LAST NAME Solution 2007 midTerm no. 1

FIRST NAME _____

STUDENT NO. _____

Department of Civil Engineering and Applied Mechanics
McGill University

CIVE281 ANALYTICAL MECHANICS

Test No.1

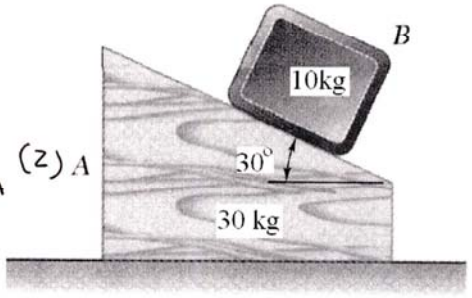
Examiners: Prof. V. H. Chu
Prof. S. Babarutsi

Date: Wednesday, October 10, 2007
Time: 8:30 a.m. - 9:25 a.m.

Answer on the space provided below the question. Continue on the facing page if more space is needed.

QUESTION	MARK
1 (50%)	
2 (50%)	
TOTAL	

1. (50%) Block A has a mass of 30 kg and block B has a mass of 10 kg. Neglect friction. Determine (a) the acceleration of the block A and (b) the acceleration of block B relative to A.



$\nearrow B$: $m_B g \cos 30^\circ - N = m_B a_A \sin 30^\circ$ (1)

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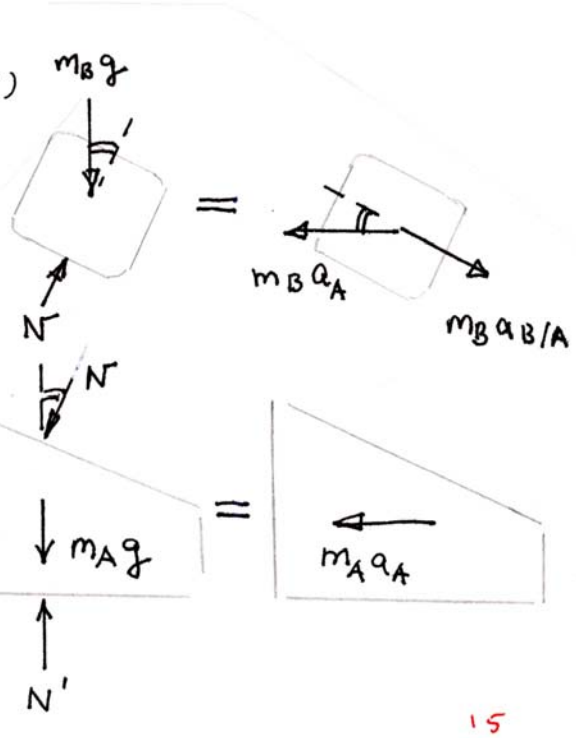
$\searrow B$: $m_B g \sin 30^\circ = -m_B a_A \cos 30^\circ + m_B a_{B/A}$ (2)

$\leftarrow$: $N \sin 30^\circ = m_A a_A$ (3)

From (3), $N = \dfrac{m_A a_A}{\sin 30^\circ}$ (4)



Substituting (4) for N in (1),

$$m_B g \cos 30^\circ - \frac{m_A a_A}{\sin 30^\circ} = m_B a_A \sin 30^\circ$$

$$\therefore a_A = \frac{m_B g \cos 30^\circ}{m_B \sin 30^\circ + \dfrac{m_A}{\sin 30^\circ}}$$

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$$= 1.307 \ m/s^2$$

Equation (2):

$$a_{B/A} = g \sin 30^\circ + a_A \cos 30^\circ = 6.03 \ m/s^2$$

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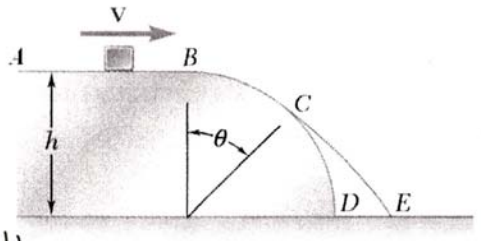
2. (50%) A small block initially slides from A to B at a speed of v = 4 m/s on a horizontal surface at a height of $h = 10$ m above the ground. Determine (a) the angle θ at which it will leave the cylinder surface BCD, and (b) the speed of the small block when it hits the ground at E. Neglect friction and air resistance.

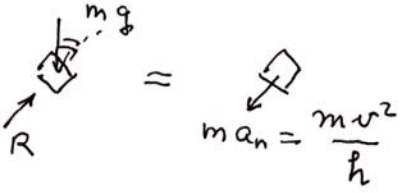


Energy B → C :

$$\frac{1}{2}mv_0^2 + mgh = \frac{1}{2}mv^2 + mgh\cos\theta$$

$$\therefore v^2 = v_0^2 + 2gh(1-\cos\theta) \quad \cdots(1)$$

Momentum @ C :



$$\nwarrow\theta: \quad -R + mg\cos\theta = \frac{mv^2}{h}$$

$$R = 0 \rightarrow \quad v^2 = gh\cos\theta \quad \cdots(2)$$

(2) into (1) :

$$gh\cos\theta = v_0^2 + 2gh(1-\cos\theta)$$

$$3\cos\theta = \frac{v_0^2}{gh} + 2 = \frac{4^2}{9.81\times 10} + 2$$

$$\therefore \cos\theta = 0.721, \quad \boxed{\theta = 43.9^\circ}$$

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Energy B → E : $\frac{1}{2}mv_0^2 + mgh = \frac{1}{2}mv_E^2 + 0$

$$v_E^2 = v_0^2 + 2gh = 16 + 2\times 9.81\times 10 = 212.2$$

20 $\boxed{v_E = 14.6 \text{ m/s}}$