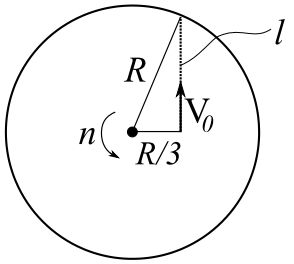
Олимпиада «Phystech International» - 2016. Физика. Решения. 11-01.

1. $V_0 = 2\pi n \cdot \dfrac{R}{3}$

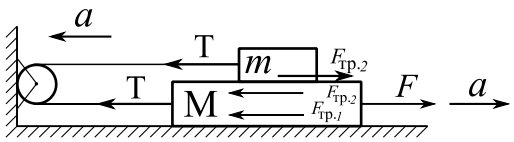


$l = \sqrt{R^2 - (R/3)^2} = \dfrac{2\sqrt{2}}{3}R$

$T = \dfrac{l}{V_0} = \dfrac{2\sqrt{2}R}{3} \cdot \dfrac{3}{2\pi nR} = \dfrac{\sqrt{2}}{\pi n}$

2. $F_{Tp1} = \mu(M+m)g; \;\; F_{TP2} = \mu mg$ (1)

$F - F_{TP1} - F_{TP2} - T = Ma$ (2)



(1)→(2): $F - \mu(M+m)g - \mu mg - T = Ma$

$F - \mu g(M+2m) - T = Ma$ (3)

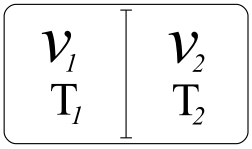
$T - F_{TP2} = ma \Rightarrow T - \mu mg = ma$ (4)

$T = m(a+\mu g) = 1 \cdot (\dfrac{10}{10} + 0{,}2 \cdot 10) = 3\,\text{Н}$

Из (3), (4): $F - \mu g(M+3m) = (M+m)a$

$F = (M+m)a + \mu g(M+3m) = 4 \cdot \dfrac{10}{10} + 0{,}2 \cdot 10 \cdot (3+3 \cdot 1) = 16\,\text{Н}$

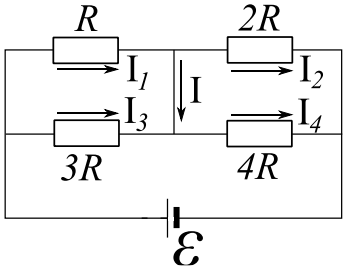
3. $\nu_1 C_V (t_1 - t) = \nu_2 C_V (t - t_2); \;\; \nu_1 t_1 - \nu_1 t = \nu_2 t - \nu_2 t_2$



$t = \dfrac{\nu_1 t_1 + \nu_2 t_2}{\nu_1 + \nu_2} = \dfrac{0{,}4 \cdot 27 + 0{,}6 \cdot 7}{0{,}4 + 0{,}6} = 15^0$ C (288K)

$\dfrac{P_1'}{P_1} = \dfrac{T}{T_1} = \dfrac{\nu_1 T_1 + \nu_2 T_2}{(\nu_1 + \nu_2)T_1} = \dfrac{0{,}4 \cdot 300 + 0{,}6 \cdot 280}{300} = 0{,}96$

4. $R_{13} = \dfrac{R_1 R_3}{R_1 + R_3} = \dfrac{3}{4}R; \qquad R_{24} = \dfrac{R_2 R_4}{R_2 + R_4} = \dfrac{4}{3}R;$



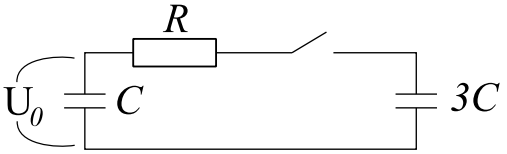
$U_{13} = \dfrac{\varepsilon R_{13}}{R_{13} + R_{24}} = \dfrac{9}{25}\varepsilon; \qquad I_1 = \dfrac{U_{13}}{R} = \dfrac{9}{25}\dfrac{\varepsilon}{R} = 0{,}36$ A

$U_{24} = \varepsilon - U_{13} = \dfrac{16}{25}\varepsilon; \qquad I_2 = \dfrac{U_{24}}{3R} = \dfrac{8}{25}\dfrac{\varepsilon}{R} = 0{,}32$ A

$I = I_1 - I_2 = \dfrac{1}{25}\dfrac{\varepsilon}{R} = 0{,}04$ A (ток течёт вниз)

5.

1) $I_0 = \dfrac{U_0}{R}$

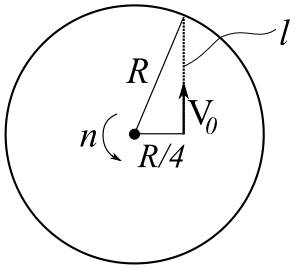


2) Закон сохранения заряда: $CU_0 = CU + 3CU \Rightarrow U = \frac{U_0}{4}$

3) $Q = \frac{CU_0^2}{2} - \frac{(C+3C)U^2}{2} = \frac{CU_0^2}{2} - 2C\frac{U_0^2}{16} = \frac{3}{8}CU_0^2$

Олимпиада «Phystech International» - 2016. Физика. Решения. 11-02.

1.



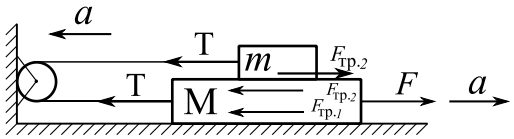
$$V_0 = 2\pi n \cdot \frac{R}{4}$$

$$l = \sqrt{R^2 - (R/4)^2} = \frac{\sqrt{15}}{4} R$$

$$T = \frac{l}{V_0} = \frac{\sqrt{15}R}{4} \cdot \frac{4}{2\pi nR} = \frac{\sqrt{15}}{2\pi n}$$

2. $F_{Tp1} = \mu(M+m)g; \;\; F_{TP2} = \mu mg$ (1)

$F - F_{TP1} - F_{TP2} - T = Ma$ (2)



(1)→(2): $F - \mu(M+m)g - \mu mg - T = Ma$

$F - \mu g(M+2m) - T = Ma$ (3)

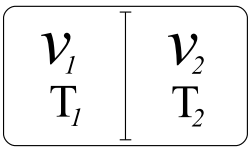
$T - F_{TP2} = ma \Rightarrow T - \mu mg = ma$ (4)

$$T = m(a + \mu g) = 1 \cdot (\frac{10}{5} + 0{,}2 \cdot 10) = 4\,\text{Н}$$

Из (3), (4): $F - \mu g(M+3m) = (M+m)a$

$$F = (M+m)a + \mu g(M+3m) = 5 \cdot \frac{10}{5} + 0{,}2 \cdot 10 \cdot (4 + 3 \cdot 1) = 24\,\text{Н}$$

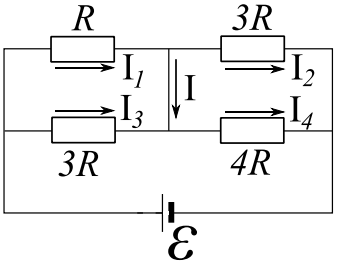
3. $\nu_1 C_V (t_1 - t) = \nu_2 C_V (t - t_2); \;\; \nu_1 t_1 - \nu_1 t = \nu_2 t - \nu_2 t_2$



$$t = \frac{\nu_1 t_1 + \nu_2 t_2}{\nu_1 + \nu_2} = \frac{0{,}2 \cdot 127 + 0{,}8 \cdot 7}{0{,}2 + 0{,}8} = 31^0 \text{ C} \quad (304\text{K})$$

$$\frac{P_1'}{P_1} = \frac{T}{T_1} = \frac{\nu_1 T_1 + \nu_2 T_2}{(\nu_1 + \nu_2) T_1} = \frac{0{,}2 \cdot 400 + 0{,}8 \cdot 280}{400} = 0{,}76$$

4. $R_{13} = \frac{R_1 R_3}{R_1 + R_3} = \frac{3}{4} R; \qquad R_{24} = \frac{R_2 R_4}{R_2 + R_4} = \frac{12}{7} R;$

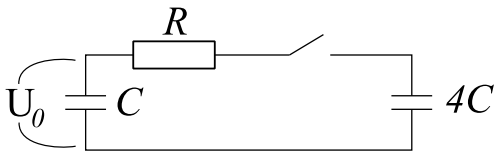


$$U_{13} = \frac{\varepsilon R_{13}}{R_{13} + R_{24}} = \frac{7}{23}\varepsilon; \qquad I_1 = \frac{U_{13}}{R} = \frac{7}{23}\frac{\varepsilon}{R} = 2{,}1\,\text{А}$$

$$U_{24} = \varepsilon - U_{13} = \frac{16}{23}\varepsilon; \qquad I_2 = \frac{U_{24}}{3R} = \frac{16}{69}\frac{\varepsilon}{R} = 1{,}6\,\text{А}$$

$$I = I_1 - I_2 = \frac{5}{69}\frac{\varepsilon}{R} = 0{,}5 \text{ А (ток течёт вниз)}$$

5.



1) $I_0 = \frac{U_0}{R}$

2) Закон сохранения заряда:

$$CU_0 = CU + 4CU \Rightarrow U = \frac{U_0}{5}$$

3) $$Q = \frac{CU_0^2}{2} - \frac{(C+4C)U^2}{2} = \frac{CU_0^2}{2} - \frac{5CU_0^2}{2 \cdot 25} = \frac{2}{5} CU_0^2$$