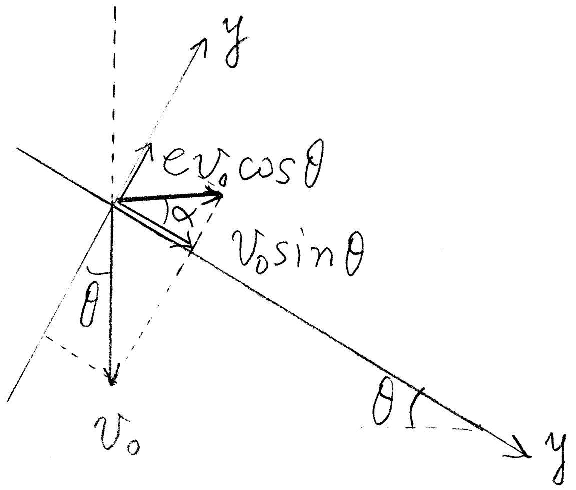
3

(1) $mgh = \frac{1}{2}mv_0^2$　　$v_0 = \underline{\sqrt{2gh}}$

(2)

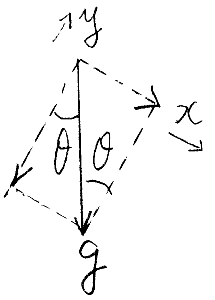


x成分　$\underline{\sqrt{2gh}\sin\theta}$

y成分　$\underline{e\sqrt{2gh}\cos\theta}$

$$\tan\alpha = \frac{ev_0\cos\theta}{v_0\sin\theta} = \underline{\frac{e}{\tan\theta}}$$

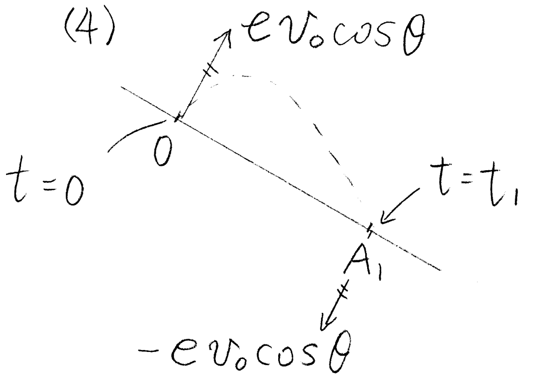
(3)



x成分　$\underline{g\sin\theta}$

y成分　$\underline{-g\cos\theta}$

(4)



$$-ev_0\cos\theta = ev_0\cos\theta - g\cos\theta\cdot t_1$$

$$t_1 = \frac{2ev_0}{g} = \frac{2e}{g}\sqrt{2gh} = \underline{2e\sqrt{\frac{2h}{g}}}$$

$$OA_1 = v_0\sin\theta\cdot t_1 + \frac{1}{2}g\sin\theta\cdot t_1^2$$

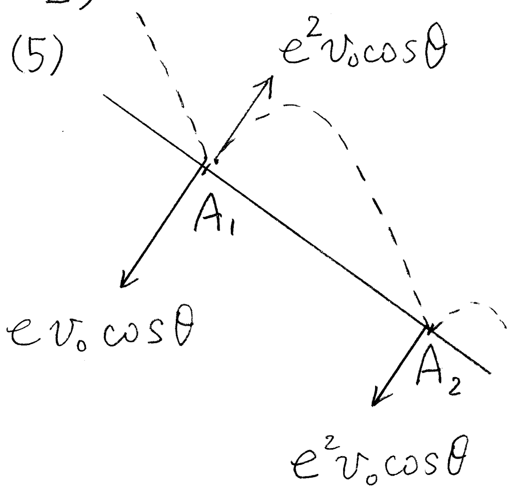
$$= \sqrt{2gh}\sin\theta\cdot 2e\sqrt{\frac{2h}{g}} + \frac{1}{2}g\sin\theta\cdot 4e^2\cdot\frac{2h}{g}$$

$$= 4eh\cdot\sin\theta + 4e^2h\sin\theta$$

$$= \underline{4eh(1+e)\sin\theta}$$

(3 − 2)

(5)



(4)のt_1から，

$$t_2 = \frac{2e^2 v_0}{g} = \underline{e t_1}$$

(6) 無限回はね返ると考える。OB間の時間をTとする。

$$T = t_1 + t_2 + t_3 + \cdots\cdots$$
$$= (1 + e + e^2 + \cdots\cdots) t_1$$
$$eT = (e^2 + e^3 + \cdots\cdots) t_1$$

$$(1-e)T = t_1 \qquad T = \frac{t_1}{1-e} = \frac{2e}{1-e}\sqrt{\frac{2h}{g}}$$

$$OB = v_0 \sin\theta \cdot T + \frac{1}{2} g \sin\theta \cdot T^2$$ （x方向も等加速度運動）

$$= \left\{ \sqrt{2gh} \cdot \frac{2e}{1-e}\sqrt{\frac{2h}{g}} + \frac{1}{2}\cancel{g}\left(\frac{2e}{1-e}\right)^2 \frac{2h}{\cancel{g}} \right\} \sin\theta$$

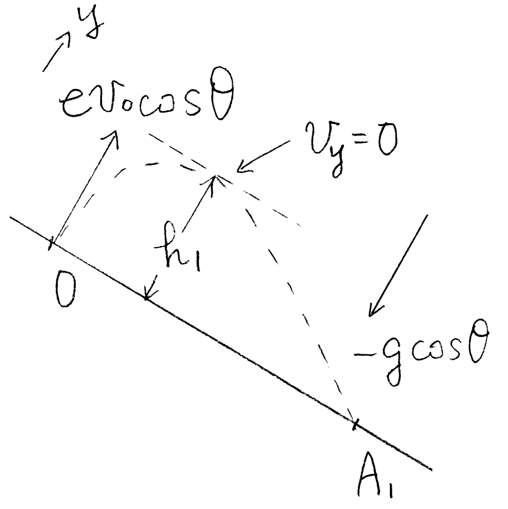
$$= \left\{ \frac{2e}{1-e} \cdot 2h + \frac{2e}{1-e} \cdot 2h \cdot \frac{e}{1-e} \right\} \sin\theta$$

$$= \left\{ \frac{4eh}{1-e}\left(1 + \frac{e}{1-e}\right) \right\} \sin\theta$$

$$= \underline{\frac{4eh}{(1-e)^2} \sin\theta}$$

(3-3)

Q_1

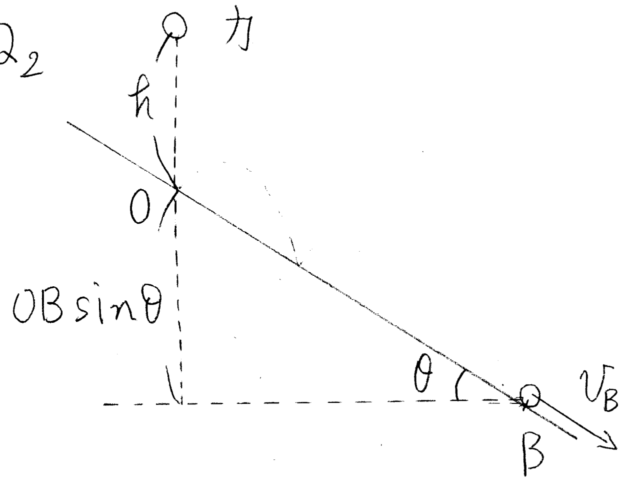


$$0^2-(ev_0\cos\theta)^2=-2g\cos\theta\cdot h_1$$

$$h_1=\frac{e^2\times 2gh\times\cos^2\theta}{2g\cos\theta}$$

$$=\underline{e^2h\cos\theta}$$

Q_2



$$v_B=v_0\sin\theta+g\sin\theta\cdot T$$

$$=\left\{\sqrt{2gh}+\frac{2e}{1-e}\sqrt{2gh}\right\}\sin\theta$$

$$=\frac{1+e}{1-e}\sqrt{2gh}\sin\theta$$

$$\Delta E=\frac{1}{2}mv_B^2-mg(h+OB\sin\theta)$$

(失うエネルギーは 後−前)

$$=\frac{1}{2}m\cdot\left(\frac{1+e}{1-e}\right)^2 2gh\sin^2\theta-mg\left\{h+\frac{4eh}{(1-e)^2}\sin^2\theta\right\}$$

$$=\left(\frac{1+e}{1-e}\right)^2 mgh\sin^2\theta-mgh\left\{1+\frac{4e}{(1-e)^2}\sin^2\theta\right\}$$

$$=\frac{mgh}{(1-e)^2}\left\{(1+2e+e^2)\sin^2\theta-(1-2e+e^2)-4e\sin^2\theta\right\}$$

$$=\frac{mgh}{(1-e)^2}\left\{(1-e)^2\sin^2\theta-(1-e)^2\right\}=\underline{mgh\cos^2\theta}$$

(注) x方向の等加速度運動について，

$v_B^2-(v_0\sin\theta)^2=2g\sin\theta\cdot OB$ から，

$\frac{1}{2}mv_B^2=\frac{1}{2}m(v_0\sin\theta)^2+mg\sin\theta\cdot OB$ とすると，ΔEの計算は簡単になる。