Mozgások

~~Egyenes vonalú egyenletes~~ mozgás

- Másik tárgyhoz viszonyítva

Sebesség

$v = \frac{s}{t}$ — s: megtett út, t: idő

v: velocity

$1\frac{m}{s} = 3{,}6\frac{km}{h}$

Gyorsulás

$a = \frac{\Delta v}{\Delta t}$ — Δv: sebesség változás, Δt: idő

a: accelaration

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

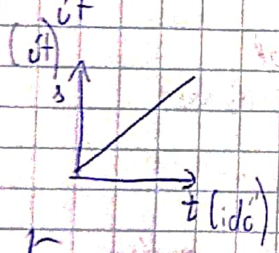
Egyenes vonalú egyenletes mozgás

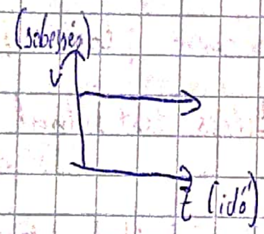
$s = v \cdot t$ — t: idő

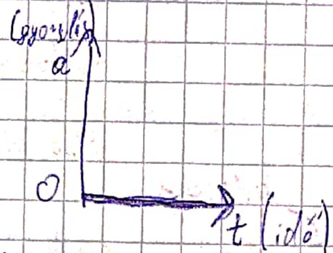
s: megtett út, v: sebesség

const v (sebesség)

$a = 0$ (gyorsulás)







Egyenes vonalú egyenletesen változó mozgás

$s = \frac{a}{2}t^2$ — a: gyorsulás, t: idő

s: megtett út

$v = at$ — t: idő

v: sebesség, a: gyorsulás

const a (gyorsulás)

g = gravitáció = $10 m/s^2$

$\emptyset$ nulla kezdősebességű Egyenes vonalú egyenletesen változó mozgás

$s = v_0 t + \frac{a}{2}t^2$ — v_0: kezdősebesség, a: gyorsulás, t: idő

$v = v_0 + at$

const a

megtett út = eredeti sebesség által megtett út + gyorsulás által megtett út

Feladatok

1.1 $v = 4.5\ km/h$
$t = 1.25\ h$

$s = ?$

~~1.25 × 60~~

$4.5 \times 1.25 = \cancel{9 \times 1.25 / 2}\ x$

$9 \times 1.25 = 2x$

$9 \times 2.5 = 4x$

$9 \times 5 = 8x$

$45 = 8x$

$x = \frac{45}{8}$

$45 / 8 = 5,625$
50
20
40

5,625 km-t tett meg a gyalogos

1.2 $V_0 = 15\ m/s$ $V_5 = 25\ m/s$ $t = 5s$ $a = ?$

$25 = 15 + 5 \cdot x$ $/ -15$

$10 = 5x$ $/ 5$

$x = 2$

$2\ m/s^2$ az autó gyorsulása

1.4) $a = 1.2\ m/s^2$ $t = 2.5s$ $v = ?$ $s = ?$

$v = a \cdot t$

$V = 2.5 \times 1.2$ $/ \cdot 2$

$2V = 5 \times 1.2$

$2V = 6$ $/ 2$

$V = 3\ m/s$

$s = \frac{V_0 + V_n}{2} \cdot t$ $V_0 + V_n = a$

$\frac{1.2}{2} \cdot 2.5$

$\frac{3}{2} \cdot 2.5 = 3.75$

1.5 $s = 10cm$ $a = g = 10\ m/s^2$ gravitáció || $t = 0.14\ s$ $v = \cancel{...} = s \cdot t = 1.4\ m/s$

~~$10cm = \frac{a}{2} t^2$~~

~~$0.1m = \frac{10m/s^2}{2} t^2$~~

~~$10cm = 5t^2$~~ $/ 2$

~~$0.1m = 5m/s^2 \cdot t^2$~~

~~$5cm = t^2$~~ $/ \sqrt{}$

~~$1m = 50m/s^2 \cdot t^2$~~

~~$t = \sqrt{5}$~~

~~$0 = 10 - \frac{a}{2} \cdot t^2$~~ ~~$/ \cdot 10 \cdot (-1)$~~

~~$10 = \frac{a}{2} t^2$~~

~~$10 = 5t$~~ $/ 5$

~~$t = 2$~~

$0 = 0.1 - \frac{a}{2} t^2$ $/ -0.1$

$-0.1 = -\frac{a}{2} t^2$ $/ \cdot (-1)$

$0.1 = \frac{a}{2} t^2$ $/ a = 10$

$0.1 = 5t^2$ $/ \cdot 10$

$1 = 50t^2$ $/ 5$

$\frac{2}{100} = t^2$ $/ \sqrt{}$

$0.14 = t$

~~16 AVG(40,60) = 50~~

1.7

gyalogos 8km/h rel: út
villamos 30km/h rel: út

A) gyalogos irány == villamos irány

$-30+8=22$ km/h

B) ↓↑ } gyal. rel. villamos

$-30+8=38$ km/h

1.8

N
W ↗ 1m/s E
S

SPEED { NORTH?
EAST?

0° 90°

$\frac{\sqrt{4}}{2}$ $\frac{\sqrt{3}}{2}$ $\frac{\sqrt{2}}{2}$ $\frac{\sqrt{1}}{2}$ $\frac{\sqrt{0}}{2}$

$v \cdot \cos 45° = \cos 45°$

↓

$\frac{\sqrt{2}}{2}$ mindkét oldali sebesség komponens

1.6

~~$2/3 \cdot 40$ km/h + $1/3 \cdot 60$ km/h~~

~~$\frac{80+60}{3} = \frac{140}{3} = 46.\dot{6}$ km/h~~

~~$40 \cdot \frac{2}{3} + 60 \cdot \frac{1}{3}$~~

$s_1 = s_2$ $V_1 = 40$ km/h $V_2 = 60$ km/h

40 : 60
4 : 6
2 : 3

$t_1 = 2/3$
$t_2 = 1/3$

~~$v = \frac{s_1+s_2}{t_1+t_2} = \frac{40 \cdot \frac{2}{3} + 60 \cdot \frac{1}{3}}{0.\dot{6}+0.\dot{3}} = \frac{26.\dot{6}+20}{1} = 46.\dot{6}$~~

$\frac{2(40)(60)}{40+60} = \frac{4800}{100} = 48$ km/h

1.9 $V_0 = 54 km/h$ $V_n = 90 km/h$ $a = 1.6 m/s^2$ $t = ?$ $6.25 s$ $s = ?$ $125 m$

~~t = ...~~ $\Delta V = 90 - 54 = 36 km/h = 10 m/s$

$\overset{m/s}{10} / \overset{m/s^2}{1.6} = 6.25 s$

~~s = 54 · 6.25 + 1.6/2 × 6.25~~

$V_0 = 15 m/s$ $V_n = 25 m/s$ $t = 6.25 sec$ ~~337.5 + 5 = 342.5~~

~~15 × 6.25~~

$15 m/s \times 6.25 sec + (25 m/s - 15 m/s) \times 6.25 sec / 2$

$93.75 + 62.5 / 2$

~~156.25~~

125m

1.10

$V_0 =$ [redacted] 0

$V = 6 m/s$

$a = 2 m/s^2$

$t = 8$

$V = at$

$6 = 2t \quad /2$

$t = 3$

$\underbrace{3 \cdot \frac{6}{2}}_{t_{gyorsul}} + \underbrace{(8-3) \cdot 6}_{t_{nagy}} = 9 + 30 = \underline{\underline{39 m}}$

1.11 $a = g$ $t_1 = 6$ $t_2 = 8$ $s = ?$

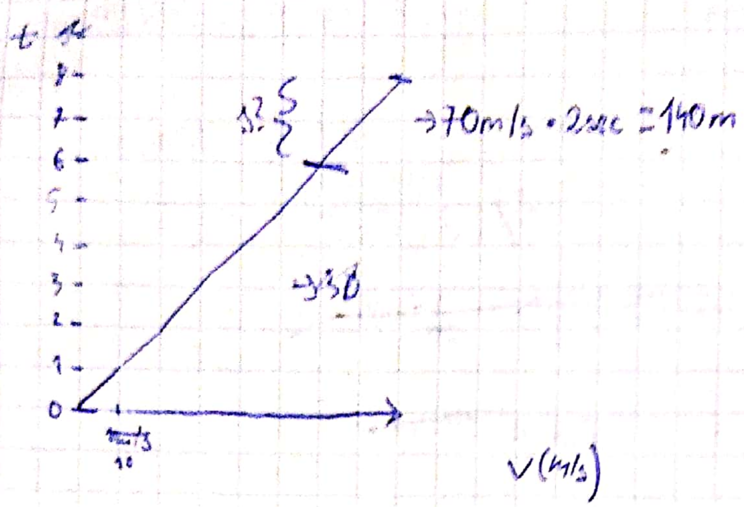
$V_0 = ?$ $60 m/s$

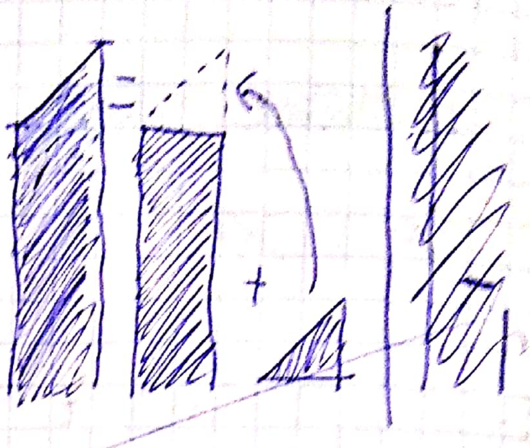
$V_0 \times (t_2 - t_1) + \frac{g}{2} (t_2 - t_1)^2$

$60 \cdot 2 + 5 \cdot [2^2 = 4]$

$120 + 20$

140





~~Egy tárgy kezdősebessége 60m/s, 2 másodpercen keresztül 10m/s² sebességgel gyorsul. Mekkora utat tett meg a gyorsulás ideje alatt?~~

~~60m/s~~

$\Delta s\ \frac{10}{2}8^2 - \frac{10}{2}6^2$

$8^2\cdot 5 - 6^2\cdot 5$

$320 - 180 = 140$

$\cancel{64\cdot 5} - \cancel{180}$

$\cancel{6^2\cdot 5 - 8^2\cdot 5}$

$\cancel{180}$

$314.112 - 176.688 = 137.424m$

$\frac{10}{2}8^2 - \frac{10}{2}6^2$

$5\cdot 8^2 - 5\cdot 6^2$

$5\cdot 8\cdot 8 - 5\cdot 6\cdot 6$

$40\cdot 8 - 30\cdot 6$

$320 - 180$

$10(32-18)$

$20(16-9)$

$20\cdot 7$

140

1.12 $V_0 = 20 m/s$

$s_1 = 20 + \frac{10}{2} \cdot 1^2 = 25$ $V_1 = 20 + 10 \cdot 1 = 30$

$s_2 = 20 \cdot 2 + \frac{10}{2} 2^2$ $V_2 = 20 + 10 \cdot 2 = 40$
60

$s_3 = 20 \cdot 3 + \frac{10}{2} 3^2$ $V_2 = 20 \cdot 10 \cdot 3 = 50$
105

1.13 $h_0 = 30 m$ $V_0 = 20 m/s$ $g = -10 m/s^2$

$V_1 = 20 \cdot 1 - 10 \cdot 1$ $s_1 - s_0 =$
$10 m/s$

Órai munka

$$\frac{PV}{T} = nR = \frac{m}{M} R = N \cdot k_b \quad \left(\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2} \right)$$

$°C + 273.15 = K$

$$E_B = \frac{f}{2} nRT = \frac{f}{2} PV = \frac{f}{2} N k_B T = \frac{f}{2} \frac{m}{M} RT$$

$$R = 8{,}314 \frac{J}{mol K} ; \; k_B = 1{,}38 \cdot 10^{-23} \frac{J}{K}$$

$P = 10^5$ Pascal $M_{CH_4} = 16 \frac{g}{mol}$

$T_1 = 20°C$ $293.15 K$

$T_2 = 80°C$ $353.15 K$

$V_1 = 2 m^3$
$V_2 = ?$ $2.4 m^3$
$\Delta E_b = ?$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{2}{293} = \frac{x}{353}$ $\cdot 353$

$\frac{2 \cdot 353}{293} = x$

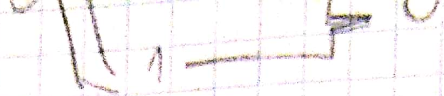
$\frac{706}{293} = 2.4 m^3$

~~$c_p = \frac{f+2}{2} \cdot \frac{R = 8.314}{M}$~~

$f = 6$ $\frac{6}{2} \cdot 10^5 \cdot 2.4 - \frac{6}{2} \cdot 10^5 \cdot 2$

$3 \cdot 10^5 \cdot 0.4 = 120 kJ$

$$\boxed{\frac{f}{2} pV_1 - \frac{f}{2} pV_2}$$



$\cancel{s = v_0 t + \frac{a}{2} t^2}$ $\qquad$ $\cancel{v = v_0 + at}$

$$s = \frac{v^2 - v_0^2}{2a}$$

$$\frac{v_0 + at + v_0}{2}\, t \qquad \frac{\cancel{2(m/s)^2 + (m/s^2)\,t\,4}}{2/s} \qquad 1m$$

$\cancel{Y = V_0 t + \frac{a}{2} t^2}$

Függőleges hajítás

$$Y = \underbrace{V_0 t}_{\text{lassulás nélkül}} + \underbrace{\frac{g}{2}t^2}_{\text{lassulás által}} \qquad V = \underbrace{V_0}_{\text{kezdő sebesség}} + \underbrace{gt}_{\text{gyorsulás}}$$

megtett út

$$t_{emelkedési} = \frac{V_0}{g} \qquad Y_{max} = \frac{V_0^2}{2g}$$

Vízszintes hajítás

$X = V_0 t$ $\qquad$ $y = \frac{g}{2}t^2$ $\qquad$ const V_x

$V_y = gt$ $\qquad$ $y = \frac{g}{2V_0^2}x^2$

Ferde hajítás

szög = α

$\underbrace{V_x = V_0 \cdot \cos(\alpha)}_{X \text{ komponens}}$ $\underbrace{V_y = V_0 \sin(\alpha) - gt}_{Y \text{ komponens}}$ $V = \sqrt{V_x^2 + V_y^2}$

$\tan\beta = \frac{V_y}{V_x}$

$X = \underbrace{V_0 \cdot \cos(\alpha) \cdot t}$ $Y = \underbrace{V_0 \cdot \sin(\alpha) \cdot t} - \underbrace{\frac{g}{2}t^2}$

haladás külső erő nélkül

gravitáció miatti zuhanás

$t_{emelkedés} = \frac{V_0 \sin\alpha}{g}$

$Y_{max} = \frac{V_0^2 \sin^2\alpha}{2g}$

hajítás távolsága = d $(y_0 = y_{end})$ → $d = \frac{V_0^2 \sin 2\alpha}{g}$

$Y = \tan\alpha\, x - \frac{g}{2 v_0^2 \cos^2\alpha} x^2$

Erő (Force)

Mértékegysége: Newton $N = kg \frac{m}{s^2}$

Egy kg-os testet
Egy Newton
Egy másodperc alatt
Egy m/s sebességre gyorsít

Newton törvények

I) nem változik egy test mozgási állapota ha nem hat rá semmilyen erő

II) gyorsulás egyenesen arányos a testre ható erőkkel. $a \sim F$

III) $F_{sum} + F_{ellen} = 0$ → F_e vagy $\Sigma F = F_{ele}$

eredendő

Sűrűség

$\rho = \frac{m}{V}$ – tömeg, térfogat

sűrűség

kg/m³

Nehézségi erő = gravitációs

Súly = G = mass · gravity

Súrlódási erő

Tapadási súrlódási erő

$$\mu_0 = \frac{F_{t,max}}{F_{ny}}$$ ← Tapadási súrlódási erő maximuma
← nyomóerő (pl autó motor)

Csúszási súrlódási erő

$$\mu = \frac{F_{cs}}{F_{ny}}$$ ← csúszási súrlódási erő
← nyomóerő

Lendület

jele: I

$I = mv$

$$F_{eredendő} = ma = \frac{\Delta I}{\Delta t}$$

Munka

$$W = F s \cdot \cos\alpha = kg\frac{m}{s^2} \cdot m$$

erő, elmozdulás

Emelési munka

$F = mg$

$$\alpha = 0^\circ \rightarrow W_{em} = F s \cdot \cos\alpha = mgh\cos 0^\circ = mgh_2 - mgh_1$$

Gyorsítási munka

$$W_{gyorsulás} = F s = mas$$

megtett út; tömeg, gyorsulás

$$W_{gy} = \frac{mv^2}{2} - \frac{mv_0^2}{2}$$

Rugalmasság

$$W_r = \frac{Dx_2^2}{2} - \frac{Dx_1^2}{2}$$ Dx = megnyúlás

Teljesítmény

$$P = \frac{W}{t}$$

Hatásfok

$$\eta = \frac{W_{hasznos}}{W_{összes}}$$

Mechanikai energia

$$W_{em} = mgh_2 - mgh_1$$ #emelés

$$W_{gy} = \frac{mv^2}{2} - \frac{mv_0^2}{2}$$ #gyorsítás

$$W_r = \frac{Dx_2^2}{2} - \frac{Dx_1^2}{2}$$ #rugalmassági

Dx = megnyúlás

$\cancel{E_r}$

$$\left.\begin{aligned} \frac{mv^2}{2} &= A_{mozgási} \\ \frac{Dx_2^2}{2} &= A_{rugalmas} \end{aligned}\right\} = W_1 + W_2 + W_3 \dots W_n$$

$$\Delta E_{mozgási} = W_{össz.}$$

Egy test mozgási energiájának megváltozása = Munkák összege

Hőtan

l: length
α: anyag hőtágulási együtthatója
ΔT: hőmérséklet különbség

Rúd (1D)

$$l = l_0 \cdot (1 + \alpha \cdot \Delta T)$$

ha $\Delta l = 0$

$$l_0 \cdot \alpha \cdot \Delta T = \frac{l_0 \cdot F}{E \cdot A}$$

TEST (3D) vagy folyadék

$$\Delta V = V_0 \cdot \underset{3\alpha}{\beta} \cdot \Delta T$$

$$V = V_0 \cdot (1 + \beta \cdot \Delta T)$$

~~K~~hő

jele: Q

Mértékegysége: Joule

~~J / kg·K~~

Fajhő:

jele: c

mértékegysége: J/ kg·K

1 KG anyag 1 Kelvinnel való melegítéséhez szükséges energ

$Q = m \cdot c \cdot \Delta T$

Gázok

$M = g/mol$

$n = \frac{m}{M}$ ← mass

$N = 6 \cdot 10^{23} \cdot n$

const $\frac{PV}{T}$ (P ← Pascal, V ← térfogat, T ← Tempature)

~~$pV = nRT$~~

$p_1V_1 = p_2V_2$ # nem lesz több gáz, csak kitágul

Gay törvényei

1) $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ Ha a mennyiség és a nyomás azonos 2 állapotban, akkor a térfogat a hőmérséklet is.

2) $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ Ha a mennyiség és a térfogat azonos két állapotban akkor a nyomás és a hőmérséklet egyenesen arányos

$\frac{pV}{T} = nR$ (n ← proton szám, R → 8.314)

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$

Termodinamika Főtételei

1) Energia változás = hőközlés + munka

2) Egy elzárt környezetben semmi más nem történik, csak kiegyenlítődik a hőmérséklet

3) Abszolút 0° nem érhető el $-\boxed{499}$

Nyomás mértékegysége: Pascal   JELE: P

e = töltés (E) = 1.6×10^{-19}

Égés

I fokú: bőrpír, duzzanat, fáj

II ~~hólyag~~ fokú: hólyag, fertőző veszély, naptól is lehet } Magától gyógyul

III. korona kiterjed, ∅ érzés

IV. fokú: Elszenesedés: mélység & felület szerint, hány tenyérnyi a sérültéhez képest

Csecsemő: Minden veszélyes; orvost hívni kis területre

Tünetek: fáj, folyadék vesztés, halálfélelem és

Teendők: hűtés 20p

Steril fedőkötés   nagy felület:

szénsav és alkoholmenteset, sós vizet igyon

∅ hűlhet ki az ember

Kipufogógáz mérgezés (CO)

fejfájás hányinger, ∅
izomgyengeség
eszméletlen → Rautek fogás
légzés bénulás

Ablak letekerése, kiszellőztetés

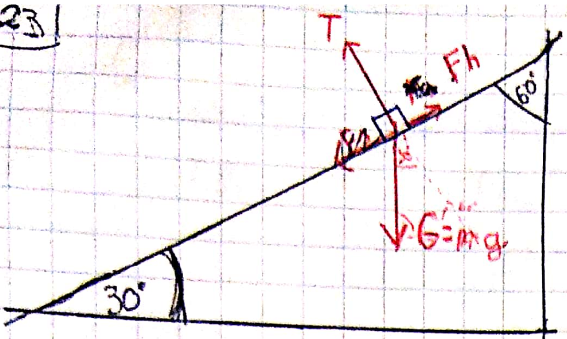
~~Benzin~~ Benzin mérgezés

szédül, köhög, rosszul van

tüdőhólyagocskákban benzin van

parafin olajat kell inni

223



400 N

$G_v = m \cdot g \cdot \sin 30°$

a) $\underbrace{m \cdot g}_{400N} \cdot \underbrace{\sin 30°}_{0.5} \leq Fh$

$200 \leq Fh$

$Fh \geq 200$

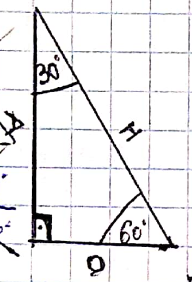
$Fh \geq 200N$ ✓

b) $\cancel{\underbrace{m \cdot g}_{400N} \cdot \underbrace{\sin 30°}_{1/2} \leq Fh \cdot \sin 30°}$

$\cancel{400 \leq Fh \cdot \frac{\frac{1}{\cos 30°}}{\sin 30°} \cdot \frac{\sin 30°}{\cos 30°}}$

$\frac{\frac{7}{5}}{2} = \frac{7}{5} \cdot \frac{1}{2} =$

$\frac{\frac{1}{\cos 30°}}{\sin 30°} = \frac{1}{\cos 30°} \cdot \frac{1}{\sin 30°} = \cancel{\frac{\cos 30° + \sin 30°}{\cos 30° \cdot \sin 30°}}$



S O H
C A H
T O A

$\cancel{m \cdot g \cdot \sin 30° \leq Fh / \cos 30°}$

$\cancel{m \cdot g \cdot \sin 30° \cdot \cos 30° \leq Fh}$

$\cancel{400N \cdot \frac{1}{2} \cdot \frac{\sqrt{3}}{2} \leq Fh}$

$\cancel{100\sqrt{3} \leq Fh}$

$\cancel{200 \cdot \frac{\sqrt{3}}{2} \leq Fh}$

$\frac{\frac{7}{5}}{2} = \frac{7}{5} \cdot \frac{1}{2} = \frac{7 \cdot 1}{5 \cdot 2}$

$\frac{1}{\cos 30°} \cdot \frac{1}{\sin 30°} = \frac{1}{\ }$

$m \cdot g \cdot \sin 30° \leq Fh \cdot \cos 30°$

$\underbrace{m \cdot g}_{400N} \cdot \tan 30° \leq Fh$

$231 \leq Fh$

$Fh \geq 231N$

2.30

$l_0 = 0{,}1m$
$l_1 = 0{,}12m$
$\Delta l = 0{,}02m$

$0{,}02m = 0{,}02N$

$1N = 1M$

$15l_1 = 1{,}5m$
$15l_2 = 1{,}65m$
$15\ \Delta l = 0{,}15m$ /15 rugó
$\Delta l = 0{,}01m$ / rugó

a) $0{,}01m = 0{,}01N$

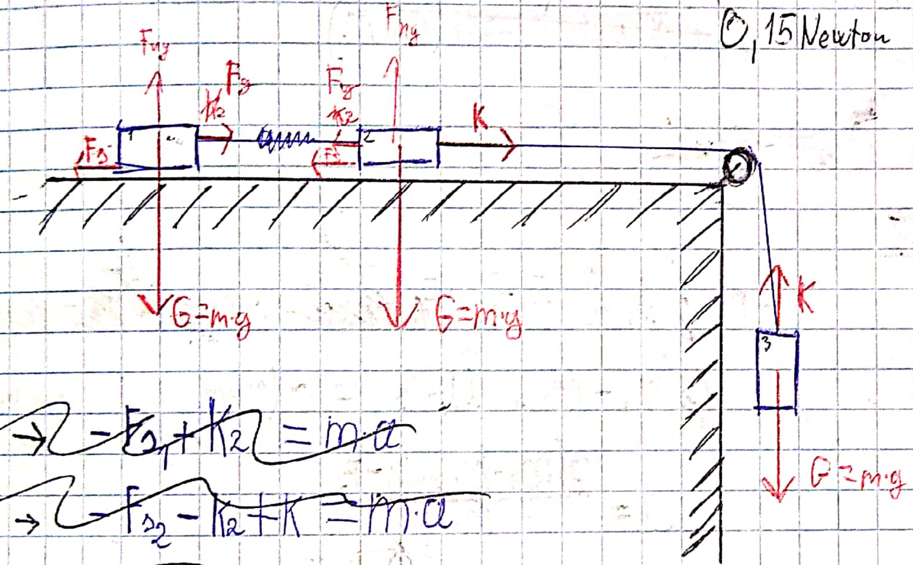
$\Delta l = 0{,}15m$ /1 rugó

$0{,}15m$ / rugó
=
$0{,}15$ Newton

$-\mu + \frac{F_r}{ma} = 1$

$-\mu \cdot m \cdot a + F_r = m \cdot a$ /ma

3.12



I: $-F_s + F_r = m \cdot a$

F_s
$-\cancel{\mu \cdot m \cdot a} + F_r = \frac{\cancel{m} \cdot (G - 2F_s)}{\cancel{m} \cdot 3\cancel{m}}$

$-\mu \cdot m \cdot a + F_r = \frac{G - 2F_s}{3}$

~~I. → $-F_{s_1} + K_2 = m \cdot a$~~
~~II. → $-F_{s_2} - K_2 + K = m \cdot a$~~
~~III ↓ $m \cdot g - K = m \cdot a$~~

I+II+III

~~$-F_{s_1} - F_{s_2} + K_2 - K_2 + K - K + mg = 3 \cdot m \cdot a$~~
~~$-m \cdot g \cdot \mu - m \cdot g \cdot \mu + m \cdot g = 3 \cdot m \cdot a$~~
~~$m \cdot g(-\mu - \mu + 1) = 3\ ma$~~ $/:3m$
~~$\frac{g}{3}(2\mu + 1) = a$~~

$a = \frac{G - 2F_s}{3m}$

HELP

I → $-F_s + F_r = -m \cdot a \cdot \mu + m \cdot a \cdot D$
II → $-F_s - F_r + K = -m \cdot a \cdot \mu + K - m \cdot a \cdot D$
III ↓ $G - K = m \cdot a$

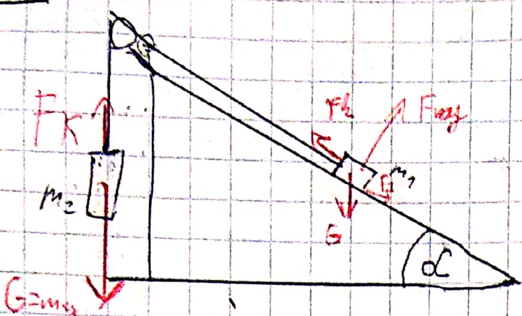
I + II + III = $3ma$

$-2F_s + G = 3ma$
$-2 \cdot \mu\ m_a + mg = 3ma$

~~$-0{,}4ma + mg = 3ma$~~

~~$mg = 3{,}4ma$~~
~~$40 = 3{,}4a$~~
$a = 0{,}34$

3.13



$a \rightarrow \swarrow$

I. $-G_1 \cdot \sin\alpha \pm F_3 + F_k = m_1 \cdot a$

II. $+G_2 \cancel{\sin\alpha} - F_k = m_2 \cdot a$

$I + II = m_1 a + m_2 a$

$\cancel{G_1 + G_2 - F_3 = m_1 a + m_2 a}$

$\cancel{-m_1 g + m_2 g - \mu m_1 g} = m_1 \cdot a + m_2 \cdot a$

$\cancel{g(m_2 - m_1 - \mu m_1) = a(m_1 + m_2)}$

$\mu = 0$

$g\cancel{(m_2 - (1+\mu) m_1)} = \cancel{a(m_1 + m_2)}$

$\cancel{g(m_2 - m_1) = (m_1 + m_2) a} \quad \cancel{| : m_1 + m_2}$

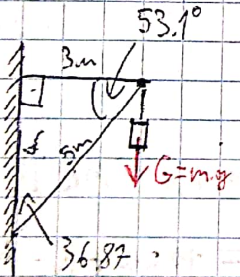
$\cancel{a = \frac{g(m_2 - m_1)}{m_1 + m_2}}$

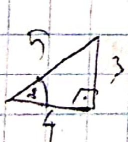
$-m_1 \cdot g \cdot \sin\alpha \pm F_3 + \cancel{F_k} \cancel{-F_k} + m_2 \cdot g = m_1 \cdot$

$g(m_2 - m_1 \cdot \sin\alpha) - F_3 = a(m_1 + m_2) \quad | : m_1 + m_2$

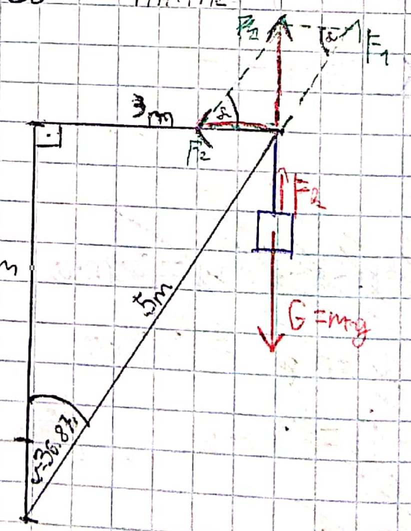
$a = \frac{g(m_2 - m_1 \cdot \sin\alpha) \pm F_3}{m_1 + m_2}$

5.9





G =



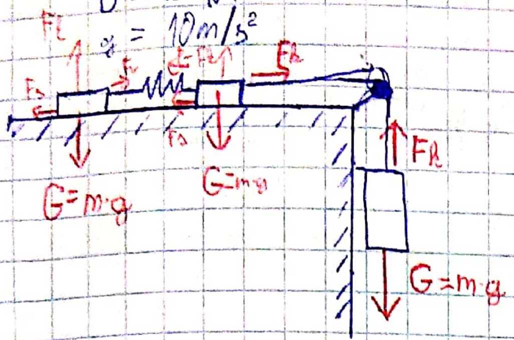
SOH $\quad \sin\alpha = \frac{3}{5}$

CAH

TOA

3.12

$m = 1kg$
$\mu = 0.2$
$D = 400\ N/m$
$g = 10\ m/s^2$



$$\text{I.}\ \rightarrow F_r - F_s = m\cdot a$$

$$\text{II.}\ \rightarrow -F_r - F_s + F_k = m\cdot a$$

$$\text{III.}\ \downarrow G - F_k = m\cdot a$$

$$\text{I} + \text{II} + \text{III} = 3ma$$

$$\cancel{F_r} - F_s - \cancel{F_r} - F_s + \cancel{F_k} + G - \cancel{F_k} = 3\cdot m\cdot a$$

$$G - 2F_s = 3ma \qquad /3m$$

$$\cancel{m\cdot g - 2\cdot mg\mu = 3ma} \qquad /3m$$

$$\cancel{\frac{m}{3}(g - 2\mu g) = ma} \qquad \cancel{a = \frac{g - 2\mu g}{3}}$$

$$\frac{G - 2F_s}{3m} = a \qquad G = m\cdot g \qquad \frac{mg - 2\cdot m\cdot g\cdot \mu}{3m} = a$$

$$\frac{\cancel{m}(g - 2g\mu)}{3\cancel{m}} = a$$

$$\frac{g(1 - 2\mu)}{3} = a \qquad 0.2$$

$$\frac{0.6g}{3} = a$$

$$\frac{1}{5}g = a \approx 2m/s^2$$

$400\%\ \frac{1}{5}g$

$$F_r - F_s = m\cdot \frac{\overset{a}{G - 2F_s}}{3m} \qquad \cdot 3$$

$$3F_r - 3F_s = G - 2F_s \qquad +2F_s$$

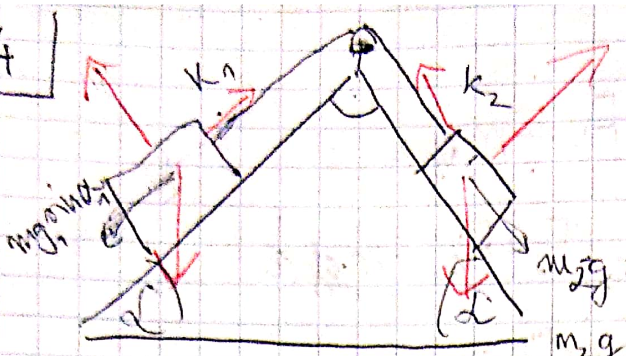
$$3F_r - \underset{\underset{m\cdot g}{G\cdot\mu}}{F_s} = G \qquad F_r - \mu mg = \frac{1}{5}mg$$

$$F_r = \frac{1}{5}mg - \mu mg$$

$$mg\left(\frac{1}{5} - \mu\right)$$

$\cancel{F_r \leq 0}$ $\quad 0$

5.24



$m_2 g \sin\alpha_2 = m_2 g \cos\alpha$

$m_2 g \sin(90° - \alpha)$

$$\text{I.} \swarrow \quad G_1 - F_k - F_t = m_1 \cdot a$$

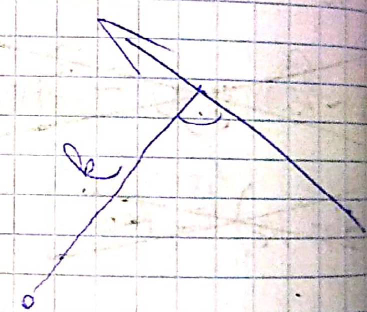
$$\text{II.} \nwarrow \quad -G_2 + F_k - F_t = m_2 \cdot a$$

$$G_1 = m_1 \cdot g$$
$$G_2 = m_2 \cdot g$$

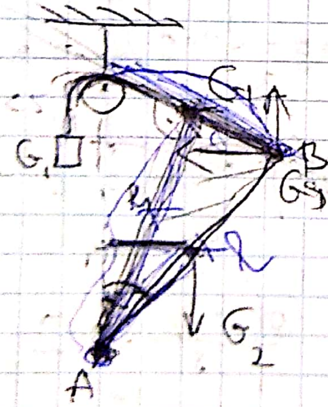
$m_1 g \sin\alpha = m_2 g \cos\alpha \qquad /\cos\alpha$

$m_1 \cdot \tan\alpha = m_2$

$\underline{\underline{\tan\alpha = \frac{m_2}{m_1}}}$



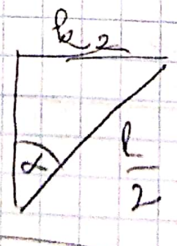
5.29



$G_1 = 25\,N \qquad \Sigma F = m \cdot a \qquad \Sigma F_i = 0$

$G_2 = 100\,N \qquad \Sigma M = \Theta\beta \qquad \Sigma M_i = 0$

$M = F \cdot k$



$$\boxed{G_1 \cdot l_1 - G_2 \cdot l_2 = 0} \qquad \text{Egyensúly feltétele}$$

$$G_1 \cos\left(\frac{\alpha}{2}\right) \cdot l_1 - G_2 \cdot \sin\alpha \cdot \frac{l_1}{2} = 0$$

$$25 \cdot \cos\frac{\alpha}{2} - \frac{100 \cdot \sin\alpha}{2} = 0$$

$25\cos\frac{\alpha}{2} = 50\sin\alpha = 0$

$\boxed{\sin 2\alpha = 2\cdot\sin\alpha\cos\alpha}$

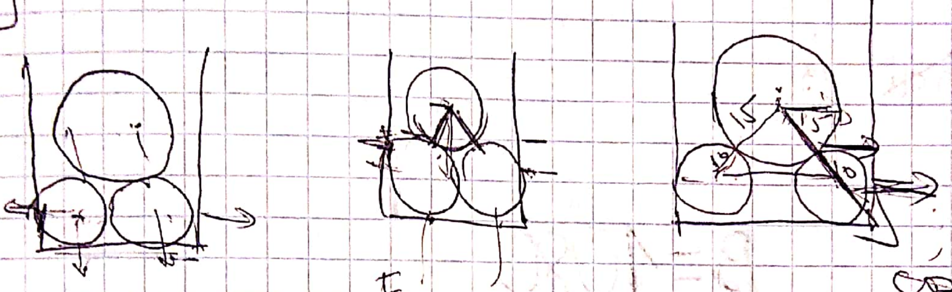
$25\cos\frac{\alpha}{2} = 50\cdot\sin\left(2\cdot\frac{\alpha}{2}\right)$ $\quad \sin\left(2\cdot\frac{\alpha}{2}\right) = 2\cdot\sin\frac{\alpha}{2}\cos\frac{\alpha}{2}$

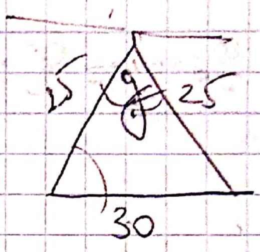
$25\cdot\cancel{\cos\frac{\alpha}{2}} = 50\cdot 2\sin\frac{\alpha}{2}\cdot\cancel{\cos\frac{\alpha}{2}}$ addíciós tétel

$1 = 4\sin\frac{\alpha}{2}$ $\quad \sin(2\alpha) = 2\cdot\sin\alpha\cos\alpha$

$\sin\frac{\alpha}{2} = \frac{1}{4}$ $\quad \alpha_1 = 28.9550°$ $\quad \alpha_2 = 180°$

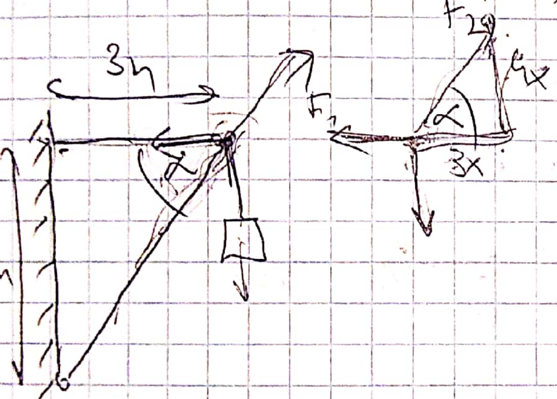
$\boxed{5.36}$





$\cos\frac{3}{2}$

$30^2 = 25^2 + 25^2 - 2\cdot 25\cdot 25\cdot\cos$



800

$mg = F_2\sin\alpha$ $\quad 4x$

$F_1 = F_2\cdot\cos\alpha$ $\quad 3x$

$800 =$

$\cancel{(\sin\alpha)(\sin\alpha) = 2(\sin\alpha)(\cos\alpha)}$

$\sin^2\alpha + \cos^2\alpha = 1$

$\boxed{6.15}$

$V = 30 \, m/s$

$d = 0{,}75m \quad 2\pi r = 0{,}75\pi \ m$ ← kerék hossza

~~$r = 0{,}375m$~~

$f = \underbrace{30}_{\text{1 s}} / \underbrace{(0{,}75\pi)}_{\text{1 fordulat}} = 40/\pi \ \frac{1}{s}$ ≈ rotation/sec

$\underbrace{\frac{40}{\pi}}_{\text{1 s alatt}} \cdot \underbrace{(2\pi)}_{\text{1 kör}} = 80 \ \cancel{rad} \ /s$

$\boxed{6.18}$

$\omega_0 = 0/s \qquad \beta = 1080^\circ$

$\omega(t = 10s) = \frac{30 \cdot \overset{360^\circ}{\cancel{2\pi}}}{s} = 10800^\circ/s$

~~$\frac{1}{2} \cdot 10^2 = 50$~~ $\qquad \frac{1080}{2} \cdot 10^2 = 54000^\circ = 1500$ fordulat

1.1 $V = 4{,}5\,km/h$
~~$t =$~~

$X(t = 1{,}25\,h) = 4{,}5 \cdot 1{,}25 = \underline{5{,}625\,km}$ ✓

1.2
$V(t=0) = 15\,m/s$ $\quad \Delta t = 5\,s$
$V(t=5s) = 25\,m/s$ $\quad \Delta v = 10\,m/s$

$$\frac{10\,m/s}{5\,s} = 2\,m/s^2$$ ✓

1.3
a) ↑ ✓
b) ↓ ✓
c) ↓ ✓
d) ↑ ✓

1.4 $a = 1{,}2\,m/s^2$

$v(t=2{,}5s) = a \cdot t = 3\,m/s$ ✓

$x(t=2{,}5s) = \frac{a}{2}t^2 = 3{,}75\,m$ ✓

1.5
$\Delta x = 10\,cm = 0{,}1\,m$ $\quad 0{,}1 = \frac{10}{2}t^2$
$a = g$

$\frac{0{,}2}{g} = t^2$ $\quad t = \sqrt{0{,}02} = 0{,}14\,s$ ✓

$v(t=0{,}14) = a \cdot t = 1{,}41\,m/s$ ✓

1.6 $V_1 = 40\,km/h$
$V_2 = 60\,km/h$

$v = s/t \quad s = vt \quad t = s/v$

$40 \cdot t_1 = 60 \cdot t_2 = s/2$ $\quad 40 \cdot t_1 \rightarrow$ $\quad \leftarrow 60 \cdot t_2$

~~$t_2 = \frac{3}{2}t_1$~~

~~$\frac{60 + \frac{3}{2}40}{1 + \frac{3}{2}} = 48\,km/h$~~

~~$\frac{40+60}{1+1{,}5}$~~

$$\frac{40t_1 + 60t_2 \,\}\,km}{t_1 + t_2 \,\}\,h} \qquad \frac{40\,t_1 + 60 \cdot \frac{3}{2}t_1}{t_1 + \frac{3}{2}t_1} = \frac{130t_1}{2.5t_1} = 52\,km/h$$

2

$s = 40\,\mathrm{km/h} \cdot t_1$ $\qquad 2t_1 = 3t_2$

$s = 60\,\mathrm{km/h} \cdot t_2$ $\qquad t_1 = \frac{3}{2} t_2$

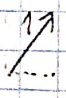
$$\frac{40 \cdot t_1 + 60 \cdot t_2}{t_1 + t_2} = \frac{40 \frac{3}{2} t_2 + 60 t_2}{\frac{3}{2} t_2 + t_2} = \frac{120 \cancel{t_2}}{2{,}5 \cancel{t_2}} = 48\,\mathrm{km/h}$$ ✓

1.7 $V_{gr} = 8\,\mathrm{km/h}$

a) $-30 + 8 = -22\,\mathrm{km/h}$ ✓

b) $-30 - 8 = -38\,\mathrm{km/h}$ ✓

1.8



a, b) $1/\sqrt{2} = 0{,}7$ ✓

1.9 $V(t=0s) = 54\,\mathrm{km/h} = 15\,\mathrm{m/s}$
$V(t=?) = 90\,\mathrm{km/h} = 25\,\mathrm{m/s}$ $\qquad \Delta v = 10\,\mathrm{m/s}$

$a = 1{,}6\,\mathrm{m/s^2}$

$10\,\mathrm{m/s} = 1{,}6\,\mathrm{m/s^2} \cdot t$
$t = 6{,}25\,s$ ✓

$\} \; 10/2 \cdot 6{,}25 = 31{,}25\,m$
$\} \; 15 \cdot 6{,}25 = 93{,}75\,m$ $= \underline{125\,m}$ ✓

1.10 $a = 2\,\mathrm{m/s^2}$, $t = 8s$
$a = 0\,\mathrm{m/s^2}$
$6\,\mathrm{m/s} = 2\,\mathrm{m/s^2} \cdot t$
$t = 3s$ ✓

$\} \; \frac{2}{2} \cdot 3^2 = 9$
$\} \; 6 \cdot 5 = 30$ $= \underline{39\,m}$ ✓

1.11 $V(t=0s) = 0$
$a = g$

$X(t=8s) - X(t=6s)$ $\qquad g = 9.81$

$\frac{g}{2} \cdot 8^2 - \frac{g}{2} \cdot 6^2 = \Delta X = 140\,m$ ✓

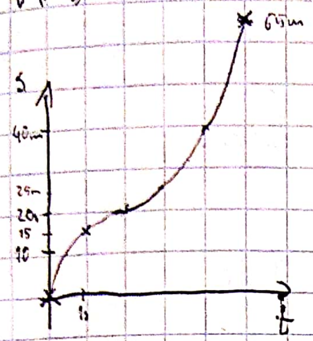
1.12 $V(t=0s) = 20\,\mathrm{m/s}$
$a = g$

$X(t=1s) = 20 \cdot 1 + \frac{10}{2} \cdot 1^2 = 25\,m$ ✓
$X(t=2s) = 20 \cdot 2 + \frac{10}{2} \cdot 2^2 = 60\,m$ ✓
$X(t=3s) = 20 \cdot 3 + \frac{10}{2} \cdot 3^2 = 105\,m$ ✓

1.13 $X_0 = 30m$
$V(t=0) = 20 m/s$
$a = -g$

$t(y_{max}) = 20/10 = 2s$

$V(t=1_s) = 20 - 1\cdot 10 = 10\ m/s$ $X(t=1_s) = \cancel{30} + 20\cdot 1 - \frac{10}{2}\cdot 1^2 = 45m$ $s = 20-5 = 15m$
$V(t=2_s) = 20 - 2\cdot 10 = 0\ m/s$ $X(t=2_s) = \cancel{30} + 20\cdot 2 - \frac{10}{2}\cdot 2^2 = 50m$ $s = 2\cdot 20 - 20 = 20m$
$V(t=3_s)\ 20 - 3\cdot 10 = -10\ m/s$ $X(t=3_s) = \cancel{30} + 20\cdot 3 - \frac{10}{2}\cdot 3^2 = 45m$ $s = 2\cdot 20 - 20 + 5 = 25m$
$V(t=4_s)\ 20 - 4\cdot 10 = -20\ m/s$ $X(t=4_s) = \cancel{30} + 20\cdot 4 - \frac{10}{2}\cdot 4^2 = 30m$ $s = 2\cdot 20 - 20 + 20 = 40m$
$V(t=5_s)\ 20 - 5\cdot 10 = -30\ m/s$ $X(t=5_s) = \cancel{30} + 20\cdot 5 - \frac{10}{2}\cdot 5^2 = 5m$ $s = \underbrace{2\cdot 20 - 20}_{fel} + \underbrace{45}_{le} = 65m$



40	2
20	2
10	2
5	5

1.14 $a = g$
$Y = 200m$
$V_x = 360 km/h = 100 m/s$
$V_y = 0 m/s$

$200m = \frac{10}{2}\cdot t^2$ $\sqrt{40}_s \cdot 100 m/s =$

$t = \sqrt{40}_s$ $2\sqrt{10}\cdot 100 = 200\sqrt{10} \approx 632.46m$

$V_y(t=\sqrt{40}) = 10\cdot\sqrt{40} \approx 63.25 m/s$
$V_x = 100 m/s$

$V = \sqrt{100^2 + 10\cdot\sqrt{4}}$ $\approx$ ~~100 m/s~~ $118.32 m/s$

1.15 120 m/s

30

$X =$

$V = 120 m/s$ $X(t=3_s) = 180\sqrt{3} \approx 312m$
$Y(t=3_s) = 60\cdot 3 - \frac{10}{2} 3^2 = 135m$

$V_x = V\cdot\cos\alpha = 60\sqrt{3}$
$V_y = V\cdot\sin\alpha = 60$

1.16

~~0, 5, 10, 15, 20, 25, 30~~ $0; 7{,}5; 15; 22{,}5; 30$

~~$30/(5-1) = 7{,}5_s$~~ $0; 6; 12; 18; 24; 30$

$\underline{6_s}$

$30/(6-1) = 6$

1.17

$V(t_1) = 40 km/h$

$V(t_2) = ?$

$\bar{V} = 50 km/h$

$s = 40 \cdot t_1 = ? \cdot t_2$

$$\frac{40t_1 + xt_2}{t_1 + t_2} = \frac{50}{1}$$

$$\frac{40t_1 + xt_2}{t_1 + t_2} = 50$$

$$\frac{80t_1}{t_1 + t_2} = \frac{50}{1} \quad /80$$

$$\frac{t_1}{t_1 + t_2} = \frac{5}{8}$$

$$\frac{t_1 + t_2}{t_1} = \frac{8}{5}$$

$$t_1 + t_2 = \frac{5}{8} t_1 \quad /t_1$$

$$1 + \frac{t_2}{t_1} = \frac{5}{8} \quad / - \frac{8}{8}$$

$$\frac{t_2}{t_1} = -\frac{3}{8}$$

$$\frac{50}{1} =$$

$40t_1 = s = xt_2$

$t_2 = \frac{40t_1}{x}$

$$\frac{40t_1 + xt_2}{t_1 + t_2} = 50$$

$$\frac{40t_1 + x \cdot \frac{40}{x} t_1}{t_1 + \frac{40}{x} t_1} = 50$$

$$\frac{80t_1}{t_1 (1 + \frac{40}{x})} = 50$$

$$\frac{80}{1 + \frac{40}{x}} = 50$$

$$\frac{1 + \frac{40}{x}}{80} = \frac{1}{50} \quad \cdot 80$$

$$1 + \frac{40}{x} = \frac{8}{5} \quad \cdot x$$

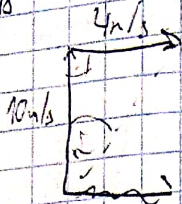
$$\frac{40 + x}{x} = \frac{8}{5}$$

$$40 + x = \frac{8}{5} x \quad \cdot 5$$

$$200 + 5x = 8x \quad -5x$$

$$200 = 3x$$

1.18



$V = \sqrt{116} \approx 10.8$ m/s

116 | 2
58 | 2
29 | 29

$\alpha =$

$\frac{\sin \alpha}{4} = \frac{90°}{\sqrt{116}}$

$\cancel{\alpha = 360/10.8}$
$\cancel{\alpha \approx 330°}$

360 · 5
15
30
00
1800

360 5
1500 300

$10.8 \approx \frac{54}{5}$

$\cancel{\alpha = \frac{1800}{54} = \frac{900}{27} \approx 33°}$

$\cancel{\frac{\sin \alpha}{4} = \frac{\sqrt{116}}{10}}$

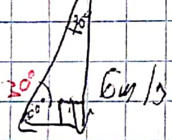
$\cancel{\sin \alpha =} \quad \cancel{\frac{2\sqrt{116}}{5}}$ 232

$\frac{\sin \alpha}{4} = \frac{\sin 90° = 1}{\sqrt{116}}$ $/ \cdot 4$

60 · 0,8 = 48

$\sin \alpha = \frac{4}{\sqrt{116}}$ $\cancel{\alpha \approx 21.8}$

1.19



$\frac{\sin 60°}{6} = \frac{\sin 30°}{x}$ ($\sin 60° \leftarrow \frac{\sqrt{3}}{2}$, $\sin 30° \leftarrow 0,5$)

$\frac{6}{\frac{\sqrt{3}}{2}} = \frac{x}{0,5}$ $\cdot 2$

$\frac{6}{\sqrt{3}} = x$ $x \approx 3,46$

1.20

a) $V_0 = 0$ km/h
$V(t = 19,3s) = 80$ km/h

$\cancel{a = 4,15 km/h^2 \approx 1,15 m/s^2}$

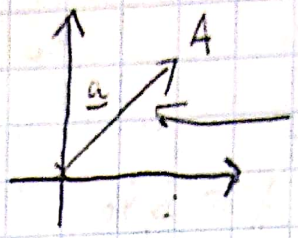
b) $400 = \frac{a}{2} \cdot 24,5^2$ $a \approx 1,33$ m/s²

c) 30 km/h 15 s

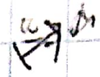
$0.\dot{5}$ m/s²

leave()
dropBlocks
moveBlocks(dir "right" | "left")

$A(2;3)$ $B(-1;5)$
$\underline{a}(2;3)$ $\underline{b}(-1;5)$



helyvektor (origóból indul)



szabadvektor

$\underline{a}+\underline{b}\,(2+(-1);\ 3+5)=(1;8)$

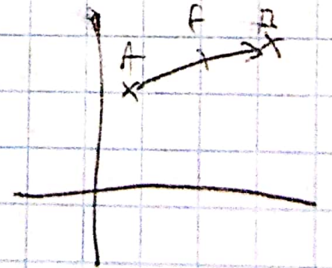
$\underline{a}-\underline{b}\,(2-(-1);\ 3-5)=(3;-2)$

$\underline{a}\cdot\underline{b}=a_1b_1+a_2b_2$

$\underline{a}\cdot\underline{b}=2\cdot(-1)+3\cdot5=(-2;15)$

$|\underline{a}|=\sqrt{2^2+3^2}$

$A(-1;8)$ $\overrightarrow{AB}=b-a\,(3;-1)$
$B(2;7)$ $\overrightarrow{BA}=a-b\,(-3;1)$

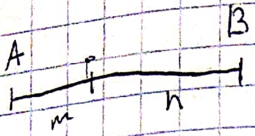


$\underline{F}=\underline{a}+\frac{1}{2}\overrightarrow{AB}$

$\underline{f}=\frac{\underline{a}+\underline{b}}{2}$

$\overrightarrow{AB}(b_1-a_1;\ b_2-a_2)$

$|\overrightarrow{AB}|=\sqrt{(X_A-X_B)^2+(Y_A-Y_B)^2}$



$$P = \frac{n\cdot a + m\cdot b}{m+n}$$

$X^2 - X + X + 1^2$

$3x^2 + 6x - 9$

$3(x^2+2x-3) \quad 3(X+1)(X-1)$

$x^2 + x - 6$

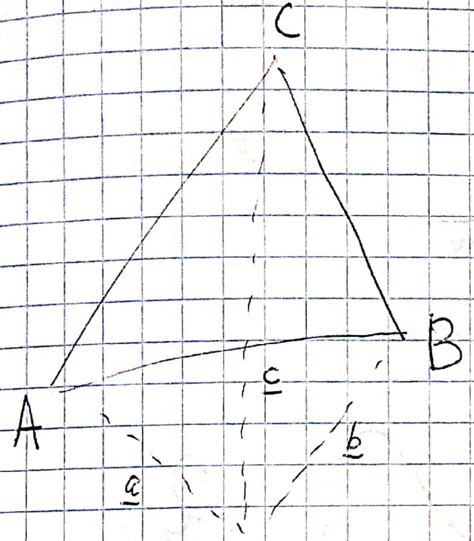
A(-1; 8)
B(2; 7)

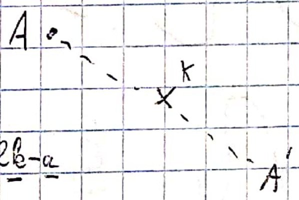
AP : PB = 5 : 3

$$X_p = \frac{3\cdot(-1)+5\cdot 2}{5+3} = \frac{7}{8}$$

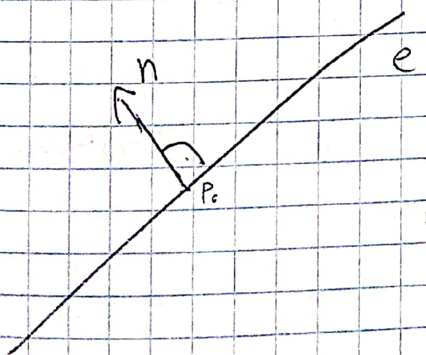
$$Y_p = \frac{8\cdot 3 + 7\cdot 5}{8} = \frac{59}{8}$$

$$\underline{s} = \frac{\underline{a}+\underline{b}+\underline{c}}{3}$$





$A' = 2\underline{k} - \underline{a}$



$\underline{n}(A, B)$
$P_0(X_0; Y_0)$

$\overrightarrow{P_0P}(X - X_0; Y - Y_0)$

$e \begin{cases} n(2,5) \\ P_0(3,-1) \end{cases}$

$n \perp \overrightarrow{P_0P} \iff \underline{n}\cdot \overrightarrow{P_0P} = 0$

$2X + 5Y = 2\cdot 3 + 5\cdot(-1)$

$2X + 5Y = 1$

elforgatás:
X, Y
-Y, X

$A(X - X_0) + B(Y - Y_0) = 0$

$$\boxed{Ax + By = Ax_0 + Bx_0}$$

$f \parallel e \quad Q(1;8) \in f$

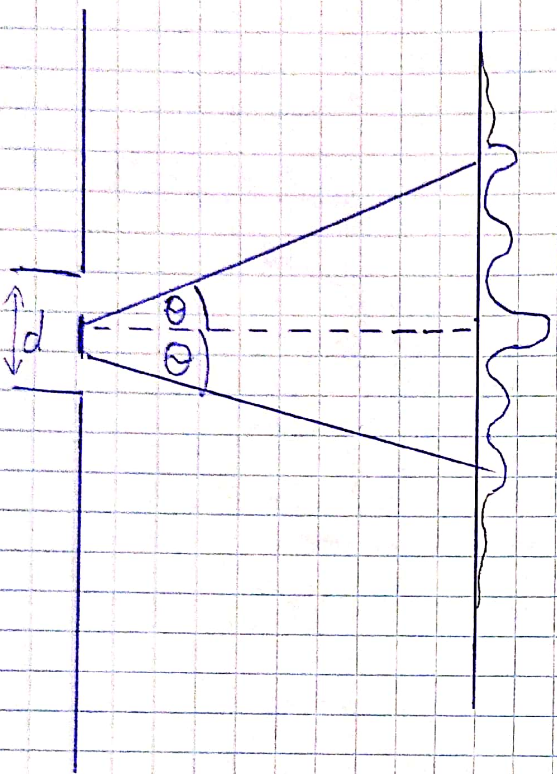
$2X + 5Y = 2\cdot 1 + 5\cdot 8 = 42$

12.9

$\frac{1}{f}=\frac{1}{t}+\frac{1}{k}$ $\qquad D_{sz}=\frac{1}{t}+\frac{1}{k}$ $\qquad$ II I. $\qquad$ II-I.

$\frac{1}{f'}=\frac{1}{t}+\frac{1}{k}$ $\qquad D_{sz}+D_{ein}=\frac{1}{t'}+\frac{1}{k}$ $\qquad$ II.

$\frac{1}{t'}-\frac{1}{t}=\frac{1}{0{,}25}-\frac{1}{0{,}5}=4-2=2$

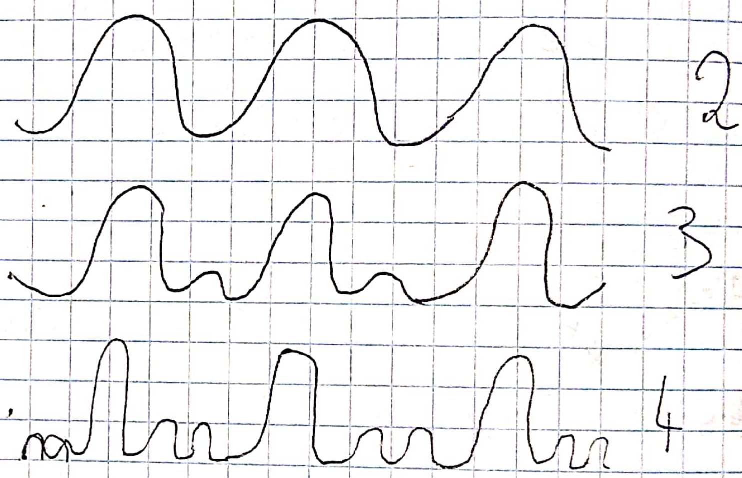


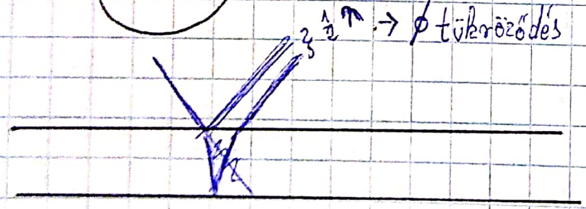
$m\cdot\lambda=d\cdot\sin\Theta$

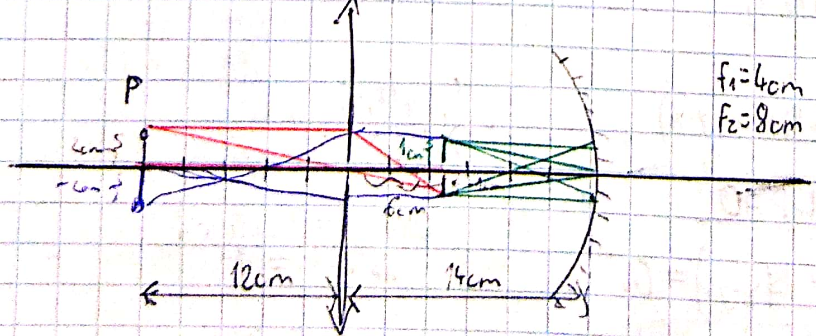
$m=-3;-2;-1;0;1;2;3;\dots$

pacák száma $\approx \frac{1}{\Delta \text{hullámhossz}}$

koherencia





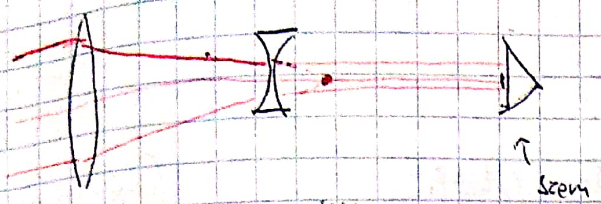


$\frac{1}{f_1}=\frac{1}{t_1}+\frac{1}{k_1}\Rightarrow\frac{1}{k_1}=\frac{1}{f_1}-\frac{1}{t_1}=\frac{t_1-f_1}{f_1t_1}$ $\qquad k_1=\frac{4\cdot 12}{12-4}=\frac{48}{8}=6cm$

$N_1=-\frac{k_1}{t_1}=-\frac{6}{12}=-\frac{1}{2}$ $\qquad 2\cdot(-\frac{1}{2})=-1$

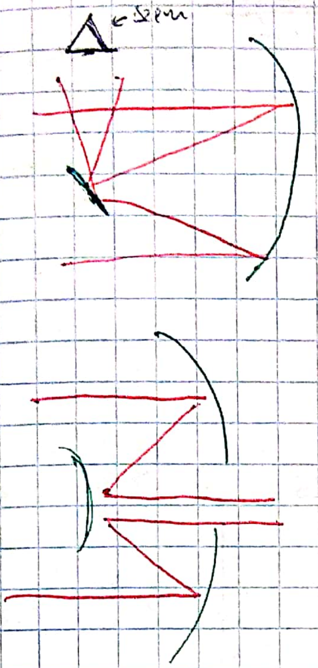
10.35
10.36
11.33
12.15

Elektrosztatika ???

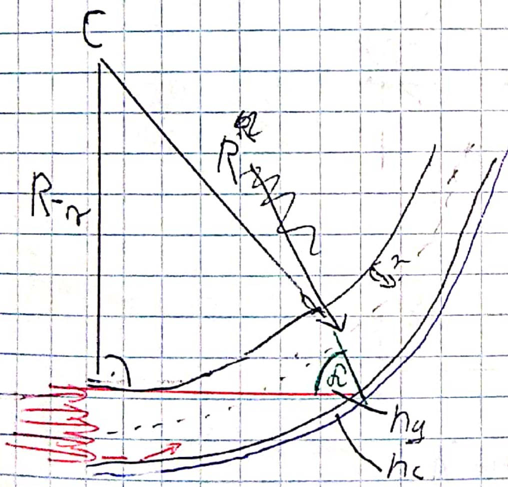


Interferometria

rayleigh kritér.



kompakt
& jobb fókusz



Min. szög teljes visszaverődéshez

$$n_g \cdot \sin\alpha \geq n_c \cdot \cancel{\sin 90°}$$

$$\sin\alpha \geq \frac{n_c}{n_g}$$

$$\cancel{\sin\alpha = R\cos\alpha = r}$$

$$(R-r) = (R+r)\cos\alpha$$

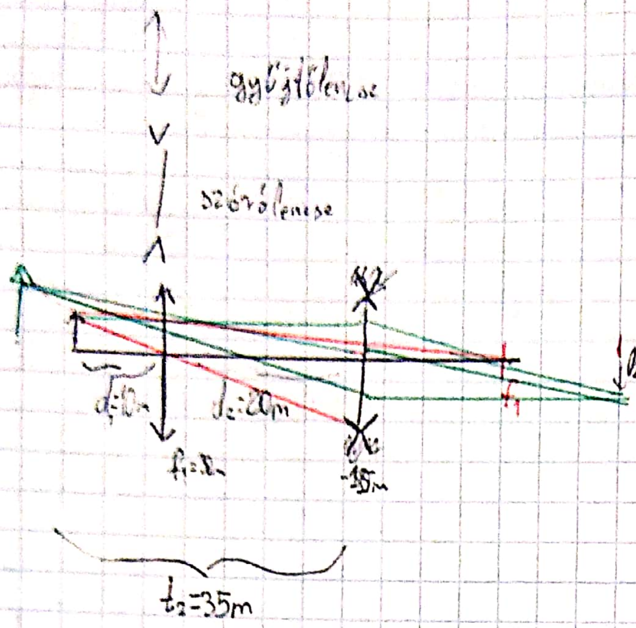
$$\sin\alpha = \frac{R-r}{R+r}$$

$$n_g \frac{R-r}{R+r} \geq n_c$$

$$n_g R - n_g r \geq n_c R + n_c r$$

$$(n_g - n_c) R \geq (n_g + n_c) r$$

$$R \geq \frac{n_g + n_c}{n_g - n_c} r$$



$$\frac{1}{f_1} = \frac{1}{t_1} + \frac{1}{k_1}$$

$$\frac{1}{k_1} = \frac{1}{f_1} - \frac{1}{t_1} = \frac{t_1-f_1}{t_1 f_1}$$

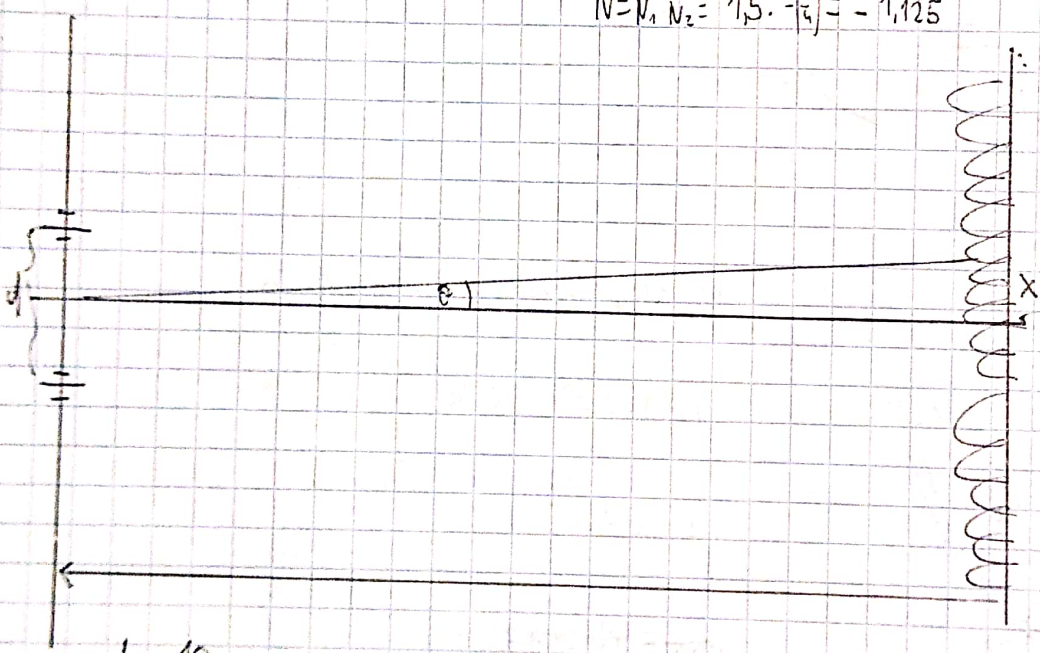
$$k_1 = \frac{t_1 f_1}{t_1-f_1} = -15m$$

$$N_1 = -\frac{k_1}{t_1} = -\frac{-15}{10} = 1{,}5$$

$$\frac{1}{f_2} = \frac{1}{t_2} + \frac{1}{k_2} = 26{,}25m$$

$$N_2 = -\frac{k_2}{t_2} = -\frac{26{,}25}{35} = -\frac{3}{4}$$

$$N = N_1 N_2 = 1{,}5 \cdot \left(-\frac{3}{4}\right) = -1{,}125$$



$L = 10m$
$d = 10mm$
$\lambda = 500nm$

$\lambda_2 =$

$4\lambda_1 = 5\lambda_2$

$\lambda_2 = \frac{4}{5}\lambda_1 = 400nm$

$$d \underbrace{\sin\theta}_{\text{nagyon kicsi}} = m \cdot \lambda$$

$$\sin\theta \approx tg\,\theta \approx \frac{x}{L}$$

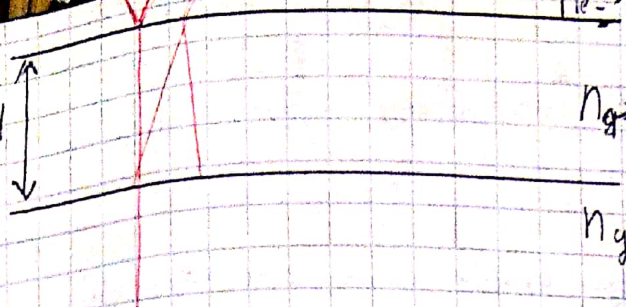
$$d\frac{x_m}{L} \approx m \cdot \lambda$$

$$x_m \approx m\frac{L\lambda}{d}$$

$$x_{m+1} - x_m = (m+1)\frac{L\lambda}{d} - m\frac{L\lambda}{d}$$

$$\Delta x \approx \frac{L\lambda}{d} = \frac{10 \cdot 500 \cdot 10^{-9}}{10 \cdot 10^{-3}} = 0{,}5mm$$

↑ sávok távolsága



$n_g = 1,3$

$n_y = 1,7$

$\lambda_1 = 500nm$ ANTI-REF.

$2 n_r d = (m + \frac{1}{2}) \lambda_1$

↳ legkisebbnél $m=0$

$d = \frac{\lambda_1/2}{2n} = \frac{500 \cdot 10^{-9}/2}{2 \cdot 1,3}$

$2n_r d = m\lambda$

$x_m = \frac{2n_r d}{m} = \frac{250 \cdot 10^{-9}}{m}$ → 250 nm → 150 nm → 83,3 nm

---

$\lambda_1 = 500nm$ növeli

$\lambda_2 = 400nm$ csökkenti } a reflekciót

$2n_r \cdot d = m\lambda_1$ $m \in \mathbb{N}$

$2n_r d = (l + \frac{1}{2}) \lambda_2$ $l \in \mathbb{N}$

$m\lambda_1 = (l + \frac{1}{2}) \lambda_2$

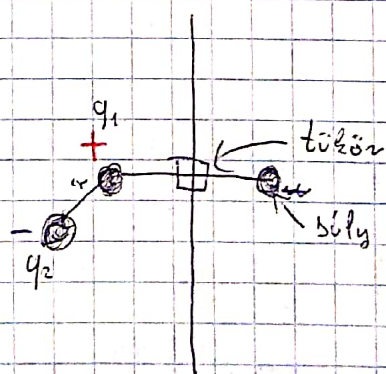
$\frac{\lambda_1}{\lambda_2} = \frac{l + \frac{1}{2}}{m}$

$\frac{500}{400} = \frac{2l+1}{2m}$ → $l=2, m=2$ ⇒ $d = \frac{2 \cdot 500 \cdot 10^{-9}}{2 \cdot 1,3} = 380nm$

→ $l=7, m=6$

Elektrosztatika

torziós mérleg



Ókori görögök

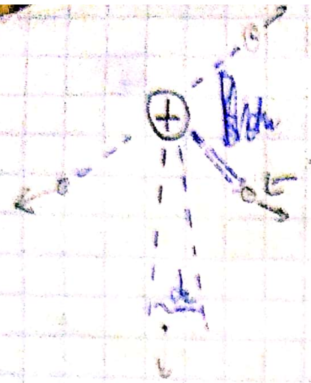
dörzsölés → pozitív
→ negatív

~~Columb~~ Coulomb tv.:

$$F = \frac{q_1 q_2}{r_2}$$

tömeg = gravitációs töltése

ellentétes vonzza egymást



$\rightsquigarrow$ Elektromos térerősség (E)

$d \approx r^2$ (a töltéshez közelebb egyre közelebb vannak a térerő vonalak)

Egy zárt felület felületén lévő térerő vonalak: Elektromos fluxus

$$\underline{E} \cdot \underline{A} = \Phi$$

térerősség, felület, fluxus

$$E = \frac{F}{q}$$

F ← erő, q ← próba töltés

I. Maxwell

$$\Phi = \oiint \underline{E} \cdot dA = \frac{q}{\varepsilon_0}$$

térerősség zárt felület; felület integrálja; ε_0 ← Vákum dielektromos állandó

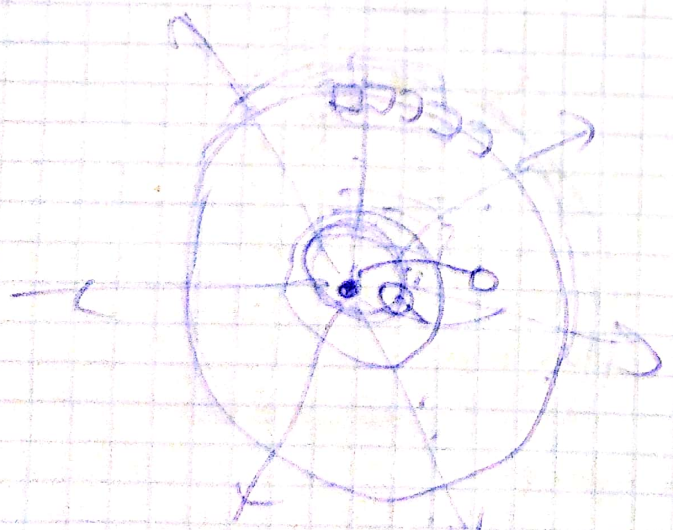
Gauss tv.

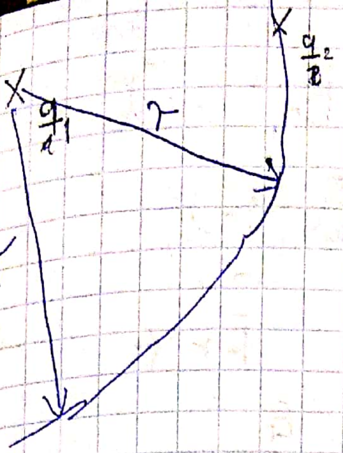
$$\iint_{\partial V} \underline{E} \cdot d\underline{A} = \frac{1}{\varepsilon_0 \varepsilon_r} \iiint_V \rho \, dV$$

gömb felületére integrál

térfogaton belüli töltés mennyisége

gömb térfogatára





$$\left(k\left(\frac{q_1 q_2}{r^2}\right)\right)$$

zárt felületen belüli töltésmennyiség $= q_1$

$$\oint \underline{E} \cdot d\underline{A} = \frac{1}{\varepsilon_0} \iiint \varrho \cdot dV$$

konstans (gömbön) kivihető

gömbfelület

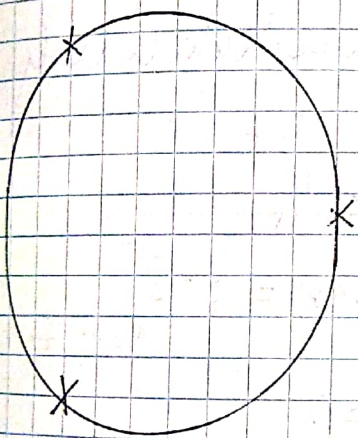
$$E(r) \cdot 4r^2\pi = \frac{1}{\varepsilon_0} \cdot q_1$$

$$\boxed{E(r) = \frac{1}{4\pi\varepsilon_0\varepsilon_r} \cdot \frac{q_1}{r^2}}$$ térerősség gömb felületén E

$$F = E \cdot q_2 = \frac{1}{4\pi\varepsilon_0\varepsilon_r} \cdot \frac{q_1 q_2}{r^2} \qquad \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{r^2} \cdot 4\pi r^2 = \frac{1}{\varepsilon_0} Q$$

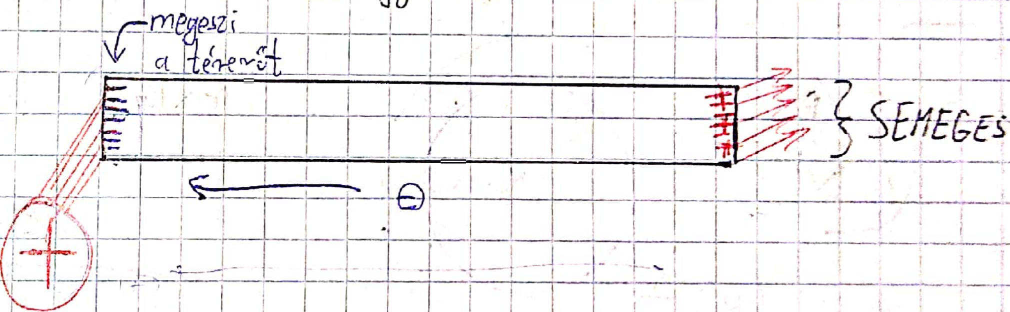
$$F_C = k \cdot \frac{q_1 q_2}{r^2}$$

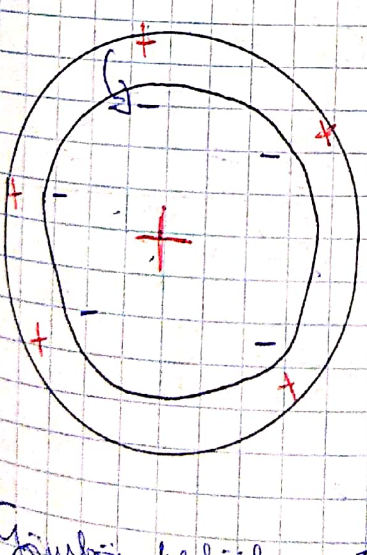
Töltések



(Elektronok) taszítják egymást

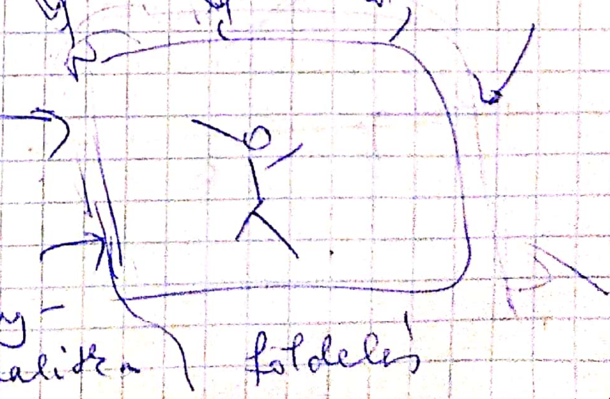
↳ felületen gyűlnek össze





Gömb ürege: SEMLEGES

FLUXUSA: 0, mivel zárt terület



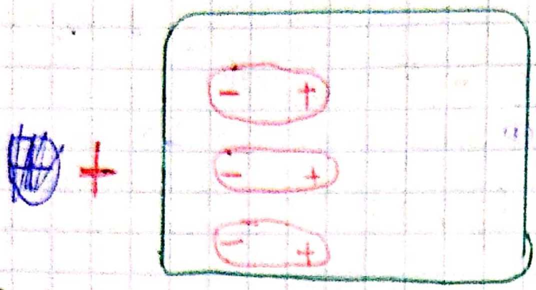
Gömbön belül $\underline{E} = 0$ árnyékolás

Szigetelő anyag

E $= E_0 + E_0 \cdot \chi$

$= E_0(1+\chi)$

ε_r ←



+ Q, vákum E_0

egységnyi potenciális energia

$E_{p'} = k\frac{q_1 q_2}{r^2}$

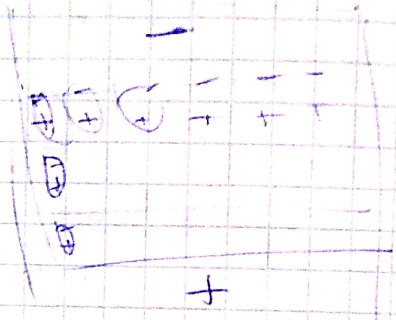
$U = \frac{E_{p'}}{q}$

egységny. potenciális energia

$E_p = k\frac{q_1 q_2}{r^2}$

$U = \frac{E_p}{q}$ $-Q$, r

potenciális energia adott pozícióban

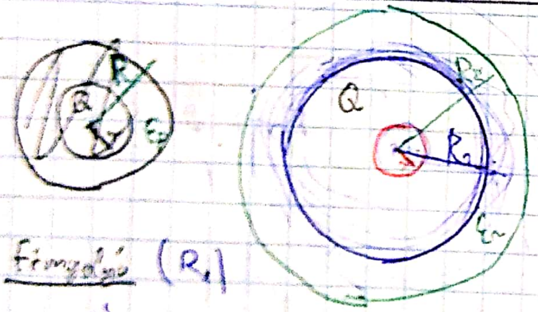


U_A potenciál az A pontban

U_{AB} potenciálkülönbség

$U_{AB} = U_A - U_B$

feszültség



Fémgolyó (R_1)

két körvonal

$r < R_1$ $E(r)\cdot 4\pi r^2 = \frac{1}{\varepsilon_0}\cdot \emptyset$

zárt fém

$E(r) = 0$

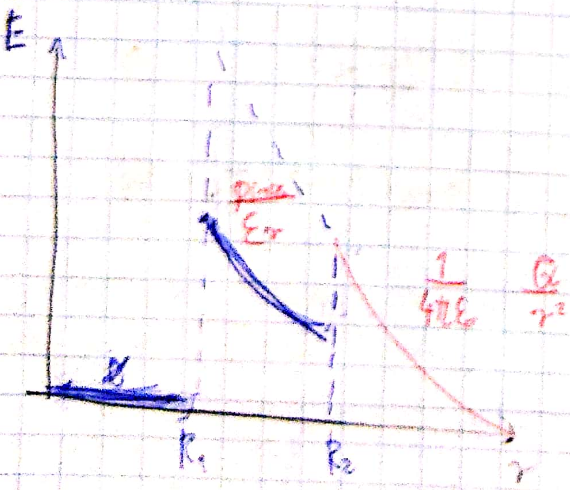
$R_1 < r < R_2$

$E(r)\cdot 4\pi r^2 = \frac{1}{\varepsilon_0 \varepsilon_r}\cdot Q$

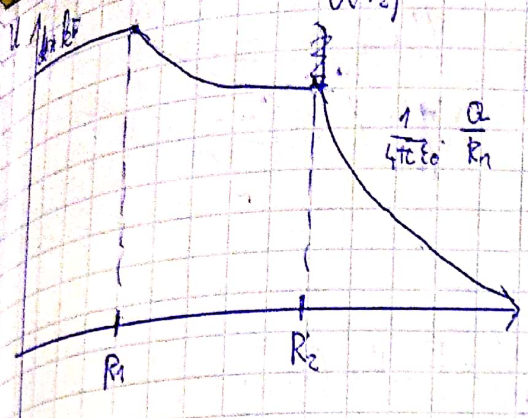
$E(r) = \frac{1}{4\pi\varepsilon_0\varepsilon_r}\cdot\frac{Q}{r^2}$

$R_2 < r$ $E(r)\cdot 4\pi r^2 = \frac{Q}{\varepsilon_0}$

$E(r) = \frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{r^2}$



$U(R_1) = U(R_2) + \frac{1}{4\pi\varepsilon_0\varepsilon_r} \cdot \frac{Q}{R_1} - \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{R_2}$



$U(r) = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{r}$

17.2

$\varepsilon_0 = const$ 13

$k = 9 \cdot 10^9$

$Q = 10^{-5}$ C

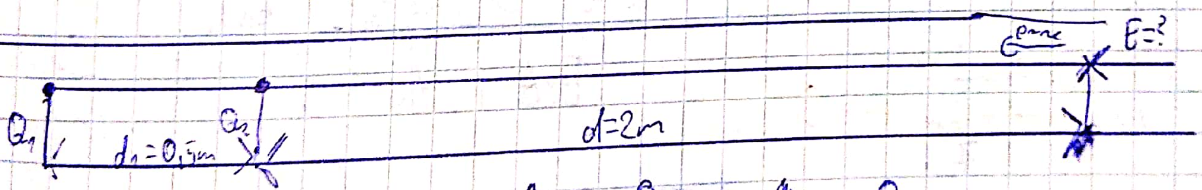
$r = 1m$

$E(r) = ?$

$F(r) = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}$

$E(r) = \frac{F(r)}{q_2} = \underbrace{\frac{1}{4\pi\varepsilon_0}}_{k} \cdot \frac{Q}{r^2} = 9 \cdot 10^{-4} \frac{N}{C}$

17.5



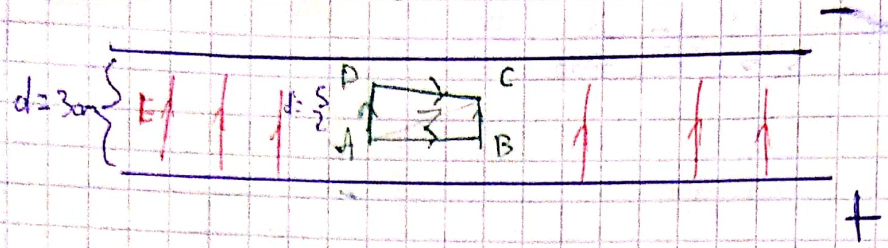
$Q_1 = 2 \cdot 10^{-6}$ C

$Q = -2 \cdot 10^{-6}$ C

$E = k \frac{Q_1}{(d_1 + d_2)^2} + k \cdot \frac{Q_2}{d_2^2}$

$E = k\left(\frac{2 \cdot 10^{-6}}{2,5^2} + \frac{-2 \cdot 10^{-6}}{2^2}\right) = -1620 \frac{N}{C}$

19.7 a) Töltes mozgás → munka



$W(A \to B) = 0$
$W(D \to C) = 0$
$\cos 90°$

$d = 3\,cm$
$d' = 1\,cm$

$E = 1000\,\frac{N}{C}$

$Q = 5 \cdot 10^{-5}\,C$

$W = E \cdot d' \cdot Q$

$\underline{5 \cdot 10^{-4}\,J}$

volt Q = energia

b) Potenciál különbség (A, D)

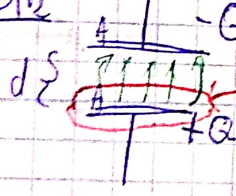
$\Delta U = E \cdot d' = 1000 \cdot 10^{-2} = \underline{10V}$

c) Potencionál különbség (lapok)

$\Delta U = E \cdot d = 1000 \cdot 3 \cdot 10^{-2} = \underline{30V}$

Kondenzátor

Sík



Elektromos térerősség kívül

$E \cdot A + A_{valami} \cdot 0 = \frac{Q}{\varepsilon_0 \varepsilon_r}$

$E = \frac{Q}{\varepsilon_0 \varepsilon_r A}$

$\Delta U = E \cdot d = \frac{Q \cdot d}{\varepsilon_0 \cdot \varepsilon_r \cdot A}$

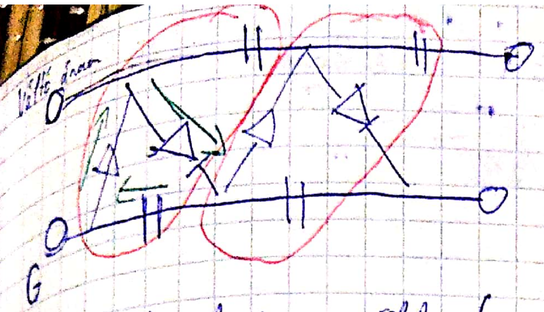
$C = \frac{\varepsilon_0 \varepsilon_r A}{d}$

$Q = C \cdot U$

kapacitás

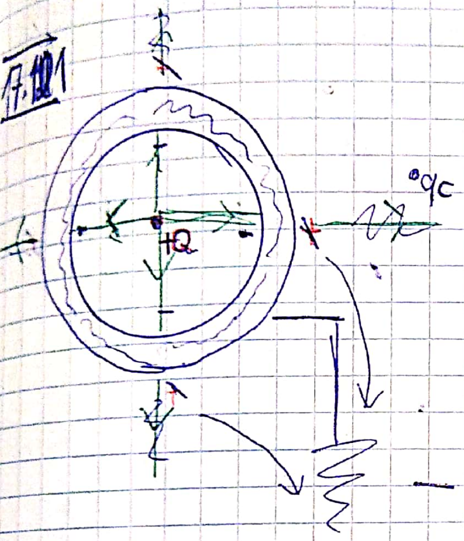
$\frac{m}{s^2}$ / s

$\cos 90°$



Ingadozás csökken (exponenciálisan) →

17.11



— ∅ pozitív töltés a külső felületen
∅ külső térerősség

17.14	17.23
37	24
46	26
50	28
	30

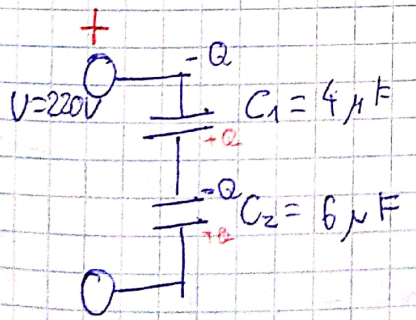
Jó árnyékoló: jól vezet & ferro mágneses

réz < vas

↑

kis frekvencia átjut rajta

17.13



$$Q = C_1 \cdot U_1 \Rightarrow U_1 = \frac{Q}{C_1}$$

$$Q = C_2 \cdot U_2$$

$$U_1 + U_2 = \cancel{220V}\ U \Rightarrow U_2 = \frac{Q}{C_2}$$

$$\frac{Q}{C_1} + \frac{Q}{C_2} = U$$

$$Q = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}} U$$

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\left(\frac{1}{\frac{1}{4} + \frac{1}{6}} = \frac{24}{10}\right) \cdot 220 \cdot 10^{-6} = 528\mu C$$

$\boxed{17.1}$

$$\cancel{k \cdot \frac{10^{-5}}{\ldots}}$$

$$\cancel{Q_1 \cdot Q_2 = k \cdot \frac{F \cdot r^2}{r^2}}$$

$$F = k \cdot \frac{Q_1 \cdot Q_2}{r^2}$$

$$\cancel{Q^2 = \frac{10^{-3} \cdot 1^2}{9 \cdot 10^9} : \frac{9 \cdot 10^9}{10^3}}$$

$$\cancel{Q = 3000}$$

$$\cancel{Q^2 = \frac{F \cdot r^2}{k} = \frac{10^{-3} \cdot 1}{9 \cdot 10^9} = \frac{\frac{1}{10^3}}{9 \cdot 10^9}}$$

$$F = k \cdot \frac{Q_1 \cdot Q_2}{r^2}$$

$Q_1 = Q_2$
$r = 1m$
$F = 10^{-3}\,N$
$k = 9 \cdot 10^9$

$$10^{-3} \cdot \cancel{\frac{1}{1000}} = 9 \cdot 10^9 \cdot \frac{Q^2}{\cancel{r^2}} \quad /k$$

$$\frac{10^{-3}}{9 \cdot 10^9} = Q^2$$

$$\frac{1}{9} \cdot 10^{-12} = Q^2 \quad /\sqrt{\ }$$

$$\sqrt{\frac{1}{9}} \cdot (10^{-12})^{1/2} = Q$$

$$\frac{1}{3} \cdot 10^{-6} = Q$$

$$\underline{\underline{Q = 3 \cdot 10^{-7}\ C}}$$

$\boxed{17.2}$ $Q_1 = 10^{-5}\,C$

$r = 1m$; ε_0

$$\cancel{E = \frac{Q}{\varepsilon_0 \cdot r^2} = \frac{\left(\frac{1}{10^5}\right)}{8{,}8 \cdot 10^{12} \cdot 1^2} = \frac{1}{10^5} \cdot 8{,}8 \cdot 10^{12} = 10'000'000}$$

a) SI képlettel: $\frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{r^2} = \underline{\underline{9 \cdot 10^4\ \frac{N}{C}}}$

b) Gömb felszíne

c) a töltéstől ~~...~~ kifelé, gömbsugarakban át mutat

17.3 $U = 350V$

$C = 16\mu F$

$\cancel{U = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{r}}$ $k = 9 \cdot 10^9$

$\cancel{350 = 9 \cdot 10^9 \cdot Q}$

$$C = \frac{Q}{U}$$

$$16 \cdot 10^{-6} = \frac{Q}{350} \quad / \cdot 350$$

$$\underline{\underline{Q = \cancel{5600} \; 5600 \cdot 10^{-6} \, C}}$$

17.4

$Q_1 = +1$
$Q_2 = +4$
l táv

$$\cancel{k} \cdot \frac{Q_1}{r_1^2} = \cancel{k} \cdot \frac{Q_2}{r_2^2} \qquad r_1 + r_2 = l$$

$$\frac{1}{r_1^2} = \frac{4}{r_2^2} \quad / \sqrt{\ }$$

$$\frac{1}{r_1} = \frac{2}{r_2} \quad / r_2 = l - r_1$$

$$\frac{1}{r_1} = \frac{2}{l - r_1} \quad / \cdot r_1$$

$$1 = \frac{2r_1}{l - r_1} \quad / \cdot (l - r_1)$$

$$l - r_1 = 2r_1 \quad / + r_1$$

$$l = 2r_1 + r_1$$

$$l = 3r_1 \qquad r = \frac{l}{3}$$

$$\frac{1}{r_1^2} = \frac{4}{r_2^2} \quad / l = r_1 + r_2$$

$$\frac{1}{(l - r_2)^2} = \frac{4}{r_2^2} \quad / 4$$

$$\frac{1}{4(l - r_2)^2} = \frac{1}{r_2^2}$$

$$4(l - r_2)^2 = r_2^2$$

$$4(l^2 - 2lr_2 + r_2^2) = r_2^2$$

$$4l^2 - 8lr_2 + 4r_2^2 = r_2^2 \quad / (4r_2)^2$$

$$\ldots = (\ldots - 3r_2)^2$$

$$\cancel{k} \frac{Q^2}{x^2} = \cancel{k} \frac{4Q^2}{(l-x)^2} \quad / 4Q^2 \cancel{k}$$

$$\frac{1}{4x^2} = \frac{1}{(l-x)^2} \quad / \ldots$$

$$l^2 - 2lx + x^2$$

$$4x^2 = l^2 - 2lx + x^2 \quad / -4x^2$$

$$0 = l^2 - 2lx - 3x^2 \qquad \cancel{l - x + 1} \quad \cancel{\ldots}$$

~~$a = 3 \quad b = 2 \quad c = 0$~~

$$\frac{-2l \pm \sqrt{4l^2 + 12}}{6}$$

$$3x^2 + 2lx - l^2 = 0$$

$a = 3 \quad b = 2 \quad c = -1$

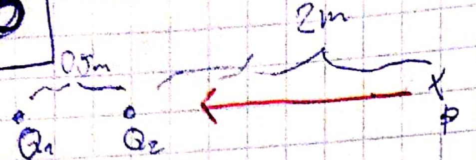
$$\frac{-2 \pm \sqrt{2^2 + 4 \cdot 3 \cdot 1}}{2 \cdot 3} = \begin{cases} + \; \frac{14}{6} = \frac{7}{3} \\ - \; -3 \leftarrow \text{értelmetlen} \end{cases}$$

16

$d = 7 + 3 = 10$

a táv $\frac{3}{10}$-énél kell a nagyobb felé elhelyezkednie.

$\boxed{17.5}$



$C = \frac{Q}{U}$

$\frac{C}{Q} = \frac{1}{U}$

$\frac{1}{Q} = \frac{1}{CU}$

$Q_1 = 2 \cdot 10^{-6} C$
$Q_2 = -2 \cdot 10^{-6} C$

$$k\left(\frac{-2 \cdot 10^{-6}}{2{,}5^2} + \frac{+2 \cdot 10^{-6}}{2^2}\right) = 1{,}8 \cdot 10^{-7} \cdot k$$

$$-1{,}62 \cdot 10^3 = -1620\ N/C = 1620 \frac{V}{m}$$

$\boxed{17.6}$

$E = 10^5\ V/m$

$Q = 2 \cdot 10^{-8} C$
$m = 5g$

$10^5 = \frac{2 \cdot 10^{-8}}{U}$ $\quad U ; 10^5$

$U = \frac{2 \cdot 10^{-8}}{10^5} = 2 \cdot 10^{-13}$

$\frac{10^5}{k} = 1{,}1 \cdot 10^{-5} = \frac{2 \cdot 10^{-8}}{r^2}$ $\quad r^2 ; 1{,}1 \cdot 10^{-5}$

$r^2 = \frac{2 \cdot 10^{-8}}{1{,}1 \cdot 10^{-5}} = 1{,}8 \cdot 10^{-3}$ $\quad \sqrt{\ }$

$r = 0{,}04242 m$

$$E = F/Q \Rightarrow F = \underline{\underline{2 \cdot 10^{-3}}}$$

$E \leftarrow 10^5$, $Q \leftarrow 2 \cdot 10^{-8}$

$a = \frac{m}{s^2} \quad \frac{m \cdot kg}{s^2}$ $\qquad 2 \cdot 10^{-3} = \frac{m}{s^2} \cdot 0{,}005$ $\quad /0{,}005$

$\underline{\underline{0{,}4\ m/s^2}}$

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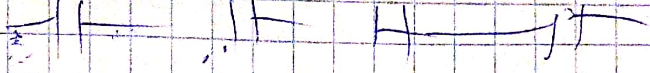
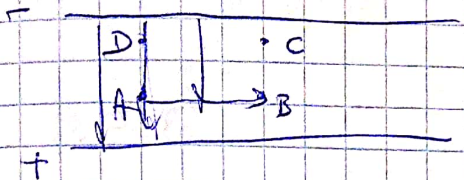
Jún 14-20



$N = F \cdot s$



$W_{AB} = 0$

$W_{DC} = 0$

$W_{AD} = E \cdot d \cdot Q$

$U = \frac{W}{Q}$

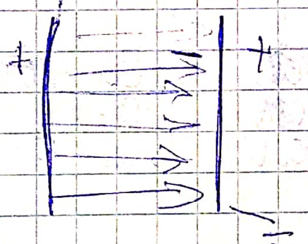
$W = U \cdot Q$

$U = E \cdot d$

SOROS

$Q_1 = Q_2 = Q_3 \ldots$ ~~$U_1 = U_2 = U_3$~~

$C = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

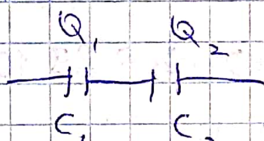


NEM SOROS

Párhuzamos kapcs.

$C_e = C_1 + C_2$

$U_1 = U_2 = U_3$



$C = \frac{\Sigma Q}{\Sigma U}$

$\Sigma Q = Q_1 + Q_2$ $/ : U$

$\Sigma C_e = C_1 + C_2$

17.14

~~$U_1 = 100V$~~

$U_2 = 200V$

$C_1 = C_2$

Q_1 Q_2

17.37

$E = 4000 N/C$

$Q = 10^{-12} C$

$s = 1 cm$

$4 \cdot 10^{-9} N \cdot 0{,}01 m$ (10^{-2})

$4 \cdot 10^{-11} N \cdot m$ ✓

$\underline{W = 4 \cdot 10^{-11} J}$

$Q = C \cdot U$

$Q = 2C(U_1 - U_2)$

$200V - 100V = 2U$

$U = 50V$

17.46

$C_1 = 1 \mu F$

$C_2 = 2 \mu F$

$C_3 = 3 \mu F$

$U_{max} = 1000V$

$U_{2 max} = 200V$

$U_{3 max} = 500V$

$Q_1 = 0{,}001 C$

$Q_2 = 0{,}0004 C$

$Q_3 = 0{,}0015 C$

soros

$U = 1000 + 200 + 500 = \underline{1700V}$

$\frac{1}{C} = \frac{1}{0{,}001} + \frac{1}{0{,}0004} + \frac{1}{0{,}0015}$ → ~~$C = 2{,}4 \cdot 10^{-5}$ ... $= 0{,}04$~~ $\frac{6}{11} 10^{-6} F$

párhuzamos

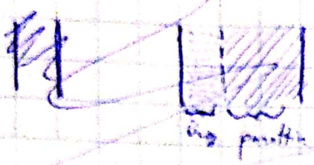
$Q = 0{,}0029 C$

$\underline{C = 6 \mu F}$

$U = 0{,}002 V$

17.50

$U = 3000 V$



$\varepsilon_{üveg} = 7$

$\varepsilon_{paraff} = 2$

$C = \varepsilon_0 \varepsilon_r \frac{A}{d}$

$C_1 = 1\mu F$ $\quad U_{max} = 1000V$ $\quad Q_1 = 10 \cdot 10^{-4} C$

$C_2 = 2\mu F$ $\quad U_{max}\ 2000V$ $\quad Q_2 = 4 \cdot 10^{-4} C$

$C_3 = 3\mu F$ $\quad U_{max} = 500V$ $\quad Q_3 = 15 \cdot 10^{-4} C$

3 soros

$U_e = U_1 + U_2 + U_3 = 1700V$

$C_e = \frac{6}{11} \cdot 10^{-6} F$

$Q = 9{,}2 \cdot 10^{-4}$

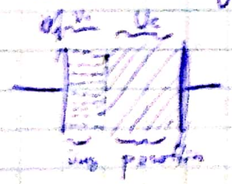
3 párhuzamos

$Q_e = Q_1 + Q_2 + Q_3 = 29 \cdot 10^{-4} C$

$C = 6\mu F$

$U = C \cdot U = 2 \cdot 10^{-8} V$

17.50 $\quad U = 3000V$



$\varepsilon_{üveg} = 7$
$\varepsilon_{paff} = 2$

$C = \varepsilon_0 \varepsilon_r \frac{A}{d}$

$E = \left(\frac{1}{4\pi\varepsilon_0\varepsilon_r}\right)^2 \cdot \frac{Q}{r^2}$

$E = \frac{U}{d}$ $\quad U = E \cdot d$

$3000 = \frac{E}{7} +$

3 behelyettesített

卌 卌 卌 卌 卌

$F_c = k \cdot \frac{qQ}{r^2}$

$$\oint\!\!\oint_{\partial V} \underline{E} \cdot \underline{dA} = \frac{1}{\varepsilon_0} \iiint_V \rho \, dV$$

$$\Phi E = \frac{Q}{\varepsilon_0}$$

$$E_p = k \frac{qQ}{r}$$

potenciális energia

$$U = k \frac{Q}{r}$$

Munkavégzési képesség egy pontban

Kondenzátor

$$C = \frac{Q}{U}$$

Síkkondenzátor

$$C = \frac{\varepsilon_0 \cdot \varepsilon_r A}{d}$$

felület

távolság

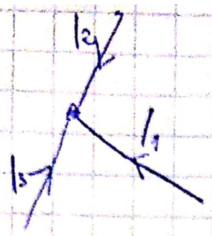
Elektromos áram

$$I = \frac{dQ}{dt}$$

Kábelen Q töltés megy át t idő alatt.

Ohm tv.: Ellenállás

$$R = \frac{U}{I} \qquad [\Omega]$$

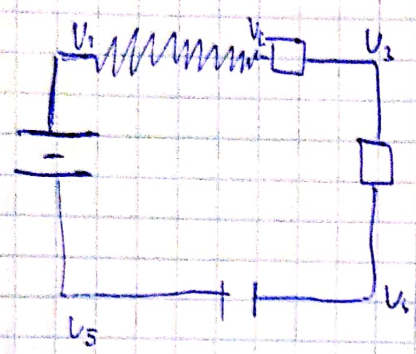


$\Sigma I = 0$

↳ Valamelyik negatív kell, hogy legyen

CSOMÓPONTOK

Potenciáli törvénye



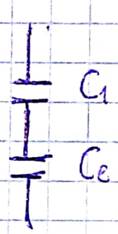
KUKOK ÁRAMOK TÖRVÉNYE

$\Sigma U = 0$

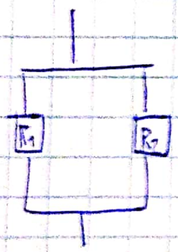
Egy teljes körben a feszültség = 0
Kell lennie negatív feszültségnek

Kapcsolások

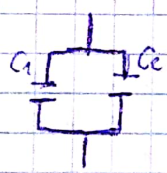
$R_e = R_1 + R_2$



$\frac{1}{C_e} = \frac{1}{C_1} + \frac{1}{C_2}$



$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2}$



$C_e = C_1 + C_2$

18.7

$R = \rho \frac{l}{A}$

$l = 30\,mm$

$d = 2{,}4\,mm \rightarrow A = d^2/4 \cdot \pi$

$\rho = 0{,}017 \frac{\Omega mm^2}{m}$

$0{,}017 \cdot \frac{4 \cdot 30}{2{,}4^2 \cdot \pi} = \underline{0{,}113\,\Omega}$

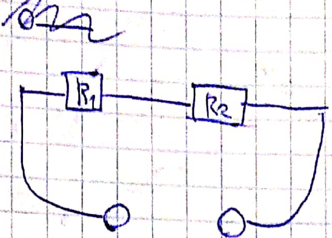
18.9

$R_1 = 40\,000\,\Omega$

$P_{max} = 4W \quad = U \cdot I$

$R_2 = 10\,000\,\Omega$

$P_{max} = 4W$



$$R_e = R_1 + R_2 = 50\,k\Omega$$

$$I = \frac{U}{R_e}$$

$U_1 = R_1 \cdot I$ $\qquad$ $U_2 = R_2 \cdot I$

$P_1 = U_1 \cdot I = R_1 I^2$ $\qquad$ $P_2 = U_2 \cdot I = R_2 I^2$

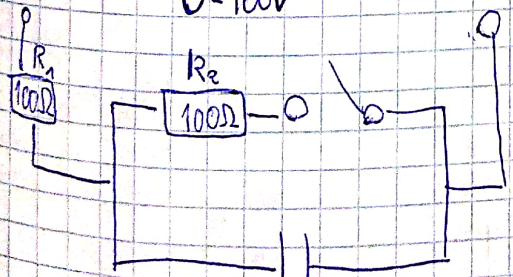
$P_1 = R_1 \cdot \frac{U^2}{R_e^2}$ $\qquad$ $P_2 = R_2 \frac{U^2}{R_e^2}$

mivel $R_1 > R_2$, az füstöl el előbb

$$U \le \sqrt{\frac{P_1 \cdot R_e^2}{R_1}} = \sqrt{\frac{4W \cdot (50^2\,\Omega)^2}{\cancel{4 \cdot 10^4\,\Omega}}} = \sqrt{\frac{(5 \cdot 10^4)^2}{10^4}} = \frac{5 \cdot 10^4}{10^2} = \underline{500\,V}$$

18.12

$U = 100V$



$C = 10\mu F$

Kapcsoló: nyitva

$$t = \infty \Rightarrow U_C = 100V$$

$$I = \emptyset$$

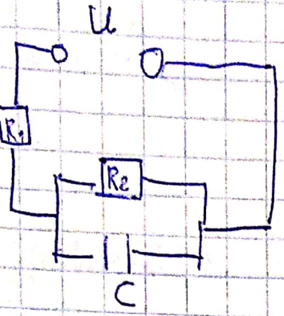
kondenzátorban tárolt energia

$E_C = \frac{1}{2} C \cdot U^2$

$$E_C = \frac{10\mu F}{2} \cdot {10^2}^2 = 0{,}05\,J$$

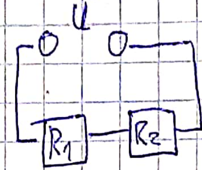
$$I = 0 \Rightarrow P = U \cdot I = 0$$

Kapcsoló zárva



Ha $t=\infty$

$I_c=0$



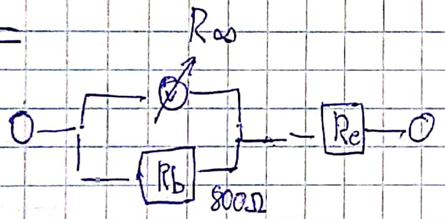
$$P=U\cdot I=U\cdot\frac{U}{R_1}=\frac{U^2}{R_1+R_2}=\frac{100^2}{100+100}=50W$$

$$U_c=U_{R_2}=50V$$

$$R_2\cdot I\Rightarrow R_2\cdot\frac{U}{R_e}\Rightarrow\frac{R_2}{R_1+R_2}U=\frac{100}{100+100}=50V$$

$$E_c=\frac{1}{2}CU_c^2=\frac{1}{2}\cdot10^{-5}\cdot50^2=0{,}0125\,J$$

18.16



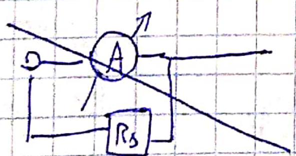
$R_e=15200\,\Omega$

$U_{Rb}\leq 5V$

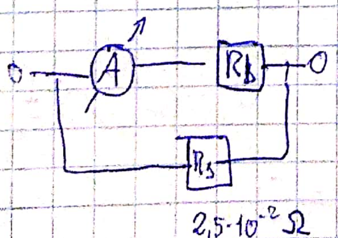
$$U_{Rb}=\frac{R_b}{R_b+R_e}\cdot U\Rightarrow U=U_{Rb}\cdot\frac{R_b+R_e}{R_b}$$

$$U\leq U_{max}\frac{R_b+R_e}{R_b}=5\cdot\frac{16000}{800}=100V$$

18.17



$R_s=0{,}025\,\Omega$



$$I_{Rb}=\frac{R_s}{R_b+R_s}\cdot I$$

$$I=\frac{R_b+R_s}{R_s}\cdot I_{Rb}$$

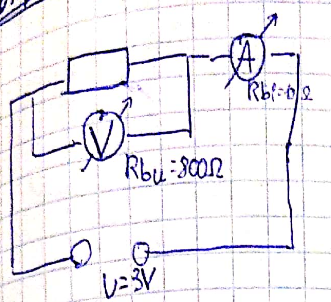
$$I\leq\frac{R_b+R_s}{R_s}\cdot I_{max}$$

$$I\leq 10A$$

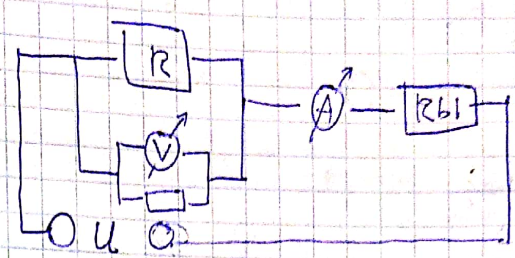
= 50W

0V

18.47



⇄



$$\frac{1}{R_{e1}} = \frac{1}{R} + \frac{1}{R_{bu}} = \frac{R_{bu} + R}{R \cdot R_{bu}}$$

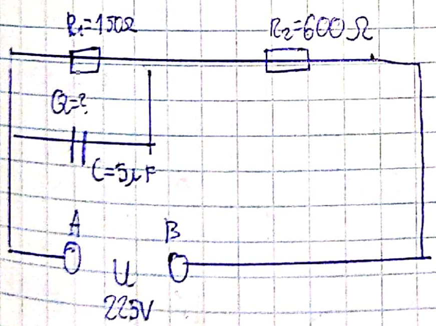
$$R_{e1} = \frac{R \cdot R_{bu}}{R + R_{bu}} = \frac{40 \cdot 800}{40 + 800} = 38{,}1\,\Omega$$

$$R_{e2} = R_{e1} + R_{b1} = 38{,}1 + 10 = 48{,}1\,\Omega$$

$$I = \frac{U}{R_{e2}} = \frac{3}{48{,}1} = 0{,}062\,A$$

$$U_1 = R_{e1} \cdot I = 38{,}1 \cdot 0{,}062 = 2{,}38\,V$$

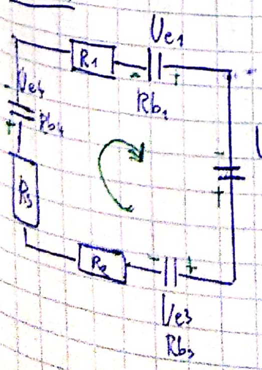
18.46



$$U_C = \frac{R_1}{R_1 + R_2} \cdot U = \frac{150}{750} \cdot 225 = 45\,V$$

$$Q = C\,U_c = 5 \cdot 10^{-6} \cdot 45 = 225\,\mu C$$

19.16



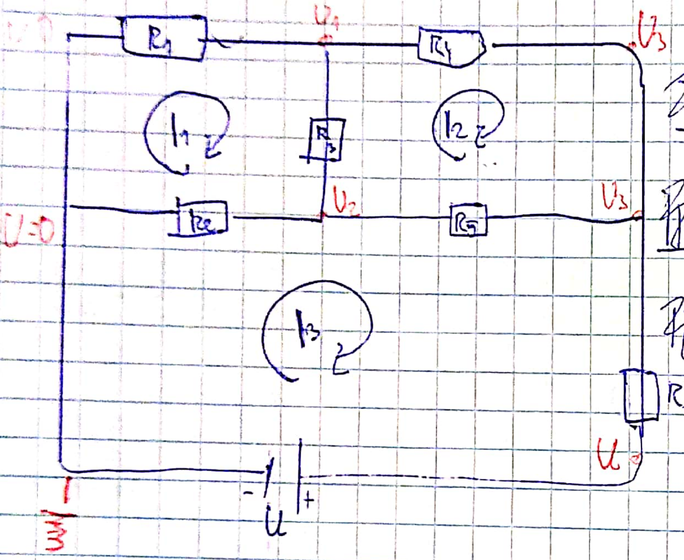
$R_1 = 20\,\Omega$
$R_2 = 40\,\Omega$
$R_3 = 10\,\Omega$
~~$R_4 =$~~
$U_{e1} = 10\,V$
$U_{e2} = 10\,V$
$U_{e3} = 6\,V$
$U_{e4} = 20\,V$

$R_{b1} = 20\,\Omega$
$R_{b2} = 0{,}1\,\Omega$
$R_{b3} = 0{,}1\,\Omega$
$R_{b4} = 0{,}01\,\Omega$

$$R_1 \cdot I - U_{e1} + R_{b1} I$$
$$-U_{e2} + R_{b2} \cdot I + U_{e3} + R_{b3} \cdot I$$
$$+R_2 \cdot I + R_3 \cdot I + U_{e4} + R_{b4} \cdot I = 0$$

$$I = \frac{U_{e1} + U_{e2} - U_{e3} - U_{e4}}{R_1 + R_2 + R_3 + R_{b1} + R_{b2} + R_{b3} + R_{b4}}$$

$$I = \frac{10+16-6-20}{20+40+10+0{,}2+0{,}1+0{,}01} = \frac{-6}{70{,}41} = -8{,}5 \cdot 10^{-2}\ A$$



I. $R_1 \cdot I_1 + R_2 \cdot (I_1 - I_3) + R_3(I_1 - I_2) = 0$

II. $R_4 \cdot I_2 + R_5(I_2 - I_3) + R_3(I_2 - I_1) = 0$

III. $R_2(I_3 - I_1) + R_5(I_3 - I_2) + R_6 I_3 = \cancel{0} - U$

~~I + II + III~~: Össz kell adogatni

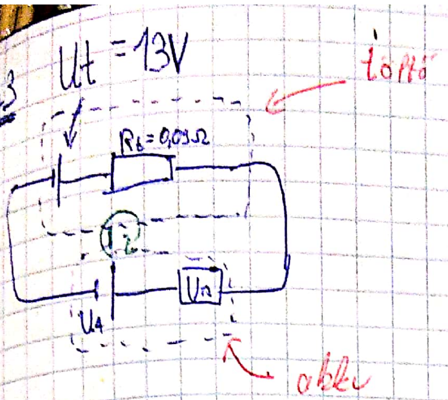
~~$R_4 I_4 +$~~

$$\frac{0-U_1}{R_1} + \frac{U_3-U_1}{R_4} + \frac{U_2-U_1}{R_3} = 0$$

$$\frac{0-U_2}{R_2} + \frac{U_1-U_2}{R_3} + \frac{U_3-U_2}{R_5} = 0$$

$$\frac{U_1-U_3}{R_4} + \frac{U_2-U_3}{R_5} + \frac{U-U_3}{R_6} = 0$$

19.43 $U_t = 13V$



$-U_t + I \cdot R_t + I \cdot R_A + U_A = 0$

$I(R_t + R_A) = U_t - U_A$

$I = \frac{U_t - U_A}{R_t + R_A} = \frac{13-12}{0{,}09+0{,}01} = \frac{1}{0{,}1}$

$I = 10A$

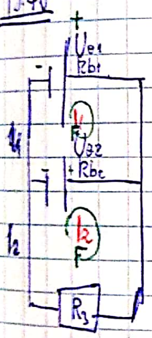
$P_t = U_t \cdot I - I^2 \cdot R_t = 130 - 9 = 121W$

$P_{hő} = I^2 \cdot R_b + I^2 \cdot R_t = 10^2 \cdot 0{,}09 + 10^2 \cdot 0{,}01 = 10W$

$P_A = U_A \cdot I = 12 \cdot 10 = 120W$

$-U$

19.46



$U_{e1} = 2V$
$U_{e2} = 2V$
$R_{b1} = 1\Omega$
$R_{b2} = 2\Omega$
$I_1 = 1A$

$I_1 R_1 - U_{e1} + U_{e2} + R_{b2}(I_2 - I_2) = 0$

$R_{b2}(I_2 - I_1) - U_{e2} + R_3 I_2 = 0$

$I. \to I_2 = \frac{I_1 R_{b1} \cancel{- U_{e1} + U_{e2}} + R_{b2} \cdot I_1}{R_{b2}} = I_1\left(\frac{R_{b1}}{R_{b2}} + 1\right)$

$II. \to R_3 = \frac{R_{b2}(I_1 - I_2) + U_{e2}}{I_2} = \frac{2(1-1{,}5)+2}{1{,}5} = \frac{2}{3}\Omega$

18.14 19.26
18.24 19.28
18.28 19.39
18.29
18.30

Mágneses tér

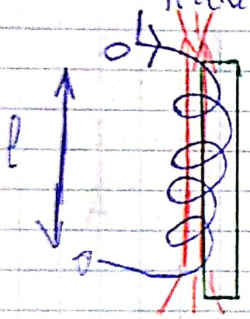
Elektromos

$$\underbrace{\oiint_{\partial V} \underline{E}\cdot d\underline{A}}_{\phi E} = \frac{1}{\varepsilon_0}\underbrace{\iiint_V \rho \, dV}_{Q}$$

$$\frac{\partial}{\partial t}\iint_{A} \underline{B}\cdot d\underline{A} = \oint_{\partial A} \underline{E}\cdot d\underline{l} \qquad \oiint_{\partial V} \underline{B}\cdot d\underline{A} = \emptyset$$

AMPER TV.!!!

Tekercs, N menet



$B\cdot l + \cancel{0} + \cancel{0} + \cancel{0}$
$= \mu_0 N\cdot I$

$B = \mu_0 \frac{N\cdot I}{l}$

Máneses tér:
- Tekercsen belül: Homogén
- Tekercsen kívül $= 0$
- Tekercs alatt, fölött ≈ 0

$$F_l = \underbrace{q\,\underline{E}}_{\text{q-ra ható elektromos erő}} + q\,\underbrace{\underline{v}\times\underline{B}}_{\text{merőlegeses}}$$

sebesség

szinusz

A mágneses tér mozgó részecskékre erőt fejt ki.

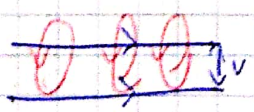
$F_e = I\cdot \underline{l}\times\underline{B}$

drót

Lorentz tv.!!!

$B\cdot 2r\pi = \mu_0\cdot I$

$B = \frac{\mu_0}{2\pi}\cdot\frac{1}{r}$



$v = \frac{s}{t} \rightarrow s = t \cdot v$ - const v

$a = \frac{v}{t}$

a = gyorsulás (m/s^2)

$\bar{v} = \frac{s_1 + s_2}{t_1 + t_2} = \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2}$

if $(s_1 = s_2)$

$\bar{v} = \frac{2 v_1 v_2}{v_1 + v_2}$

$s = \frac{a}{2} t^2 \quad v = at$ const a

g

g: gravitáció $= 10 m/s^2$

Hajítás

$y = v_0 t + \frac{g}{2} t^2 \quad v = v_0 + gt$

s: megtett út (méter)

t: idő (sec)

v: sebesség (m/s)