Answer on Question #77752, Physics / Mechanics | Relativity

Two bodies A and B of masses mA = 1 kg and mB are initially at rest at the same height y0 = 80 cm above a horizontal plane. At t = 0 they are both releases. A slides along a plane inclined by an angle θ = 45° while B falls vertically. Let tA and tB be the time required for A and B to reach the horizontal plane, vA and vB are the corresponding speed at tA and tB. Which of the following results is correct? (Assume g = 10 m/s2)

A: vA = 1/2 vB and tA = tB = 0.4 s

B: vA = 2 vB and tA = tB = 0.4 s

C: vA = vB = 4 m/s and tA = √2tB

D: vA = vB = 4 m/s and tA = 1/2tB = 0.8 s

E: vA = vB = 4 m/s and tA = 1/√2tB

Solution

m_A=1 kg

m_B

y_0 =80 cm = 0.8 m

$t_{0A} = t_{0B} = 0$

$\theta = 45°$

t_A

t_B

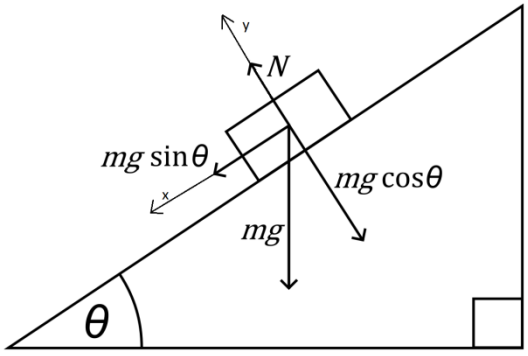
υ_A

υ_B

t_A/t_B-?

υ_A/υ_B -?

1. Find t_A.



As body A slides along a plane inclined by an angle θ = 45° we can make a consumption that there is no friction between body and plane.

Newton's Second Law of motion: $\vec{F} = m\vec{a}$

$$\vec{N} + \overrightarrow{F_{grav}} = m\vec{a}$$

$$\vec{N} + m\vec{g} = m\vec{a}$$

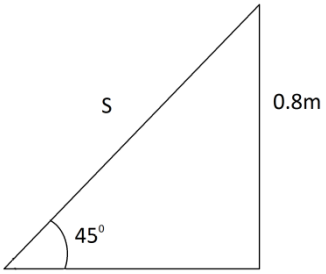
x: $m_A \cdot g \cdot \sin\theta = m_A \cdot a_A$

$$g \cdot \sin\theta = a_A$$

$$a_A = 10 \cdot \sin 45^0$$

$$a_A = 10 \cdot \frac{\sqrt{2}}{2} \ (m/s^2)$$

Find displacement of body A:



$S_A = 0.8/\sin 45^0 = \frac{0.8}{\frac{\sqrt{2}}{2}} = \frac{0.8 \cdot 2}{\sqrt{2}}$ (m)

$S_A = \upsilon_{0A} t_A + \frac{1}{2} a_A t_A^2$, as $\upsilon_{0A} = 0 \Rightarrow S_A = \frac{1}{2} a_A t_A^2$;

$$\frac{0.8 \cdot 2}{\sqrt{2}} = \frac{1}{2} \cdot 10 \cdot \frac{\sqrt{2}}{2} \cdot t_A^2$$

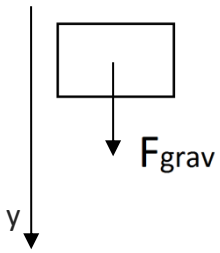
$$t_A = 0.4 \cdot \sqrt{2} \ (s)$$

2. Find υ_A.

$$\upsilon_A = \upsilon_{0A} + a_A \cdot t_A$$

$$\upsilon_A = 0 + 10 \cdot \frac{\sqrt{2}}{2} \cdot 0.4 \cdot \sqrt{2} = 4 \ (m/s)$$

3. Find t_B.



Newton's Second Law of motion: $\vec{F} = m\vec{a}$

$$\overrightarrow{F_{grav}} = m\vec{a}$$

$$m\vec{g} = m\vec{a}$$

y: $m_B \cdot g = m_B \cdot a_B$

$$g = a_B$$

$$a_B = 10\ m/s^2$$

Displacement of body B is 0.8 m.

$$S_B = \upsilon_{0B} \cdot t_B + \frac{1}{2} \cdot a_B \cdot t_B^2$$

As $\upsilon_{0B} = 0 \Rightarrow S_B = \frac{1}{2} \cdot a_B \cdot t_B^2$

$$0.8 = \frac{1}{2} \cdot 10 \cdot t_B^2$$

$$t_B = 0.4\ (s)$$

4. Find υ_B.

$$\upsilon_B = \upsilon_{0B} + a_B \cdot t_B$$
$$\upsilon_B = 0 + 10 \cdot 0.4 = 4\ (m/s)$$

So, $\upsilon_A = \upsilon_B = 4m/s$

$$\frac{t_A}{t_B} = \frac{0.4 \cdot \sqrt{2}}{0.4} = \sqrt{2} \quad or\ t_A = \sqrt{2} \cdot t_B$$

The answer to the question is C: $v_A = v_B = 4$ m/s and $t_A = \sqrt{2}t_B$

Answer: C: $v_A = v_B = 4$ m/s and $t_A = \sqrt{2}t_B$