807 AP Physics Schmidt

Name [redacted]

U4H3 **Conservation of Mechanical Energy Practice Problems**

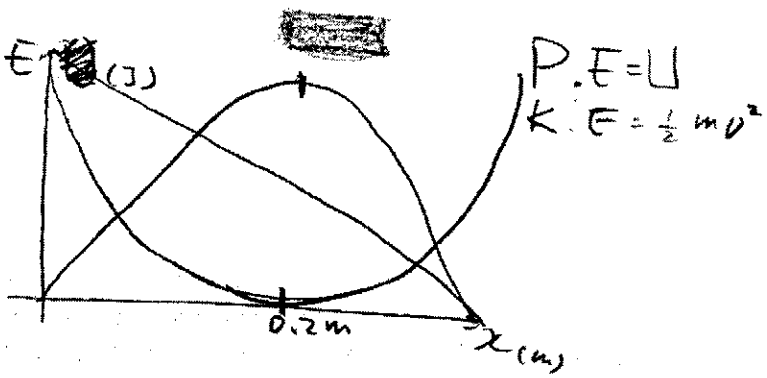
$$K.E_0 + G.P.E_0 + E.P.E_0 = K.E_1 + G.P.E_1 + E.P.E_1$$

1. A pendulum consists of a 2.0 kg stone swinging on a 4.0 m string of negligible mass. The stone has a speed of 8.0 m/s when it passes the lowest point. What is the speed of the stone when the string is at 60° to the vertical? (4.9 m/s)

2. A spring with a force constant of 500N/m hangs vertically. A block of mass 10kg is attached to the un-stretched spring and let go. Find the max. distance the block falls before it begins to move upwards. Draw an energy diagram of this system. (0.4 m)

$k = 500\,N/m$

$m = 10\,kg$



3. A 10kg block is gently placed on a vertical spring with a force constant of 500N/m that is attached to the ground. (a) Find the max. compression of the spring. (b) Find the compression of the spring corresponding to the max. speed of the block? (c) What is the maximum speed of the block? Draw an energy diagram of this system. (0.4 m, 0.2 m, √2 m/s)

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4. Tarzan who weighs 688 N, swings from a cliff at the end of a convenient vine that is 18 m long. From the top of the cliff to the bottom of the swing, he descends by 3.2 m. The vine will break if the force on it exceeds 950 N. (a) Does the vine break? (b) If no, what is the greatest force on it during the swing? If yes, at what angle does it break? (No, 933N)

$mgh = 688 \cdot 3.2 = 2201.6$ J

$\frac{1}{2}mv^2 = 1201.6$

$mv^2 = 4403.2$ / $688 = 8$.

$F = \frac{688}{10} \cdot \frac{64}{18} = 244.62$

$244.62 + mg = 244.62 + 688$

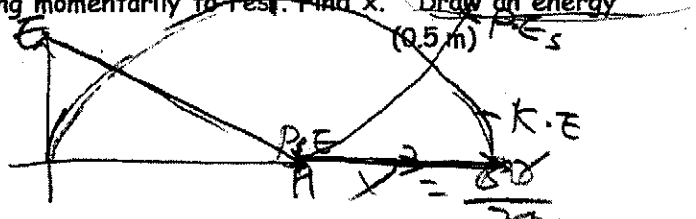
$= 933$ N

5. A 3.20 kg block starts at rest and slides a distance d down a frictionless 30° incline, where it runs into a spring. The block slides an additional 21.0 cm before it is brought to rest momentarily by compressing the spring, whose spring constant is 431 N/m. (a) What is the value of d? (b) What is the distance between the point of first contact and the point where the block's speed is greatest? (0.38 m, 3.7 cm)

6. A 1 kg object is released from rest at a height of 5 m on a curved frictionless ramp. At the foot of the ramp is a spring of spring constant 400N/m. The object slides down the ramp and onto the spring, compressing it a distance x before coming momentarily to rest. Find x. Draw an energy diagram for this system.

$k = 400$

$mgh = 50$ J. $h = 5$, $m = 1$



$\frac{1}{2}mv^2 = 50$ J

$v^2 = 100$

$v = 10$ m/s

$\frac{1}{2}mv^2 + \frac{1}{2}kx^2 = 50$ J

$\frac{1}{2} \cdot 400 \cdot x^2 = 50$

$x = \sqrt{\frac{100}{400}} = \frac{1}{2}$

0.5 m

7. An elastic string 25 cm long obeys Hooke's law. When a 150g object is suspended from the string, it stretches 5cm. If the object is attached to the end of the string and dropped from the point of support of the string, find the distance it falls before first coming to rest. (0.47 m)

$F = 0.15 \times 10 = k \cdot 0.05$

$100 = 5k$

$k = 30$

$mgh = 0.15 \cdot 10 \cdot 0.25 = 0.375$ J

$mgh = 0.15 \cdot 10 \cdot -x = -1.5x$

$\frac{1}{2}kx^2 = \frac{1}{2} \cdot 30 \cdot x^2 = 15x^2$

$15x^2 = -1.5x + 0.375$

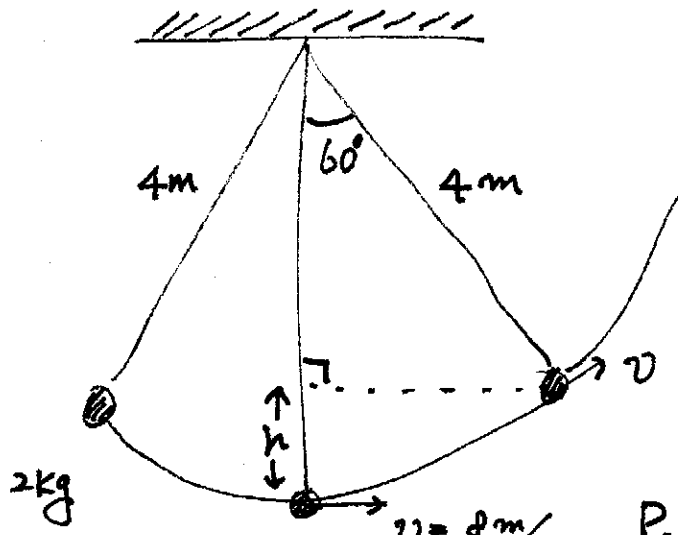
$15x^2 + 1.5x$

$15x(10x + 1) = 0.375$

$0.22 + 0.25 = 0.47$ M

4H3.

1.



P.E. = mgh = 2 × 9.8 × (4 − 4cos60°)

= 20 × 4 (1 − cos60°)

= 40 J

K.E. = $\frac{1}{2}$ × m × v^2

= $\frac{1}{2}$ × 2 × v^2 = v^2.

Total E = 40 + v^2

P.E. = mgh = ∅

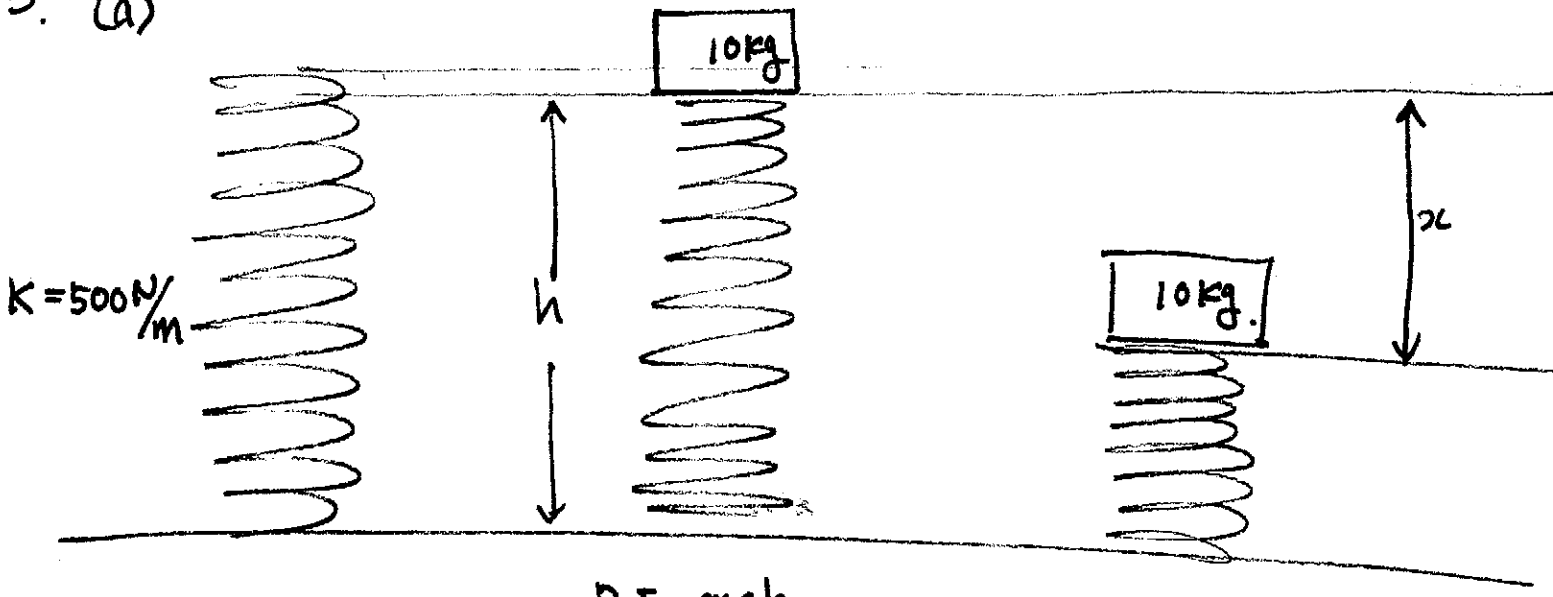
K.E. = $\frac{1}{2}mv^2$ = $\frac{1}{2}$ × 2 × 8^2 = 64 J.

Total Energy = 64 J.

∴ Conservation of Energy

$64 = 40 + v^2$ ⟶ $v = 4.899$ m/s.

3. (a)



P.E. = mgh
= 10 × 10 × h
= 100h

P.E spring
$= \frac{1}{2} k x^2$
$= \frac{1}{2} \times 500 \times 0$
= 0

K.E = 0

Total Energy = 100h

P.E = 10 × 10 × (h − x)
= 100(h − x)

P.E. spring
$= \frac{1}{2} \times 500 \times x^2$
$= 250x^2$

K.E. = 0
max compression.

Total E = $100h - 100x + 250x^2$

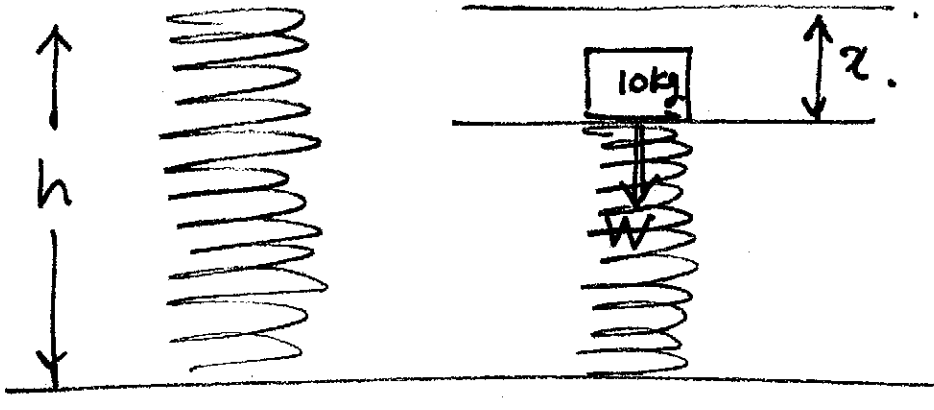
$\therefore \quad 100h = 100h - 100x + 250x^2$

$250x^2 - 100x = 0$.

$x(5x - 2) = 0 \qquad x = \frac{2}{5}$

$= 0.4\ m$

(b). max speed → equilibrium location with 10kg Block.



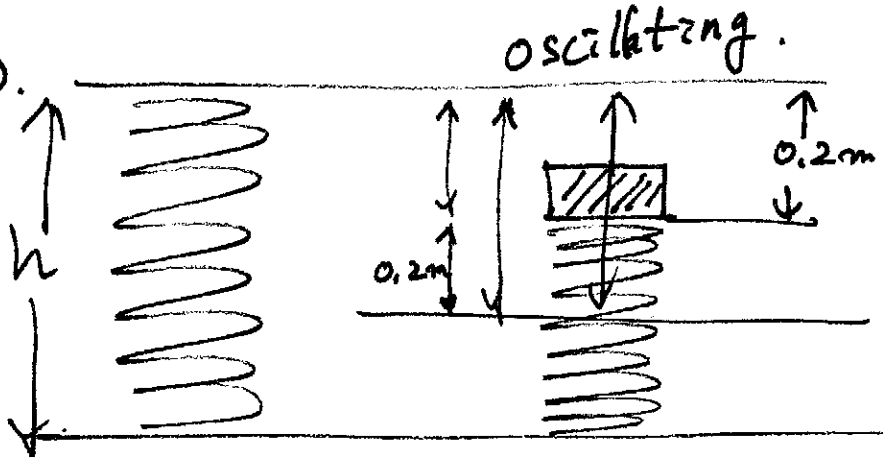
$\therefore F = kx$

Weight $= k \cdot x$

$10 \times 10 = 500 \cdot x$

$x = \frac{1}{5} = 0.2\,m.$

(c).



$P.E. = mgh = 10 \times 10 \times (h - 0.2)$

$P.E.\text{-spring} = \frac{1}{2}kx^2 = \frac{1}{2} \times 500 \times 0.2^2$

$= 10.$

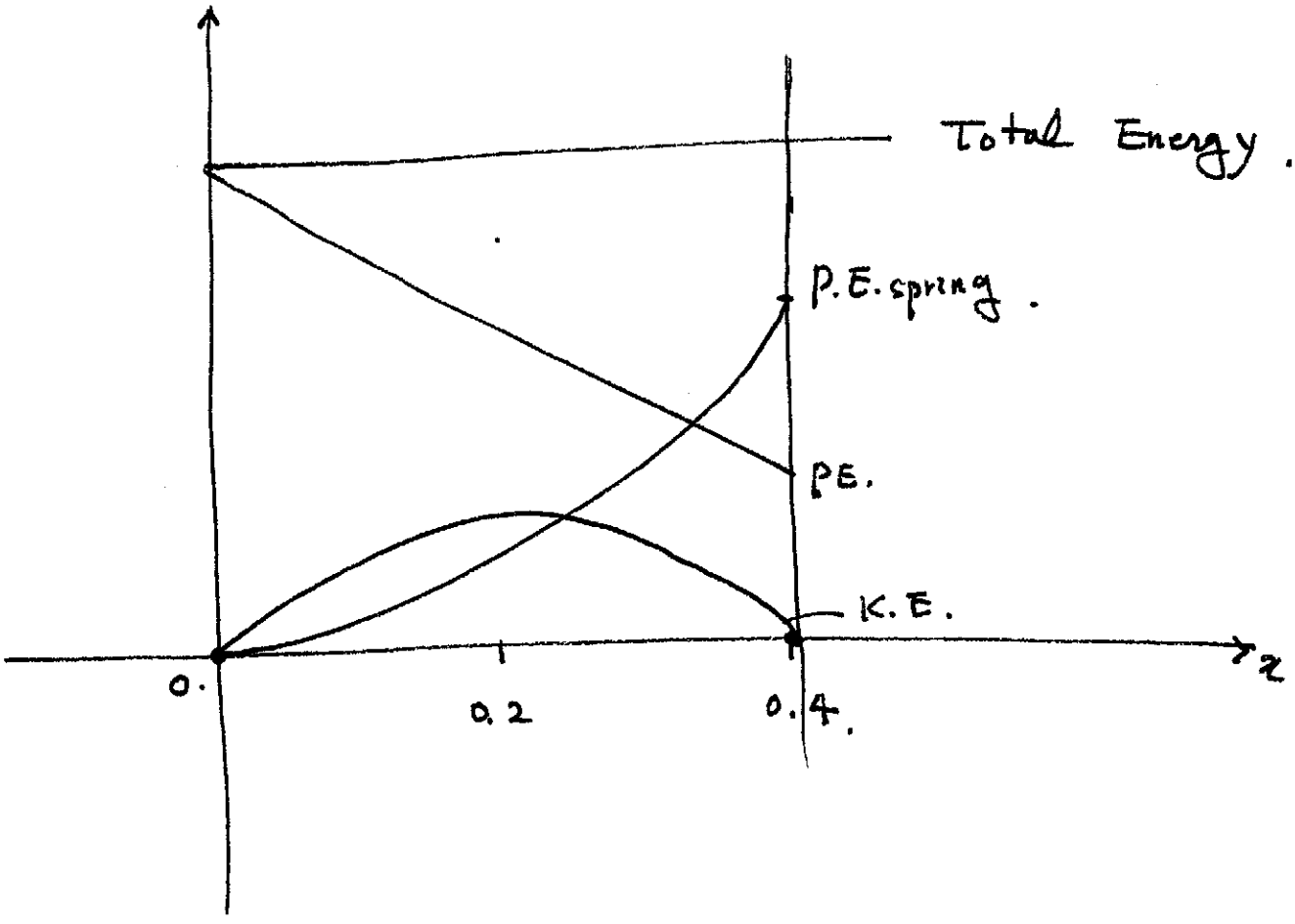
$K.E. = \frac{1}{2}mv^2 = \frac{1}{2} \times 10 \times v^2 = 5v^2$

from (a)

$100h = \text{Total } E = 100h - 20 + 10 + 5v^2$

$10 = 5v^2$

$v = \sqrt{2}\ m/s$

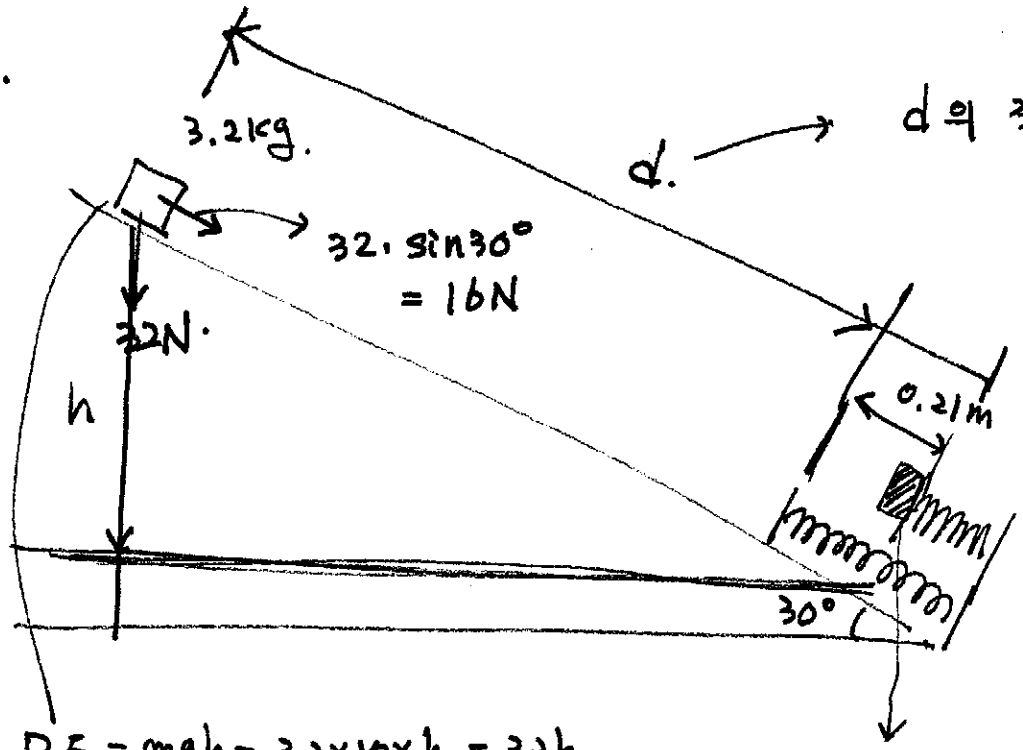


$K.E. = \frac{1}{2} \times m v^2$.

$P.E_{spring} = \frac{1}{2} k x^2$.

$PE. = mgh$.

5.



d의 길이가 이 길이라고 Assum 한다.

K = 431 N/m.

P.E. = mgh = 3.2x10xh = 32h

K.E. = 0

P.E.spring = 0.

Total E = 32h

P.E. = 0.

K.E. = 0.

P.E.spring = $\frac{1}{2}xKx^2 = \frac{1}{2}x431x0.21^2$

= 9.5

Total E = 9.5

$\therefore$ 32h = 9.5

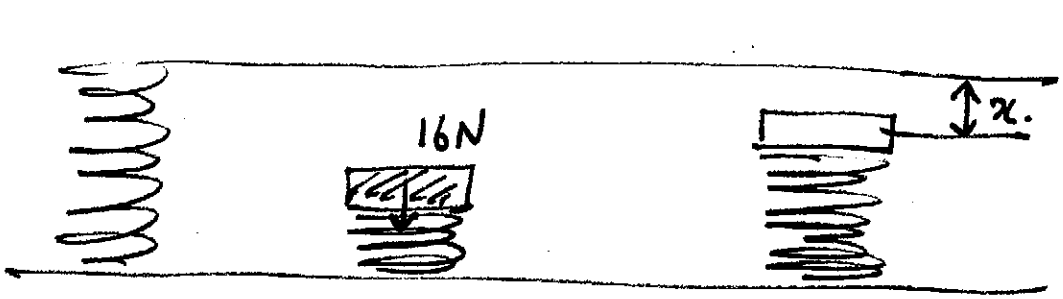
h = 0.2968 ft.

$\sin 30° = \frac{h}{d+0.21}$

$0.21 + d = \frac{h}{\sin 30°} = 0.59375$

d = 0.38.

(d) Like "3" Problem.



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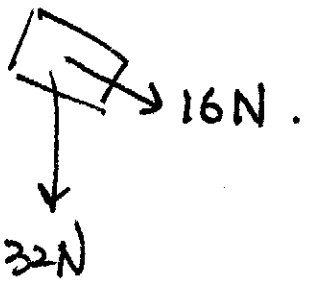
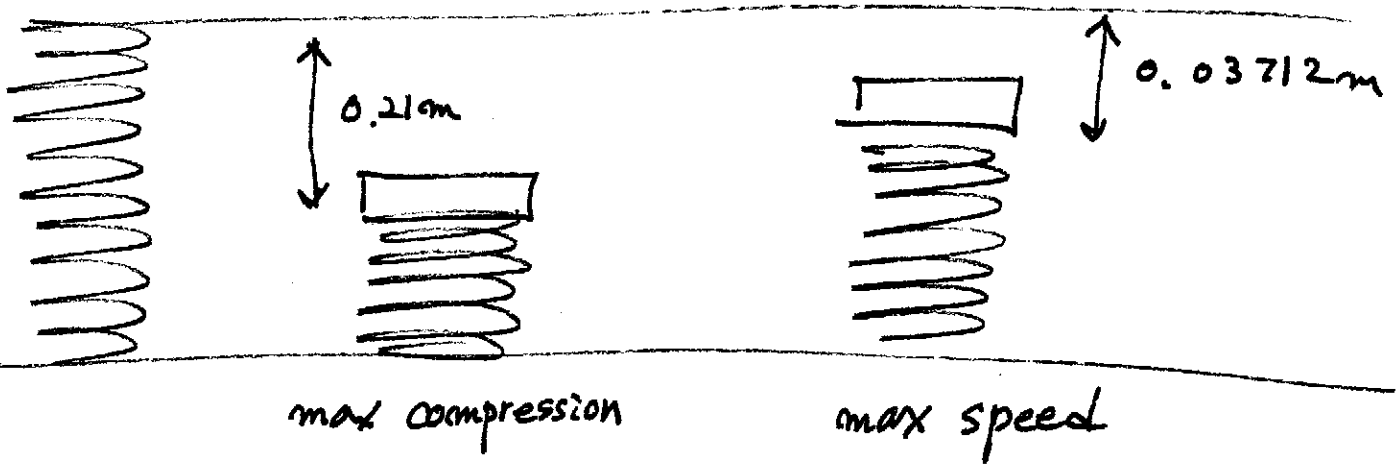
16N is the weight of the block.



max speed → equilibrium location.

$F = kx$

$16 = 431 \times x$ → $x = 0.03712\,m$



~~P.E. = 3.2×10×(0.21−0.03712) × sin30°~~

~~= 2.7661~~

~~P.E spring = $\frac{1}{2}$ × 431 × 0.03712²~~

~~= 0.29694~~

~~K.E. = $\frac{1}{2}$ × 3.2 × v²~~

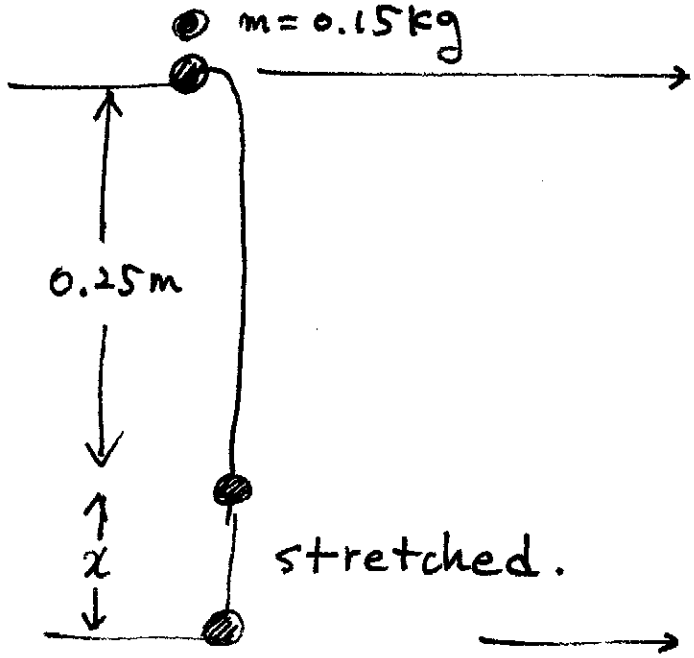
~~Total E = 3.063 + 1.60²~~

~~= 3.063 + 1.60²~~

7.

$F = kx$.

$0.15 \times 10 = K \cdot 0.05 \quad \rightarrow K = 30\ N/m$.



$P.E = mgh = 0.15 \times 10 \times (0.25 + x)$

$K.E. = 0$

$PE_{spring} = 0$.

$P.E. = 0$.

$K.E. = 0$

$KE_{spring} = \frac{1}{2} kx^2$

$= \frac{1}{2} \times 30 \times x^2 = 15x^2$.

$\therefore \quad 1.5(0.25 + x) = 15x^2$

$x = 0.21583\ m$.

$\therefore$ total distance $= 0.25 + 0.21583$

$= 0.46583\ m$