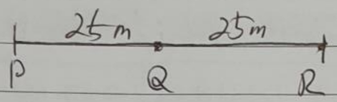
Goo 쌤의 뿌리물리

1강 – 힘과 운동 숙제 2

1-2.

1.

1)



물체의 총 이동거리 = 50m

= v-t 전체면적

$= (5+v)\cdot 4\cdot\frac{1}{2} + v\cdot 6\cdot\frac{1}{2}$

$= 5v + 10 = 50$

$\therefore \boxed{v = 8\,m/s}$

2) 0~4초까지의 가속도 = 0~4초까지 직선 기울기

$= \frac{8-5}{4} = \frac{3}{4}\,m/s^2$

4~10초까지의 가속도 = 4~10초까지 직선기울기

$= \frac{0-8}{6} = -\frac{4}{3}\,m/s^2$

$\boxed{\therefore |a_{t=2}| < |a_{t=6}|}$

3) 0~4초 사이에 이동한 거리

$= \frac{1}{2}(v+5)\cdot 4 = \frac{1}{2}(8+5)\cdot 4$

$= 26m > 25m.$

즉, 0~4초 사이에 Q를 지남

2. s-t 그래프의 기울기 : 속도

→ 0~3초 사이에서 기울기가 점점 감소

= 속도가 점점 감소

(1) → 가속도는 $-x$ 방향

(2) 0~1초 기울기 : 5m/s = 0~1초 사이의 평균속력

0~2초 기울기 : 4m/s = 0~2초 "

0~3초 기울기 : 3m/s = 0~3초 "

1~2초 기울기 : 3m/s = 1~2초 "

2~3초 기울기 : 1m/s = 2~3초 "

→ 초당 2m/s 씩 속력 감소

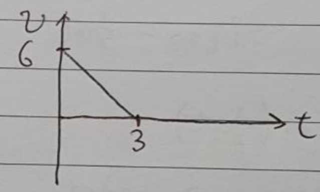
$a = -2\,m/s^2$, 0~1초동안 2m/s 감소

$v_0 + at = v_0 - at$

$= v_0 - 2$

→ v_0와 $v_0 - 2$의 평균이 5

→ $v_0 = 6\,m/s$



$t=2$일 때 $v = 6 - a\cdot 2$

$= 6 - 2\cdot 2$

$= \boxed{2\,m/s}$

(3) 3~4초 기울기 : 2m/s = 평균속력 $= \frac{v_3 + v_4}{2}$

$v_{t=3} = 0 \rightarrow v_4 = 4\,m/s$

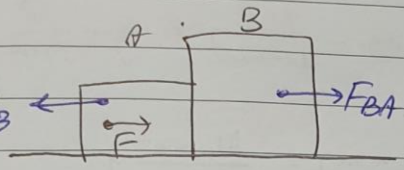
$a = 4\,m/s^2$ (1초에 4m/s 증가)

$\boxed{\therefore |a_1| < |a_4|}$

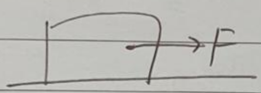
3.

(가)

①



② 한 물체



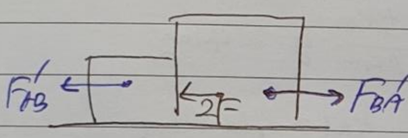
$F_{net} = F = (m_A + m_B)a$

$\therefore a = \frac{F}{m_A + m_B}$

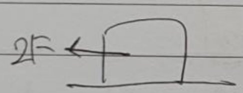
③,④ $a = \frac{F}{m_A + m_B} = a_A = a_B$.

(나)

①



②



$F_{net} = 2F = (m_A + m_B)\,a'$

$a' = \frac{2F}{(m_A + m_B)}$

(가) $F_B = m_B a_B \quad = F_{BA}$

$= \frac{m_B}{m_A + m_B} F$

$\therefore F_{BA} = \frac{m_B}{m_A + m_B} F$

(나) $F_A = m_A a' \quad = F'_{AB}$

$= \frac{2m_A}{m_A + m_B} F$

$\therefore F'_{AB} = F'_{BA} = \frac{2m_A}{m_A + m_B} F$

문제에서 $F_{BA} = 2F'_{BA}$ 이라 했으므로

$\frac{m_B}{m_A + m_B} F = 2 \cdot \frac{2m_A}{m_A + m_B} F$

(1) $\therefore \boxed{m_B = 4m_A}$ //

$m_A = m$ 이라 하면, $m_B = 4m$.

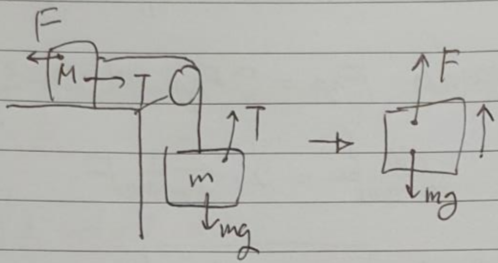
(2) $F_{net,A} = m_A a$

$= m \cdot \frac{F}{5m} = \boxed{\frac{1}{5}F}$ //

(3) $F'_{BA} = \frac{2m}{5m} F = \boxed{\frac{2}{5}F}$ //

4.

(가)

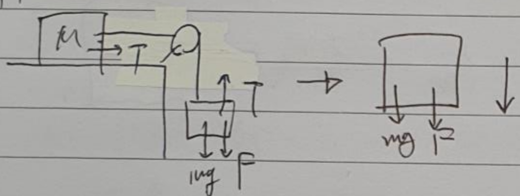


$$F_{net} = (M+m)a = F - mg$$

$$a = \frac{F-mg}{M+m}$$

$$a = a_A = a_B$$

(나)



$$F_{net} = (M+m)a' = F + mg$$

$$a' = \frac{F+mg}{M+m}$$

$a' = 3a$ 이므로, $\frac{F+mg}{M+m} = 3 \cdot \frac{F-mg}{M+m}$

$$\therefore F = 2mg.$$

$$a = \frac{mg}{M+m}, \quad a' = \frac{3mg}{M+m}$$

(가)에서 $F_A = m_A a_A = F - T$

$$= \frac{Mm}{M+m} g \qquad = 2mg - T$$

$$\therefore T = 2mg - \frac{Mm}{M+m} g.$$

$$F_B = m_B a_B = T - mg$$

$$= \frac{m^2}{M+m} g \qquad \therefore T = mg + \frac{m^2}{M+m} g$$

$$T = 2mg - \frac{Mm}{M+m} g = mg + \frac{m^2}{M+m} g$$

(나)에서 $F_A = m_A a_A' = T'$

$$= M \cdot \frac{3mg}{M+m}$$

$$= \frac{3Mm}{M+m} g$$

$$T' = \frac{3Mm}{M+m} g$$

$T' = 2T$ 이므로 $\frac{3Mm}{M+m} g = 2\left(2mg - \frac{Mm}{M+m} g\right)$

$$\frac{5Mm}{M+m} g = 4mg$$

$$5M = 4M + 4m$$

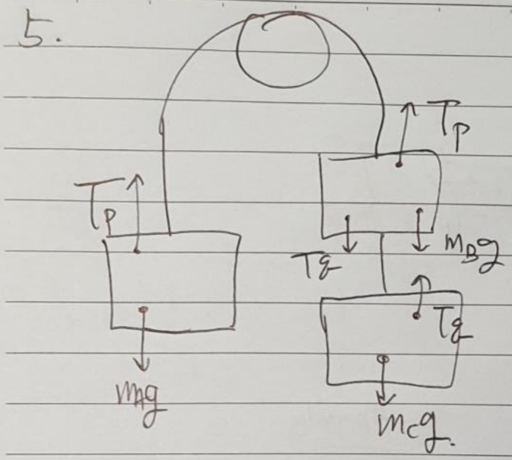
(1) $\therefore \boxed{M = 4m}$

(2) $\boxed{a_A = a = \frac{mg}{M+m} = \frac{mg}{5m} = \frac{1}{5} g}$

(3) $T' = \frac{3Mm}{M+m} g = \frac{3 \cdot 4m \cdot m}{4m+m} g$

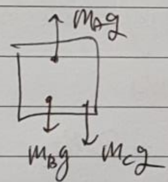
$$= \boxed{\frac{12}{5} mg}$$

5.



(1) A의 중력 m_Ag와 실 p에 의한 장력 T_p가 힘의 평형을 이루어 알짜힘이 0이다.

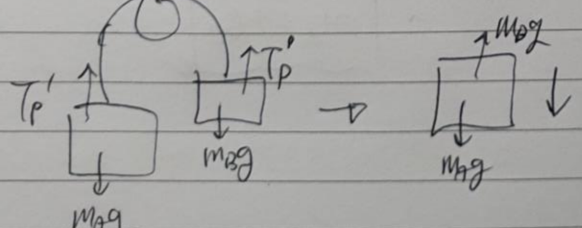
$F_{net,A} = T_p - m_Ag = 0$

한 물체 → 

$F_{net} = m_Ag - m_Bg - m_Cg = (m_A+m_B+m_C)\cdot a$
$= 0.$

$\therefore m_A = m_B + m_C$

실 q가 끊어지면, A, B 한 물체



$F_{net} = m_Ag - m_Bg = (m_A+m_B)\cdot a$
$= (m_A+m_B)\cdot\frac{1}{3}g$

$a = \frac{m_A-m_B}{m_A+m_B}g = \frac{1}{3}g$

$m_A = 2m_B$

$m_A = 2m_B = m_B + m_C$ 이므로

$\therefore m_B = m_C$

$m_B = m_C = m$이라 하면

$\boxed{m_A = 2m,\ m_B = m,\ m_C = m}$

(3)

(가)에서 $F_C = m_Cg - T_q = 0$

$T_q = m_Cg = mg.$

$F_B = m_Bg + T_q - T_p$
$= mg + mg - T_p = 0$

$\therefore T_p = 2mg$

(나)에서 $F_B = T_p' - m_Bg = m_Ba_B$
$= T_p' - mg = m\cdot\frac{1}{3}g$

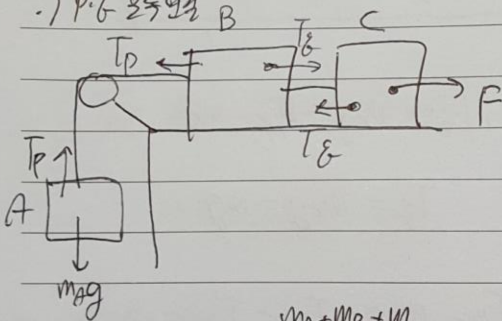
$T_p' = \frac{4}{3}mg$

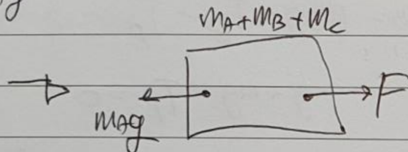
$T_p : T_p' = 3:2$ ($\frac{2}{3}$배가 됨)

6. p가 끊어진 경우 : $5m/s^2$
q가 끊어진 경우 : $4m/s^2$
→ B와 연결된 물체는 동일.

(v-t 그래프 기울기)

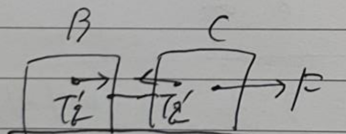
i) p·q 모두 연결

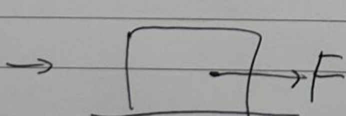




$$F_{net} = F - m_A g = (m_A+m_B+m_C)a$$
$$= 0.$$
$$\therefore F = m_A g$$

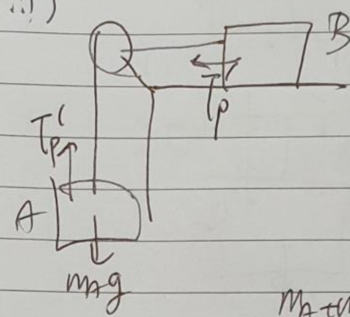
ii) p 끊어졌을 때.

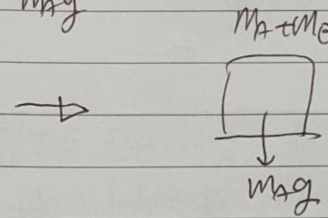




$$F_{net} = F = (m_B+m_C)a$$
$$F = (m_B+m_C)\cdot 5$$

iii)



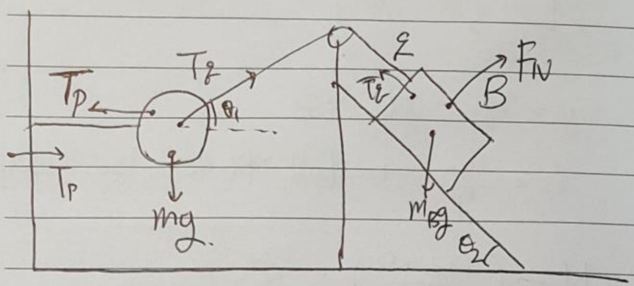


$$F_{net} = m_A g = (m_A+m_B)a$$
$$\therefore m_A g = 4(m_A+m_B)$$
$$= 10 m_A$$
$$\therefore 3m_A = 2m_B.$$

$$F = m_A g = 5(m_B+m_C)$$
$$= 10 m_A = 5(m_B+3)$$

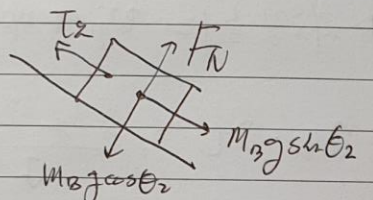
→ 연립하면, $\boxed{\begin{matrix} m_A = 6kg \\ m_B = 9kg \end{matrix}}$

17.



p가 벽에 작용하는 힘 : $T_p = \frac{2}{3}mg$

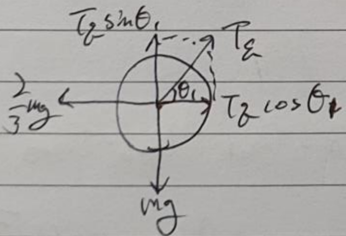
B에서 보면



$F_{B,빗면} = T_q - m_B g\sin\theta_2 = m_B \cdot a$
$= 0$

$\therefore T_q = m_B g\sin\theta_2$

A에서 보면



$F_{A,x} = \frac{2}{3}mg - T_q\cos\theta_1 = 0$

$= \frac{2}{3}mg - m_B g\sin\theta_2\cos\theta_1 = 0$

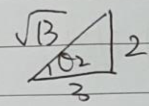
$\rightarrow m_B\sin^2\theta_2 = \frac{2}{3}m \quad (\cos\theta_1 = \sin\theta_2)$
$\cdots ①$

$F_{A,y} = T_q\sin\theta_1 - mg = 0$

$= m_B g\sin\theta_2\sin\theta_1 - mg = 0$

$\rightarrow m_B\sin\theta_2\cos\theta_2 = m \cdots ②$

$① \div ② \rightarrow \tan\theta_2 = \frac{2}{3}$



$\rightarrow \sin\theta_2 = \frac{2}{\sqrt{13}}$

$\cos\theta_2 = \frac{3}{\sqrt{13}}$

$\therefore m_B\sin^2\theta_2 = \frac{2}{3}m$

$m_B \cdot \left(\frac{2}{\sqrt{13}}\right)^2 = \frac{2}{3}m$

$\boxed{m_B = \frac{13}{6}m}$

8.

동시에 던지고 동시에 도달 : 걸린 시간이 동일

→ 걸린 시간은 y축 속도와 관련

($v_y = v_{0y} - gt = 0$ 일 때부터

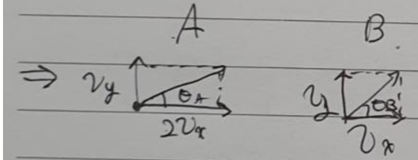
$t = \frac{v_{0y}}{g}$ 의 두배 동안 운동하므로)

→ y축 방향 처음 속도 동일.

같은 시간 동안 A가 2배 멀리 이동

그런데 x축 방향 속도는 등속

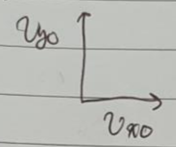
→ x축 방향 속도는 A가 B의 2배



$\tan\theta_A = \frac{v_y}{2v_x}$ $\tan\theta_B = \frac{v_y}{v_x}$

$$\boxed{\therefore \frac{\tan\theta_B}{\tan\theta_A} = 2}$$

9.



$v_y = v_{y0} - gt = 0$

$t = \frac{v_{y0}}{g}$ → 최고점 까지 시간은 v_{y0}에 비례

$H = \left(\frac{v_{y0}+0}{2}\right)\cdot\frac{v_{y0}}{g}$

$= \frac{v_{y0}^2}{2g}$

→ 최고점 높이는 v_{y0}^2에 비례

$R = v_{x0}\cdot 2t = \frac{2v_{y0}\cdot v_{x0}}{g}$

→ 수평도달거리는 $v_{y0}\cdot v_{x0}$에 비례

$H_A : H_B = 2h : h = 2:1$

→ $v_{y0A} : v_{y0B} = \sqrt{2} : 1$

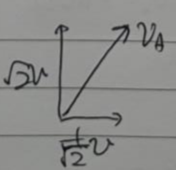
$R_A : R_B = 1:1$

→ $v_{y0A}\cdot v_{x0A} : v_{y0B}\cdot v_{x0B} = 1:1$

→ $v_{x0,A} : v_{x0,B} = 1:\sqrt{2}$

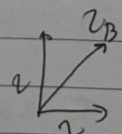
v_B는 45°의 각을 이루므로 $v_{y0B} = v_{x0B} = v$라 하면

$v_{x0A} = \frac{1}{\sqrt{2}}v$, $v_{y0,A} = \sqrt{2}v$



$|\vec{v_A}| = \sqrt{\frac{5}{2}}v$

$= \frac{\sqrt{10}}{2}v$



$|\vec{v_B}| = \sqrt{2}\cdot v$

(1) $t \propto v_{0y}$ → $A > B$

(2) 최고점에서는 A, B 모두 속력은 0.

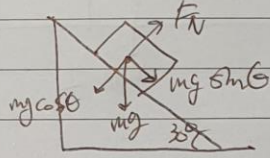
(3) $|\vec{v_A}| = \frac{\sqrt{5}}{2}|\vec{v_B}|$

10.

마찰면 전까지 : 속도 증가

마찰면 : 속도 감소 (그래야 정지 가능)

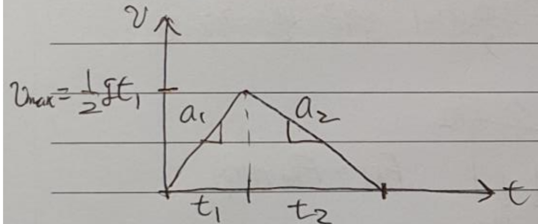
마찰면 전까지



$F_{net} = mg\sin\theta = ma$

$\therefore a = g\sin\theta = \frac{1}{2}g \quad (\theta = 30°)$

v-t 그래프를 그려보면,



① 물체 이동거리 $\frac{1}{4}h : \frac{3}{4}h$

→ 면적비가 1:3

→ 높이 동일하므로

$t_1 : t_2 = 1 : 3$

② t_1동안 이동거리 $= \frac{1}{4}h$

넓이: $\frac{1}{2}\left(\frac{1}{2}gt_1\right)t_1 = \frac{1}{4}h$

→ $t_1 = \sqrt{\frac{2h}{g}}$

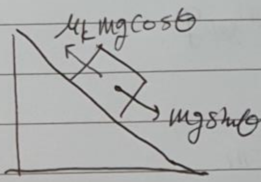
$v_{max} = \frac{1}{2}gt_1 = \frac{1}{2}g\sqrt{\frac{2h}{g}}$

(1) $= \boxed{\frac{\sqrt{2}}{2}\sqrt{gh}}$

(2) $t_1 : t_2 = 1 : 3$ 이므로

기울기는 3 : 1 (속도 감소)

→ 마찰면을 지나는 동안 가속도는 $-\frac{1}{6}g$



$F_{net} = mg\sin\theta - \mu_k F_N$

$= mg\sin\theta - \mu_k mg\cos\theta$

$= ma = m\left(-\frac{1}{6}g\right)$

$\frac{1}{2}mg - \frac{\sqrt{3}}{2}mg\cdot\mu_k = -\frac{1}{6}mg$

$\boxed{\therefore \mu_k = \frac{4}{3\sqrt{3}}}$

수고하셨습니다 :)