The 50-kg block A is released from rest. Determine the velocity of the 15-kg block B in 2 s.

解:

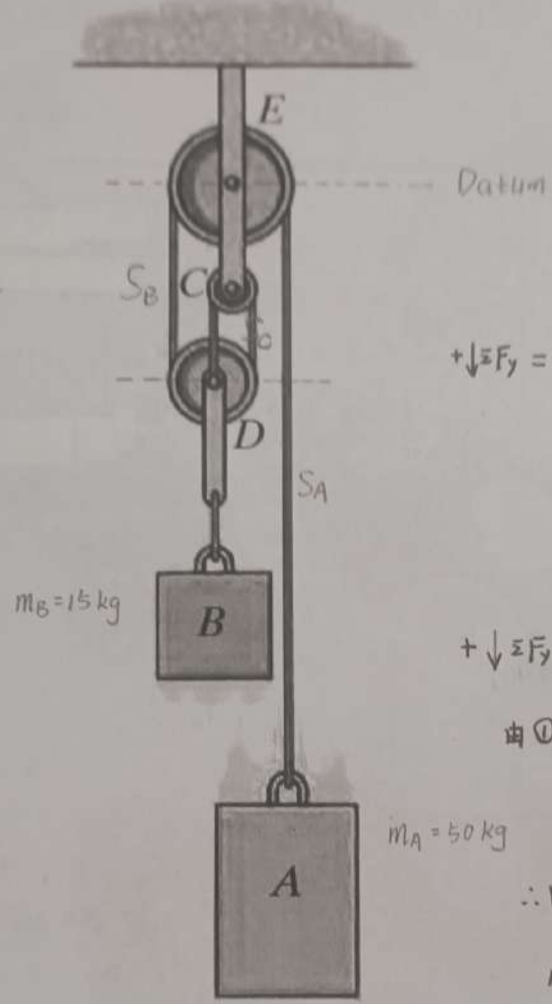
$$S_A + S_B + 2S_C = L$$
$$S_B - S_C = l_{CB}$$

$$\Delta S_A + \Delta S_B + 2\Delta S_C = 0$$
$$\Delta S_B - \Delta S_C = 0$$

$$v_A + v_B + 2v_C = 0$$
$$v_B - v_C = 0$$

$$\Rightarrow a_A + a_B + 2a_C = 0$$
$$a_B - a_C = 0$$

$$\Rightarrow a_A + 3a_B = 0 \quad ①$$



For block A

T

$m_A g$

$$+\downarrow \Sigma F_y = m_A g - T = m_A a_A \quad ②$$

For block B

$3T$

$m_B g$

$$+\downarrow \Sigma F_y = m_B g - 3T = m_B a_B \quad ③$$

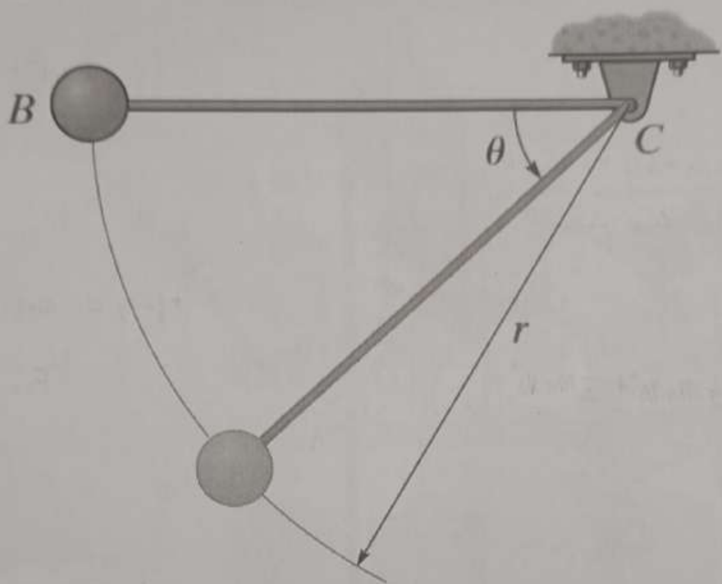
由①②③:

$$a_B = -\frac{9}{31} g$$

$$\therefore v_B = a_B \cdot t = -\frac{18}{31} g = -5.70\ m/s$$

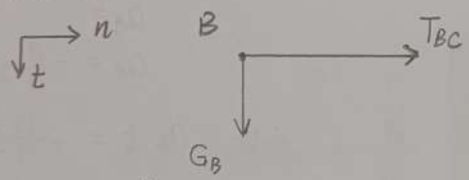
namely, upwards $\boxed{\text{ANS}}$

The pendulum bob B has a weight of 5 lb and is released from rest in the position shown, $\theta = 0°$. Determine the tension in string BC just after the bob is released, $\theta = 0°$, and also at the instant the bob reaches $\theta = 45°$. Take $r = 3$ ft.



解: ① just after releasing

For B:



$$a_n = \frac{v^2}{r} = 0$$

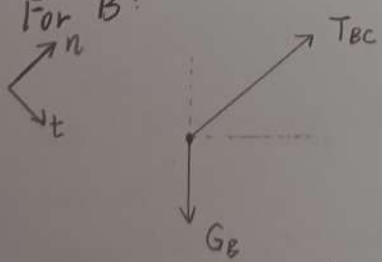
$\therefore T_{BC} = m_B \cdot a_n = 0$ $\boxed{\text{ANS}}$

② when $\theta = 45^0$

$$T_{B_1} + U_{1\text{-}2} = T_{B_2}$$

$$0 + G_B \cdot r\sin\theta = \frac{1}{2} m_B \cdot V_B^2 \qquad (1)$$

For B:

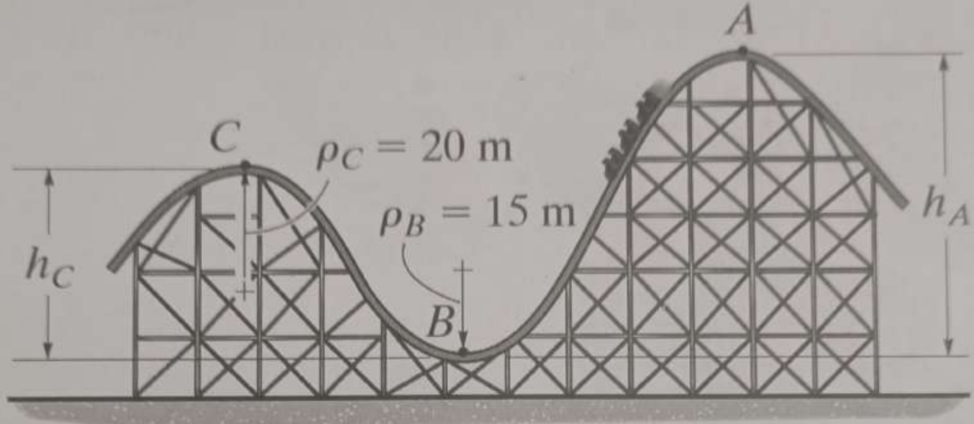


$$\Sigma F_n = T_{BC} - G_B \cdot \cos 45^0 = m_B a_n = m_B \frac{V_B^2}{r} \qquad (2)$$

由(1)(2)得: $T_{Bc} = \frac{15}{2}\sqrt{2}\ lb = 10.61\ lb$ $\boxed{\text{ANS}}$

If the track is to be designed so that the passengers of the roller coaster do not experience a normal force equal to zero or more than 4 times their weight, determine the limiting heights h_A and h_C so that this does not occur. The roller coaster starts from rest at position A. Neglect friction.

$0 < N \leq 4W$



解: From A to B, $V_A = 0$

$\frac{1}{2}mV_A^2 + W\cdot h_A = \frac{1}{2}mV_B^2$ (1)

At point B

N_B ↑, W ↓, y ↑

$\Sigma F_y = N_B - W = m a_{nB} = m\cdot\frac{V_B^2}{\rho_B}$ (2)

let $N_B = 4W$

We solve (1)(2): $h_A = 22.5$ m (max)

From B to C.

$\frac{1}{2}mV_B^2 - W\cdot h_C = \frac{1}{2}mV_C^2$ (3)

At point C

N_C ↑, W ↓

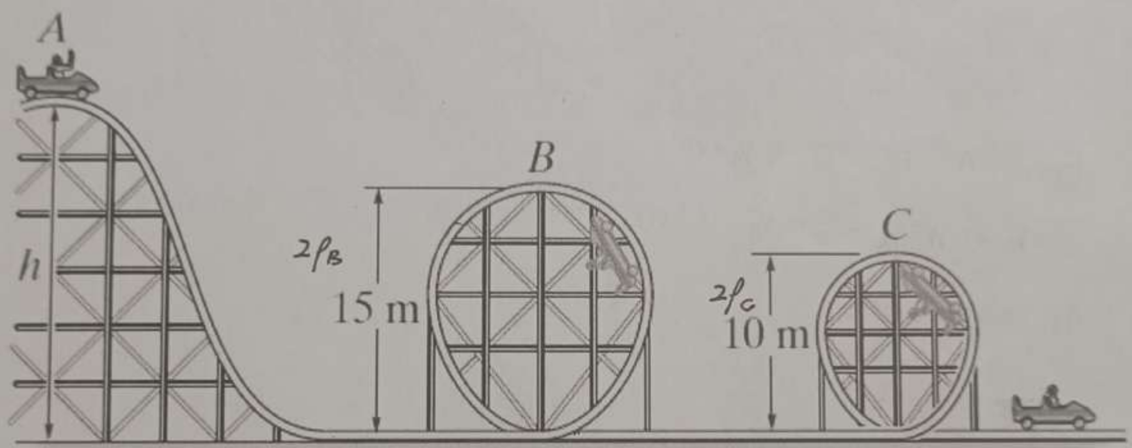
$\Sigma F_y = W - N_C = m a_{nC} = m\cdot\frac{V_C^2}{\rho_C}$ (4)

let $N_C = 0$

Solving (3)(4): $h_C = 12.5$ m (min)

$\therefore$ $12.5\text{m} < h_C \leq h_A \leq 22.5\text{m}$ $\boxed{\text{ANS}}$

The roller coaster car has a mass of 700 kg, including its passenger. If it is released from rest at the top of the hill A, determine the minimum height h of the hill crest so that the car travels around both inside the loops without leaving the track. Neglect friction, the mass of the wheels, and the size of the car. What is the normal reaction on the car when the car is at B and when it is at C? Take $\rho_B = 7.5$ m and $\rho_C = 5$ m.



解: At point B

$t \leftarrow \;\; \downarrow n$

$\downarrow N_B$

$\downarrow W$

$$\Sigma F_n = W + N_B = m \cdot a_{nB} = m \cdot \frac{V_B^2}{\rho_B} \quad (1)$$

From A to B, $V_A = 0$

$$\frac{1}{2} m V_A^2 + W \cdot (h_1 - 2\rho_B) = \frac{1}{2} m V_B^2 \quad (2)$$

Assume $N_B = 0$

$$\Rightarrow h_1 = \frac{5}{2}\rho_B = 18.75 \text{ m} > h_2 = 12.5 \text{ m}$$

$\therefore$ the min $h = 18.75$ m to meet the condition.

and $N_B = 0$ with this height. $\boxed{\text{ANS}}$

At point C

$$W + N_C = m \cdot \frac{V_C^2}{\rho_C}$$

$$0 + W(h - 2\rho_C) = \frac{1}{2} m V_C^2$$

$$\Rightarrow N_C = 2.5\,W = 2.5 \times 700 \times 9.81 = 17167.5 \text{ N} = 17.17 \text{ kN} \qquad \boxed{\text{ANS}}$$

At point C

Similarly,

$$W + N_C = m \cdot \frac{V_C^2}{\rho_C}, \quad N_C = 0$$

$$\frac{1}{2} m V_A^2 + W(h_2 - 2\rho_C) = \frac{1}{2} m V_C^2$$

$$\Rightarrow h_2 = \frac{5}{2}\rho_C = 12.5 \text{ m} < h_1$$