Hvilke klør klyper hardest?

Evolutionary variation in the mechanics of fiddler crab claws

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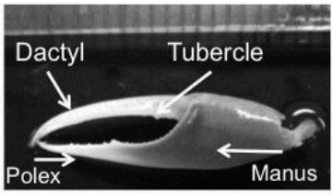
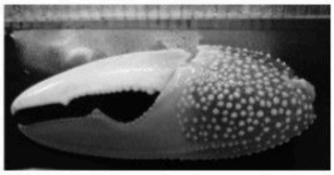
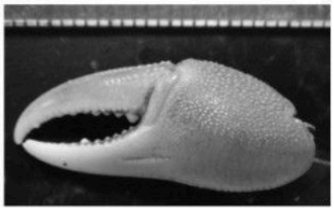


Uca terpsiochres

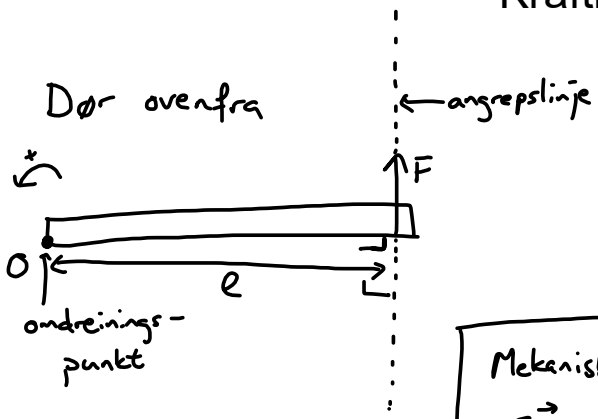


Uca stylifera



Uca argolicola

Kraftmoment M



kraft x arm

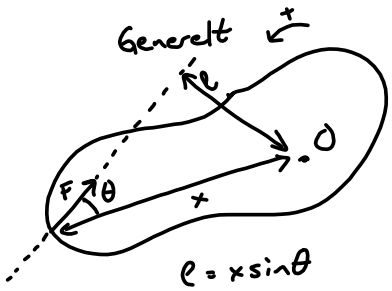
$M_0 = Fe$

$[M] = Nm$

Mekanisk likevekt

$\Sigma \vec{F} = 0$

$\Sigma M_0 = 0$

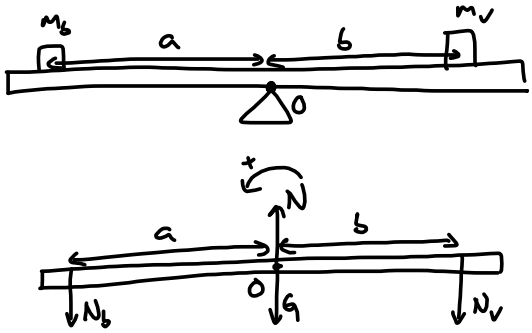


$e = x \sin\theta$

$M_0 = -Fx\sin\theta$

Likevekt

Samsnakk: Et barn (40 kg) og en voksen (80 kg) sitter på en dumphuske. Hvordan skal de sitte for å få dumpa i balanse?



m_b m_v

bare barnet

$\Sigma M_o = 0$

$N_b a - N_v b = 0$

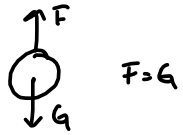
$N_b a = N_v b$

$$\frac{a}{b} = \frac{N_v}{N_b} = \frac{m_v g}{m_b g} = \frac{80\,kg}{40\,kg} = 2$$

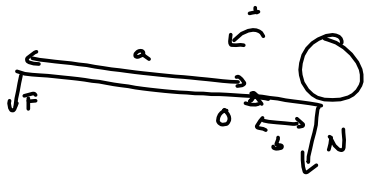
$a = 2b$

Vektstangprinsippet

løfte noe rett opp:



$F = G$

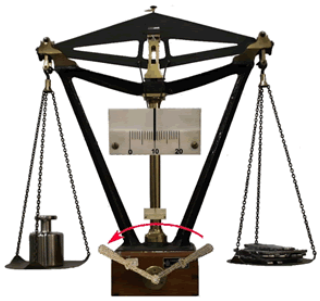


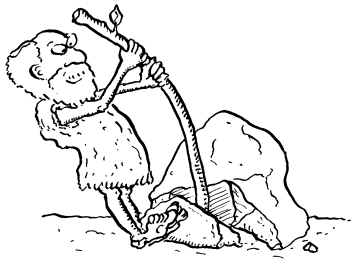
$\Sigma M_0 = 0$

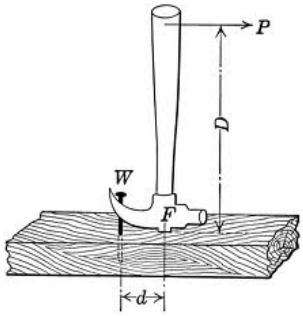
$Fa = Nb \qquad N = G$

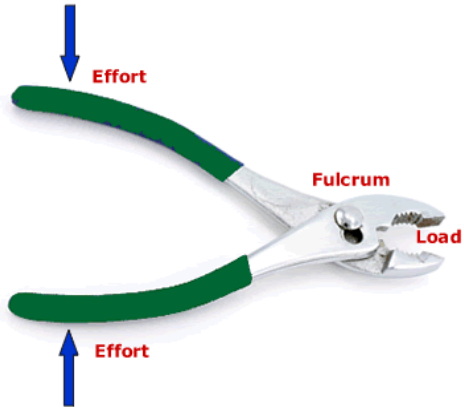
$F = G\frac{b}{a} \qquad a > b$

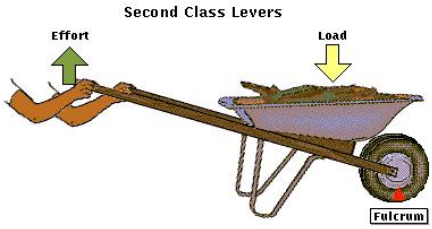
$\frac{b}{a} < 1 \Rightarrow F < G$





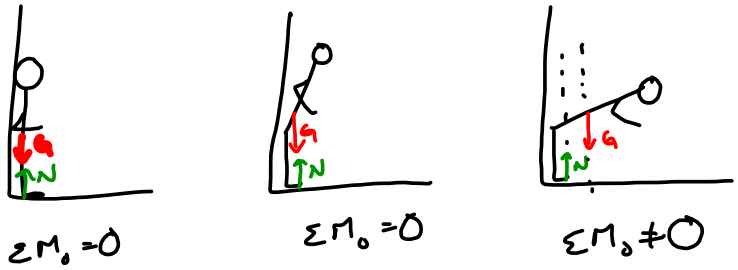

P
W
F
d


Effort
Fulcrum
Load
Effort


Second Class Levers
Effort
Load
Fulcrum

Tyngdepunkt

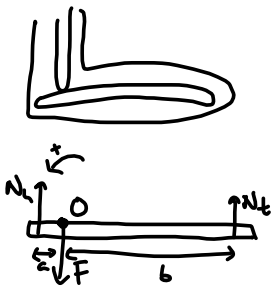
Massesentrum



Foten som vektstang

Samsnakk: Du står på en fot. Tegn kreftene som virker på foten.

Tips: Tåballen og hælen er nedi bakken.



$F = mg$

hva er N_h og N_t

$\Sigma F_y = 0$

$N_h + N_t = F = mg$

$\Sigma M_0 = 0$

$-N_h a + N_t b = 0$

$N_h a = N_t b$

$N_h = N_t \frac{b}{a}$

$a = 4cm \quad b = 16cm$

$N_h = N_t \frac{16cm}{4cm} = 4N_t$

$4N_t + N_t = mg$

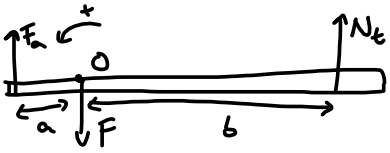
$5N_t = mg$

$N_t = \frac{1}{5} mg$

$N_h = \frac{4}{5} mg$

Foten som vektstang - på tå

Samsnakk: Du løfter opp hælen. Tegn kreftene som virker på foten.



$\Sigma M_o = 0$

$F_a a = N_t b$

$F_a = 4N_t$

$F_a = 4mg$

Hva er F og F_a?

hele kroppen

$\Sigma F_y = 0$

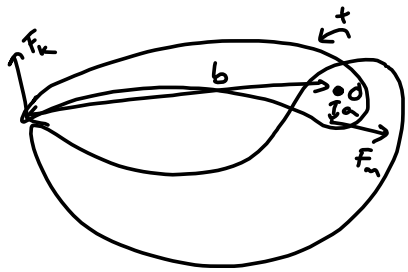
$N_t = G = mg$

Foten: $\Sigma F_y = 0$

$F_a - F + N_t = 0$

$F = F_a + N_t = 4mg + mg = 5mg$

Hvilke klør klyper hardest?



$\Sigma M_o = 0$

$F_m a - F_k b = 0$

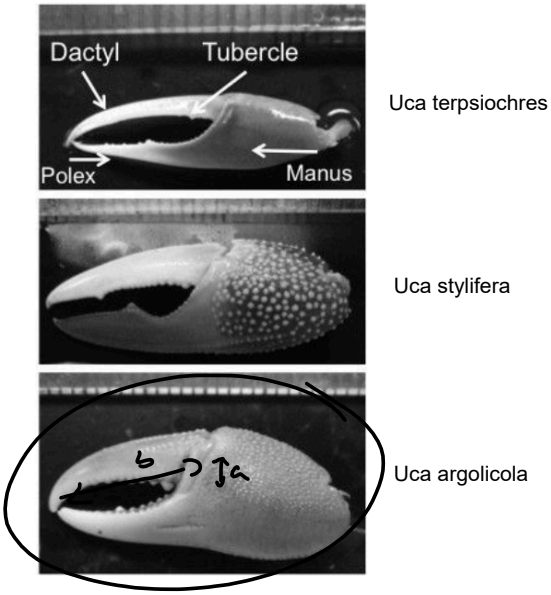
$F_k = F_m \frac{a}{b}$

F_k stor

⇓

a stor

b liten



Uca terpsiochres

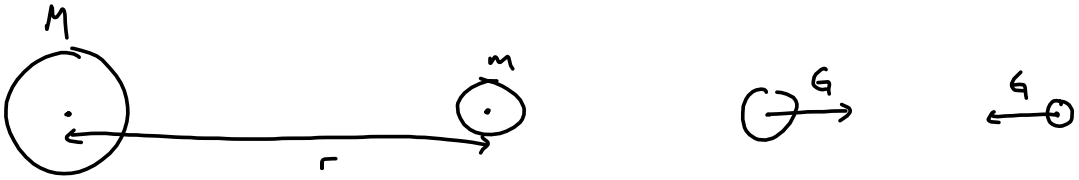
Uca stylifera

Uca argolicola

Hvorfor er det 365 dager i et år?

Bilde: NASA

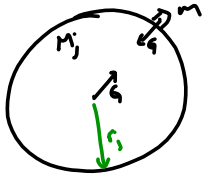
Newtons gravitasjonslov



$$G = \frac{\gamma M m}{r^2}$$

$\gamma = 6{,}67 \cdot 10^{-11}\ m^3/kg\,s^2$

På jord:



$M_j = 5{,}972 \cdot 10^{24}\ kg$

$r_j = 6371\ km$

$$G = \frac{\gamma M_j m}{r_j^2} = mg$$

$$g = \frac{\gamma M_j}{r_j^2} = 9{,}81\ m/s^2$$

ekvator: $r_j = 6378\ km \Rightarrow g = 9{,}79\ m/s^2$

nordpolen: $r_j = 6357\ km \Rightarrow g = 9{,}86\ m/s^2$

10 km opp (fly) $\Rightarrow g = 9{,}78\ m/s^2$

408 km opp (ISS) $\Rightarrow g = 8{,}66\ m/s^2$

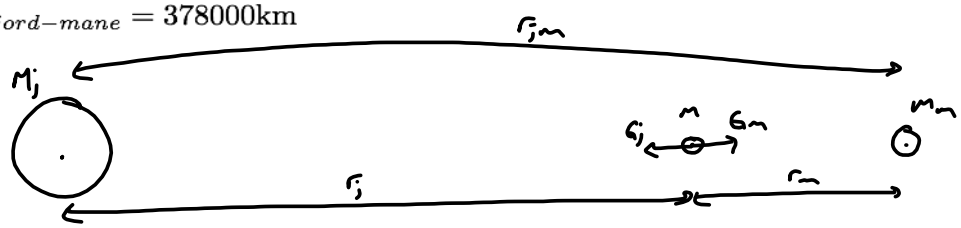
Samsnakk:

Hvor er kraften fra månen like stor som kraften fra jorda?

$m_{jord} = 6 \times 10^{24}\text{kg}$

$m_{mane} = 7 \times 10^{22}\text{kg}$

$r_{jord-mane} = 378000\text{km}$



$$G_j = \frac{\gamma M_j m}{r_j^2}$$

$$G_m = \frac{\gamma M_m m}{r_m^2}$$

$$G_j = G_m$$

$$\frac{\gamma M_j \cancel{m}}{r_j^2} = \frac{\gamma M_m \cancel{m}}{r_m^2}$$

$$r_m^2 = r_j^2 \frac{M_m}{M_j}$$

$$r_m = r_j \sqrt{\frac{M_m}{M_j}} = 0{,}11\, r_j$$

$$r_m + r_j = r_{mj} = 378\,000\text{ km}$$

$$0{,}11\, r_j + r_j = r_{mj}$$

$$1{,}11\, r_j = r_{mj}$$

$$r_j = \frac{r_{mj}}{1{,}11} = 341\,000\text{ km}$$

Når astronauten Astri tar på seg romdrakten sin og står på en baderomsvekt på jorda, viser vekta at hun og romdrakten veier 158 kg til sammen. Astri reiser til månen og tar med seg baderomsvekta. Hva viser vekta at hun og romdrakten veier når hun står på vekta på månens overflate?

Jorda har massen $5,97 \cdot 10^{24}$ kg og radien 6371 km, månen har massen $7,35 \cdot 10^{22}$ kg og radien 1737 km.

Slutteksamen 2019

på jorda $m = 158\,kg$

vekta viser $\frac{N}{g_j}$

$G = N = mg$

$m = \frac{N}{g}$

På månen

$N = mg_m$

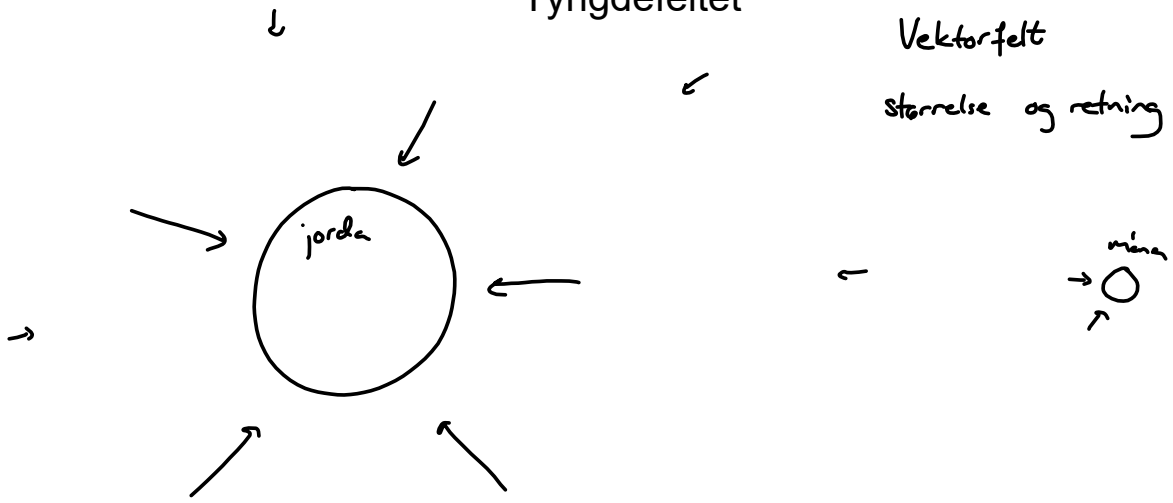
$g_m = \frac{\gamma M_m}{r_m^2} = 1,62\,m/s^2$

$m_{vekt} = \frac{N}{g_j} = \frac{mg_m}{g_j} = \frac{158\,kg \cdot 1,62\,m/s^2}{9,81\,m/s^2} = 26,1\,kg$

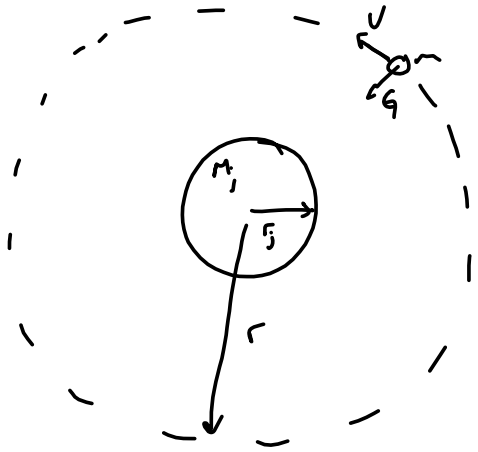
Tyngdefeltet

Vektorfelt

størrelse og retning



Satellittbaner



Hva er v?

$$\Sigma F_r = ma \qquad G = \frac{v^2}{r}$$

$$= mG$$

$$G = \frac{\gamma M_j m}{r^2} = m\frac{v^2}{r}$$

$$v^2 = \frac{\gamma M_j}{r}$$

$$v = \sqrt{\frac{\gamma M_j}{r}} \qquad r\uparrow \Rightarrow v\downarrow$$

Geostasjonær bane

$$T = 24\,t = 24 \cdot 3600\,s = 86400\,s$$

$$v = \frac{2\pi r}{T} = \sqrt{\frac{\gamma M_j}{r}}$$

$$\frac{4\pi^2 r^2}{T^2} = \frac{\gamma M_j}{r}$$

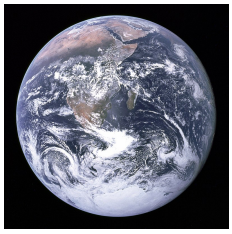
$$r^3 = \frac{\gamma M_j T^2}{4\pi^2}$$

$$r = \left(\frac{\gamma M_j T^2}{4\pi^2}\right)^{1/3} = 42{,}2 \cdot 10^3\,km$$

$$h = r - r_j$$

$$= 36 \cdot 10^3\,km$$

Hvor langt er et år på Jorda?



$$T_{jord} = \sqrt{\frac{4\pi^2 r_{jord-sol}^3}{\gamma M_{sol}}}$$

$r_{jord-sol} = 149{,}6 \cdot 10^9$ m

$M_{sol} = 1{,}989 \cdot 10^{30}$ kg

$= 365$ dager