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PHYS 101 MIDTERM

1) a) Block A: Tension force : T to the right (Towards Block B)
w : $m_A g$ Net Force : $T - f = m_A a$

Block B: Tension force : T to the left (towards Block A)
w : $m_B g$ Net force : $T - f = m_A a$

Block A : $T - f = m_A a$ (since the block is moving at costant velocity, acceleration $a = 0$)

Block B : The force f is balanced by the tension force T in the rope connecting the two blocks.
$T - f = m_B a$ (since the block is moving at the constat velocity, accelerotion $a = 0$)

b) $F = f$ $T - \mu_k m_A g = 0$

$T - f = m_A a$ $T = \mu_k m_A g$

$T = \mu_k m_B g = \mu_k m_A g = F$

$F = \mu_k (m_A + m_B) g$

c) $T = \mu_k m_A g = \mu_k m_B g$

$T = \mu_k (m_A + m_B) g$

(4) a) Using the same coordinate system we solve for $y = h$:

$h = y_0 + v_0 \sin\theta_0 t - \frac{1}{2} g t^2$ $h = 51.8$ $y_0 = 0$ $v_0 = 42$ m/s

$\theta_0 = 60^\circ$ $t = 5.55$

b) $v = \sqrt{(v_0 \cos\theta_0)^2 + (v_0 \sin\theta_0 - gt)^2} = 27.4$ m/s

$H = \frac{(v_0 \sin\theta_0)^2}{2g} = 67.5$ m

2) a) $\vec{v} = d\vec{r}/dt = 2\hat{i} - 1\hat{j} + 2\hat{k}$

$\vec{a} = d^2\vec{r}/dt^2 = 0\hat{i} + 0\hat{j} + 0\hat{k}$

Thus, the acceleration is zero

b) $t=1 \quad |\vec{v}(t=1)| = |2\hat{i} - 1\hat{j} + 2\hat{k}| = \sqrt{(2^2 + (-1)^2 + 2^2)} = \sqrt{9} = 3$

The speed of the object at $t=1$ second is 3 units per second

c) To find the unit vector of acceleration at $t=0$ sec, we need to find the acceleration vector and normalize it to unit vector. Since the acceleration is zero, the unit vector of acceleration at $t=0$ second is undefined.

d) $(\vec{v} \times \vec{a}) \cdot \vec{r}$

$|\vec{v}(t=1)| \times \vec{a}(t=1) = (2\vec{i} - 1\hat{j} + 2\vec{k}) \times (0\vec{i} + 0\hat{j} + 0\vec{k}) =$

$0\vec{i} + 0\vec{j} + 0\vec{k} = |\vec{v} \times \vec{a}| \cdot \vec{r}$ at $t=1$ second is zero

3)

a) $L_2 = 1/2 \times g \times t^2 \quad d = vt$

$t = \sqrt{2 \times L_2 / g} \quad D = d + L_1$

$D = v\sqrt{2 \times L_2 / g} + L_1$

$D = 2\sqrt{2 \times 2 / 10} + L_1$

b) $v^2 = v_0^2 + 2gh$

$K_2 = 1/2 g t^2$

$2\sqrt{2L_2/10} + L_1 = D$

$v^2 = 2 \cdot 10 \cdot L_2$

$v = \sqrt{20 L_2}$