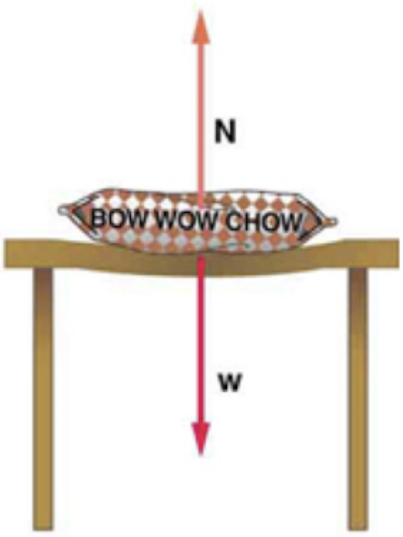
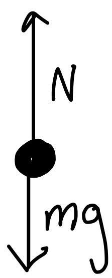
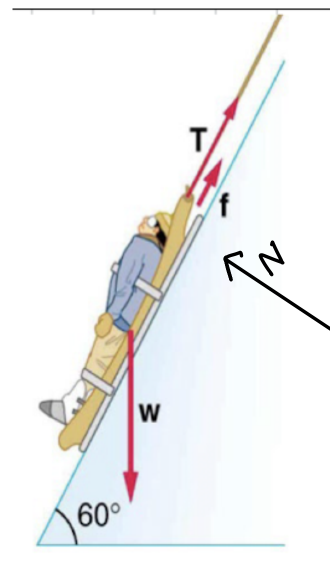
Forces

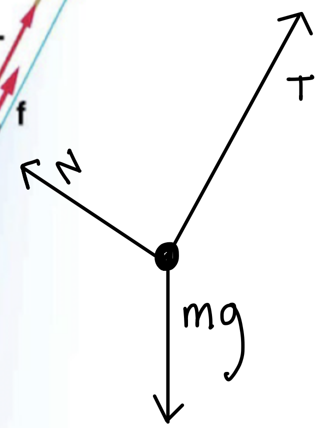
Free Body diagram

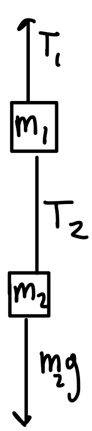
Draw the free-body diagrams for the images shown below

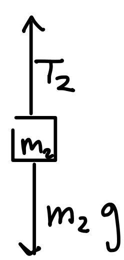


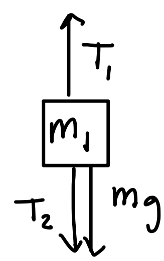










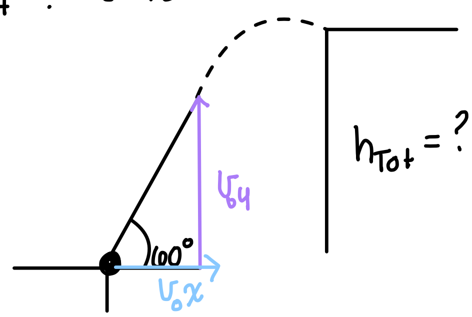


Practice

An arrow is shot from a height of 1.5 m toward a cliff of height H. It is shot with a velocity of 30 m/s at an angle of 60° above the horizontal. It lands on the top edge of the cliff 4.0 s later.

$U_o = 30 m/s$ $\theta = 60°$ $h_1 = 1.5m$ $h_2 = ?$ $h_{Tot} = ?$ $t = 4s$

$U_{oy} = 30 \sin 60°$ $U_{ox} = 30 \cos 60°$



(a) What is the height of the cliff?

$H_{Tot} = h_1 + h_2 = 1.5 + ?$

$y_2 = U_{oy} t + \frac{1}{2} g t^2$

$y_2 = 30 \sin 60 \cdot 4 + \frac{1}{2} \cdot -9.8 \cdot 4^2$

$y_2 \approx 26m$

$26m + 1.5m = 27.5m \approx 28m$

(b) What is the maximum height reached by the arrow along its trajectory?

$H_{max} = \frac{U^2}{2g} = \frac{26^2}{2 \cdot 9.8} = 34.5m \approx 35m$

(c) What is the arrow's impact speed just before hitting the cliff.

(1) $\cos\theta = \frac{a}{h}$

$U_{ix} = 30 \cos(60°) = 15 m/s$

$U_{fx} = U_{ix} = 15 m/s$

$U_{fy} = U_{iy} + at$

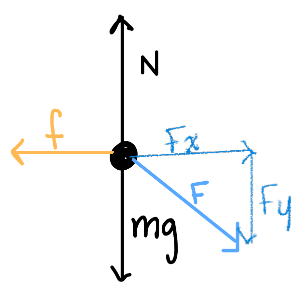
$U_{fy} = 26 + -9.8 \cdot 4$

$U_{fy} = -13 m/s$

$R = \sqrt{-13^2 + 15^2} = 20 m/s$

A nurse pushes a cart by exerting a force on the handle at a downward angle 35.0° below the horizontal. The loaded cart has a mass of 28.0 kg, and the force of friction is 60.0 N.

(a) Draw a free-body diagram for the system of interest.



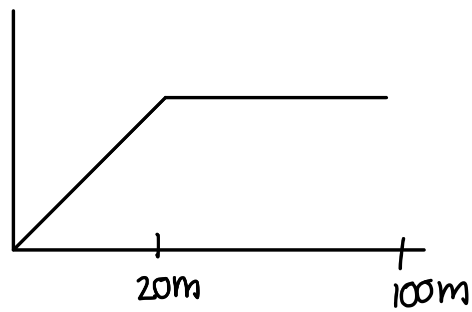
(b) What force must the nurse exert to move at a constant velocity?

A 63.0-kg sprinter starts a race with an acceleration of 4.20 m/s2. What is the net external force on him? If the sprinter then accelerates at that rate for 20 m, and then maintains that velocity for the remainder of the 100-m dash, what will be his time for the race?

$m = 63.0\ kg$ $a = 4.20\ m/s^2$ $d_1 = 20\ m$ $d_{Tot} = 100\ m$ $d_2 = d_T - d_1 = 80m$

(a) $F = ma$

$F = 63\ kg \cdot 4.2\ m/s^2 = 264N$



Step 1:

$t_1 = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2 \cdot 20}{4.2}} = 3.086s$

Step 2:

$v = v_0 + at = 4.2 \cdot 3.086 = 12.96\ m/s$

Step 3:

$t_2 = \frac{d_2}{v} = \frac{80}{12.96} = 6.17s$

Step 4:

$t_{Tot} = t_1 + t_2 = 3.86 + 6.17 = 9.26s$

A 63.0-kg sprinter starts a race with an acceleration of 4.20 m/s2. What is the net external force on him? If the sprinter then accelerates at that rate for 20 m, and then maintains that velocity for the remainder of the 100-m dash, what will be his time for the race?

mass = 63.0 kg
$a = 4.2\ m/s^2$
$d_1 = 20\ m$
$d = 100$

$F = ma = 63 \cdot 4.2 = 264N$

$t = \sqrt{\frac{2d_1}{a}} = \sqrt{\frac{2 \cdot 20}{4.2}} = 3.086s$

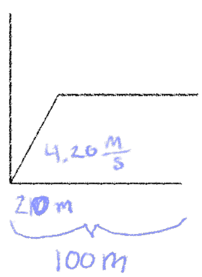
$V = V_0 + at_1$

$V = at_1 = 4.2 \cdot 3.086 = 12.96$

$d_2 = 100 - 20 = 80$

$t = t_1 + t_2 = 3.086 + 6.17 = 9.26s$

$t_2 = \frac{d_2}{V} = \frac{80}{12.96} = 6.17$



The net external force is 264.6N for a total time of about 9.26 s

$a_c = \frac{V}{t}$