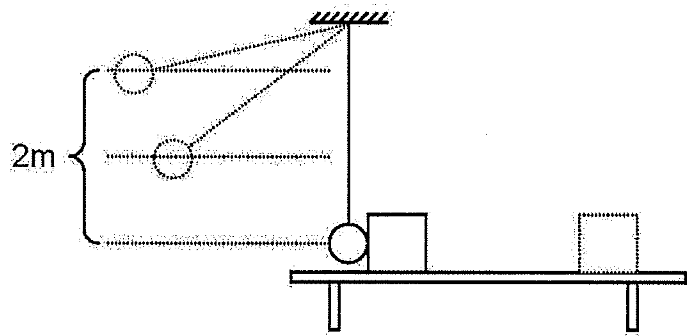
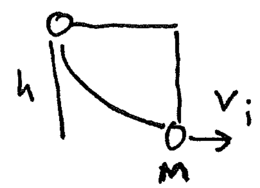
Discussion 7b : Linear Momentum and Collision

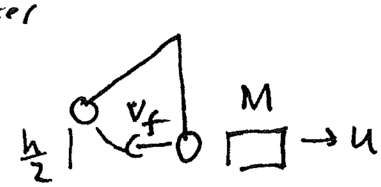
Name: Nancy Drew

A) A 18kg block is at rest on a table with a coefficient of kinetic friction $\mu_k = 0.2$. A 2-kg ball on a string swings down from rest and collides with the block. The ball bounces back and returns to one half its original height.



1. How far does the block slide on the table before coming to a stop?



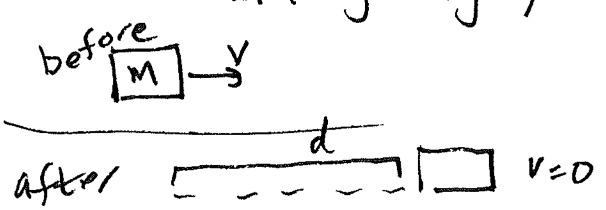


so

$$m v_i = m(-v_f) + M u \quad \text{or} \quad u = \frac{m(v_i + v_f)}{M}$$

$v_i = \sqrt{2gh}$ by energy conservation, and $v_f = \sqrt{gh}$ as well so

$$u = \frac{m}{M}\left(\sqrt{2gh} + \sqrt{gh}\right) = \frac{2}{18}\left(\sqrt{2\cdot 10\cdot 2} + \sqrt{10\cdot 2}\right) = 1.20\ m/s$$



so $W_{lost} = KE$. $W_{lost} = fd$ since f const

$$\mu m g d = \tfrac{1}{2} m u^2$$

so

$$d = \frac{u^2}{2\mu g} = \frac{(1.2)^2}{2\cdot 0.2\cdot 10} = \boxed{0.36\ m}$$

2. Is the collision completely elastic?

For it to be elastic, $E_i = E_f$, so

$$E_i = KE_{mi} + \cancel{KE_{Mi}} = \tfrac{1}{2} m v_i^2 = mgh = 2\cdot 10\cdot 2 = 40\ J \quad \text{(using energy conservation)}$$

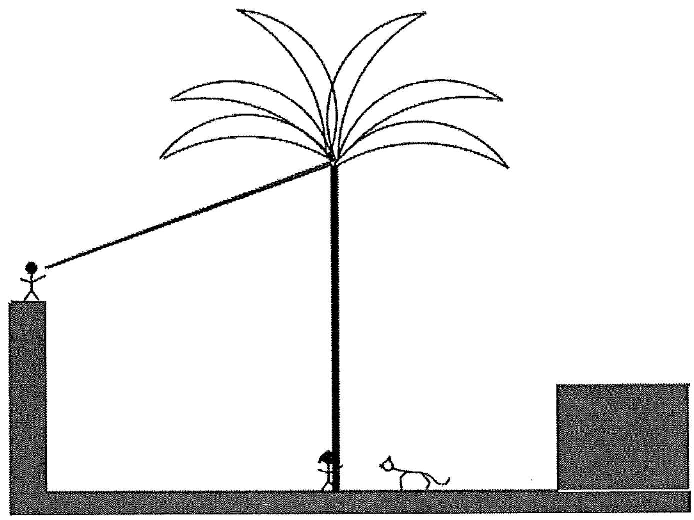
$$E_f = KE_{mf} + KE_{Mf} = \tfrac{1}{2} m v_f^2 + \tfrac{1}{2} M u^2 = mg\tfrac{h}{2} + \tfrac{1}{2} M u^2$$

$$= 2\cdot 10\cdot 1 + \tfrac{1}{2}\cdot 18\cdot (1.2)^2 = 32.96\ J$$

$E_i > E_f$ so energy <u>not</u> conserved so $\boxed{\text{inelastic}}$

Name: ______________________

B) It is a busy day in the jungle. Tarzan, with a mass of 90. kg, is standing at the edge of a cliff 20. m high, and sees Jane about to be attacked by a tiger. He quickly grabs some nearly massless vines that are anchored from a point on the shown tree 30. m above the ground. Tarzan "jumps," starting from rest, and swings through a circular arc. The vines do not stretch. At the very bottom of the swing he grabs Jane, who has a 60 kg mass, and then swings through a circular arc coming to rest at a ledge on the other side. Little g is 10 m/s² down.



1. How fast is Tarzan going the instant before he grabs Jane?

Before collision, can just use energy conservation!

$mgh = \frac{1}{2}mv^2$ or $V = \sqrt{2gh} = \sqrt{2 \cdot 10 \cdot 20} = \boxed{20\ m/s}$

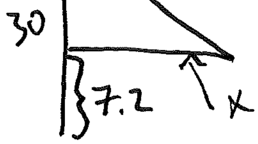
2. What position of the far cliff is needed so that they can escape? Assume Jane is at the origin and that their final velocity is zero just as they reach the cliff?

Can't use energy conservation, need momentum!

$P_i = P_f \Rightarrow m_t V_i = (m_t + m_j) V_f$ since they have the same final velocity

$90 \cdot 20 = (90 + 60) V_f$ or $V_f = 12\ m/s$

$\Delta KE = \Delta PE \Rightarrow \frac{1}{2} M_{tot} V_f^2 = M_{tot} g h$ or $h = \frac{V_f^2}{2g} = \frac{12^2}{2 \cdot 10} = \boxed{7.2\ m}$

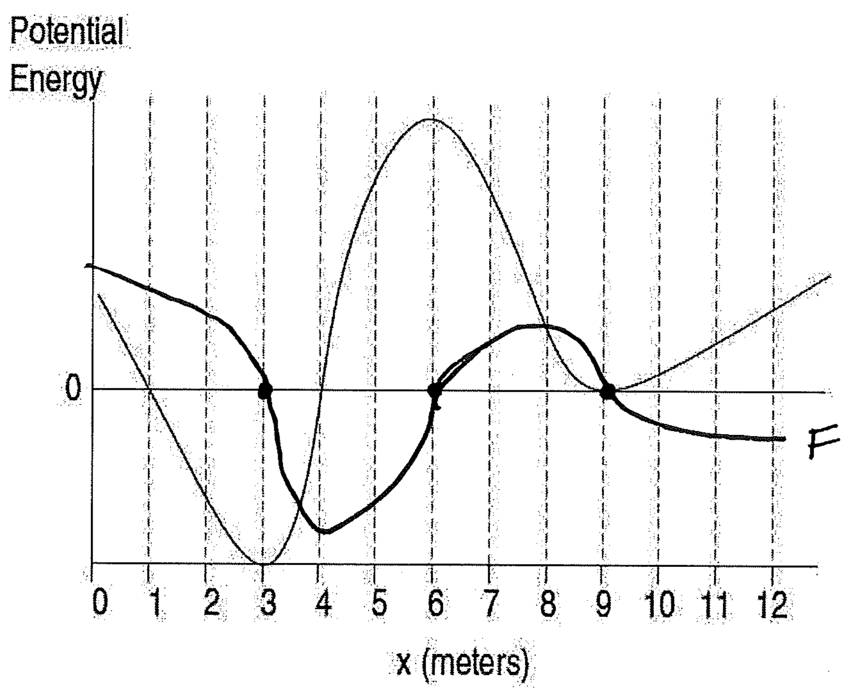


$x^2 + (30 - 7.2)^2 = 30^2$ so $x = \sqrt{900 - 22.8^2}$

$x = 19.5\ m$ or $\boxed{x = 19.5\ m,\ y = 7.2\ m}$

Name: ______________________________

C) The graph below shows the potential energy curve of a particle moving along the x-axis under the influences of a conservative force.



$F = -\frac{dU}{dt}$

1. In which interval(s) of *x* are the forces on the particles to the right?

F is to the right when $\frac{dU}{dt}$ is negative

or (0,3) and (6,9)

2. At what value(s) of *x* is the magnitude of the force a minimum?

Force (magnitude) is minimum when F=0 or slope is 0, so x = 3, 6, 9

3. At what value(s) of *x* is the magnitude of the force a maximum?

Force is maximum when slope is maximum so around x = 4 for absolute max