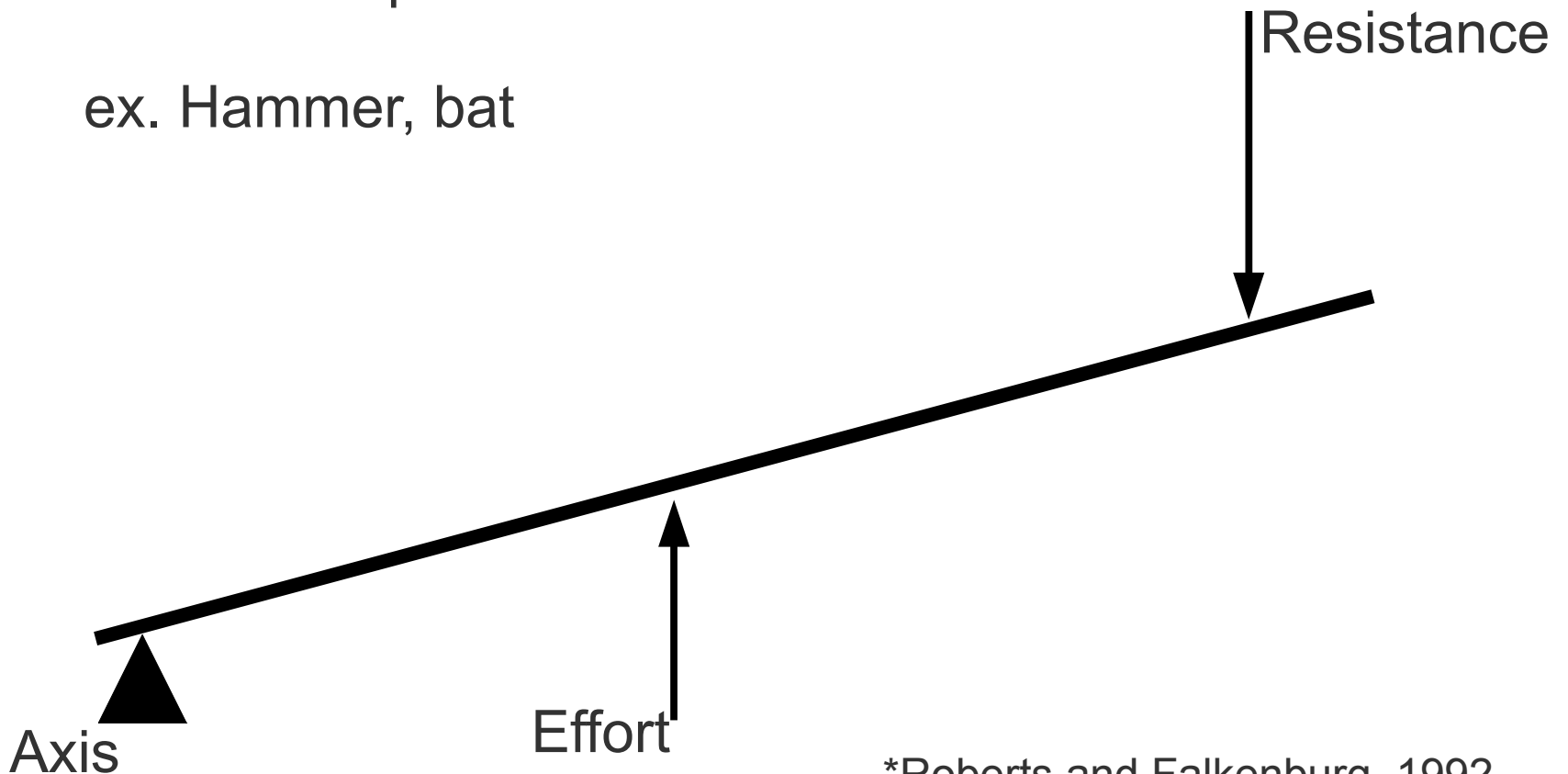
# 3 Classes of Levers

## Third-Class:

force of effort between axis and force of resistance

favors the speed and distance

ex. Hammer, bat



\*Roberts and Falkenburg, 1992

# Important concepts for levers

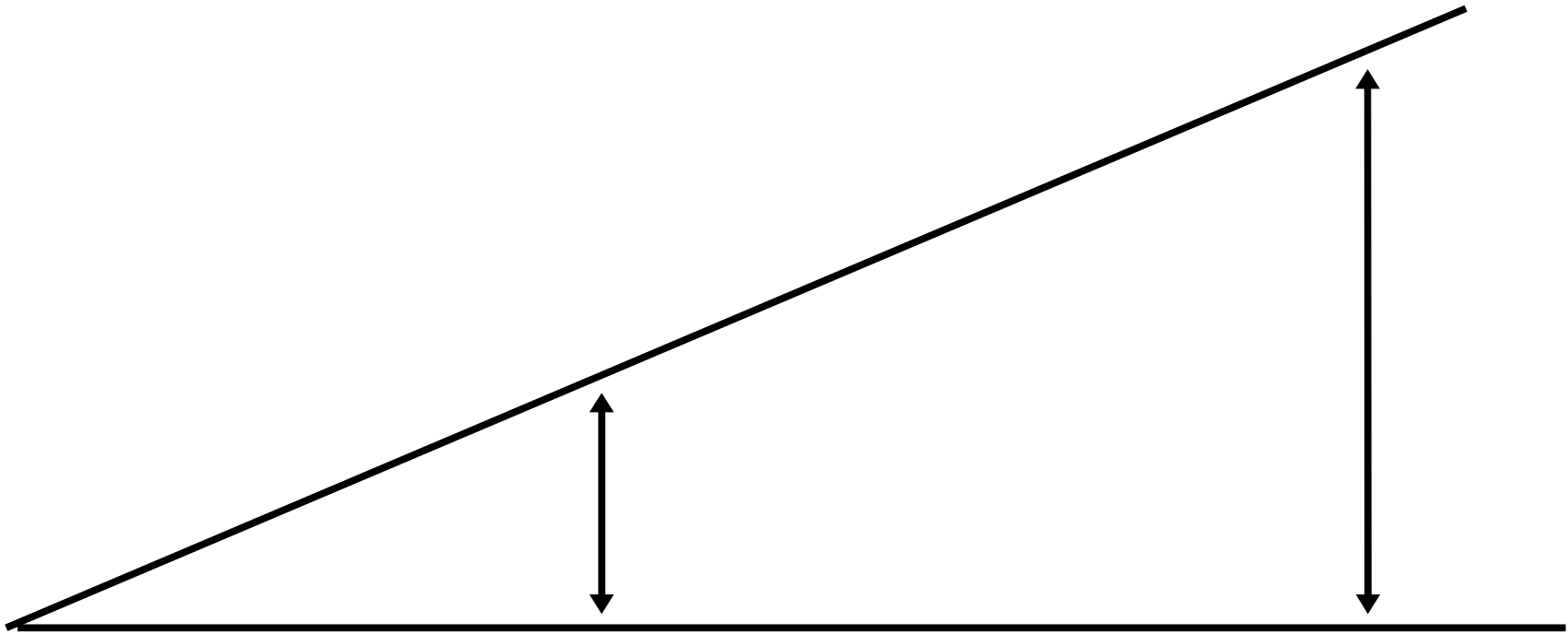
## **Moment arm:**

Distance between force and axis (d)

## **Moment:**

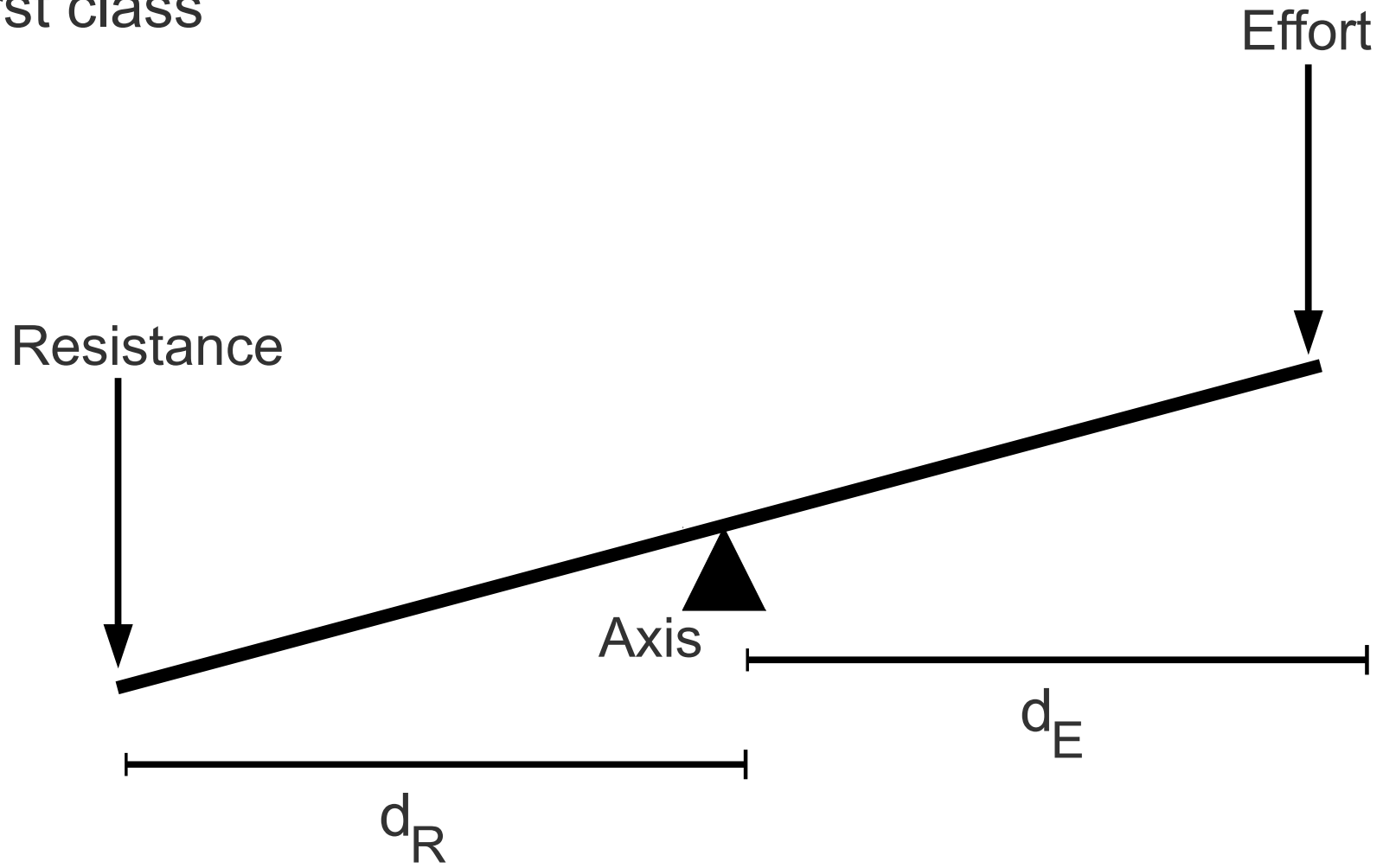
Another pencil example...

# Important concepts for levers

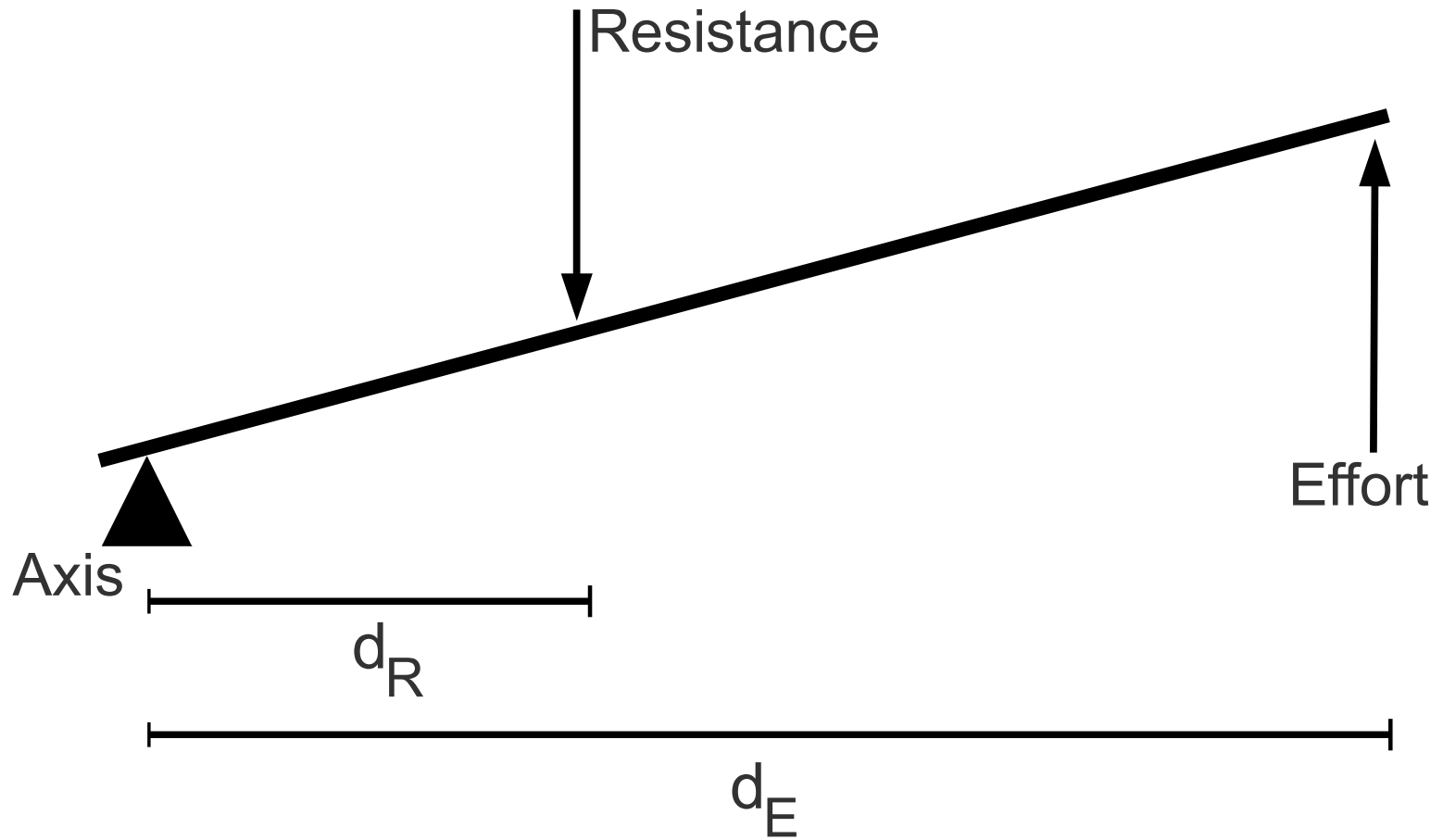


Same angle – different displacement

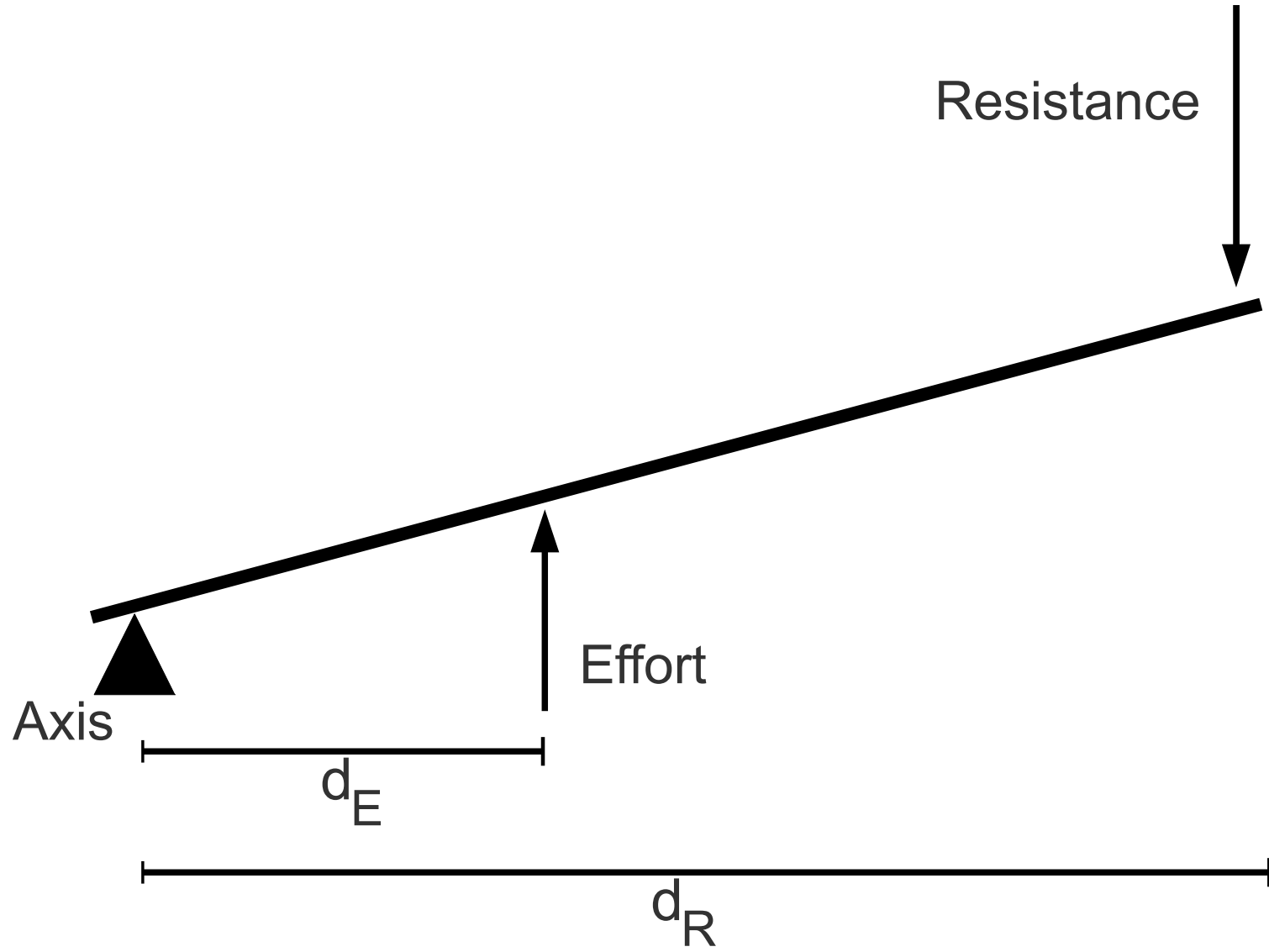
# First class

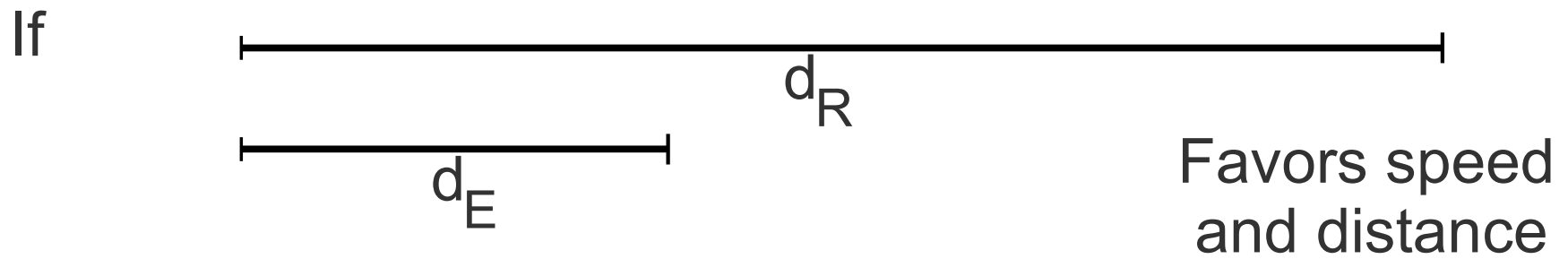
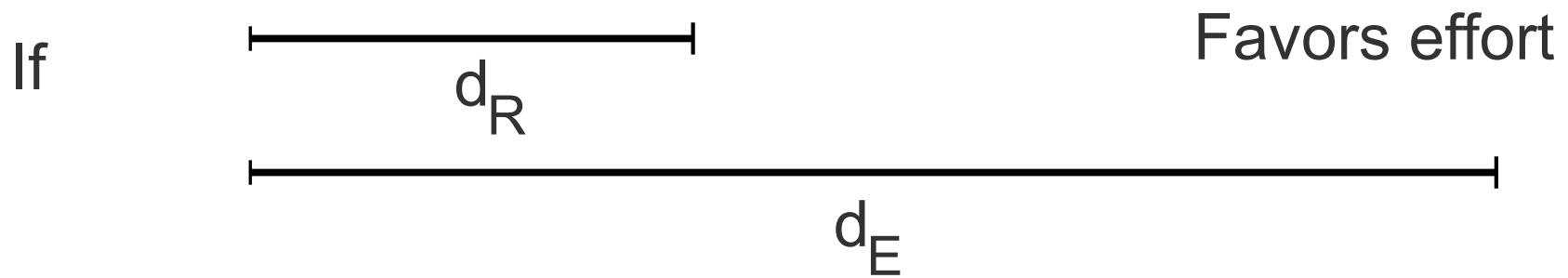
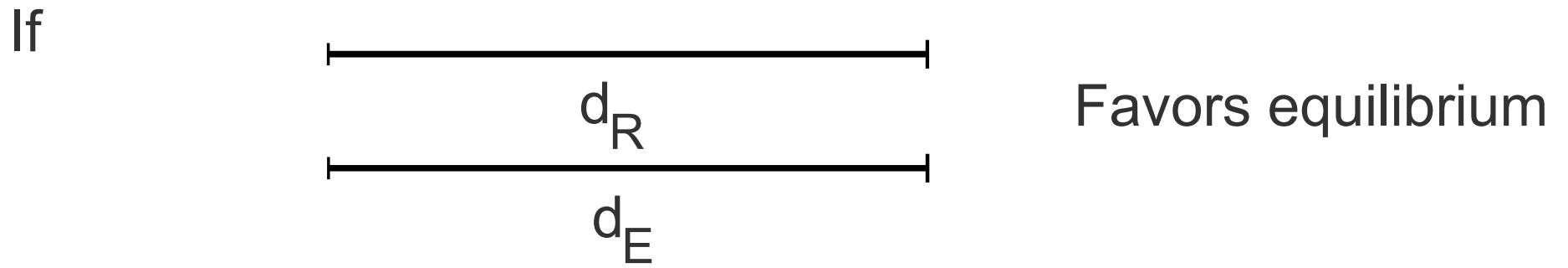


# Second class



# Third class





# For equilibrium:

effort x effort moment arm = resistance x resistance moment arm

$$\frac{\text{effort}}{\text{resistance}} = \frac{\text{resistance moment arm}}{\text{effort moment arm}}$$

For equilibrium:

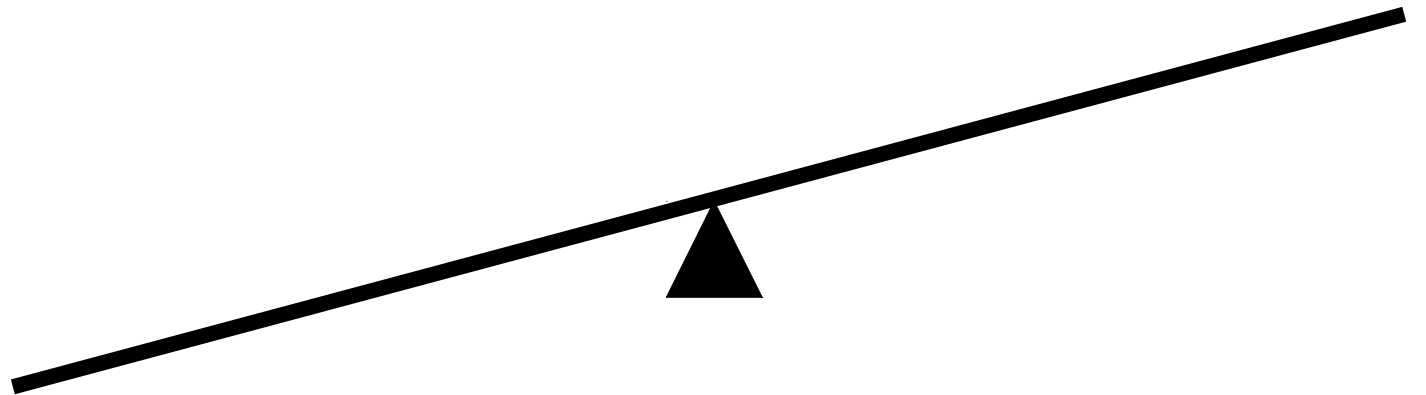
Sum of forces equal to zero

$$\Sigma F = 0$$

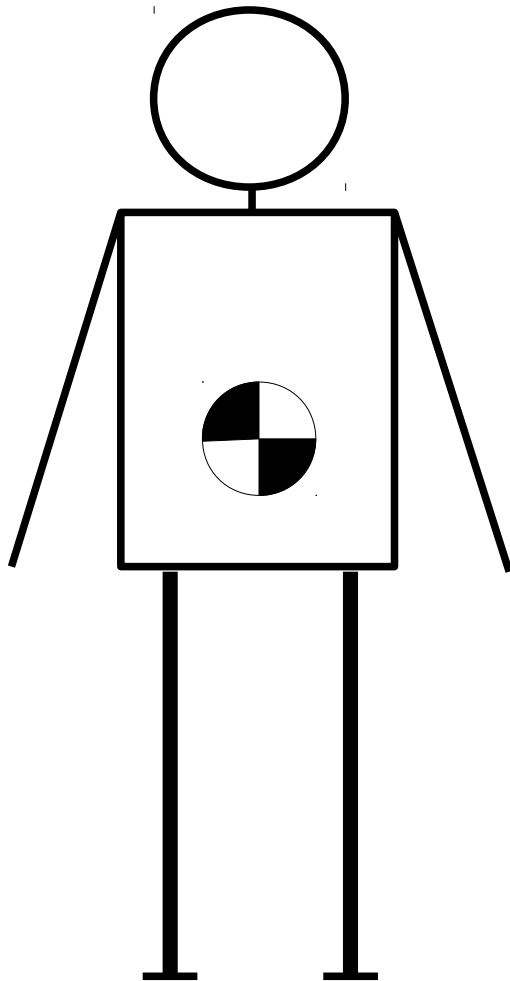
Sum of moments equal to zero

$$\Sigma M = 0$$

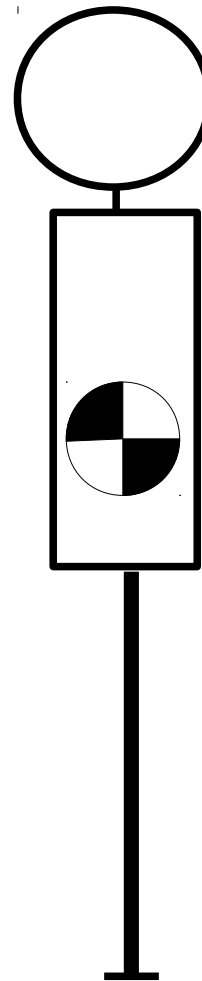
How do these concepts relate to humans?



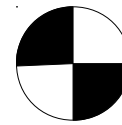
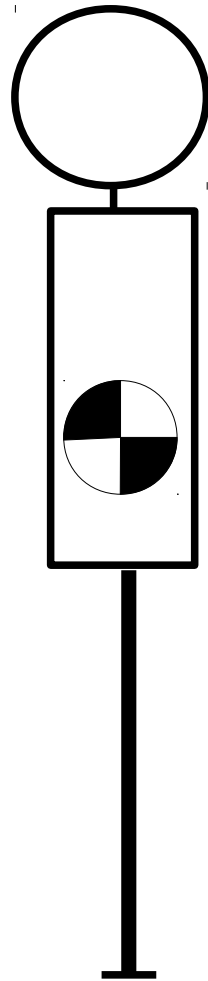
Front View



Side View



Side View

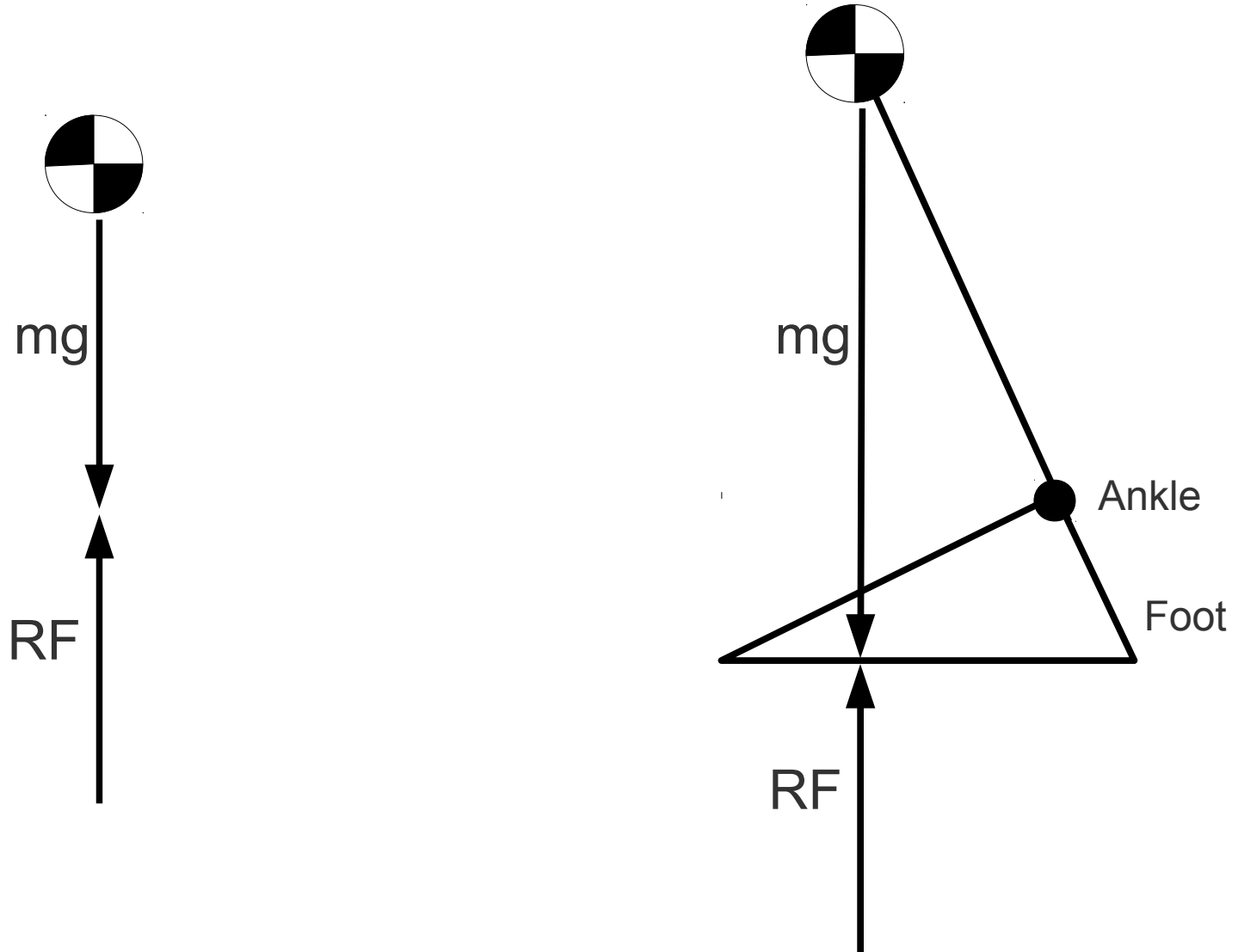


$mg$  (resistance)

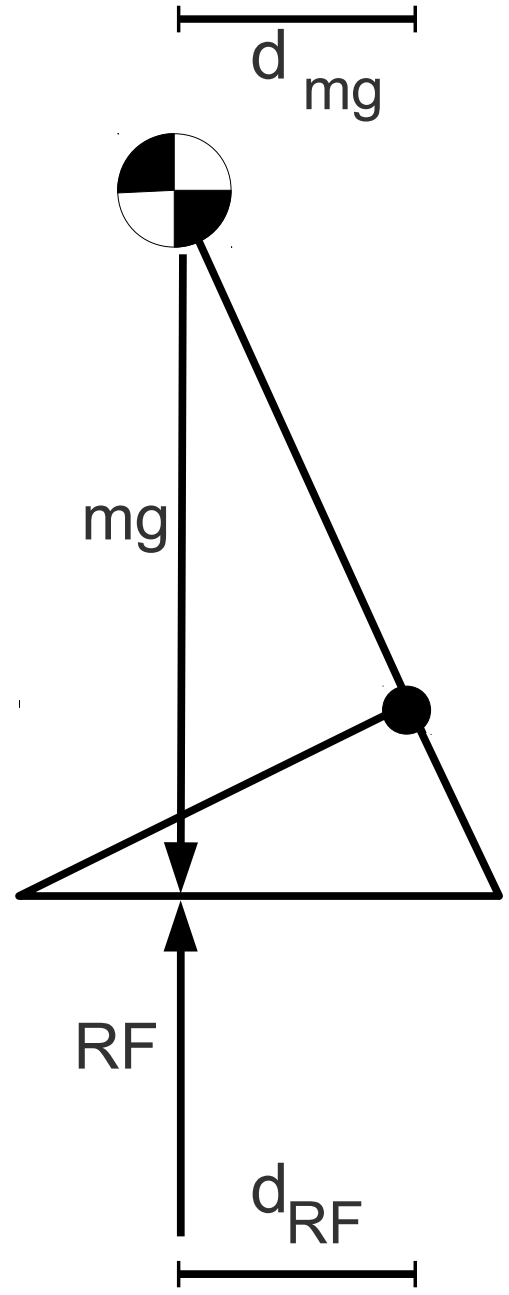


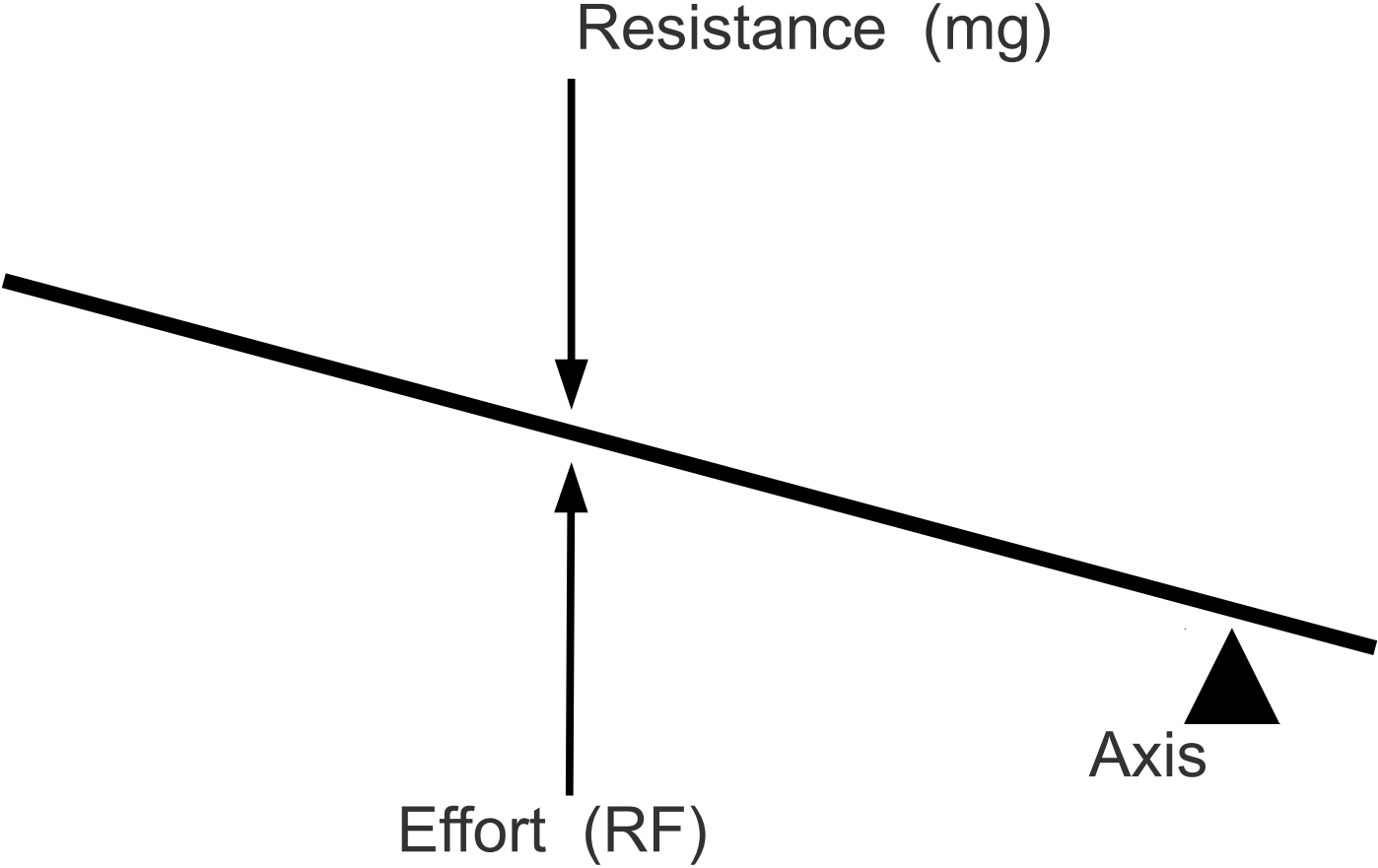
Reaction Force (RF)  
(effort)

# Side View



# Side View





Resistance (mg)



Effort (RF)



Axis

Side View

Balanced if:

$$mg + RF = 0$$

and

$$d_{mg} \times mg + RF \times d_{RF} = 0$$

