2020 愛知医大

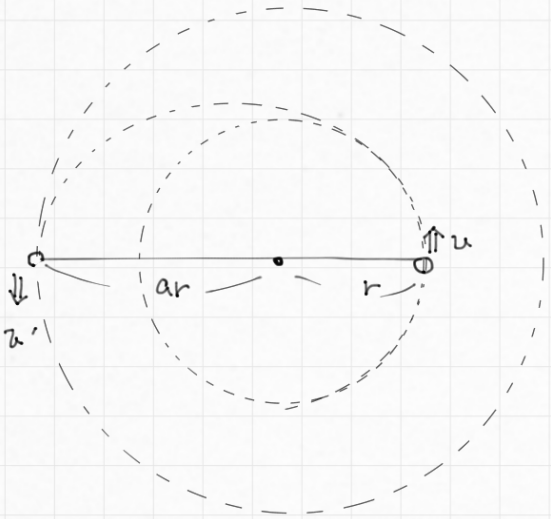
1 問1 $\omega\Delta t = \Delta\theta$ より $\omega = \dfrac{\Delta\theta}{\Delta t}$

問2 $\Delta S = \pi r^2 \times \dfrac{\omega\Delta t}{2\pi} = \dfrac{1}{2}r^2\omega\Delta t$

問3 $K = \dfrac{1}{2}m(r\omega)^2 = \dfrac{1}{2}mr^2\omega^2$

問4 運動方程式

$m r\omega^2 = T$ より $T = \dfrac{2K}{r}$



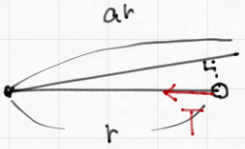
問5 面積速度一定の法則より

$\dfrac{1}{2}rv = \dfrac{1}{2}arv'$ $\quad v' = \dfrac{1}{a}v$

問6 エネルギー変化が仕事量に等しい

$\dfrac{1}{2}mv'^2 - \dfrac{1}{2}mv^2 = \dfrac{1}{2}m\left(\dfrac{v}{a}\right)^2 - \dfrac{1}{2}mv^2 = \left(\dfrac{1}{a^2}-1\right)\times\dfrac{1}{2}mv^2 = \left(\dfrac{1}{a^2}-1\right)K$

問7



$W \fallingdotseq \dfrac{1}{2}mv^2\left(\dfrac{1}{a^2}-1\right)$ と $T = m\dfrac{v^2}{r}$ を連立

$W \fallingdotseq \dfrac{1}{2}rT\left(\dfrac{1}{a^2}-1\right)$

ここに $\Delta r = ar - r$ より $a = \dfrac{r+\Delta r}{r}$ を代入

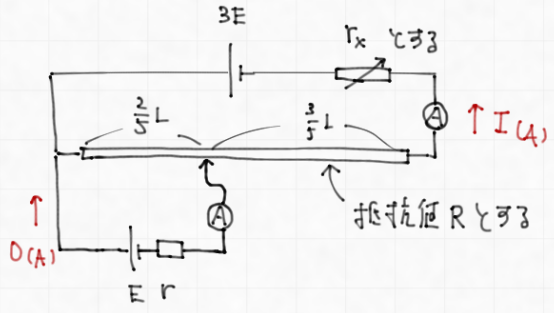
$W \fallingdotseq \dfrac{1}{2}rT\left(\dfrac{r^2}{(r+\Delta r)^2}-1\right) = \dfrac{1}{2}Tr\dfrac{-2r\Delta r-\Delta r^2}{(r+\Delta r)^2}$

$= \dfrac{1}{2}T\dfrac{-2\Delta r-\frac{\Delta r}{r}}{\left(1+\frac{\Delta r}{r}\right)^2} = -\dfrac{1}{2}T\left(2\Delta r-\dfrac{\Delta r}{r}\right)\left(1+\dfrac{\Delta r}{r}\right)^{-2}$

$\fallingdotseq -\dfrac{1}{2}T\left(2\Delta r-\dfrac{\Delta r}{r}\right)\left(1-\dfrac{2\Delta r}{r}\right)$

2020 愛知医大

2



回路の式

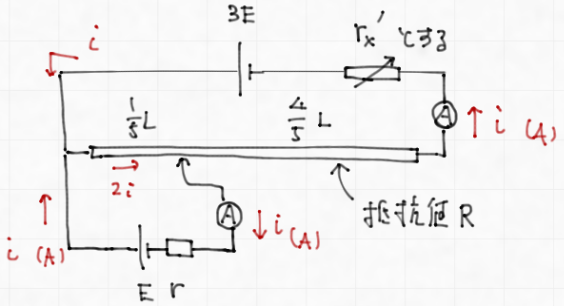
$$\begin{cases} 3E = RI + r_x I \\ E = \frac{2}{5}RI + r \times 0 \end{cases}$$

問1　上式より E

問2　電流が流れていないので 0

問3　$R = \frac{5E}{2I}$

問4　$P_{xr} = I^2 R = I^2 \times \frac{5E}{2I} = \frac{5}{2}EI$



問5

回路の式

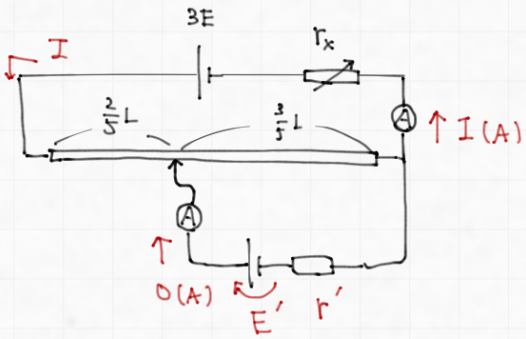
$$\begin{cases} 3E = \frac{1}{5}R \times 2i + \frac{4}{5}R \times i + i r_x' \\ E = \frac{1}{5}R \times 2i + ir \end{cases}$$

$i = \frac{E}{\frac{2}{5}R + r} = \frac{5E}{2R+5r}$ を代入

$$3E = \frac{6}{5}R \times \frac{5E}{2R+5r} + \frac{5E}{2R+5r} r_x'$$

$$r_x' = \left(3\cancel{E} - \frac{6R}{2R+5r}\cancel{E}\right) \times \frac{2R+5r}{5\cancel{E}}$$

$$= \frac{6R+15r-6R}{5} = 3r$$



問6

回路の式

$$\begin{cases} 3E = RI + r_x I \\ E' = \frac{3}{5}RI \end{cases}$$

$R = \frac{5E}{2I}$ を代入して　$E' = \frac{3}{2}E$

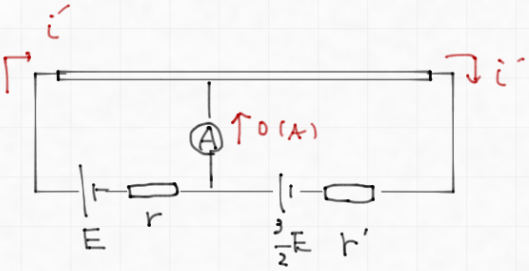
問7

$$\begin{cases} E = \frac{2}{5}Ri' + ri' \\ \frac{3}{2}E = \frac{3}{5}Ri' + r'i' \end{cases}$$

辺々割って　$\frac{2}{3} = \frac{2R+5r}{3R+5r'}$

$$\cancel{6R} + 10r' = \cancel{6R} + 15r$$

$$r' = \frac{3}{2}r$$



2020 愛知医大

3 問1 (1) $h\nu$ (2) $h\nu = W$ のときが限界 $\nu = \dfrac{W}{h}$

(3) $h\nu - W \geqq \frac{1}{2}mv^2$ が成り立つので $\frac{1}{2}mv_{max}^2 = h\nu - W$

問2 (A) $\lambda = \dfrac{Nc}{Nf}$

(B)(ア) $[\text{A}] \times [\text{V}] \times [\text{s}] = [\text{J}]$ だから

$[\text{A}] = [\text{J/Vs}] = \dfrac{1}{Nf \cdot Nh} \times \dfrac{Nf\,Nh}{Ne} \times Nc = \dfrac{Nc}{Ne}$ $\left[\dfrac{e}{c}\right]$

(C) $\lambda = \dfrac{c}{\nu} = \dfrac{1}{5.0 \times 10^4} = 2.0 \times 10^{-5}$ [c/f]

(D)(イ) $\dfrac{W}{h} = \dfrac{3.4 \times 10^4}{1} = 3.4 \times 10^4$ [f]

(E)(ウ) $h\nu - W = 1 \times 5.0 \times 10^4 - 3.4 \times 10^4 = 1.6 \times 10^4$ [f·h]