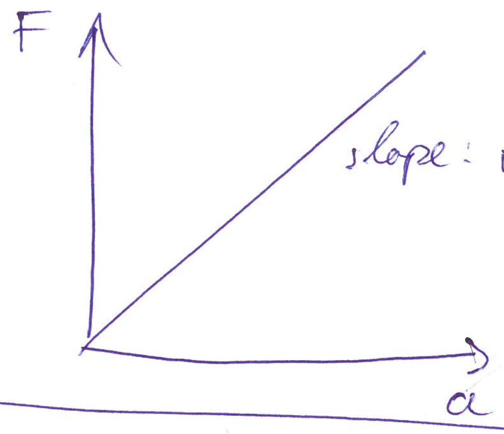
- gravitation
- electric interaction
- (strong interaction
- weak interaction)

	Aristotle	Newton
equilibrium	rest	rest OR constant velocity
process	motion	acceleration

$$F = m \cdot a$$

$[m] = kg$

$[F] = [m] \cdot [a] = kg \cdot \frac{m}{s^2} = N$



IV/2 $m = 1500\ kg$

$v_0 = 0$

$v_1 = 100 \frac{km}{h} = 27{,}78 \frac{m}{s}$

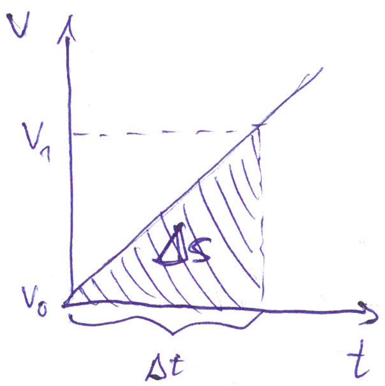
$\Delta t = 3{,}1\ s$

a) $F = m \cdot a = m \cdot \frac{\Delta v}{\Delta t} = m \cdot \frac{v_1 - v_0}{\Delta t} = 1500\ kg \cdot \frac{27{,}78 \frac{m}{s}}{3{,}1\ s} = 13\ 441 \underbrace{kg \frac{m}{s^2}}_{N}$

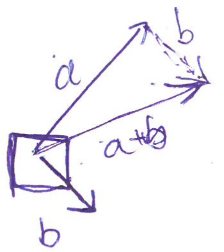
b) $\Delta s = \frac{\Delta t \cdot \Delta v}{2}$

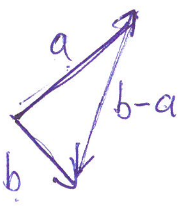
$= \frac{3{,}1\ s \cdot 27.78 \frac{m}{s}}{2}$

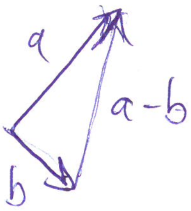
$= \underline{\underline{43.1\ m}}$



Vectorial sum of forces: we care about magnitude and direction

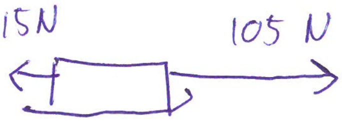






IV/5

$\Delta t = 5 s$
$v_0 = 0$
$F = 105 N$
$m = 25 kg$
$F_{fr} = 15 N$



$$\Sigma F = 105 N - 15 N = 90 N$$

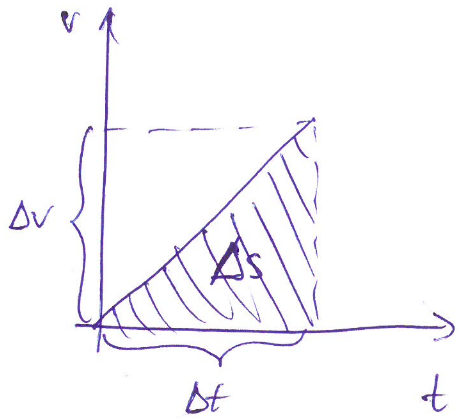
$$\frac{kg \frac{m}{s^2}}{kg}$$

a) $\Sigma F = m a \rightarrow a = \frac{\Sigma F}{m} = \frac{90 N}{25 kg} = 3.6 \frac{m}{s^2}$

b) $a = \frac{\Delta v}{\Delta t} \rightarrow \Delta v = a \cdot \Delta t = 3.6 \frac{m}{s^2} \cdot 5 s = 18 \frac{m}{s}$

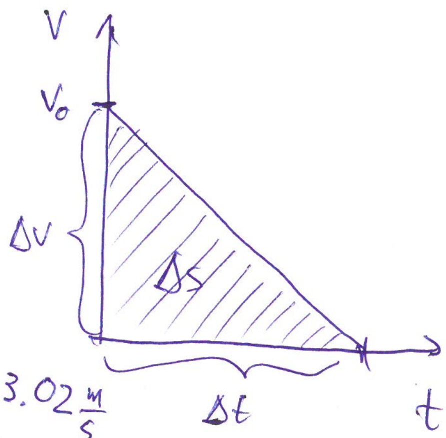
$$v_1 = v_0 + \Delta v = 0 + 18 \frac{m}{s} = 18 \frac{m}{s}$$

c) $\Delta s = \frac{\Delta v \cdot \Delta t}{2} = \frac{18 \frac{m}{s} \cdot 5 s}{2} = 45 m$



IV/6

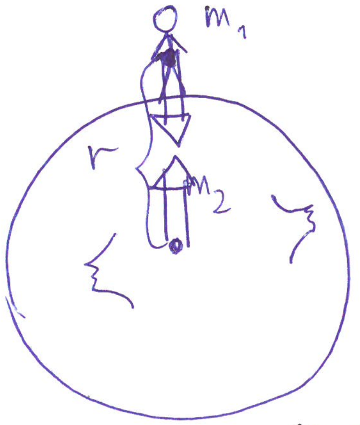
$m = 20 kg$
$\Delta t = 6.1 s$
$\Delta s = 9.2 m$
$v_0 = ?$
$v_1 = 0$



a) $\Delta s = \frac{\Delta v \cdot \Delta t}{2} \rightarrow |\Delta v| = \frac{\Delta s \cdot 2}{\Delta t} = \frac{9.2 m \cdot 2}{6.1 s} = 3.02 \frac{m}{s}$

b) $|a| = \frac{|\Delta v|}{\Delta t} = \frac{3.02 \frac{m}{s}}{6.1 s} = 0.494 \frac{m}{s^2}$

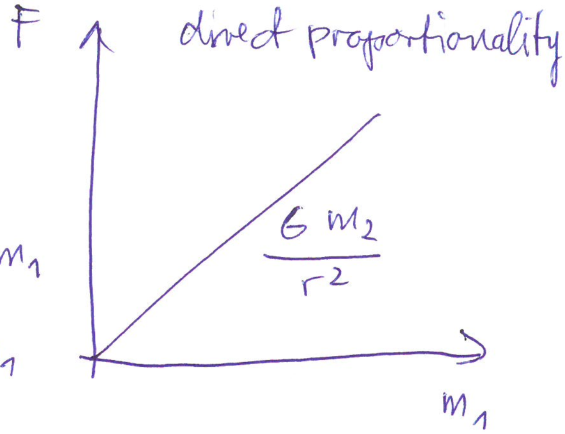
c) $F = m \cdot a = 20 kg \cdot 0.494 \frac{m}{s^2} = 9.89 \frac{m}{s^2} \cdot kg = 9.89 N$

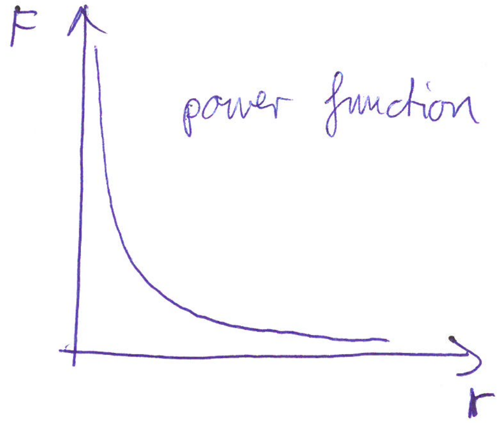


$$F = G\frac{m_1 m_2}{r^2}$$

$$F = \underbrace{\frac{G m_2}{r^2}}_{\text{fixed}} \cdot m_1$$

$$= g \cdot m_1$$



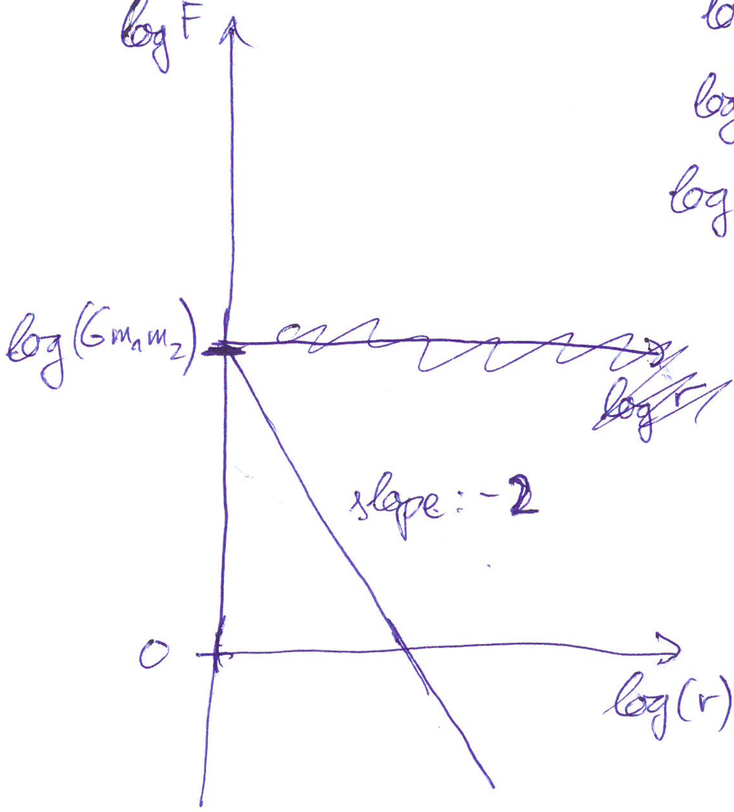


$$F = \underbrace{G \cdot m_1 \cdot m_2}_{\text{fixed}} \cdot r^{-2}$$

$$\log F = \log\left(G m_1 m_2 \cdot r^{-2}\right)$$

$$\log F = \log\left(G m_1 m_2\right) + \log\left(r^{-2}\right)$$

$$\log F = \log\left(G m_1 m_2\right) - 2\log(r)$$



IV/8

$m_1 = 200\,000\ t = 2\times 10^8\ kg$

$m_2 = 300\,000\ t = 3\times 10^8\ kg$

$r = 2\ km = 2\times 10^3\ m$

$$F = G\cdot\frac{m_1 m_2}{r^2} = 6.67\times 10^{-11}\ \frac{m^3}{kg\cdot s^2}\cdot\frac{2\times10^8\ kg \times 3\times 10^8\ kg}{(2\times 10^3\ m)^2} = 1.\ \ kg\frac{m}{s^2}$$

[mass] kg	[gravity] N	[weight] N
"resistance" against acceleration & source of gravitation	force by which an object (with a certain mass) is attracted by ~~a~~ gravitation	a force by which an object pushes or pulls a surface

in free space (interstellar):

mass	gravity	weight
✓	✗	✗

freely falling on a planet

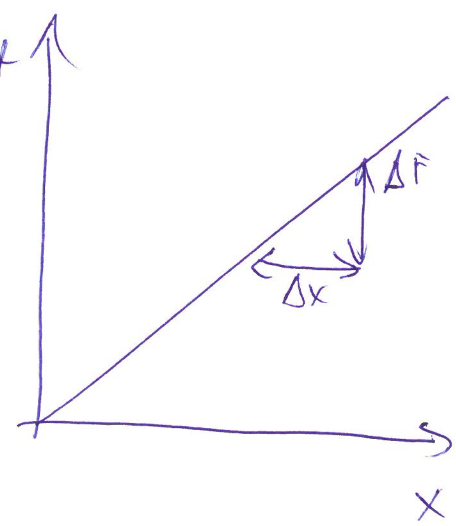
mass	gravity	weight
✓	✓	✗

lying on the desk

mass	gravity	weight
✓	✓	✓
m	$g \cdot m$	

Hooke: $F = -k\,x$

$$[k] = \frac{[\Delta F]}{[\Delta x]} = \frac{N}{m} = \frac{kg\,\frac{m}{s^2}}{m} = \frac{kg}{s^2}$$



$$\frac{\Delta F}{\Delta x} = k$$

IV/11

$m = 2\,kg$

$\Delta x = 25\,cm = 0.25\,m$

$$k = \frac{\Delta F}{\Delta x} = \frac{m \cdot g}{\Delta x} = \frac{2\,kg \cdot 9.81\,\frac{m}{s^2}}{0.25\,m} = 78.5\,\frac{N}{m}$$