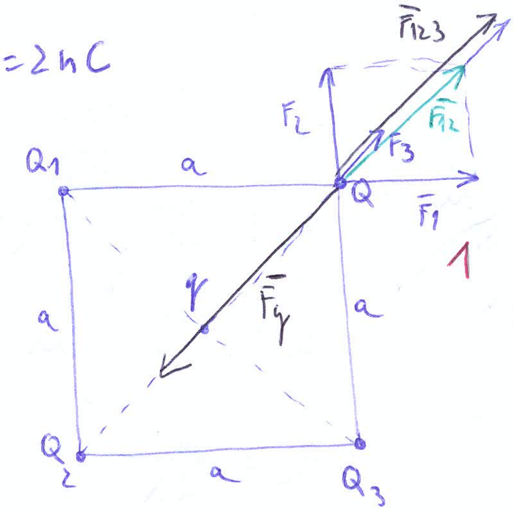
1 $Q = 2\,nC$



$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2} \; ; \; Q_1 = Q_2 = Q_3$$

$$F_1 = \frac{1}{4\pi\varepsilon_0}\frac{QQ}{a^2}$$

$$F_2 = \frac{1}{4\pi\varepsilon_0}\frac{QQ}{a^2}$$

$$F_{12} = \sqrt{F_1^2 + F_2^2} = \sqrt{\left(\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2}\right)^2 + \left(\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2}\right)^2} =$$

$$= \sqrt{2}\,\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2} \quad 1$$

$$F_3 = \frac{1}{4\pi\varepsilon_0}\frac{QQ}{(a^2+a^2)} = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2a^2}$$

$$F_{123} = F_{12} + F_3 = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2a^2} + \sqrt{2}\,\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2} =$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2}\left(\frac{1}{2} + \sqrt{2}\right) \quad 1$$

$$F_{123} = F_q$$

$$\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2}\left(\frac{1}{2}+\sqrt{2}\right) = \frac{1}{4\pi\varepsilon_0}\frac{Q|q|}{\left(\frac{\sqrt{a^2+a^2}}{2}\right)^2} \quad 1$$

$$\frac{Q}{a^2}\left(\frac{1}{2}+\sqrt{2}\right) = \frac{|q|\,4}{a^2+a^2}$$

$$\frac{Q}{a^2}\left(\frac{1}{2}+\sqrt{2}\right) = \frac{|q|\,4^2}{2a^2}$$

$$Q\left(\frac{1}{2}+\sqrt{2}\right) = 2|q|$$

$$|q| = \left(\frac{1}{4}+\frac{\sqrt{2}}{2}\right)Q$$

$$|q| = 0{,}957\,Q$$

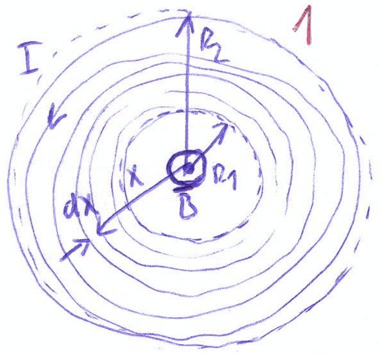
$$q = -0{,}957\,Q$$

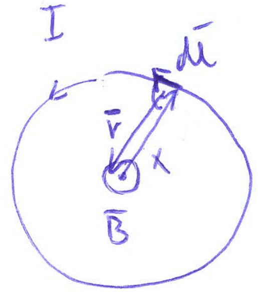
$$q = -0{,}957 \cdot 2\,nC = -1{,}914\,nC$$

1

$\boxed{5b}$

② N, R_1, R_2, I





$$\bar{B} = \frac{\mu_0 I}{4\pi}\int \frac{d\bar{l} \times \bar{r}}{|\bar{r}|^3}$$

$$B_0 = \frac{\mu_0 I}{4\pi}\int_0^{2\pi x} \frac{dl\, x \sin 90^\circ}{x^{\cancel{3}2}}$$ 0,5

$$B_0 = \frac{\mu_0 I}{4\pi x^2}\int_0^{2\pi x} dl = \frac{\mu_0 I}{4\pi x^2}\, 2\pi x$$ 0,5

$$B_0 = \frac{\mu_0 I}{2x}$$ 0,5

1,5

$$dB = B_0\, dN$$

$$dB = \frac{\mu_0 I}{2x}\, dN$$ 1

$$= \frac{\mu_0 I}{2x}\, g\, dx$$

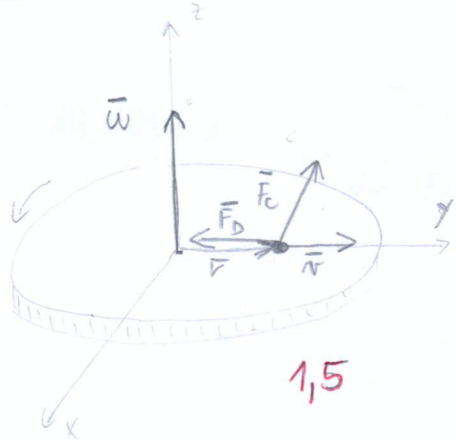
$$= \frac{\mu_0 I}{2x}\, \frac{N}{R_2 - R_1}\, dx$$ 1

$$B = \int_{R_1}^{R_2} dB = \int_{R_1}^{R_2} \frac{\mu_0 I}{2x}\, \frac{N}{R_2 - R_1}\, dx = \frac{\mu_0 I N}{2(R_2 - R_1)} \int_{R_1}^{R_2} \frac{1}{x}\, dx = \frac{\mu_0 I N}{2(R_2 - R_1)} \ln \frac{R_2}{R_1}$$

0,5 1

$\boxed{6b}$

~~4~~ 3



1,5

OTEC

Coriolisova: $\bar{F}_c = (2\,\bar{\omega} \times \bar{v})\,m$

Dostredivá: $\bar{F}_D = (-\,\omega^2 \bar{r})\,m$

VY: 0,5 0,5

Coriolisova: $\bar{F}_c = (-2\,\bar{\omega} \times \bar{v})\,m$ 0,5

odstredivá: $\bar{F}_D = (\omega^2 \bar{r})\,m$

0,5 0,5 2,5

$\boxed{4b}$

4.

m_0

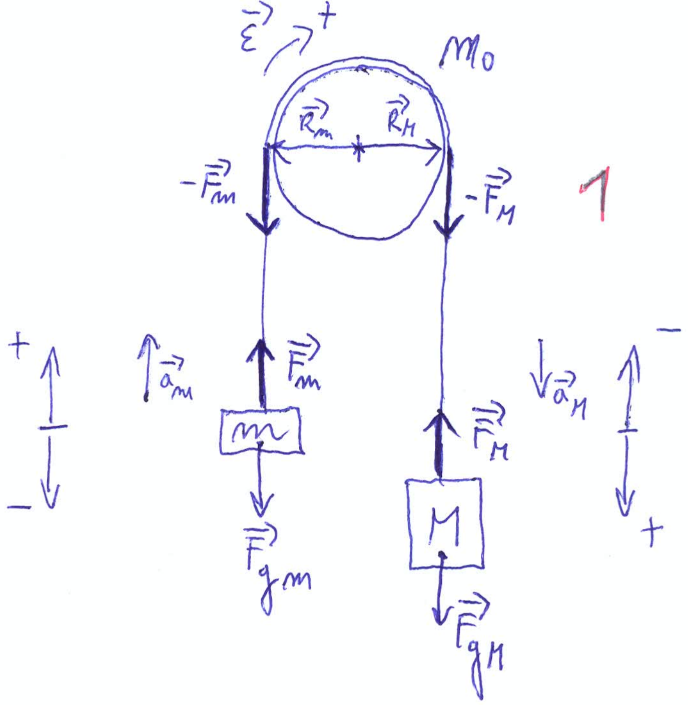
R

m
M $\gg m < M$

$a = ?\ [m/s^2]$

$F_m = ?\ [N]$

$F_M = ?\ [N]$



1) $\vec{a}_m m = \vec{F}_m + \vec{F}_{gm}$

2) $\vec{a}_M \cdot M = \vec{F}_M + \vec{F}_{gM}$

3) $J.\vec{\varepsilon} = \vec{R}_m \times (-\vec{F}_m) + \vec{R}_M \times (-\vec{F}_M)$

$|\vec{a}_m| = |\vec{a}_M| = a$; $|\vec{\varepsilon}| = \frac{a}{R}$ 0,5 ; $|\vec{R}_m| = |\vec{R}_M| = R$

---

1) $a m = F_m - F_{gm}$ 0,5

2) $a M = F_{gM} - F_M$ 0,5

3) $J \varepsilon = -(R F_m) + R F_M$ 0,5

---

1) $a m = F_m - m g$

2) $a M = M g - F_M$

3) $J \frac{a}{R} = R (F_M - F_m)$

---

1) $F_m = m a + m g = m(a+g)$

2) $F_M = M g - M a = M(g-a)$

3) $a = \frac{R^2 (F_M - F_m)}{J}$

J - kladky $\rightarrow$ J_T - valca $\Rightarrow$ $J = \frac{1}{2} m_0 R^2$ 1

3) $a = \frac{\cancel{R^2}(F_M - F_m)}{\frac{1}{2} m_0 \cancel{R^2}} = \frac{2(F_M - F_m)}{m_0}$

$$a = \frac{2(Mg - Ma - ma - mg)}{m_0}$$

$$a = \frac{2[g(M-m) - a(M+m)]}{m_0}$$

$$a m_0 = 2g(M-m) - 2a(M+m)$$

$$a m_0 + 2a(M+m) = 2g(M-m)$$

$$a[m_0 + 2(M+m)] = 2g(M-m)$$

$$a = \frac{2g(M-m)}{m_0 + 2(M+m)}$$

$$a = \frac{g(M-m)}{\frac{1}{2}m_0 + M + m}$$ 1

1) $F_m = m\left(\frac{g(M-m)}{\frac{1}{2}m_0 + M + m} + g\right)$ 1

2) $F_M = M\left(g - \frac{g(M-m)}{\frac{1}{2}m_0 + M + m}\right)$ 1

7b

5.

$m_1 = m_2 = 1\,kg$

$t_1 = 30°C \Rightarrow T_1 = 303{,}15\,K$

$t_2 = 90°C \Rightarrow T_2 = 363{,}15\,K$

$c_{vody} = 4180\ J.kg^{-1}.K^{-1}$

$$Q_1 = Q_2$$

$$m_1 c_{vody} (T_v - T_1) = m_2 c_{vody} (T_2 - T_v) \quad 1$$

; T_v – Výsledná teplota

$m_1 = m_2 = m$

$$\cancel{m}\, \cancel{c_{vody}} (T_v - T_1) = \cancel{m}\, \cancel{c_{vody}} (T_2 - T_v)$$

$$2T_v = T_2 + T_1$$

$$\boxed{T_v = \frac{T_1 + T_2}{2}} \quad 1$$

$$\Delta S = \int_{T_1}^{T_v} \frac{dQ}{T} + \int_{T_2}^{T_v} \frac{dQ}{T} = \int_{T_1}^{T_v} \frac{m c_{vody}\, dT}{T} + \int_{T_2}^{T_v} \frac{m c_{vody}\, dT}{T} = \quad 1$$

$$= m c_{vody} \left[\int_{T_1}^{T_v} \frac{dT}{T} + \int_{T_2}^{T_v} \frac{dT}{T} \right] = m c_{vody} \left[\ln \frac{T_v}{T_1} + \ln \frac{T_v}{T_2} \right] =$$

$$= m c_{vody} \ln \frac{T_v^2}{T_1 T_2} = m c_{vody} \ln \frac{\left(\frac{T_1+T_2}{2}\right)^2}{T_1 T_2} = \underline{\underline{m c_{vody} \frac{(T_1+T_2)^2}{4 T_1 T_2}}} = \quad 1$$

$$= 1 \cdot 4180 \frac{(303{,}15 + 363{,}15)^2}{4 \cdot 303{,}15 \cdot 363{,}15} = \underline{\underline{4214{,}17\ J.K^{-1}}} \quad 1$$

5b