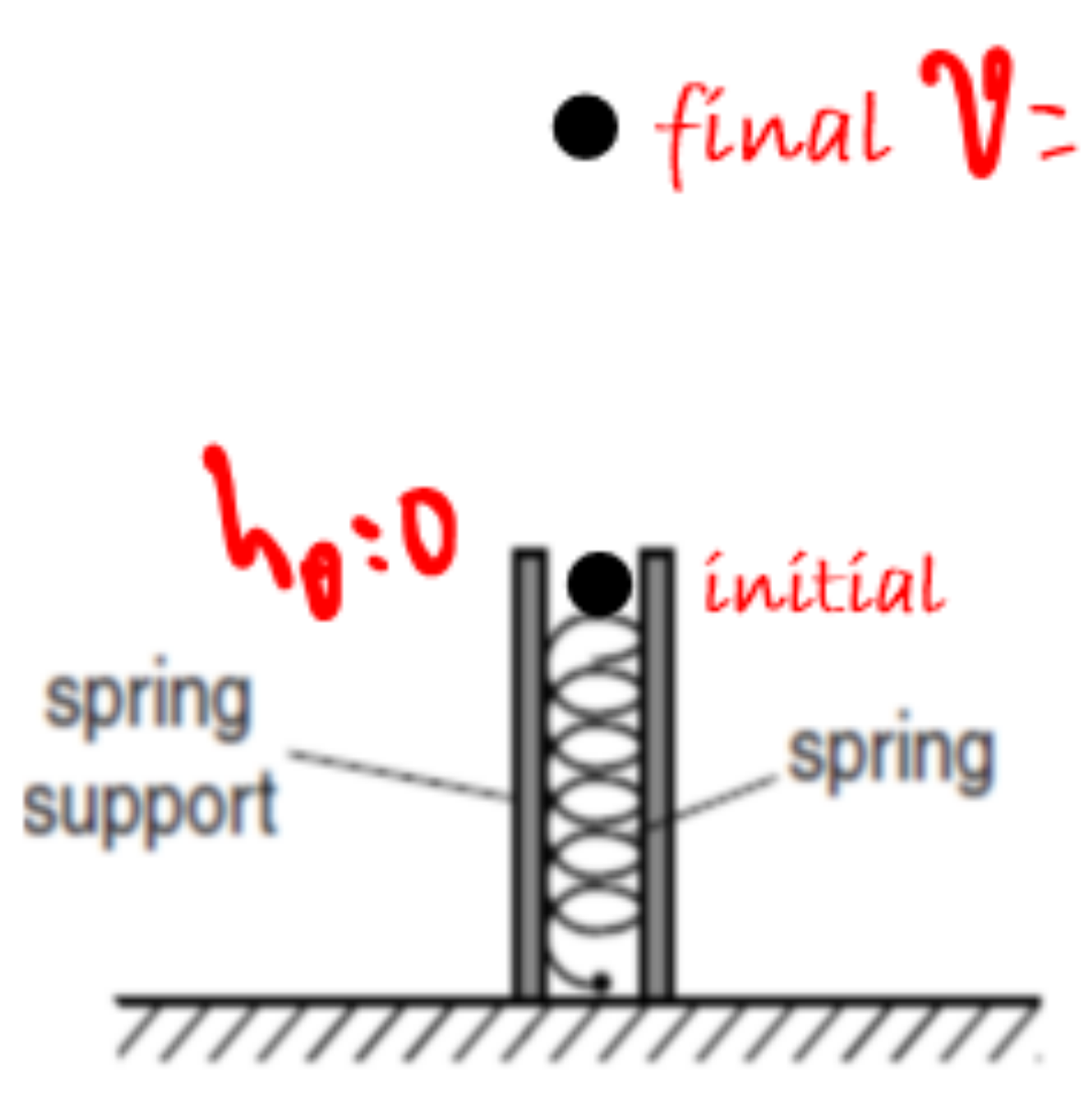
Practice: Conservation of Mechanical Energy

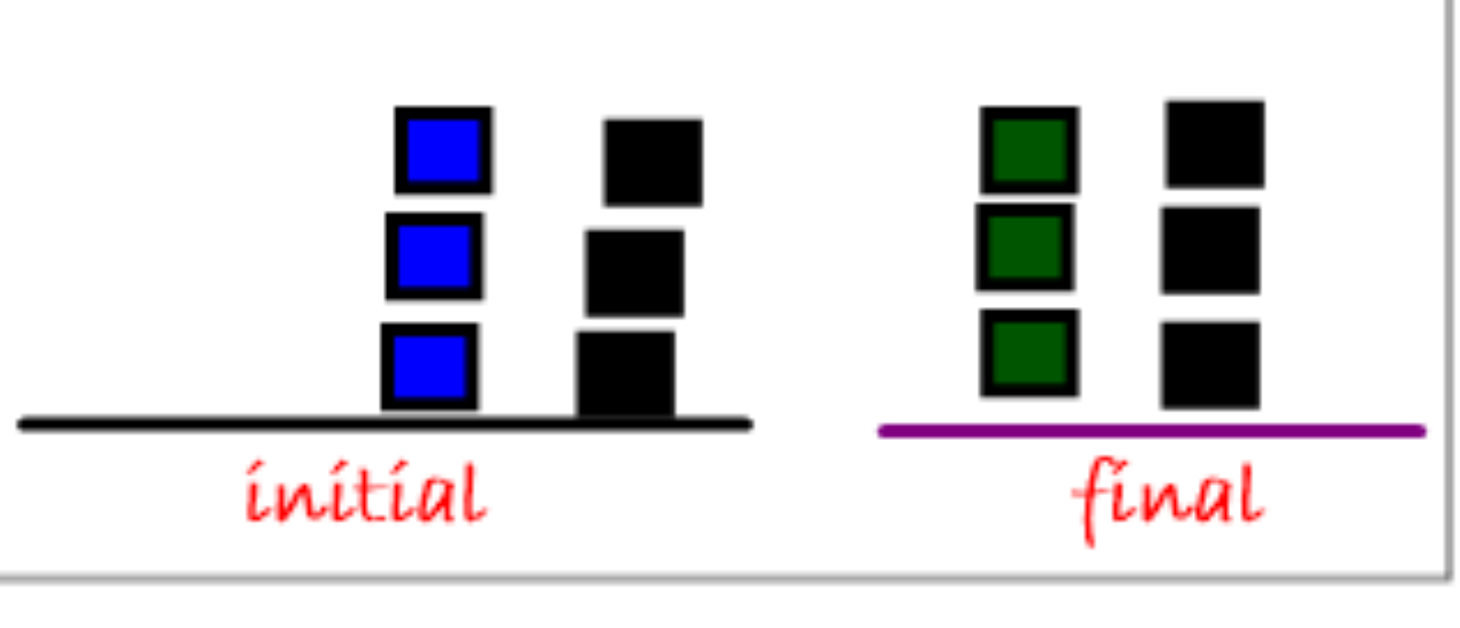
26/02/24 8:45 am

5. A box rests on a tightly coiled spring and then is launched into the air. Initial: box on spring, at rest; final, box halfway up to its highest point.

Pictorial Representation:



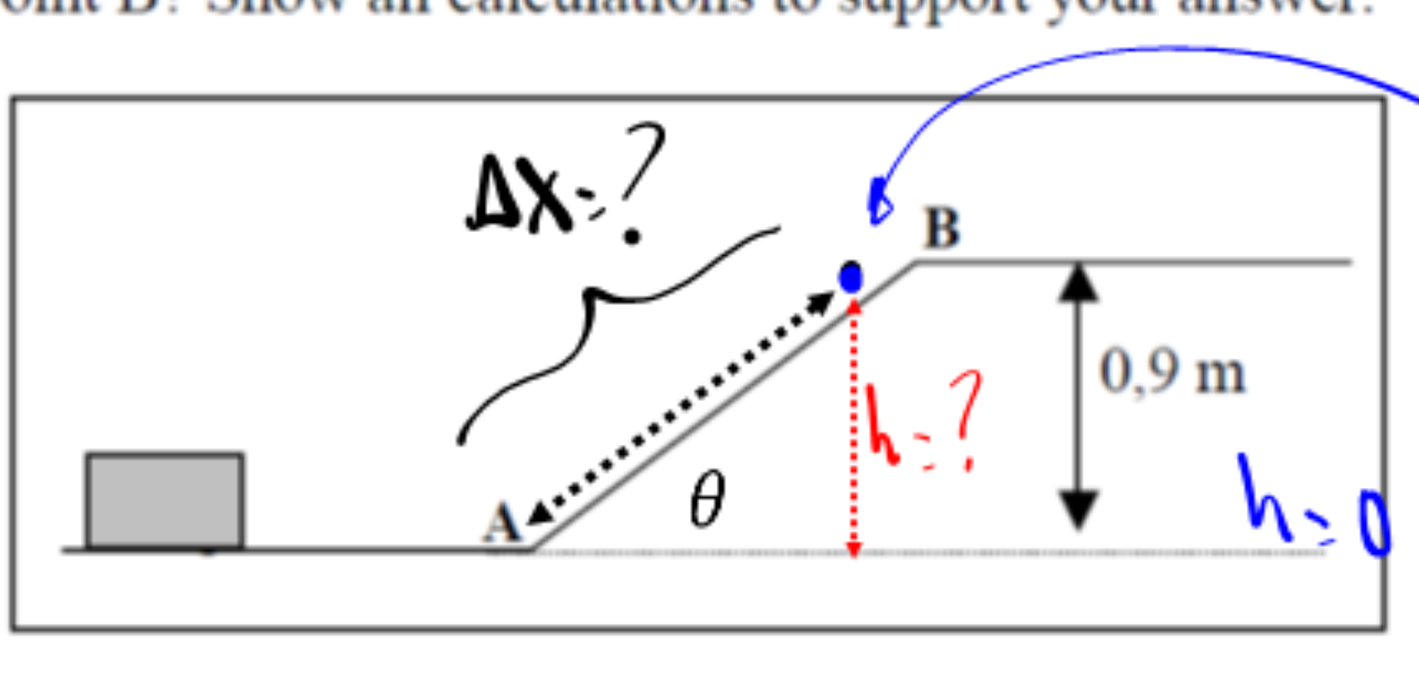
Energy Bar Diagram:

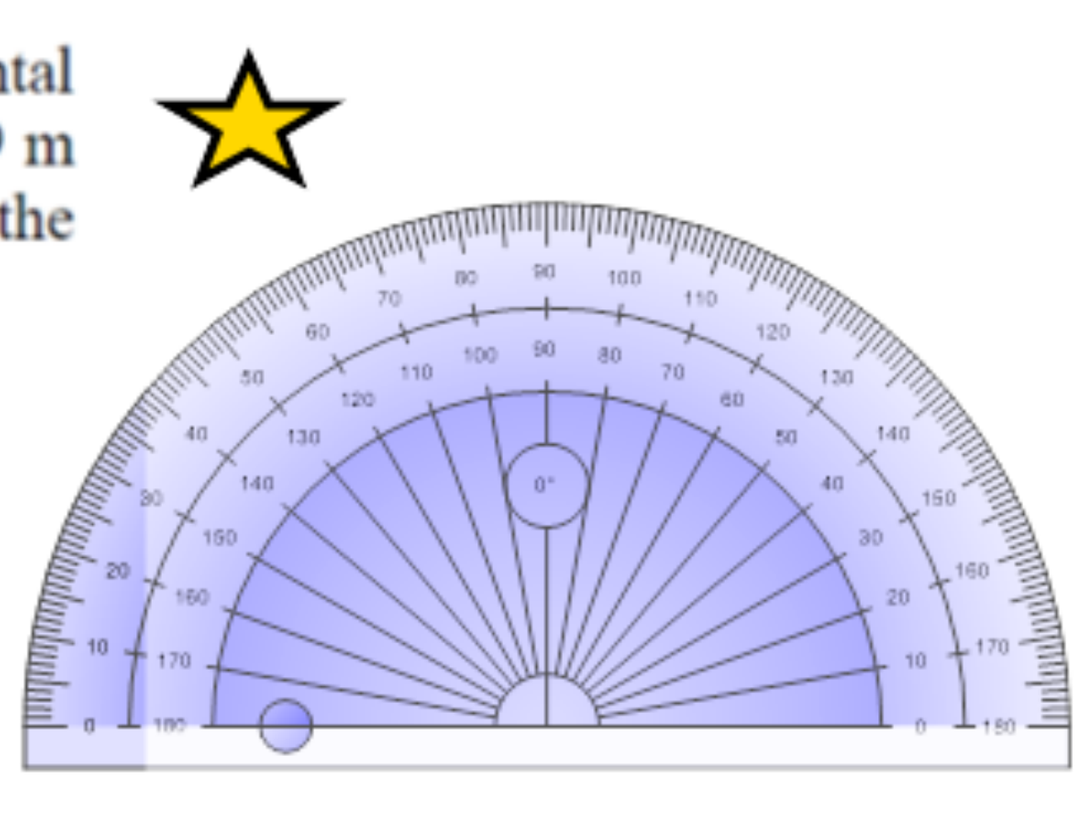


K W U_g U_s E

An object with mass 25 kg moves at a constant speed of 4 m/s along a horizontal surface towards point A. It then moves up an incline towards point B which is 0,9 m higher than point A (see sketch below). Provided all surfaces are frictionless, will the object reach point B? Show all calculations to support your answer.

$\theta = 38^o$





b. If the object does not reach point B, calculate how far is from point A.

$E_0 = E$

$F_f = 0$ ($W_{F_f} = 0$)

$W_{NC} = \Delta E$ → zero

$K_0 + U_{g_0} = K + U_g$ (zero, h = 0; zero at h_{max})

$\frac{1}{2} m v_0^2 = mgh$ (height)

$\frac{v_0^2}{2g} = h =$

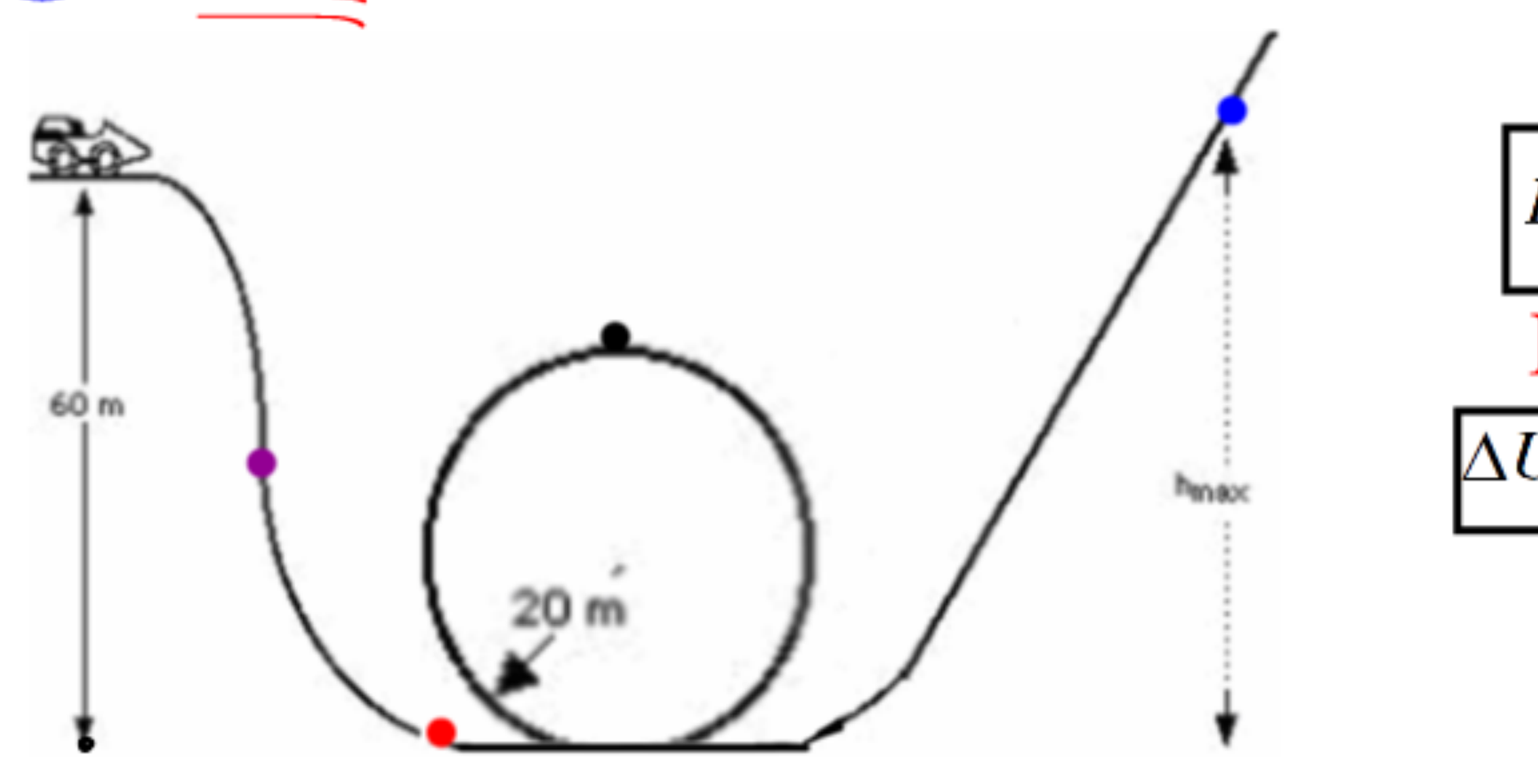
$\frac{4^2}{(2 \times 9.8)} = h = 0.816$ m

ΔX, 30, 0.816 m

$\sin(30°) = \frac{0.816}{\Delta X}$

$\Delta X = \frac{0.816}{\sin 30} = 1.63$ m

A roller coaster rolls over the top of a hill with a speed of 10. m/s The roller coaster's mass is 500. Kg (Ignore friction).



$K = \frac{1}{2}mv^2$

E= K + U

$\Delta U_g = mg\Delta y$

$U_g = mgy = mgh$

a. What is the speed of the roller coaster car half way down the hill?
b. What is the speed of the roller coaster car at the bottom of the hill?
c. What is the speed of the roller coaster car at the top of the loop?
d. What is the maximum height of the roller coaster?

$W_{NC} = \Delta E$

$0 = E - E_0$

$E_0 = E$

$F_f = 0$, $W_{NC} = 0$

$K_0 + U_{g_0} = K + U_g$

$\frac{1}{2} m v_0^2 + mgh_0 = \frac{1}{2} m v^2 + mgh$?

$\frac{1}{2} \cdot 10^2 + 9.8 \cdot 60 = \frac{1}{2} v^2 + 9.8 \times 30$

$638 = \frac{v^2}{2} + 294$

$638 - 294 = \frac{v^2}{2}$

$344 = \frac{v^2}{2}$

$344 \times 2 = v^2$

$\sqrt{688} = v = 26.2 \frac{m}{s}$

b) $E_0 = E$

$K_0 + U_{g_0} = K + U_g$ (zero, h = 0)

$638 = \frac{1}{2} v^2$ remember m was cancels out

$\sqrt{638 \times 2} = v$

$v = 35.7 \frac{m}{s}$

c) $E_0 = E$

$K_0 + U_{g_0} = K + U_g$

$638 = \frac{1}{2} v^2 + gh$

$638 = \frac{1}{2} v^2 + 9.8 \times 40$

$\sqrt{2(638 - 392)} = v$

$v = 22.2 \frac{m}{s}$

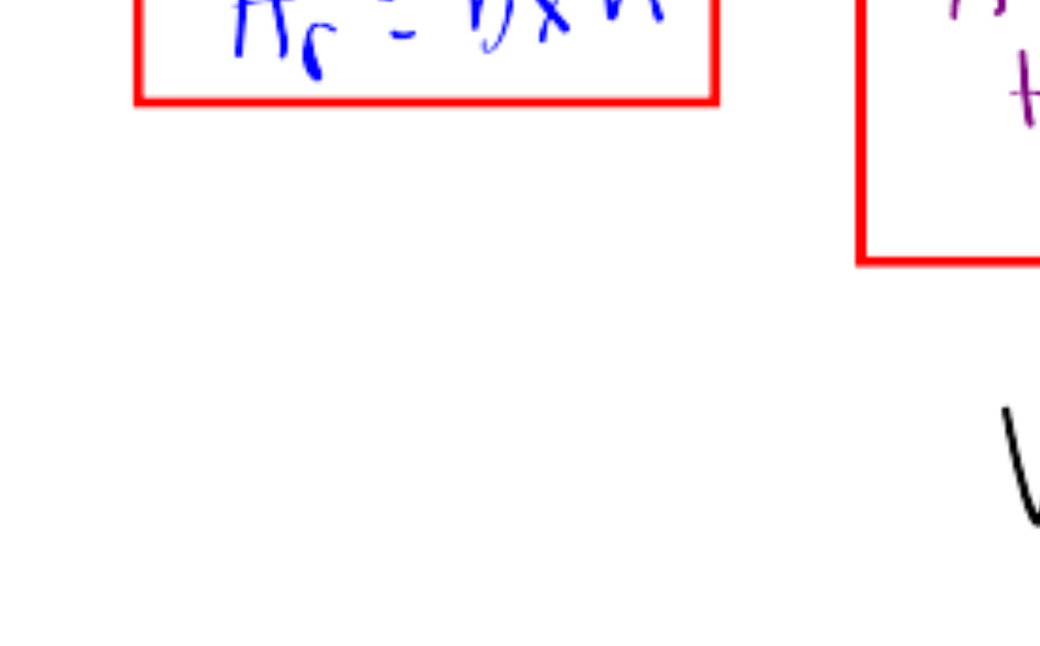
d) $E_0 = E$

$K_0 + U_{g_0} = K + U_g$ (at h_{max} "stops")

$638 = g h_{max}$

$\frac{638}{9.8} = h_{max} = 65.1 \frac{m}{s}$ ← more than 60 m cause $V_0 \neq 0$

What is the speed of a 3.2 kg object that starts at rest over the 4.0 meters distance shown is the graph?



$W = F \cdot d$ → N × m = Joule

$W = \Delta K$

$K = \frac{1}{2} m v^2$

Area!

$A_r = b \times h$

$A_{trapezoid} = \frac{(b_1 + b_2)h}{2}$

$W = \Delta K = K - K_0$ → zero ($V_0 = 0$) rest

$(2 \times 5) + \frac{(5+10)}{2} \times 2 = \frac{1}{2} m v^2$

$25 = \frac{1}{2} \cdot 3.2 \times v^2$

$\sqrt{\frac{25 \times 2}{3.2}} = v = 3.9 \frac{m}{s}$