AP Physics - Unit - Dynamics

Pre - Exam - FRQ

1)

A)

i) A digital scale is needed to measure the mass of the Block on the Table (m_1), and mass of the Block suspended from the String (m_2). To find the acceleration of the Block use a meter stick & a stopwatch.

ii)
- Measure the mass of each Block with the scale
- Use meter stick to measure the initial height of Block.
- Release the Block from the same height & use stopwatch to find the time it takes for Block m_2 to reach the ground.
- Repeat this several times to reduce experimental uncertainty.
- Record data for each Trial

B)
- Average the times recorded

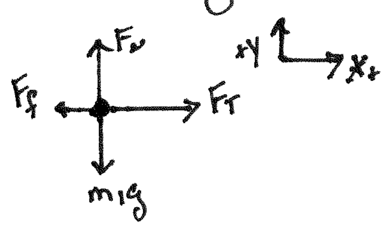
Initial height is known
final height is zero (ground)
initial velocity is zero (Rest)

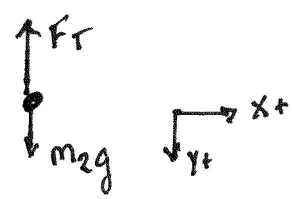
$x = x_0 + v_0 t + \frac{1}{2} a t^2$ Solve for acceleration

Both Blocks have same acceleration because they are connected by the same string

Use Newton's 2nd Law to determine coefficient of kinetic friction.

c)





$\Sigma F_x = F_T - F_f = m_1 a$

$-F_f = u_k F_N$

$F_T - u_k m_1 g = m_1 a$

$F_T = m_1 a + u_k m_1 g$

$\Sigma F_y = F_N - m_1 g = m_1 a^0$

$F_N = m_1 g$

$\Sigma F_y = -F_T + m_2 g = m_2 a$

$F_T = m_2 g - m_2 a$

$F_T = F_T$

1)

c) cont.

$$F_T \overset{?}{=} F_T$$

$$m_1 a + \mu_k m_1 g = m_2 g - m_2 a$$

$$\mu_k m_1 g = m_2 g - m_2 a - m_1 a$$

$$= m_2 g - a(m_2 + m_1)$$

$$\mu_k = \frac{m_2 g - a(m_2 + m_1)}{m_1 g}$$

d) 

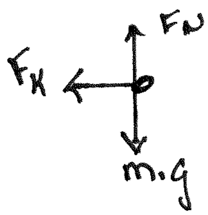
μ_k affected?

Stay the same. μ_k is a constant that measures the degree of Roughness of a given surface. Adding more mass to the system will not cause the wooden table to Be Rougher.

(F_{fk} would ↑ $F_{fk} = \mu_k F_N$)

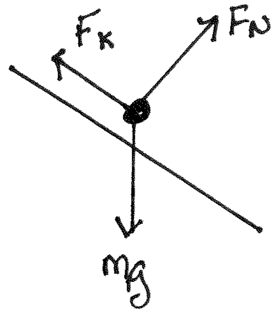
e) String Cut. forces on Each Block?

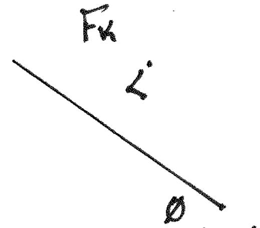
Block 1



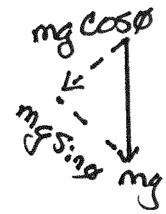
Block 2

2) (A)





Starts at Rest
$V_0 = 0$
$X = L$



$V^2 = V_0^2 + 2aX$ ($V_0 \to 0$)

$V^2 = 2aL$

Need a!

$\Sigma F_x = mg\sin\emptyset - F_K = ma$ $\qquad \Sigma F_y = F_N - mg\cos\emptyset = ma$ (→ 0)

$F_K = u_K F_N$ $\qquad F_N = mg\cos\emptyset$

$= u_K mg\cos\emptyset$

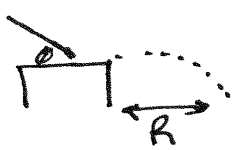
$mg\sin\emptyset - u_K mg\cos\emptyset = ma$

$a = g(\sin\emptyset - u_K\cos\emptyset)$

$V^2 = 2Lg(\sin\emptyset - u_K\cos\emptyset)$

$V = \sqrt{2Lg(\sin\emptyset - u_K\cos\emptyset)}$

(B)



Stays the Same

R is the horizontal distance accross the floor the Block will travel after it Leaves the Table Top. Because Both Blocks are released from the same height on the Incline, they Both will have the same Velocity.

After Both Blocks Leave the Bottom of the Incline, they will move across the Table with the same constant Velocity, since the tableTop is frictionless.

The Blocks will Leave the Table with the same constant Velocity (Horizontal). In Both cases the Vertical & Horizontal components are the same. Both will undergo the same Vertical acceleration due to gravity.

Both Blocks will travel the same R (Horizontal distance) due to same Vertical distance, gravity + same Horizontal Velocity

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C) Horizontal

$X = \frac{1}{2} V \Delta t$

How long in air?

Vertical

$\Delta y = \frac{1}{2} a \Delta t^2$ ← How long to fall Δy?

$\Delta t^2 = \frac{2 \Delta y}{a}$

$t = \sqrt{\frac{2 \Delta y}{a}}$

$X = \frac{1}{2} V \sqrt{\frac{2 \Delta y}{a}}$

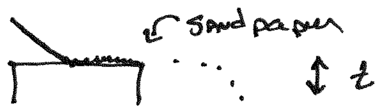
$y = h$

$R = X$

$R = \frac{V}{2} \sqrt{\frac{2h}{a}}$

Eqn ii is more Plausible

D)

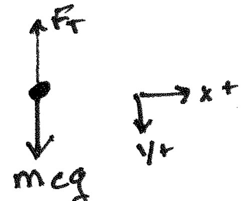


It takes the Block the same amount of time to strike the floor. The Horizonal Velocity has NO impact on the Rate the Block falls, which is Determined by the acceleration of Gravity & height of the Table.

#3)

ⓐ C at Rest

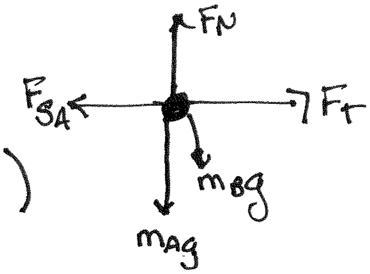
i) $F_T = ?$



$\Sigma F_y = m_c g - F_T = m a^{0}$ Rest

$F_T = m_c g$

ii)



$\Sigma F_y = F_N - m_A g - M_B g = m a^{0}$ Rest

$F_N = m_A g + M_B g$
$= g(M_A + M_B)$

$F_{SA} = U_{SA} F_N$

$F_{SA} = U_{SA}\, g (M_A + M_B)$

B) [C] falls w/ constant speed, $\therefore a = 0$

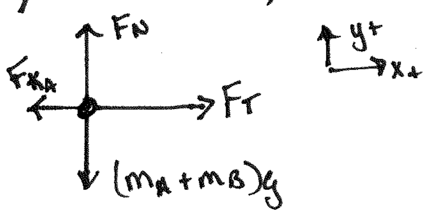
i) constant speed $\therefore$ Net force $= 0$, for Block C Tension same a at Rest

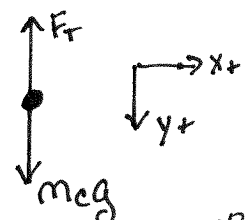
$F_T = M_c g$

ii) Constant Speed, $\therefore$ Net force $= 0$, $\therefore a = 0$, Blocks A & B moving as system, so F_S changes to F_K

$F_K = U_{KA}\, g (M_A + M_B)$

C) Block C falls, Not constant V, $\therefore a = \#$, A & B system, so only F_{KA}. F_{KB} is inside system & doesn't matter





$\Sigma F_T - F_{KA} = (m_A + M_B) a$

$F_{KA} = U_{KA} F_N$
$= U_{KA}\, g (M_A + M_B)$

$\Sigma F_y = F_N - g(m_A + M_B) = m a^{0}$
$F_N = g(m_A + M_B)$

Block C

$-F_T + M_c g = M_c a$
$-F_T = M_c a - M_c g$
$F_T = M_c g - M_c a$

$F_T - U_{KA}\, g (M_A + M_B) = (m_A + M_B) a$

$F_T = a(M_A + M_B) + U_K g (M_A + M_B)$

$F_T = F_T$

$a(M_A + M_B) + U_K g (M_A + M_B) = M_c g - M_c a$

$a(M_A + M_B) + M_c a = M_c g - U_K g (M_A + M_B)$

$a(M_A + M_B + M_c) =$

$$a = \frac{M_c g - U_K g (M_A + M_B)}{M_A + M_B + M_c}$$

#3) (D) As the acceleration of the system increases, the net force will exceed the max static friction btwn blocks A + B, and B will start to slip.

There will be a smaller amount of friction between the blocks (A+B), because slipping means kinetic friction which is less ($\mu_s > \mu_k$). Eventually, B will slide slide off A, + there will be no friction (contact) between them.