1. $v_{\text{átl}}$=18 km/h

Jelölje v a sebességet fölfelé, ekkor $v_{\text{lefelé}} = 3v$.

Mivel $s_{\text{le}} = 2s_{\text{fel}}$, így

$$v_{átl} = \frac{s_{összes}}{t_{összes}} = \frac{s_{le}+s_{fel}}{t_{le}+t_{fel}} = \frac{3s_{fel}}{\frac{2s_{fel}}{3v}+\frac{s_{fel}}{v}} = \frac{9}{5}v\,.$$ *13 pont*

$v_{\text{átl}}$=18 km/h = 9/5v → v**= 10 km/h**.

v_{fel}= 10 km/h, v_{le}**= 30 km/h**. *2 pont*

2. s= 10 km, v_A= 4 km/h, v_B = 6 km/h,

t_a= ?, x_A= ?, t_b = ?

a) t=0 $x_{A0} = 0$ x_{B0} = 10 km

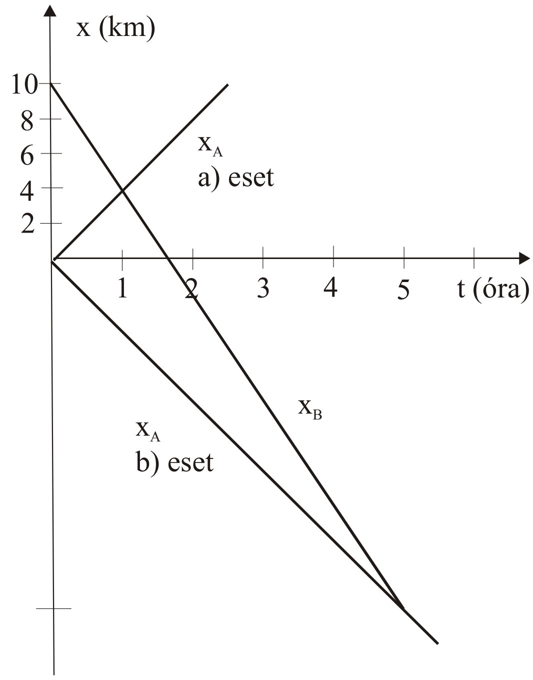
t>0 $x_A = v_A \cdot t$ $x_B = 10 - v_B \cdot t$

***t* = 1 óra, *x*$_A$ = 4 km** *10 pont*

b) $-4t = 10 - 6t$

***t* = 5 óra** *5 pont*

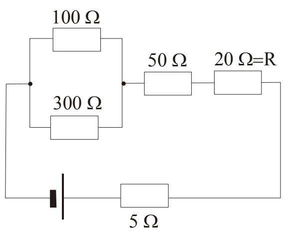
Igen, találkoznak!



3. E = 15 V, R_b = 5 Ω, t = 10 perc = 600 s.

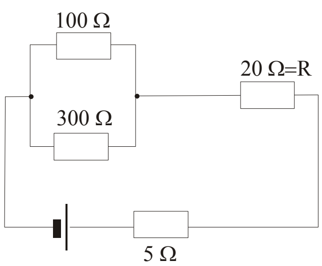
I_{ny}= ?, I_z = ?, ΔP_{20} = ?, W_{ny} = ?, W_z = ?

K nyitott állásánál:



$$I_{ny} = \frac{\mathsf{E}}{R_k+R_b} = \frac{15\,\text{V}}{\frac{1}{\frac{1}{100\,\Omega}+\frac{1}{300\,\Omega}}+50\,\Omega+20\,\Omega+5\,\Omega} = \mathbf{0{,}1\ A}\,.$$ *4 pont*

K zárt állásánál:



$$I_{ny} = \frac{\mathsf{E}}{R'_k+R_b} = \frac{15\,\text{V}}{\frac{1}{\frac{1}{100\,\Omega}+\frac{1}{300\,\Omega}}+20\,\Omega+5\,\Omega} = \mathbf{0{,}15\ A}\,.$$ *4 pont*

$\Delta P_{20} = I_z^2 R - I_{ny}^2 R = 20\ \Omega\,[(0{,}15\ \text{A})^2 - (0{,}1\ \text{A})^2] = \mathbf{0{,}25\ W}$ *3 pont*

$W_{ny} = \mathsf{E}\, I_{ny}\, t = 15\ \text{V}\cdot 0{,}1\ \text{A}\cdot 600\ \text{s} = \mathbf{900\ J}$ *2 pont*

$W_z = \mathsf{E}\, I_z\, t = 15\ \text{V}\cdot 0{,}15\ \text{A}\cdot 600\ \text{s} = \mathbf{1350\ J}$ *2 pont*

4. Készítsük el a gyertya tükörképeit! Ezek az *a)* ábra szerint T_A, T'_A, T''_A, … és T_B, T'_B, T''_B ….
Mivel csak 5 tükörkép keletkezik, ezért $T''_A = T''_B$.

5 pont

Ugyanez az elrendezés most szögekkel a *b)* ábrán. A tükrözési tulajdonságaiból következnek a belső körön jelölt szögek. Könnyen leolvasható ezek után, hogy
360° = 6α azaz **α = 60°**. *10 pont*

Hiba! Nincs megadva a témakör. *a)* **Hiba! Nincs megadva a témakör.** *b)*

5. $h_1 = 8$ m, $v_{01} = 2$ m/s ↑, $m_1 = 1$ kg, $h_2 = 14$ m, $v_{02} = 4$ m/s ↓, $m_2 = 3$ kg, $g = 10$ m/s^2

a) $h = ?$

b) $v_1 = ?$, $v_2 = ?$

c) $v' = ?$, $t_ö = ?$

$s_1 = v_{01}t - \frac{g}{2}t^2$. $\quad s_2 = v_{02}t + \frac{g}{2}t^2$.

$s_1 + s_2 = t(v_{01} + v_{02})$. $\quad s_1 + s_2 = h_2 - h_1$.

$$t = \frac{s_1 + s_2}{v_{01} + v_{02}} = \frac{h_2 - h_1}{v_{01} + v_{02}} = \frac{6\ \text{m}}{6\ \frac{\text{m}}{\text{s}}} = 1\ \text{s}.$$

$$s_1 = 2\frac{\text{m}}{\text{s}}\cdot 1\ \text{s} - 5\ \frac{\text{m}}{\text{s}^2}\cdot 1\ \text{s}^2 = -3\ \text{m}.$$

$s_2 = 4\ \frac{\text{m}}{\text{s}}\cdot 1\ \text{s} + 5\ \frac{\text{m}}{\text{s}^2}\cdot 1\ \text{s}^2 = 9\ \text{m}$. $\quad \boldsymbol{h} = \mathbf{5\ m}$. *4 pont*

$v_1 = v_{01} - gt = 2\frac{\text{m}}{\text{s}} - 10\ \frac{\text{m}}{\text{s}^2}\cdot 1\ \text{s} = \mathbf{-8\ \frac{m}{s}}$ ↓

$v_2 = v_{02} + gt = 4\frac{\text{m}}{\text{s}} + 10\ \frac{\text{m}}{\text{s}^2}\cdot 1\ \text{s} = \mathbf{14\ \frac{m}{s}}$ ↓ *3 pont*

$m_1v_1 + m_2 v_2 = (m_1 + m_2)v$.

$v = \frac{m_1v_1 + m_2v_2}{m_1 + m_2} = \frac{1\ \text{kg}\cdot 8\ \frac{\text{m}}{\text{s}} + 3\ \text{kg}\cdot 14\ \frac{\text{m}}{\text{s}}}{4\ \text{kg}} = \mathbf{12{,}5\ \frac{m}{s}}$. *3 pont*

$$h = vt + \frac{g}{2}t^2 \rightarrow 5\ \text{m} = 12{,}5\ \frac{\text{m}}{\text{s}}t + 5\ \frac{\text{m}}{\text{s}^2}t^2.$$

$5\,t^2 + 12{,}5\,t - 5 = 0$.

$t^2 + 2{,}5\,t - 1 = 0$.

$t_{1,2} = \frac{-2{,}5 \pm \sqrt{6{,}25 + 4}}{2} = \frac{-2{,}5 \pm 3{,}2}{2} = 0{,}35$ s (a másik gyök negatív). *3 pont*

$t_ö = t + t_1 = 1$ s + 0,35 s = **1,35 s.** *1 pont*

$v' = v + gt = 12{,}5\ \frac{\text{m}}{\text{s}} + 10\ \frac{\text{m}}{\text{s}^2}\cdot 0{,}35\ \text{s}^2 = \mathbf{16\ \frac{m}{s}}$. *1 pont*

6. Legyen v_0 a kezdősebesség, v a sebesség a fékezés végén, $t_f = 60$ s, $v_1 = 36$ km/h = 10 m/s, t a fékút feléig eltelt idő, $v_2 = 8$ m/s, s a fékút.

(1) $v_2 = \frac{v_0 + v}{2} \rightarrow v = 2v_2 - v_0$, azaz $v = 16 - v_0$.

(2) $s = \frac{v_0 + v}{2}t_f = v_2\cdot t_f =$ **480 m**. *5 pont*

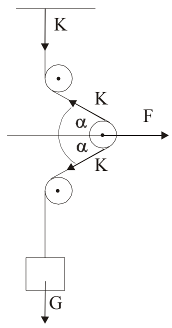
(3) $\frac{s}{2} = \frac{v_0 + v_1}{2}t = \frac{v_1 + v}{2}(t_f - t)$.

$(v_0 + 10)t = (26 - v_0)(60 - t)$ és $480 = (v_0 + 10)t$.

$v_0^2 - 16v_0 - 28 = 0$.

$\boldsymbol{v_{01}}$ **= 14 m/s**, $v_{02} = 2$ m/s (de v= 14 m/s, így nem lassulna) *5 pont*

7. $G = 100$ N



$K = G$

$F = 2K\cos\alpha$ *6 pont*

$\alpha_1 = 45°$ $F_1 = 141{,}4$ N

$\alpha_2 = 30°$ $F_1 = 173{,}2$ N *4 pont*

A beteg lábát húzó erő változása $F_2 - F_1$ **= 31,8 N**. *5 pont*

8. $V_0 = 0{,}2$ liter, $p_0 = 100$ kPa

$\Delta V = ?$, $p = 80$ kPa

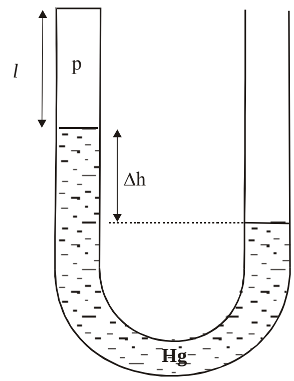
T= áll.

$p_0V_0 = pV$, $\quad V = \dfrac{p_0V_0}{p} = 0{,}25\,\text{liter}$. *10 pont*

$\Delta V = V - V_0 =$ **0,05 liter**. *5 pont*

9. $A = 3\ \text{cm}^2 = 3\cdot10^{-4}\ \text{m}^2$, $l = 0{,}1$ m, $\Delta l = 0{,}15$ m, $p_k = 10^5$ Pa, $T = 300$ K,

$\rho = 1{,}36\cdot10^4\ \text{kg/m}^3$, $g = 10\ \text{m/s}^2$.



a) $p = ?$

b) $m = ?$

$p_k = p + p_{Hg} = p + \rho g\Delta h$.

$p = p_k - \rho g\Delta h =$

$= 10^5\ \text{Pa} - 1{,}36\cdot10^4\ \dfrac{\text{kg}}{\text{m}^3}\cdot10\ \dfrac{\text{m}}{\text{s}^2}\cdot0{,}15\ \text{m} =$ **79600 Pa**. *5 pont*

$pV = NkT$

$$N = \frac{pV}{kT} = \frac{79600\,\text{Pa}\cdot0{,}1\,\text{m}\cdot3\cdot10^{-4}\,\text{m}^2}{1{,}38\cdot10^{-23}\,\frac{\text{J}}{\text{K}}\cdot300\,\text{K}} = 5{,}77\cdot10^{20}.$$ *5 pont*

$$n = \frac{N}{N_A} = \frac{5{,}77\cdot10^{20}}{6{,}02\cdot10^{23}\,\frac{1}{\text{mol}}} = 9{,}6\cdot10^{-4}\,\text{mol}.$$ *3 pont*

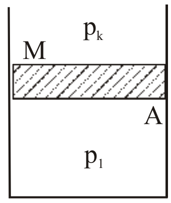
Mivel argonra $M = 40\ \dfrac{\text{g}}{\text{mol}}$, így

$m = nM = 9{,}6\cdot10^{-4}\ \text{mol}\cdot40\ \dfrac{\text{g}}{\text{mol}} = 0{,}0384\ \text{g} =$ **38,4 mg**. *2 pont*

10. $A = 20\ \text{cm}^2 = 2\cdot10^{-3}\ \text{m}^2$, $M = 10$ kg, $V_1 = 1{,}2\cdot10^{-3}\ \text{m}^3$, $T_1 = 400$ K,

$\rho_0 = 1{,}3\ \text{kg/m}^3$, $p_0 = 10^5$ Pa, $T_0 = 273$ K, $p_k = 10^5$ Pa, $g = 10\ \text{m/s}^2$,

$c_V = 710\ \dfrac{\text{J}}{\text{kg}\cdot\text{K}}$.



$m = ?$ $\Delta E_h = ?$ $\Delta E_b = ?$ $Q = ?$ $T_2 = 500$ K

$$p_1 = p_k + \frac{Mg}{A} = 10^5\ \text{Pa} + \frac{10\,\text{kg}\cdot10\,\frac{\text{m}}{\text{s}^2}}{2\cdot10^{-3}\,\text{m}^2} = 1{,}5\cdot10^5\ \text{Pa}.$$ *2 pont*

$\frac{p_1}{\rho_1 T_1} = \frac{p_0}{\rho_0 T_0} \quad \rightarrow \rho_1 = \frac{p_1 \rho_0 T_0}{p_0 T_1} = \frac{1{,}5\cdot 10^5\,\text{Pa}\cdot 1{,}3\,\frac{\text{kg}}{\text{m}^3}\cdot 273\,\text{K}}{10^5\,\text{Pa}\cdot 400\,\text{K}} = 1{,}33\,\frac{\text{kg}}{\text{m}^3}$. *2 pont*

$m = \rho_1 V_1 = 1{,}33\,\frac{\text{kg}}{\text{m}^3}\cdot 1{,}2\cdot 10^{-3}\,\text{m}^3 = \mathbf{1{,}6\cdot 10^{-3}\,kg}$. *1 pont*

$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad \rightarrow V_2 = V_1\frac{T_2}{T_1} = 1{,}2\cdot 10^{-3}\,\text{m}^3\,\frac{500}{400} = 1{,}5\cdot 10^{-3}\,\text{m}^3$. *2 pont*

$h_1 = \frac{V_1}{A} = 0{,}6\,\text{m}, \qquad h_2 = \frac{V_2}{A} = 0{,}75\,\text{m}$.

$\Delta E_h = Mg(h_2 - h_1) = 100\,\text{N}\cdot 0{,}15\,\text{m} = \mathbf{15\,J}$. *2 pont*

$\Delta E_b = c_V m \Delta T = 710\,\frac{\text{J}}{\text{kg}\cdot\text{K}}\cdot 1{,}6\cdot 10^{-3}\,\text{kg}\cdot 100\,\text{K} = \mathbf{113{,}6\,J}$ *2 pont*

$-W = W_{gáz} = p_1\Delta V = 1{,}5\cdot 10^5\,\text{Pa}\cdot 0{,}3\cdot 10^{-3}\,\text{m}^3 = \mathbf{45\,J}$ *2 pont*

$Q = \Delta E_b - W = 113{,}6\,\text{J} + 45\,\text{J} = \mathbf{158{,}6\,J}$ *2 pont*

11. $\Delta s_1 = 1000\,\text{nm} = 10^{-6}\,\text{m}$, erősítés.
$\Delta s_2 = 1{,}25\cdot 10^{-6}\,\text{m}$, gyengítés.
$\Delta s_3 = 0{,}5\cdot 10^{-6}\,\text{m}$
$\lambda = ?$

$\Delta s_1 = 2k\frac{\lambda}{2}$. *3 pont*

$\Delta s_2 = (2k+1)\frac{\lambda}{2}$. *3 pont*

$\Delta s_2 = (\frac{2\Delta s_1}{\lambda} + 1)\frac{\lambda}{2} = \Delta s_1 + \frac{\lambda}{2}$. *2 pont*

$\lambda = 2(\Delta s_2 - \Delta s_1) = 2\cdot 0{,}25\cdot 10^{-6}\,\text{m} = 0{,}5\cdot 10^{-6}\,\text{m} = 5\cdot 10^{-7}\,\text{m} = \mathbf{500\,nm}$. *2 pont*

$\Delta s_3 = x\cdot\frac{\lambda}{2} \quad \rightarrow x = \frac{2\Delta s_3}{\lambda} = \frac{2\cdot 0{,}5\cdot 10^{-6}\,\text{m}}{5\cdot 10^{-7}\,\text{m}} = 2$. *3 pont*

Mivel x páros, így Δs_3-nál ***erősítés*** lép föl. *2 pont*

12. $C = 2\,\mu\text{F} = 2\cdot 10^{-6}\,\text{F}$, $W = 10^{-2}\,\text{J}$, $U = 300\,\text{V}$, $R_1 = 100\,\Omega$.
$R_2 = ?$ $I = ?$

$W = \frac{1}{2}CU_C^2 \quad \rightarrow U_C = \sqrt{\frac{2W}{C}} = \sqrt{\frac{2\cdot 10^{-2}\,\text{J}}{2\cdot 10^{-6}\,\text{F}}} = 100\,\text{V}$. *5 pont*

$I = \frac{U_C}{R_1} = \frac{100\,\text{V}}{100\,\Omega} = \mathbf{1\,A}$. *5 pont*

$R_2 = \frac{U - U_C}{I} = \frac{300\,\text{V} - 100\,\text{V}}{1\,\text{A}} = \mathbf{200\,\Omega}$. *5 pont*

13. A részecske R sugarú körpályán mozog a ciklotronban:

$\frac{mv^2}{R} = qvB \rightarrow \omega = \frac{v}{R} = \frac{qB}{m} \rightarrow \boxed{f = \frac{1}{2\pi}\frac{qB}{m}}$. *10 pont*

$q = 1{,}6\cdot 10^{-19}\,\text{C}$, $m = 9{,}1\cdot 10^{-31}\,\text{kg}$, $B = 4\cdot 10^{-4}\,\text{T}$, $c = 3\cdot 10^8\,\text{m/s}$.
Ezekkel az adatokkal

f = 11,19 MHz, $\lambda = \frac{c}{f}$ =**26,8 m** (URH-sáv) *5 pont*