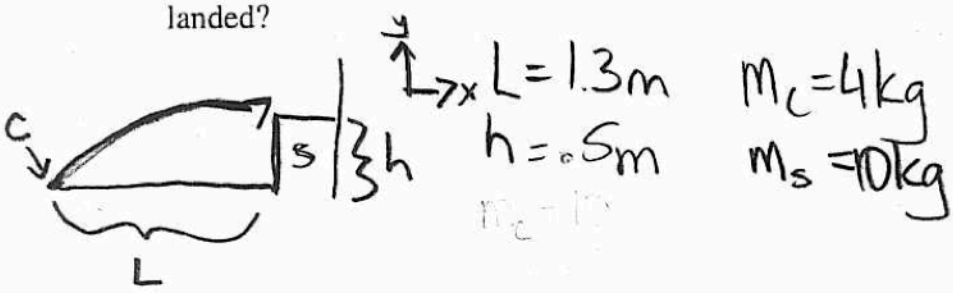
1301. F04L. P1. S1

Name: ID# Section #

Problem 1

A 4kg cat (treat it as a point particle) sits on a horizontal floor eyeing a stationary chair of mass 10kg which is a horizontal distance of 1.3m away. The seat of the chair is 0.5m above the floor. The cat jumps up and lands on the seat of the chair just as she reaches the maximum height of her trajectory. She puts out her claws and hangs on. If the chair sits on a part of the floor which has just been waxed, is very slippery and therefore frictionless, what is the momentum of the cat plus chair system just after the cat has landed?



$L = 1.3m$ $m_C = 4kg$

$h = .5m$ $m_S = 10kg$

Conservation of Momentum

$m_C V_{x_1} = (m_C + m_S) V_f$

Kinematics

$h = -\frac{1}{2}gt^2 + V_{y_i}t$; $0^2 = V_{y_i}^2 - 2hg \Rightarrow V_y = \sqrt{2hg} \Rightarrow 0 = -\frac{1}{2}gt^2 + t\sqrt{2hg} - h$

$t = \frac{-\sqrt{2hg} \pm \sqrt{2hg - 4(-\frac{1}{2}g)(-h)}}{-g} = \sqrt{\frac{2h}{g}}$

$L = V_{x_1}t \Rightarrow V_{x_1} = \frac{L}{t} \Rightarrow \frac{L}{\sqrt{2h/g}} = V_{x_i}$

$m_C V_{x_1}$ = Momentum of cat/chair system

$\frac{m_C L}{\sqrt{2h/g}} = \frac{(4kg)(1.3m)}{\sqrt{\frac{2\times(.5m)}{9.8m/s^2}}} = \boxed{16\frac{kgm}{s} = \text{momentum of cat/chair system}}$

1301.F04L.P1.S2

Name [redacted] ID# [redacted] Section # 1301 W 100

Problem 1

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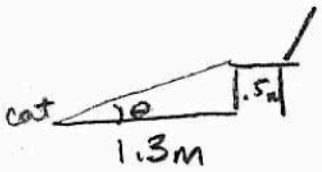
$m_c(\text{cat}) = 4\,kg$

$m_s(\text{chair}) = 10\,kg$



$m_c + m_s = 14\,kg$

conservation of momentum $m_c v_{cat} = (m_c + m_s) v_{system}$

θ of jump $= \tan^{-1}\left(\frac{.5}{1.3}\right) = 21.04°$

PE of cat when on chair $= m_c(-9.8)(.5m)$

$PE = 4(-9.8)(.5) = 19.6$

$PE = KE \quad m_{cat} g y = \frac{1}{2} m_{cat} v^2$

$\sqrt{|2gy|} = v$

$\sqrt{|2(-9.8)(.5)|} = 3.13\ m/s$

$(4\,kg)(3.13\ m/s) = 14\,kg\ v_{system}$

$\frac{(4)(3.13)}{14} = v_{system}$

$0.89\ m/s = v_{system}$

PE of cat + chair $= (m_c + m_s) v_{system}$

$= 14(.89)$

$= 12.52\ kg\ m/s$

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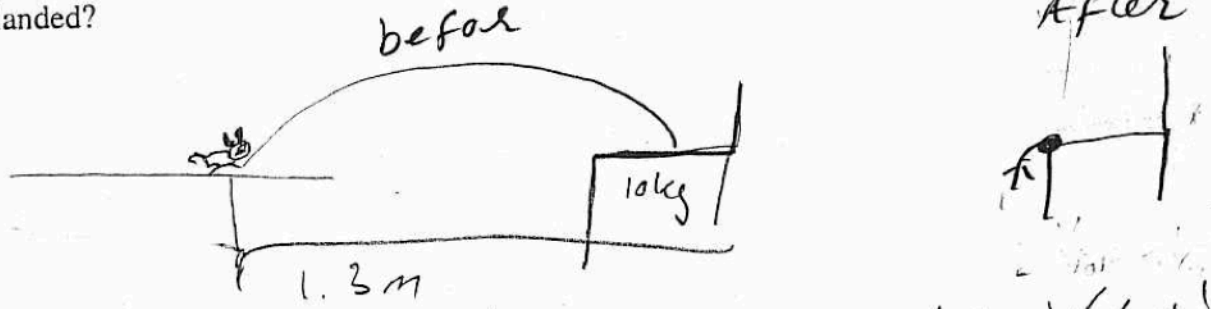

$V_x = V_{ox} + a t$

$V_x = g t$

$V_x = 10 \times .32$ No -1

$V_x = 3.16$

$y = y_0 + V_{oy} t + \frac{1}{2} g t^2$

$0.5m = \frac{1}{2} 10 t^2$

$0.5 = 5 t^2$

$t^2 = \frac{0.5}{5}$

$t = .32s$ ✓

$m v_i + M V_i = M V_f + M V_{cf}$

$m v_i + M_c V = M_E + M_c) V_f$

$V_f = \frac{m v_i + M_c V}{M_f + M_{cf}}$

$V_f = \frac{(10) 3.16 + 4 (3.16)}{10 + 4}$? -3

$V_f = 226.7 \, m/s$

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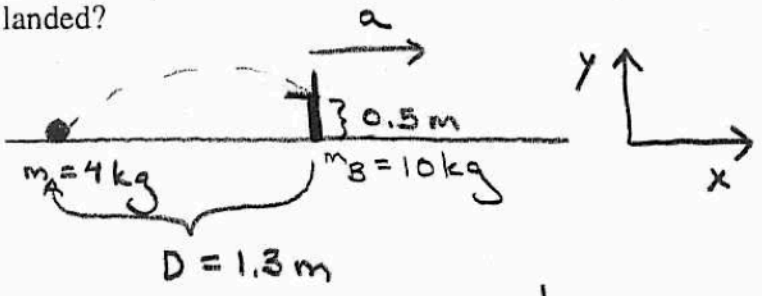
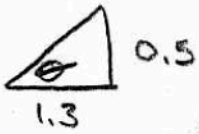
Problem 1

A 4kg cat (treat it as a point particle) sits on a horizontal floor eyeing a stationary chair of mass 10kg which is a horizontal distance of 1.3m away. The seat of the chair is 0.5m above the floor. The cat jumps up and lands on the seat of the chair just as she reaches the maximum height of her trajectory. She puts out her claws and hangs on. If the chair sits on a part of the floor which has just been waxed, is very slippery and therefore frictionless, what is the momentum of the cat plus chair system just after the cat has landed?



m_A mass of cat
m_B mass of chair



$\tan\theta = \frac{0.5}{1.3}$ (3)

$\theta = 21^\circ$

Use kinematics and conservation of momentum $P = (14kg)(1.3m/s)$

$= 61.6\ kg\cdot m/s$

$m_A v_i = (m_A + m_B) v_f$

Momentum of cat-chair system

$(4kg)(4.4m/s) = (4kg + 10kg) v_f$

$v_f = \frac{(4kg)(4.4m/s)}{14kg}$

$v_f = 1.3\ m/s$

↑ Velocity of cat-chair system

$x = x_0 + v_{0x}t + \frac{1}{2}at^2$

$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$

At the top of the cat's trajectory $v_{0y} = 0$

$v_{0x} = v\cos\theta$

$v_{0y} = v\sin\theta$

The time taken for the cat to land in the chair is $y = \frac{1}{2}gt^2$

$0.5 = \frac{1}{2}(9.8m/s^2)t^2$

$t = \sqrt{\frac{0.5}{\frac{1}{2}(9.8)}} = 0.32\ s$

The initial velocity of the cat is $D = v_i\cos\theta\, t$

$1.3\ m = v_i \cos 21\,(0.32s)$

$v_i = \frac{1.3}{(0.32)\cos 21^\circ}$ (3)

$v_i = 4.4\ m/s$

Name [redacted] ID# [redacted] 1301.F04L.P1.S20 Section # 115

Problem 1

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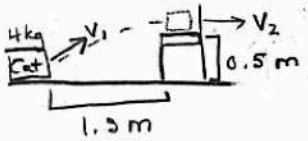
$V_y = 0$
Time $= \frac{T}{2}$

Use conservation of momentum and conservation of Energy.



Momentum = mV

Momentum of cat + chair = $(m_{cat} + m_{chair})V$

Conservation of momentum: $P_i = P_f$

$$m_{cat} V_1 = (m_{cat} + m_{chair}) V_2$$

Conservation of Energy: $KE_{cat} = PE_{cat+chair}$

$$\frac{1}{2} m_{cat} V_1^2 = (m_{cat} + m_{chair}) gh$$

No

$$\Rightarrow V_1^2 = \frac{2(m_{cat} + m_{chair})gh}{m_{cat}}$$

$$\Rightarrow V_1^2 = \frac{2(4\,kg + 10\,kg)(9.8\,m/s^2)(0.5\,m)}{(4\,kg)}$$

$$V_1 = 5.857\ m/s$$

∴ Plugging the initial velocity back into the conservation of momentum equation

$$(4\,kg)(5.857\,m/s) = (4\,kg + 10\,kg) V_2 \Rightarrow V_2 = 1.6734\ m/s$$

∴ The momentum of the cat plus chair system is P_f:

$$(m_{cat} + m_{chair}) V_2 \Rightarrow (4\,kg + 10\,kg)(1.6734\,m/s)$$

$$= 23.428\ kgm$$