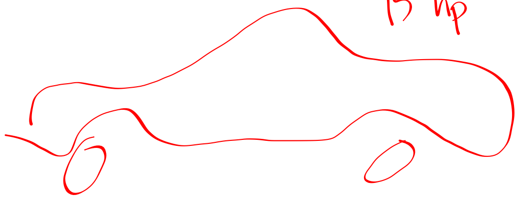
47. If a car generates 15 hp when traveling at a steady 80 km/h, what must be the average force exerted on the car due to friction and air resistance?



15 hp

$80\ \mathrm{km/hr} = 22.22\ \mathrm{m/s}$

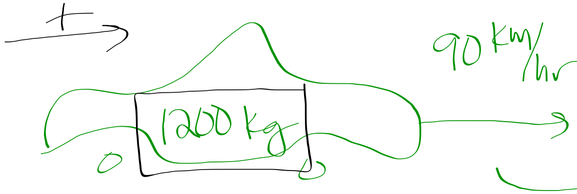
$$15\,\cancel{hp} \cdot \frac{750\,W}{\cancel{hp}} = 11{,}250\,W$$

$$P = F \cdot v \quad (v \text{ is constant})$$

$$11{,}250 = F \cdot 22.2$$

$$F = 507\ N$$

51. A 1200-kg car slows down from 90 km/h to 70 km/h in about 5.0 seconds on the level when it is in neutral. Approximately what power (watts and hp) is needed to keep the car traveling at a constant 80 km/h?



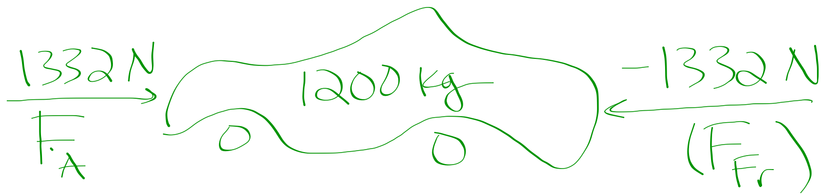

$90\,km/hr = \overset{v_0}{25}\,m/s \qquad 70\,km/hr = \overset{v}{19.44}\,m/s$

$5\,s = t$

$$v = v_0 + at$$

$$a = \frac{\Delta v}{\Delta t} = \frac{19.44 - 25}{5} = -1.11\ m/s^2$$

$$\Sigma F = ma = (1200)(-1.11)$$
$$= 1332\ N = F_{Fr}$$




= constant velocity

$$P = F \cdot v \quad (v \text{ is constant})$$
$$= (1332)\left(80\,km/hr \cdot \frac{1\,m/s}{3.6\,km/hr}\right) = 29{,}600\ W$$

There is a term in physics for an object's "bashing power":

# MOMENTUM

Momentum: $\vec{p} = m\vec{v}$ $\left(kg \cdot {}^{m}/_{s}\right)$ OR $\left(SLUG \, {}^{ft}/_{s}\right)$

momentum

# Why is the concept of momentum helpful?

$$\Sigma F = ma$$

$$\text{But } a = \frac{v - v_0}{\Delta t}$$

$$\text{So } \Sigma F = m\left(\frac{v - v_0}{\Delta t}\right) = \frac{mv - mv_0}{\Delta t}$$

$$\Sigma F = \frac{\Delta p}{\Delta t}$$

$$\boxed{\Sigma F = \frac{\Delta p}{\Delta t}}$$

Newton's 2nd Law as he thought about it -- in terms of **momentum**

$$\Sigma F = \frac{\Delta p}{\Delta t}$$ Why is this form useful?

1. Cases of changing mass can be considered. (F = ma is not helpful if mass is changing ...)

2. Momentum is conserved ($p_o = p_f$) when the sum of all forces acting on an object/system is zero. This gives us a new equation to use to find masses and/or velocities.

WHEN $\Sigma F = 0$

Law of conservation of momentum

$$\underbrace{m_1'v_1' + m_2'v_2' \ldots}_{\text{INITIAL MOMENTUM OF THE SYSTEM}} = \underbrace{m_1 v_1 + m_2 v_2 \ldots}_{\text{FINAL MOMENTUM OF THE SYSTEM}}$$

$v_1'$ = FINAL VELOCITY OF OBJECT #1

$v_2'$ = " " " " #2

EXAMPLE #1: A 30-g object gliding at 148 cm/sec across a frictionless surface strikes a 200-g object that is motionless. If the 1st object bounces off the 2nd object so that it is travelling at 80 cm/sec in the opposite direction of its original motion, what is the new velocity of the 2nd object? (Are there external forces?)

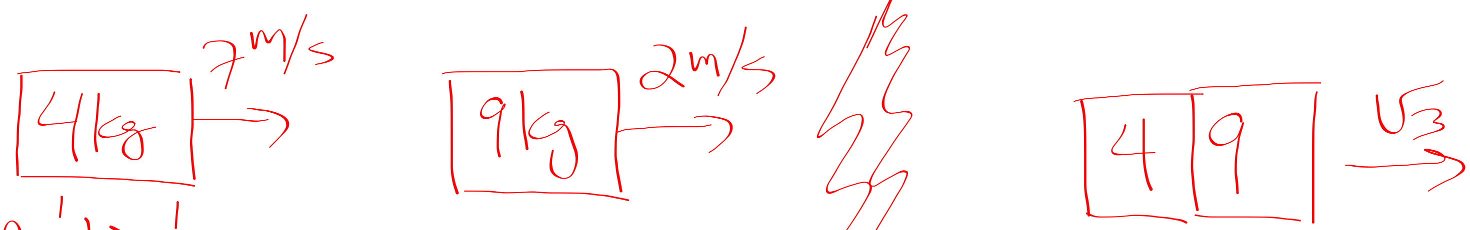
$\xrightarrow{+}$


$$m_1' v_1' + m_2' v_2' = m_1 v_1 + m_2 v_2$$

$$(30)(148) + 0 = (30)(-80) + 200 v_2$$

$$v_2 = 34.2 \text{ cm/s}$$

EXAMPLE 2: These two objects collide and stick together, what is their final speed? (Are there external forces?)

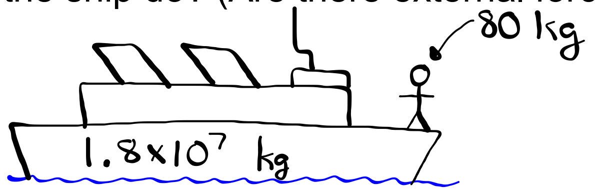



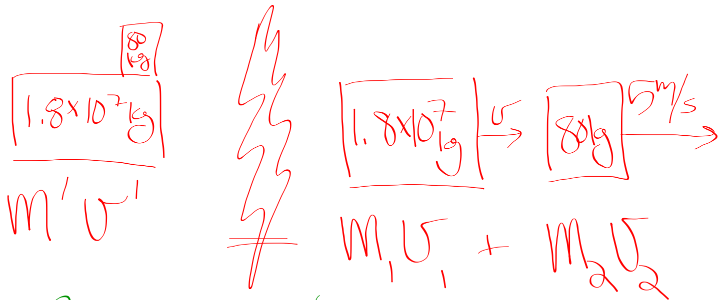

$$m_1 v_1 + m_2 v_2 = m_3 v_3$$

$$(4)(7) + (9)(2) = 13 v_3$$

$$v_3 = 3.54 \text{ m/s}$$

EXAMPLE #3: The person and ship are initially motionless. If the person jumps off horizontally at 5 m/s to the right. What will the ship do? (Are there external forces?)




$$m'v' = m_1 v_1 + m_2 v_2$$

$$0 = (1.8\times10^{7})v_1 + (80)(5)$$

$$v_1 = \frac{-(80)(5)}{(1.8\times10^{7})} = 2.2\times10^{-5}$$