P2

$v_0 = 0 \quad v = 10 \text{ m/s} \quad t = 0.20 \text{ s} \quad m = 0.5 \text{ kg}

What average force does the punter exert on the ball?

\[ F = ma \quad \text{(Newton II Law)} \]

Note that since \( F = ma \) is true at any point in time then it also applies to averages.

\[ \bar{a} = \frac{v - v_0}{\Delta t} = \frac{10 \text{ m/s}}{0.20 \text{ s}} = 50.0 \text{ m/s}^2 \]

\[ F = m\bar{a} = 0.5 \text{ kg} \times 50.0 \text{ m/s}^2 = 25.0 \text{ N} \]

P6

How long to increase speed from 0 to 80 km/h

\[ m = 1.5 \times 10^2 \text{ kg} \quad F = 7.5 \times 10^5 \text{ N} \]

\[ v_0 = 0 \quad v = 80 \text{ km/h} \quad a = ? \quad \Delta t = ? \]

Acceleration from Newton II

\[ F = ma \implies a = \frac{F}{m} = \frac{7.5 \times 10^5 \text{ N}}{1.5 \times 10^2 \text{ kg}} = 5.0 \times 10^{-2} \text{ m/s}^2 \]

Now

\[ a = \frac{v - v_0}{\Delta t} = \frac{v}{\Delta t} \implies \Delta t = \frac{v}{a} \]

\[ \Delta t = \left[ \frac{(80 \text{ km/h}) \times (1000 \text{ m})}{1 \text{ km}} \times \frac{1 \text{ km/h}}{3600 \text{ s}} \right] / (5.0 \times 10^{-2} \text{ m/s}^2) \]

\[ = 444.44 \text{s} = 7 \text{ min and 24 sec} \]
what total force to accelerate bullet?

\[ v_0 = 0 \quad v = 320 \text{ m/s} \quad m = 5.0 \text{ g} \quad \Delta x = 0.82 \text{ m} \]

force assumed constant \( \Rightarrow \) constant acceleration

use

\[ v^2 = v_0^2 + 2a\Delta x \]

then

\[ a = \frac{v^2}{2\Delta x} \quad \text{since} \ v_0 = 0 \]

\[ \text{NII: } F = ma \quad \Rightarrow \quad F = \frac{mv^2}{2\Delta x} \]

\[ F = \left(5.0 \times 10^{-3} \text{ kg}\right) \left(320 \text{ m/s}\right)^2 \]

\[ 2 \times 0.82 \text{ m} \]

\[ = 312.2 \text{ N} \]

force of wind: \( F_1 = 390 \text{ N} \text{ north} \)

water: \( F_2 = 180 \text{ N} \text{ east} \)

mass of boat: \( m = 270 \text{ kg} \)

what is the acceleration

choose coordinates \( x-y \) to be east-north

The resultant force \( \mathbf{F} = \mathbf{F}_1 + \mathbf{F}_2 \) has components

\[ F_x = F_{1x} + F_{2x} = F_{2x} = F_2 \]

\[ F_y = F_{1y} + F_{2y} = F_{1y} = F_1 \]

\[ F = \sqrt{F_x^2 + F_y^2} = \sqrt{180^2 + 390^2} = 429.5 \]

\[ \theta = \tan^{-1} \left( \frac{390}{180} \right) = 72.5^\circ \]

\[ a = \frac{F}{m} = \frac{1.6 \text{ m/s}^2}{\text{ }} \]

direction of \( a \) is the same as \( \mathbf{F} \): \( 72.5^\circ \text{ north of east} \)
Balance of forces applied to light fixture

Find the tension \( T, T_2 \)

1. \( T = 100 \text{N} \)
2. \( T_2 = 100 \text{N} \)
3. \( T_1 = T_2 \)
4. \( T = mg \)

Tension \( T \) balances weight of light fixture \( mg = 100 \text{N} \)