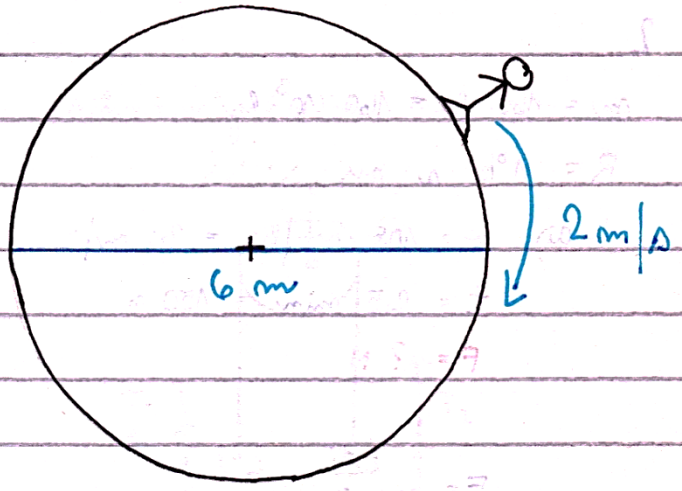
PROSEMINÁŘ Z FYZIKY

1.



$m_p = 30\ kg$

$d_D = 6\ m \Rightarrow r = 3\ m$

$J_D = 1800\ kg \cdot m^2$

$v_p = 2\ m/s$

$\omega = ?\ rad/s$

moment hybnosti: $L = J \cdot \omega$

– v klidu $\quad L_p + L_D = 0$

$J \cdot \omega_p + J \cdot \omega_D = 0$

$J = m \cdot r^2$

$\omega = \frac{v}{r}$

$\frac{m \cdot r^2 \cdot v}{r} + J \cdot \omega_D = 0$

$m \cdot r \cdot v + J \cdot \omega_D = 0 \Rightarrow \omega_D = -\frac{m \cdot r \cdot v}{J_D}$

$\omega_D = -\frac{30 \cdot 3 \cdot 2}{1800}$

$\underline{\omega_D = -0{,}1\ rad/s}$

2.

$m = 160\ t = 160 \cdot 10^3\ kg$

$R = 1\%$ z m

a) $v = 108\ km/h = 30\ m/s$

$t = 2{,}5\ min = 150\ s$

$F = ?\ N$

$F = m \cdot a$

$a = \frac{v}{t}$ $\rightarrow$ $F = m \cdot \frac{v}{t}$

$F = 160 \cdot 10^3 \cdot \frac{30}{150} = 32\,000\ N = \underline{32\ kN}$

b) $F = ?\ N$

$s = ?\ m$

– rolnobeth

$F - F_0 = m \cdot a$

$F_0 = \frac{mg}{100}$

$a = \frac{v}{t}$ $\Rightarrow$ $F - \frac{mg}{100} = m \cdot \frac{v}{t}$

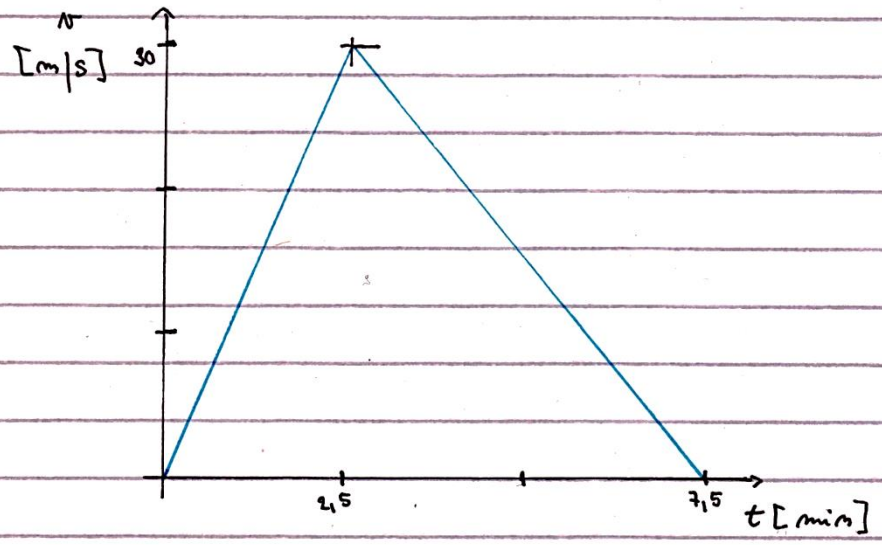
$F = m \cdot \frac{v}{t} + \frac{mg}{100}$

$F = 160 \cdot 10^3 \cdot \frac{30}{150} + \frac{160 \cdot 10^3 \cdot 10}{100}$

$F = 48\,000\ N = \underline{48\ kN}$

$s = v \cdot t$

$s = 30 \cdot 150 = \underline{4\,500\ m}$



3.

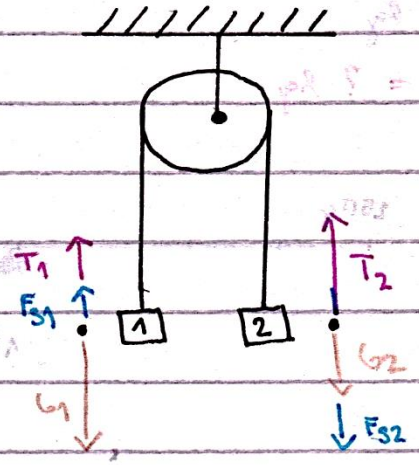
$m_1 = 6\ kg$

$m_1 > m_2$

$g = 10\ m/s^2$

$m_2 = ?\ kg$

nehmotná kladka bez tření



$F_1 = F_{S1} = m \cdot a = m \cdot g - T$

$F_2 = F_{S2} = m \cdot a = -m \cdot g + T$

$T_1 = T_2$

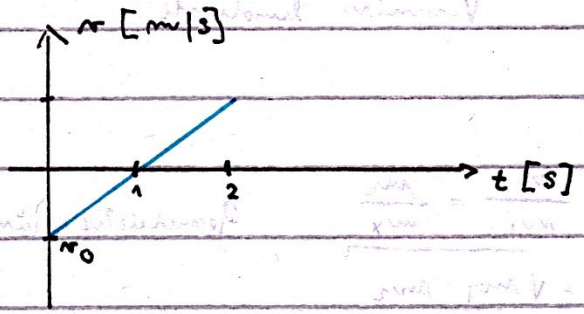
$-m_1 a + m_1 \cdot g = m_2 a + m_2 g$

$m_1 (-a + g) = m_2 (a + g)$

$6 \cdot (-5 + 10) = m_2 (5 + 10)$

$30 = 15\, m_2$

$\underline{m_2 = 2\ kg}$



$v = v_0 - at$

$a_{pád} = -\frac{g}{2}$

$v_0 < 0$

Závislost rychlosti pevného tělesa na čase:

$v < 0$; $t \in \langle 0; 1)$ ... těleso klesá

$v = 0$; $t = 0$ ... těleso stojí

$v > 0$; $t \in (1; 2)$ ... těleso stoupá

opakuje se do doby než nastane rovnováha

4.

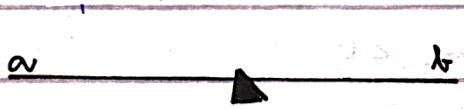
$m_1 = 250\ g = 0{,}25\ kg$ - vlevo

$m_p = 1\ kg$ - vpravo

$m_{OPRAV.} = ?\ kg$

—

Vyrovnání momentů



$m_1 \cdot a_g = m_x \cdot b_g$

$m_2 \cdot a_g = m_x \cdot b_g$

$\frac{a}{b} = \frac{m_x}{m_1} = \frac{m_2}{m_x}$ Geometrický průměr

$m_x = \sqrt{m_1 \cdot m_2}$

$m_x = \sqrt{1000 \cdot 250}$

$m_x = 500g$

5.

Geostacionární družice je umělá družice na geostacionární dráze (kruhová dráha nad rovníkem, 35 786 km). Pozorovateli se jeví jako nehybná. Užívá se k telekomunikaci, pozorování Země, navigaci a na meteorologická a astronomická pozorování vesmíru.

s = ?

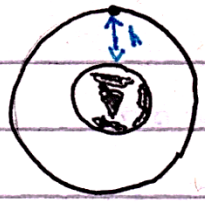
h = ? ad Zemi

T = 24 hod = 86 400 s

$\mathcal{H} = 6{,}67 \cdot 10^{-11}\ N \cdot m^2 / kg^2$ ... gravitační konstanta

$M = 5{,}97 \cdot 10^{24}\ kg$ ... hmotnost Země

R = 6 378 km ... poloměr Země



$F_g = \mathcal{H} \cdot \frac{mM}{(R+h)^2}$ ... Newtonův gravitační zákon

$F_D = ma = m\frac{v^2}{R+h}$ ... dostředivá síla

$v = \omega (R+h) = \frac{2\pi}{T}(R+h)$ ... obvodová rychlost družice

$F_g = F_D$

$\mathcal{H} \cdot \frac{mM}{(R+h)^2} = m \cdot \frac{v^2}{R+h}$

$\mathcal{H} \frac{m \cdot M}{(R+h)^2} = m \cdot \frac{4\pi^2 (R+h)}{T^2}$

$(R+h)^3 = \mathcal{H} \cdot \frac{M \cdot T^2}{4\pi^2}$

$h = \sqrt[3]{\mathcal{H} \cdot \frac{MT^2}{4\pi^2}} - R$

$h = \sqrt[3]{6{,}67 \cdot 10^{-11} \cdot \frac{5{,}97 \cdot 10^{24} \cdot 86\,400^2}{4\pi^2}} = 6\,378 \cdot 10^3$

h = 35 848 910 m = <u>35 848,9 km</u>

$s = 2\pi r = 2\pi (35\,848{,}9 + 6378) = 265\,319{,}4$ km

6.

$m_{V\ VZDUCH} = 14{,}7\ kg$

$m_{V\ VODA} = 13{,}4\ kg$

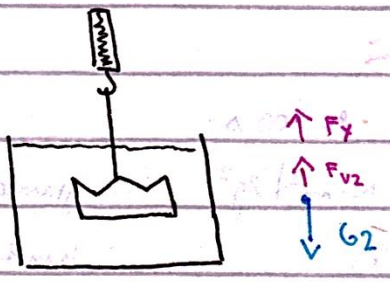
$\rho_{Au} = 19\,300\ kg/m^3$

$\rho_{KORUNA} = ?\ kg/m^3$

Je koruna zlatá?

VZDUCH

VODA



$F_x + F_{Vz} - G = 0$

$G_V = F_x$

$F_{Vz} = V \cdot \rho \cdot g$

$G = m_1 \cdot g$

$G_V = m_2 \cdot g$

$m_2 \cdot g + F_{Nz} - m_1 \cdot g = 0$

$F_{Nz} = (m_1 - m_2) \cdot g$

$F_{Nz} = (14{,}7 - 13{,}4) \cdot 10$

$F_{Nz} = 13\,N$

$V = \frac{F_{Nz}}{\rho \cdot g}$

$V = \frac{13}{1000 \cdot 10}$

$V = 1{,}3 \cdot 10^{-3}\ m^3$

$\rho = \frac{m_1}{V}$

$\rho = \frac{14{,}7}{0{,}0013}$

$\rho = 11\,307{,}7\ kg/m^3 < 19\,300\ kg/m^3$

Koruna má menší hustotu než čisté zlato, takže koruna není vyrobena z ryzího zlata

7.

struna c: $f = 180,81\ Hz$

$L = 1,1\ m$

$m = 9,9\ g$

$c = ?\ m/s$

$\tau = ?\ N$

$\lambda = ?\ m$

$x_1 = ?\ m$

$f_1 = ?\ Hz$

$$f = \frac{c}{\lambda} = \frac{c}{2L} \Rightarrow c = f \cdot 2L$$

$$c = 180,81 \cdot 2 \cdot 1,1 = \underline{397,8\ m/s}$$

μ [kg/m] – hmotnost jednotkové délky struny

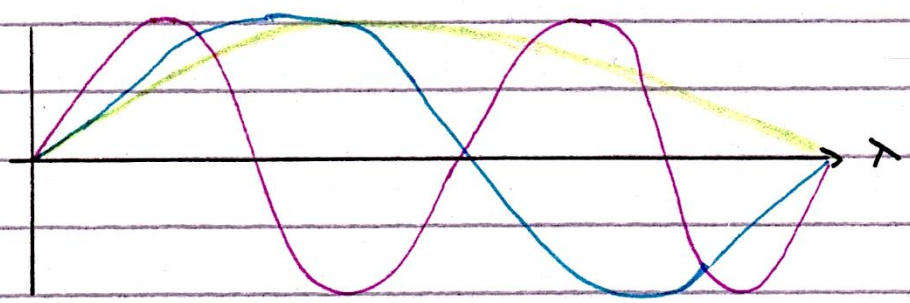
$$c = \sqrt{\frac{\tau}{\mu}} \Rightarrow \tau = c^2 \cdot \mu = c^2 \cdot \frac{m}{2}$$

$$\tau = 397,8^2 \cdot \frac{0,0099}{1,1}$$

$$\tau = \underline{1424,2\ N}$$

$$f = \frac{c}{\lambda} \Rightarrow \lambda = \frac{c}{f} = \frac{397,8}{180,81} = \underline{2,2\ m}$$

$$\lambda_i = \frac{\lambda_1}{i} \qquad f = f_1 \cdot i$$



8.

$P_0 = 2\ kW$

$V = 2\ l$

$T = 12°C \rightarrow 100°C$

$t = 409\ s$

$\eta = ?$

$c = 4\,180\ J/kg \cdot K$

$\rho_{VODA} = 1000\ kg/m^3$

$Q = m_v \cdot a \cdot (t_v - t) = V \cdot \rho \cdot c \cdot (t_v - t)$

$Q = 2 \cdot 10^{-3} \cdot 1000 \cdot 4\,180 \cdot (100 - 12)$

$Q = 735\,680\ J$

$\tau = \frac{Q}{P}$

$\tau = \frac{735\,680}{2000}$

$\tau = 367,84\ s$

$\eta = \frac{\tau}{\Delta t} = \frac{367,84}{409} = 0,189 \doteq \underline{0,9} \Rightarrow 90\%$

9.

$\varnothing_{FEMUR} = 2{,}8\ cm \quad \Rightarrow r = 1{,}4\ cm$

$\sigma_p = 170\ MPa$

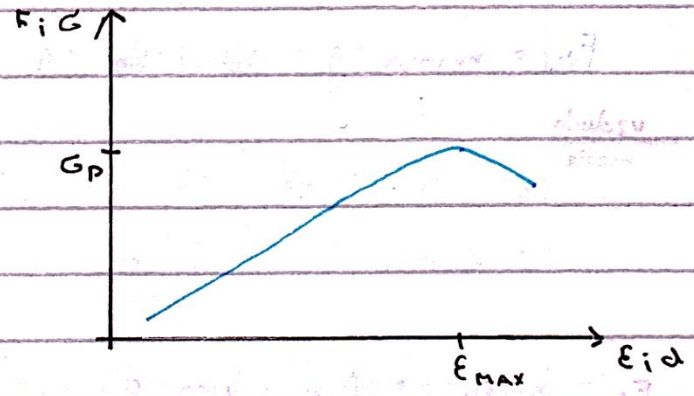
? ZATÍŽENÍ $F = ?\ N$

$S_0 = \pi \cdot r^2 = 3{,}14 \cdot 1{,}4 = 6{,}15\ cm^2 = 6{,}15 \cdot 10^{-4}\ m^2$

$\sigma = \frac{F}{S} \Rightarrow F = \sigma \cdot S = 170 \cdot 10^6 \cdot 6{,}15 \cdot 10^{-4}$

$F = 104\,550\ N = \underline{0{,}1\ MN}$

σ ... mezní napětí [Pa]



jedná se o mechanické napětí. Průřez kostí považujeme za kruhový, a proto použijeme aproximaci

10.

$\rho_{LED} = 917\ kg/m^3$

$\rho_{MOŘ} = 1024\ kg/m^3$

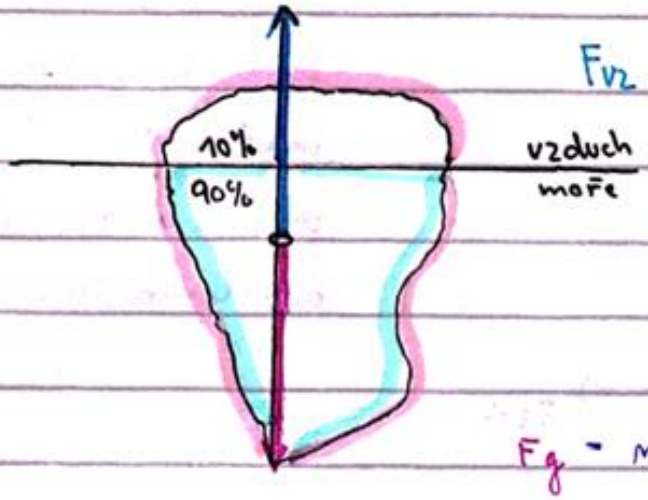
$V_{RELATIV} = ?$

$1024\ kg/m^3 \ldots\ldots 100\%$

$917\ kg/m^3 \ldots\ldots x$

$x = \frac{100 \cdot 917}{1024} = 89{,}55\ \% = 90\%$

$100 - 90 = 10\%$



$F_{VZ} = m_{VODA} \cdot g = \rho_{VODA} \cdot V_{PON} \cdot g$

$F_g = m_{LED} \cdot g = \rho_{LED} \cdot V_{LED} \cdot g$

Archimédův zákon $F = F_g - F_{VZ} = V \cdot g\ (\rho_{LED} - \rho_{VODA})$

$G = F_{VZ}$

11.

110 V | 75 W

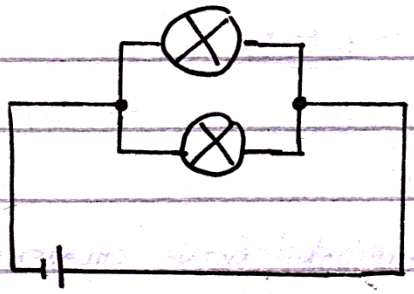
110 V | 40 W – paralelně ⊗ ke zdroji 110 V

$R = ?\ \Omega$

$P_0 = ?\ W$

R a P_0 seriově ?

PARALELNĚ



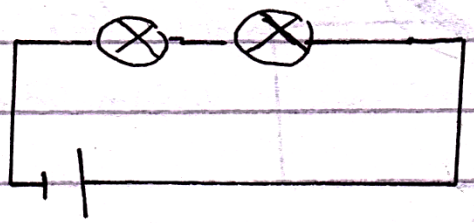
1. žárovka: $R_1 = \frac{U^2}{P} = \frac{110^2}{75} = 161{,}3\ \Omega$

2. žárovka: $R_2 = \frac{U^2}{P} = \frac{110^2}{40} = 302{,}5\ \Omega$

$R_p = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{161{,}3 \cdot 302{,}5}{161{,}3 + 302{,}5} = \underline{105{,}2\ \Omega}$

$P_p = \frac{U_2}{R_p} = \frac{110^2}{105{,}2} = \underline{115\ W}$

SÉRIOVĚ



$R_S = R_1 + R_2 = 161{,}3 + 302{,}5 = \underline{463{,}8\ \Omega}$

$P_S = \frac{V^2}{R_S} = \frac{110^2}{464} \doteq \underline{26{,}1\ W}$

12.

RTG LAMPA – $V = 120\ kV$

$I = 40\ mA$

$Q = ?$

? ODVOD TEPLA PŘES ELEKTRODY

? NAHRADA REZISTOREM

$$R_1 = \frac{V}{I} = \frac{120 \cdot 10^3}{40 \cdot 10^{-3}} = 3\,000\,000\ \Omega = 3\ M\Omega$$

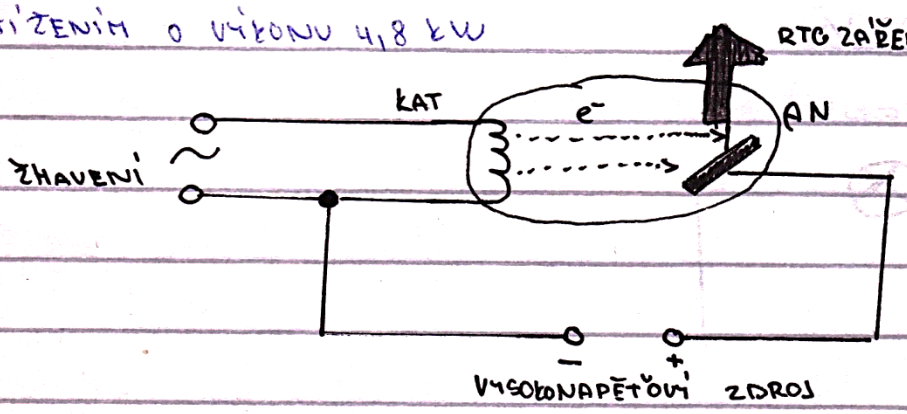
KATODA - ROZŽHAVENÍ, DOJDE K EMISI e^-

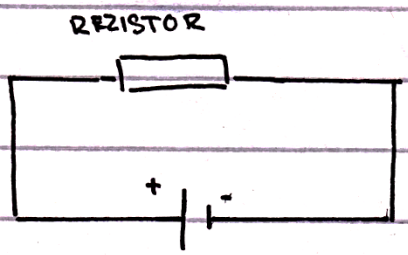
ANODA - PŘI ODPADU e^- DOCHÁZÍ K ZAHŘÍVÁNÍ, NUTNÉ CHLAZENÍ

$$P = U \cdot I = I^2 \cdot R = \frac{U^2}{R}$$

$$P = U \cdot I = 120 \cdot 10^3 \cdot 40 \cdot 10^{-3} = 4800\ W = 4{,}8\ kW$$

RTG LAMPU LZE NAHRADIT REZISTOREM O ODPORU 3 MΩ S MOŽNÝM ZATÍŽENÍM O VÝKONU 4,8 kW





13.

n DIAMANT = 2,419

λ_0 SLUNCE = 500 nm

v = ? m/s (c = rychlost šíření)

λ = ? nm

Jaký parametr se zachová na rozhraní 2 kmitů?

$$c = \frac{c_0}{n}$$

$$c = \frac{3 \cdot 10^8}{2,419} = 124\,018\,189,3 = \underline{1,24 \cdot 10^8 \text{ m/s}}$$

$$\lambda_2 = \lambda_1 \cdot n_{12}$$

$$\lambda_2 = \lambda_1 \cdot \frac{n_2}{n_1}$$

$$\lambda_2 = 500 \cdot \frac{1}{2,415}$$

$$\lambda_2 = \underline{206,7 \text{ nm}}$$

Zachovávají se frekvence. Je vlastností zdroje záření, které nemůžeme změnou prostředí ovlivnit.

$$f_1 = f_2$$

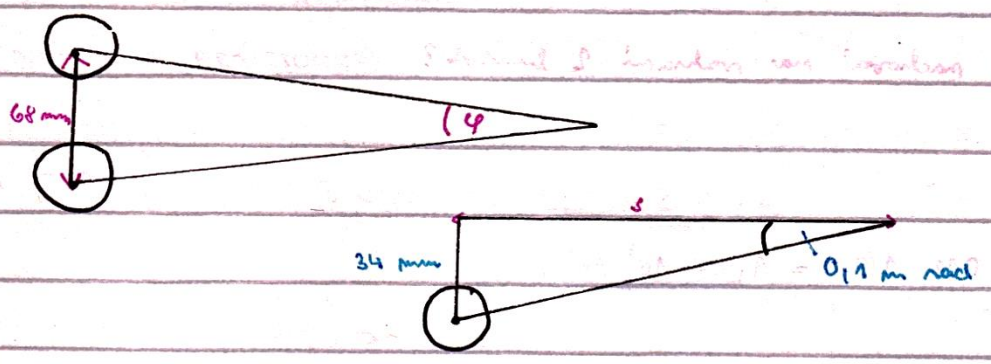
$$\frac{v_1}{\lambda_1} = \frac{v_2}{\lambda_2}$$

4

$22 - 68$ mm $\Rightarrow$ 34 mm

$\varphi = 0{,}2$ mr rad $\Rightarrow 0{,}1$ mr rad $= 5{,}173 \cdot 10^{-3}$

$\lambda = ?$ m

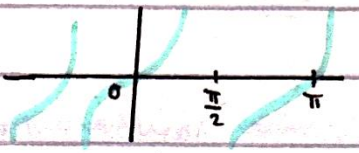


$$\operatorname{tg} \alpha = \frac{\text{proti}}{\text{pro}} \Rightarrow s = \frac{34 \cdot 10^{-3}}{\operatorname{tg} 5{,}173 \cdot 10^{-3}}$$

$s = 339{,}97$ m $\doteq$ 340 m

$\frac{\pi}{2}$ [rad] $= 90°$

$\operatorname{tg} 90° = \infty$



15.

5 cm od spojky

$f = 15$ cm

vzdálenost a změna obrazu?

$$\frac{1}{f} = \frac{1}{a} + \frac{1}{a'}$$

$$\frac{1}{15} = \frac{1}{5} + \frac{1}{a'}$$

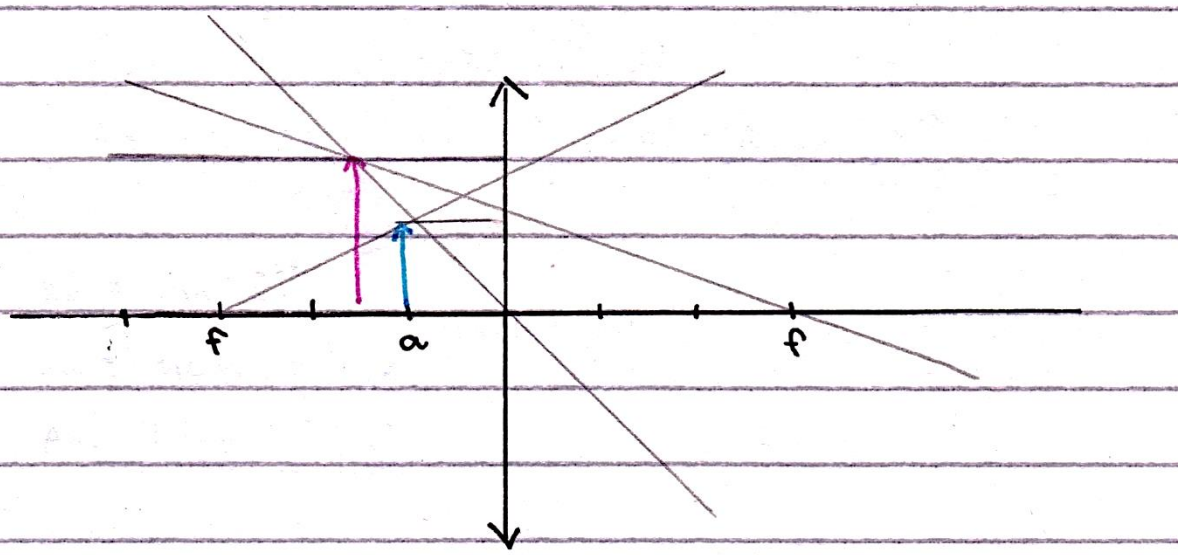
$$\frac{1}{a'} = \frac{1}{15} - \frac{1}{a}$$

$$\frac{1}{a'} = \frac{1-3}{15}$$

$$\frac{1}{a'} = -\frac{2}{15}$$

$$a' = -\frac{15}{2} = -7{,}5 \text{ cm}$$

$7{,}5 : 5 =$ 1,5 krát větší obraz



- rovnoběžný
- směřuje 1,5x
- přímý

2600 °C ⊗ -> 2 873,15 k

hvězda Panny - Spica 22 400 k

$\lambda_{SLUNCE} = 501$ nm

$\lambda_{\otimes} = ?$ nm

$\lambda_{HVĚZDA} = ?$ nm

$T_{SLUNCE} = ?$ k

Wienův zákon: $T \cdot \lambda_m = 2{,}9 \cdot 10^{-3}$ m·k

$\lambda_{\otimes} = \frac{2{,}9 \cdot 10^{-3}}{T} = \frac{2{,}9 \cdot 10^{-3}}{2873{,}15} = 1{,}009 \cdot 10^{-6}$ m = 1 μm → oblast IČ

$\lambda_{HVĚZDA} = \frac{2{,}9 \cdot 10^{-3}}{T} = \frac{2{,}9 \cdot 10^{-3}}{22\,400} = 1{,}2946 \cdot 10^{-7}$ m = 129,5 nm → oblast UV (modrá)

$T_{SLUNCE} = \frac{2{,}9 \cdot 10^{-3}}{\lambda_m} = \frac{2{,}9 \cdot 10^{-3}}{501 \cdot 10^{-9}} = 5\,788{,}4$ k

17.

$^{13}_{7}N$

$m = 1{,}51\ \mu g$

$\tau_{1/2} = 600\ s$

a) $N_0 = ?$ molécul

b) $A_0 = ?\ s^{-1}$

c) $A_{14} = ?\ s^{-1}$

d) $t = ?\ s$ $\quad A = 1$ Bq

a) $n = \frac{m}{M} = \frac{1{,}51 \cdot 10^{-6}}{12} = 1{,}26 \cdot 10^{-7}$ mol

$n = \frac{N}{N_A} \Rightarrow N_0 = n \cdot N_A$

$N_0 = 1{,}26 \cdot 10^{-7} \cdot 6{,}022 \cdot 10^{23}$

$N_0 = 7 \cdot 10^{16}$ molekul

b) $\tau_{1/2} = \frac{\ln 2}{\lambda} \Rightarrow \lambda = \frac{\ln 2}{\tau_{1/2}}$

$\lambda = \frac{\ln 2}{600}$

$\lambda = 1{,}155 \cdot 10^{-3}\ s^{-1}$

$A_0 = \lambda N_0 = 1{,}155 \cdot 10^{-3} \cdot 7 \cdot 10^{16} = 8{,}085 \cdot 10^{13}\ s^{-1}$

c) $A_{14} = A_0 \cdot e^{-\lambda t}$

$A_{14} = 8{,}085 \cdot 10^{13} \cdot e^{-1{,}155 \cdot 10^{-3} \cdot 3600}$

$A_{14} = 1{,}264 \cdot 10^{13}\ s^{-1}$

d) $A = A_0 \cdot e^{-\lambda t} \Rightarrow t = \frac{\ln \frac{A}{A_0}}{-\lambda}$

$t = \frac{\ln \frac{1}{8{,}085 \cdot 10^{13}}}{-1{,}155 \cdot 10^{-3}}$

$t = 27\,726\ s = 462{,}1$ min