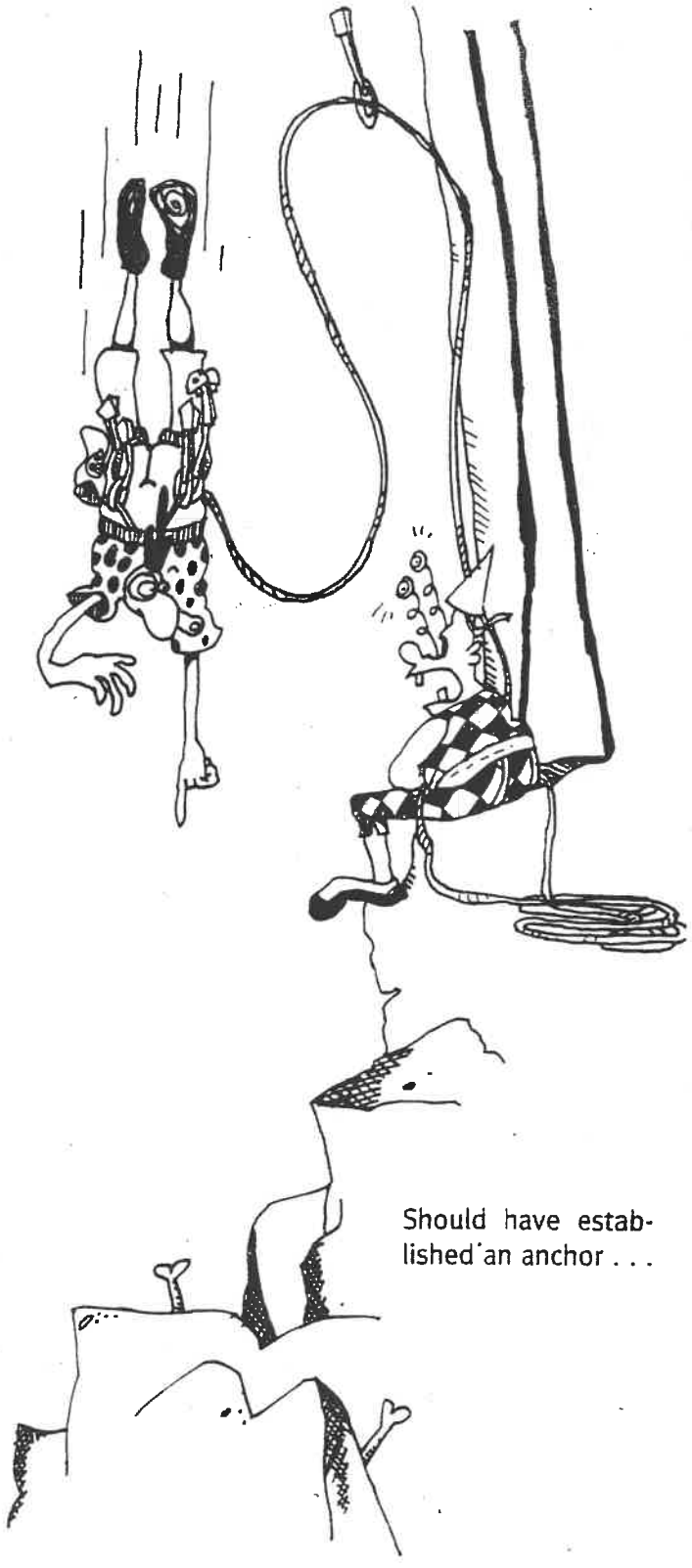


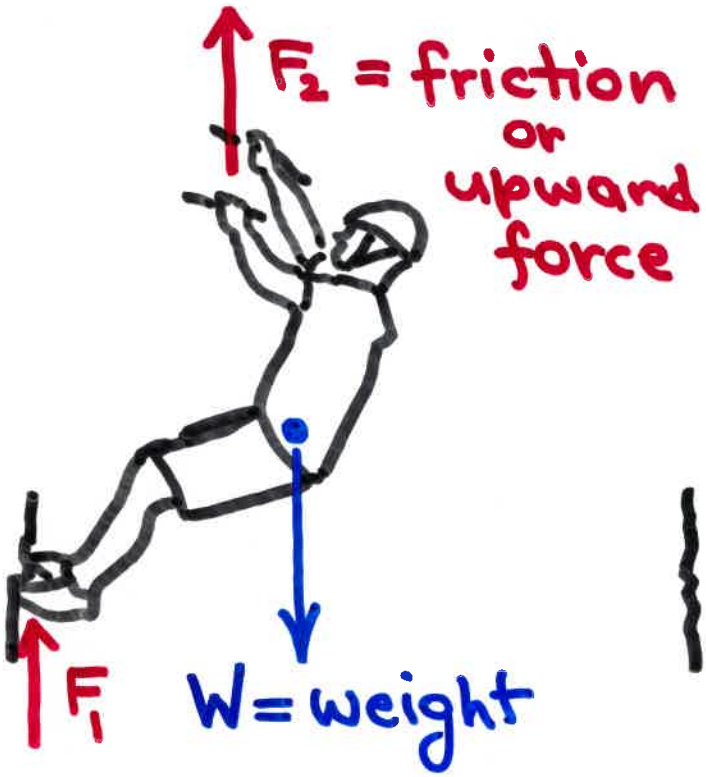
Should have established an anchor . . .

# The Physics of Climbing

The important physics concepts in climbing come from Newton's mechanics :

Force of gravity
Friction
Equilibrium of forces
Elastic forces
Impact forces
Force = Mass x Acceleration
Energy = Force x Distance

# Falling



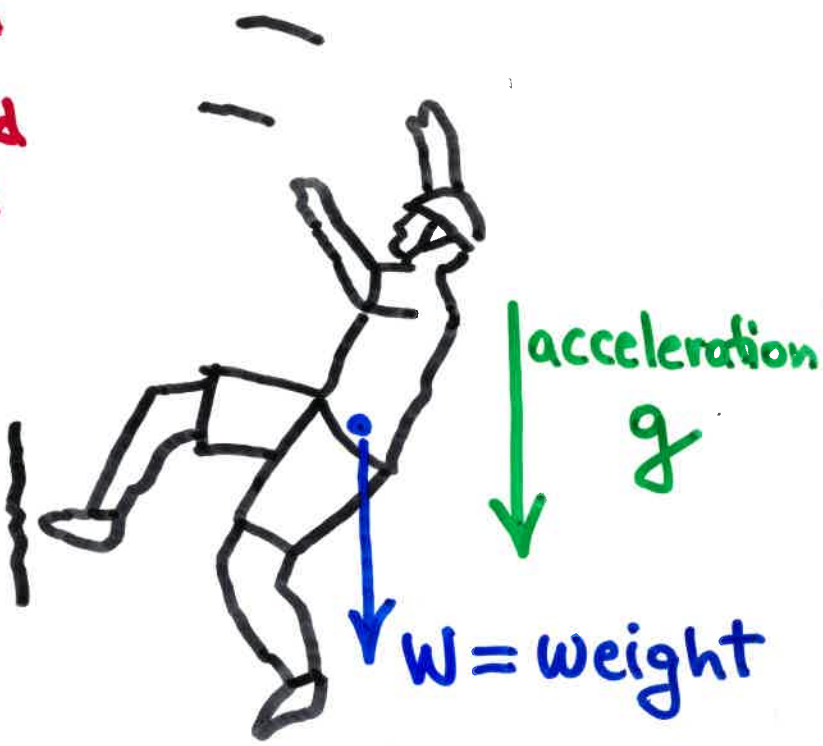

## in equilibrium

$$W = F_1 + F_2$$

or

$$W - (F_1 + F_2) = 0$$

net force = 0




## not in equilibrium

net force = $W \neq 0$

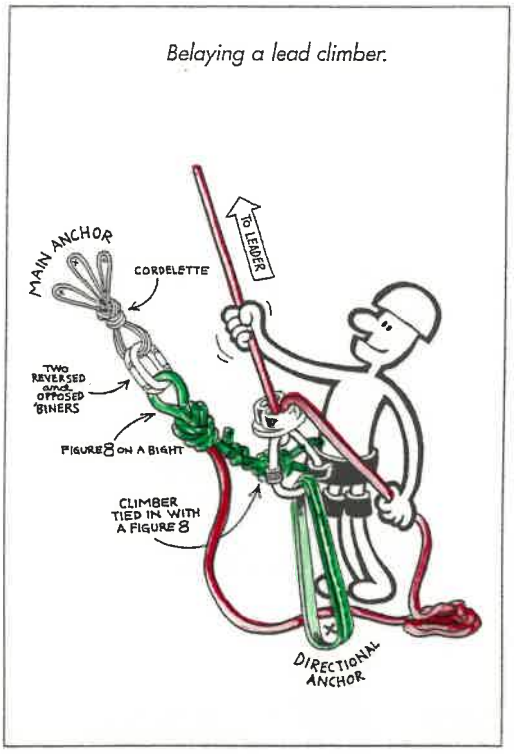
net force = (mass)(acceleration)

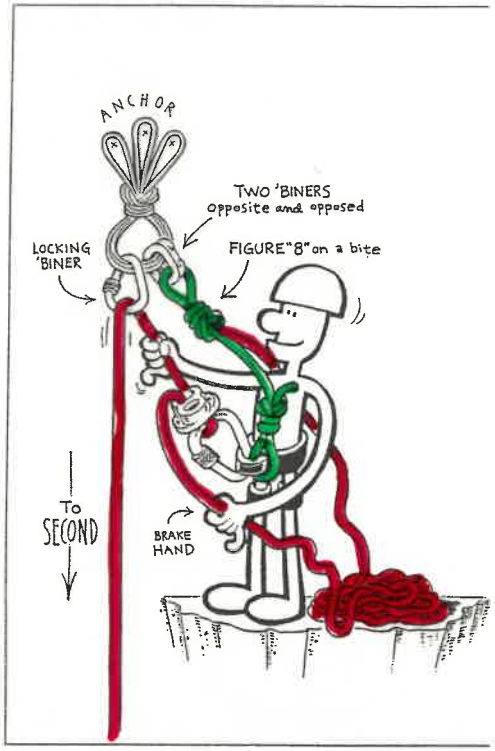
$$W = ma$$

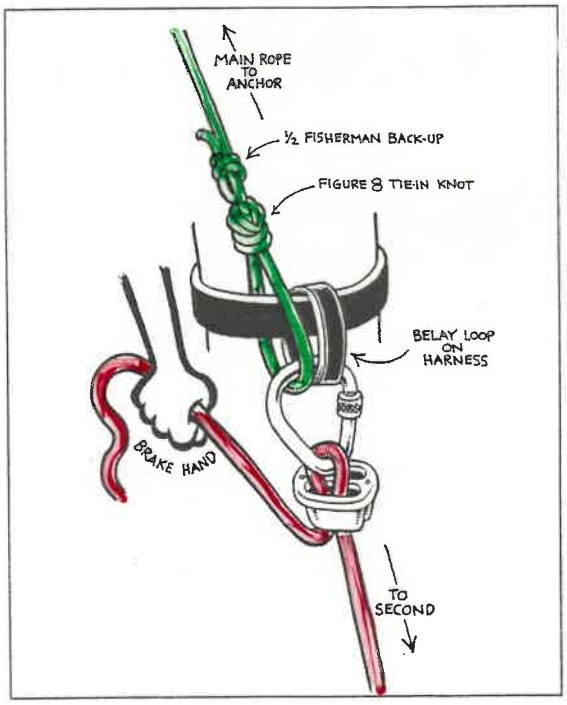
$$a = g = 9.8 \frac{m}{s^2} = 32 \frac{ft}{s^2}$$

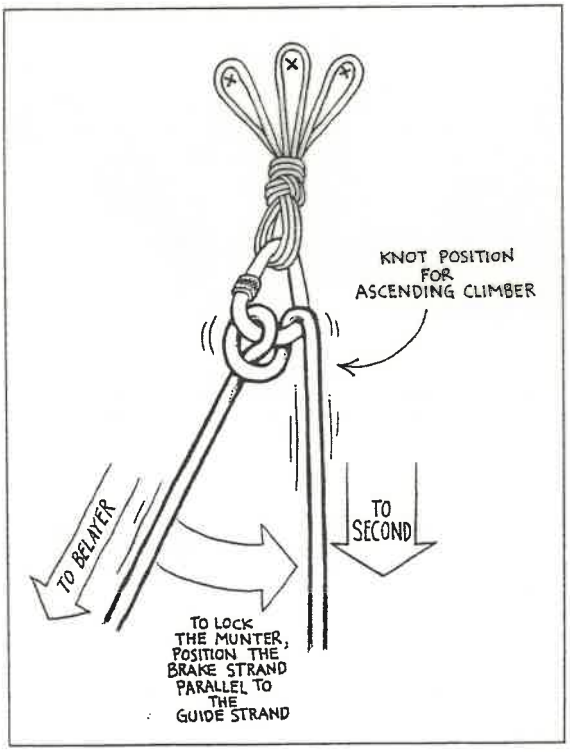
Acceleration due to gravity

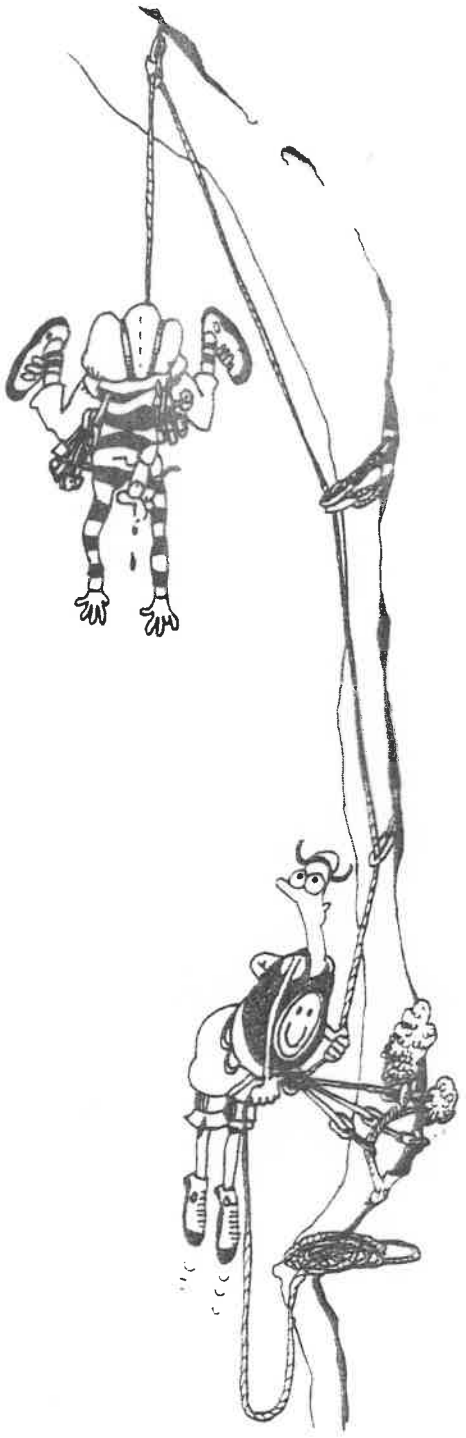
*Belaying a lead climber.*



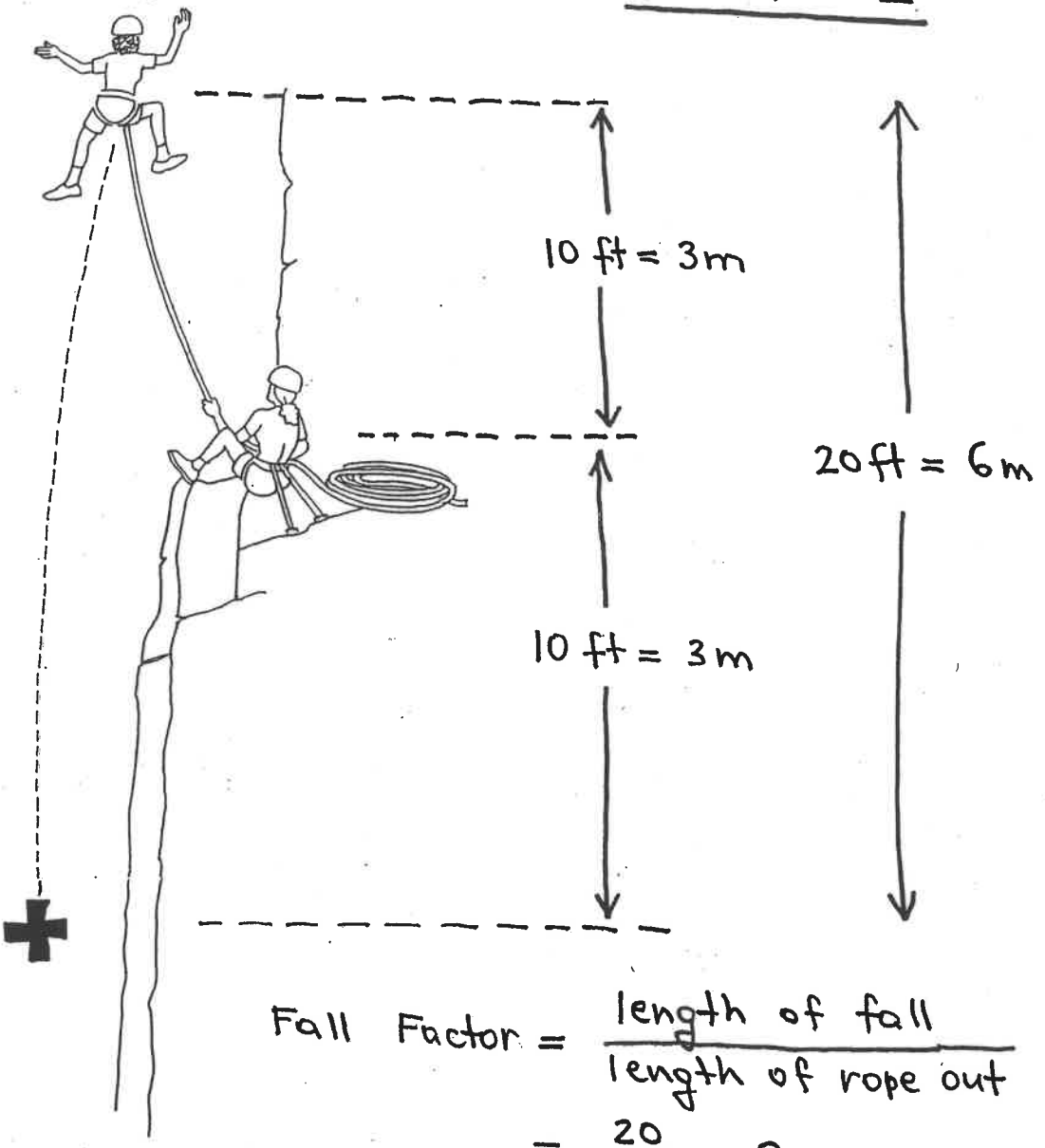





A multidirectional belay anchor withstanding upward and lateral forces

mass = m = 80 kg

## Example 1




$$\text{Fall Factor} = \frac{\text{length of fall}}{\text{length of rope out}}$$

$$= \frac{20}{10} = 2$$

Energy of fall = $mgh = (80)(10)(6) = 4{,}800$ J

stopping distance = length of rope x elongation

$= (3)(0.20) = 0.6$ m

$$\text{Force} = \frac{\text{Energy}}{\text{stopping distance}} = \frac{4{,}800}{0.6} = 8{,}000 \text{ N}$$

$= 8$ kN $= 1{,}800$ lbf