פתרון מבחן 2020 מועד א'

אמריקאיות:

1. ג'

2. ד'. מסה m1 במנוחה ולכן

$$\Sigma F = T_1 - T_2 - m_1 g = 0 \rightarrow T_2 = T_1 - m_1 g \approx 152\ N$$

3. ד'. מהירות הגשם $\vec{v}$ ביחס למכונית היא

$$\vec{v} = \vec{v}_{rain} - \vec{V}_{car} = (50\frac{km}{h}, 8\frac{m}{s})$$

והזווית ביחס לאנך

$$\theta = \tan^{-1}(v_x/v_y) \approx 60°$$

4. א'. תאוצה זוויתית ממוצעת מוגדרת

$$\alpha = \frac{\Delta w}{\Delta t} = \frac{2\pi\Delta f}{\Delta t} = 2\pi \cdot \frac{1200\ RPM}{5\ s} = 2\pi \cdot \frac{(1200/60)RPS}{5\ s} = 8\pi\ rad/\sec^2$$

5. ב'.

$$\frac{w_n}{w_e} = \frac{g_n}{g_e} = \frac{(GM_n/r_n^2)}{(GM_e/r_e^2)} = \frac{M_n}{M_e} \cdot \left(\frac{r_e}{r_n}\right)^2 \approx 1.13$$

6. א'.

$$\Sigma F_y = Psin\theta - mg - N = 0 \rightarrow N = Psin\theta - mg$$

$$ma = \Sigma F_x = Pcos\theta - \mu_k N = Pcos\theta - \mu_k(Psin\theta - mg) \approx 16.9\ N \rightarrow a \approx 3.4\frac{m}{\sec^2}$$

7. ד'.

$$W = \int_0^{2x_0} F_0\left(\frac{x}{x_0} - 1\right) = \left(\frac{1}{2x_0}x^2 - x\right)\Big|_0^{2x_0} = 0$$

8. ג'.

$$0 = p_i = p_f = m(-30m/s, 0) + m(0, -30m/s) + 3m(v_x, v_y)$$

$$(v_x, v_y) = (10m/s, 10m/s) \rightarrow |\vec{v}| = 14.14m/s$$

9. ב'.

$$\frac{1}{2}mv1^2 + mgh_1 = E_1 = E_2 = \frac{1}{2}mv_2^2 + mgh_2 \rightarrow v_2 = \sqrt{2g(h1 - h2) + v_1^2} \approx 11.3m/s$$

10. ב'.

בשני המקרים:

$$\Sigma F_{tot} = (m_1 + m_2)a \rightarrow a = \frac{F}{m_1 + m_2}$$

ניסוי ראשון (a):

$$\Sigma F_2 = N_a = m_2 a$$

ניסוי שני (b):

$$\Sigma F_1 = N_b = m_1 a$$

לכן מכיון ש $m_1 > m_2$ נקבל ש$N_a > N_b$.

פתוחות:

1) משיעורי בית.
2)
גוף m0:

$$\Sigma F = m_0 g - T \rightarrow T = m_0 g$$

גוף M:

$$\Sigma F_y = N - Mg = 0 \rightarrow N = Mg$$

$$\Sigma F_y = T - f_s = m_0 g - f_s = M\omega^2 d$$

לכן החיכוך הסטטי הוא:

$$f_s = m_0 g - M\omega^2 d$$

והתנאי עליו:

$$|fs| = |m_0 g - M\omega^2 d| < \mu_k N = \mu_k Mg$$

$$-\mu_k Mg < m_0 g - M\omega^2 d < \mu_k Mg \longrightarrow \left(\frac{m_0}{M} - \mu_k\right) g/d < \omega^2 < (\frac{m_0}{M} + \mu_k) g/d$$

$$\sqrt{\frac{\left(\frac{m_0}{M} - \mu_k\right) g}{d}} < |\omega| < \sqrt{\frac{\left(\frac{m_0}{M} + \mu_k\right) g}{d}}$$

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א)

To calculate the launch speed, we need to know the acceleration of the skier down the incline. Assuming a tilted coordinate system the forces that act on the skier:

Horizontal forces:

$F_{Wx} = m_{skier} g \sin\theta = m_{skier} a_x$

$\rightarrow a_x = g \sin\theta$

From the geometry we can determine the angle.

$\tan\theta = \frac{\Delta y}{\Delta x} = \frac{45m}{31.5m} = 1.492 \rightarrow \theta = 55^0$

Vertical forces:

$F_N - F_{Wy} = F_N - m_{skier} g \cos\theta = m_{skier} a_y = 0$

$\rightarrow F_N = m_{skier} g \cos\theta$

$v_{fxB}^2 = v_{ixA}^2 + 2a_x \Delta p_{BA}$

$\rightarrow v_{fxB} = \sqrt{2a_x \Delta p_{BA}} = \sqrt{2g \sin\theta \Delta p_{BA}} = \sqrt{2 \times \left(9.8\frac{m}{s^2} \sin 55\right) \times 54.9m} = 29.7\frac{m}{s}$

Where, $\Delta p_{BA} = \sqrt{\Delta x^2 + \Delta y^2} = \sqrt{(31.5m)^2 + (45m)^2} = 54.9m.$

ב)

Here we don't know the horizontal or vertical distance the skier travels. But we can relate the two unknowns using the geometry in the system.

$$\tan\phi = \frac{y}{x} \rightarrow y = x\tan\phi$$

Then we locate the point by using the horizontal and vertical trajectories.

$$x_f = x_i + v_{ix}t + \tfrac{1}{2}a_x t^2 \rightarrow x_f = x = v_B t \rightarrow t = \frac{x}{v_B}$$

$$y_f = y_i + v_{iy}t + \tfrac{1}{2}a_y t^2 \rightarrow -x\tan\phi = -\tfrac{1}{2}gt^2 = -\tfrac{1}{2}g\left(\frac{x}{v_B}\right)^2 = -\frac{gx^2}{2v_B^2}$$

$$\rightarrow 0 = x\tan\phi - \frac{gx^2}{2v_B^2}$$

The solutions are:

$$x = 0m$$

$$x = \frac{2v_B^2}{g}\tan\phi = \frac{2\left(29.7\frac{m}{s}\right)^2 \tan 30}{9.8\frac{m}{s^2}} = 103.9m$$

Then the distance s is given by:

$$\cos\phi = \frac{x}{s} \rightarrow s = \frac{x}{\cos\phi} = \frac{103.9m}{\cos 30} = 120m$$

ג)

To calculate the new launch speed, we need to know the acceleration of the skier down the incline. Assuming a tilted coordinate system the forces that act on the skier:

Horizontal forces:

$$F_{Wx} - F_{fr} = m_{skier}g\sin\theta - \mu F_N = m_{skier}g\sin\theta - \mu m_{skier}g\cos\theta = m_{skier}a_x$$

$$\rightarrow a_x = g\sin\theta - \mu g\cos\theta$$

$$v_{fxB}^2 = v_{ixA}^2 + 2a_x\Delta p_{BA} \rightarrow v_{fxB} = \sqrt{2a_x\Delta p_{BA}} = \sqrt{2g\sin\theta\Delta p_{BA}}$$

$$v_{fxB} = \sqrt{2\times 9.8\frac{m}{s^2}(\sin 55 - 0.5\cos 55)\times 54.9m} = 23.8\frac{m}{s}$$

$$s = \frac{x}{\cos\phi} = \frac{\frac{2v_B^2}{g}\tan\phi}{\cos\phi} = \frac{\frac{2\left(23.8\frac{m}{s}\right)^2 \tan 30}{9.8\frac{m}{s^2}}}{\cos 30} = 77.1m$$

So, the skier lands before point C by an amount $120m - 77.1m = 42.9m$.

ד) t<s