807 AP Physics C
Name: ____________________

Schmidt

U4H4

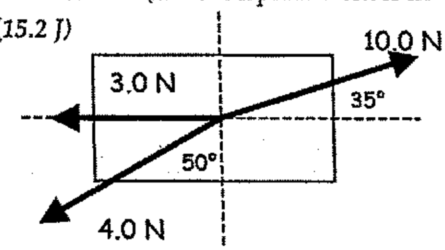
Chapter 11: Work & K.E

$$W = \vec{F}\cdot\Delta\vec{r}\,(Force\ constant);\quad W = \int \vec{F}\cdot d\vec{r}\ (Force\ not\ constant)$$

$$W_{net} = \Delta K.E(Work - Kinetic\ \ Energy\ \ principle)$$

1. To push a 50 kg crate across a floor, a worker applies a force of 200 N, directed 20· above the horizontal. The floor exerts a 175 N force of friction on the crate. As the crate moves 3.0 m, calculate the work done on the crate by (a) the worker, (b) the force of friction, (c) the force of gravity, and (d) the normal force of the floor on the crate. (e) Calculate the total work done on the crate.
   (564 J, -525 J, 0, 0, 39 J)

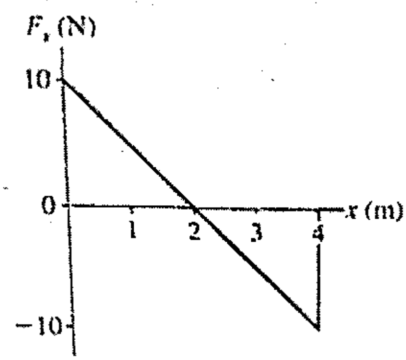
2. The fig. below shows on <u>overhead</u> view of three horizontal forces acting on a cargo canister that is initially at rest but which now moves under the action of these forces. What is the net work done on the canister by the three forces during the first 4 m of displacement? (Hint: Displacement is in the direction of F_{net}) *(15.2 J)*



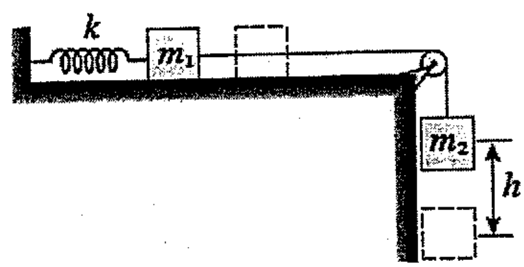
3. To push a 25.0kg crate up a frictionless incline, angled at 25° to the horizontal, a worker exerts a force of 209N, parallel to the incline. As the crate slides 1.50 m, how much work is done on the crate by (a) the worker's applied force, (b) the weight of the crate, (c) the normal force exerted by the incline on the crate? (d) What is the net work done on the crate?
   (313.5 J, -158.5 J, 0, 155 J)

4. A helicopter lifts a 72kg astronaut 15 m vertically from the ocean by means of a cable. The acceleration of the astronaut is 1 m/s^2. (a) What is the tension in the cable? How much work is done on the astronaut by (b) the cable and (c) her weight? What is the speed of the astronaut just before she reaches the helicopter? *(792 N, 11,880 J, -10,800 J, 5.48 m/s)*

10. A 2 kg particle moving along the x-axis experiences the force shown below. The particle's velocity is 4 m/s at x=0. What is it's velocity at x = 2m and x = 4m? (5.1 m/s, 4 m/s)



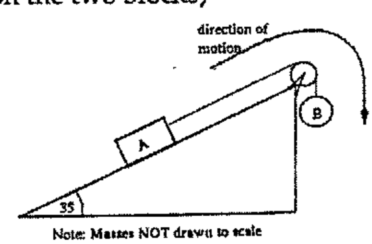
11. Two blocks are connected by a light string that passes over a frictionless pulley as in the figure. The block of mass 10 kg lies on a horizontal surface and is connected to a spring of force constant 270 N/m. The system is released from rest when the spring is unstretched. If the hanging 15 kg block falls a distance 0.8 m before coming to rest, calculate the coefficient of kinetic friction between the block m_1 and the surface. (0.42)



12. Given: $m_A = 10kg,\ m_B = 40kg,\ \mu = 0.60,\ \theta = 35^{\circ}$

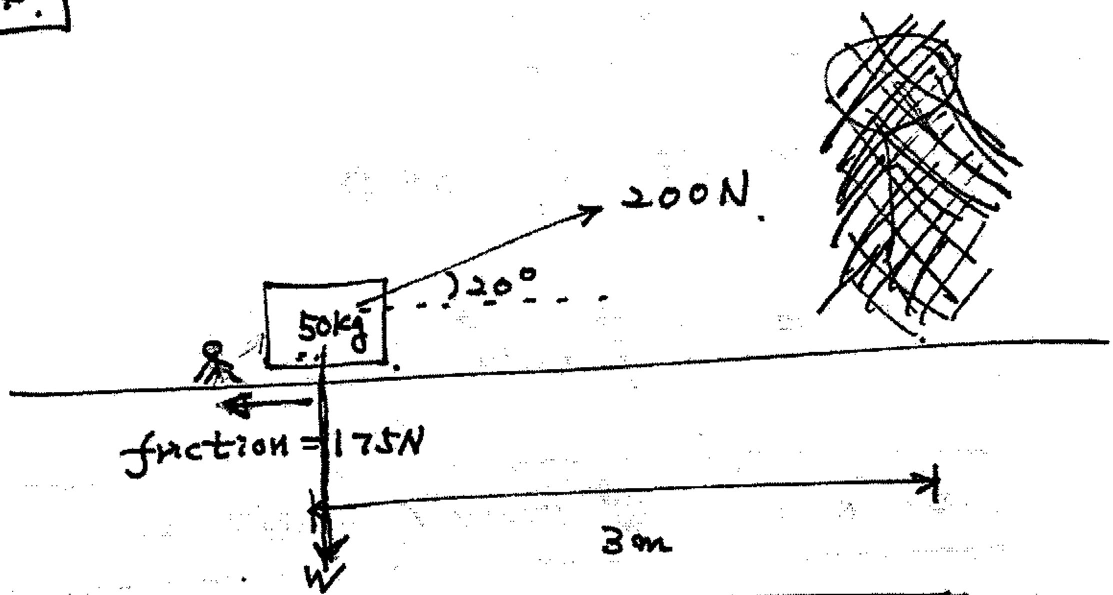
If this system starts at 1.0 m/s in the clockwise direction, what speed will the blocks have after moving 2.0m? (Hint: You will need to find the total work done on the two blocks)

(4.9 m/s)



U4H4.

1.



(a) **Work = Force × distance**

$200 \times \cos 20° \times 3$

$= 563.82\ J$

(b) $W_{friction} = -175 \times 3$

$= -525\ J$

(c) X

(d) X

(e) $563.82 - 525 = 38.82\ J$

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2.

$$\text{net } F_x = 10 \cdot \cos 35° - 3 - 4 \times \sin 50°$$
$$= 2.13 \text{ N}$$

$$\text{net } F_y = 10 \cdot \sin 35° - 4 \cdot \cos 50°.$$
$$= 3.16 \text{ N}$$

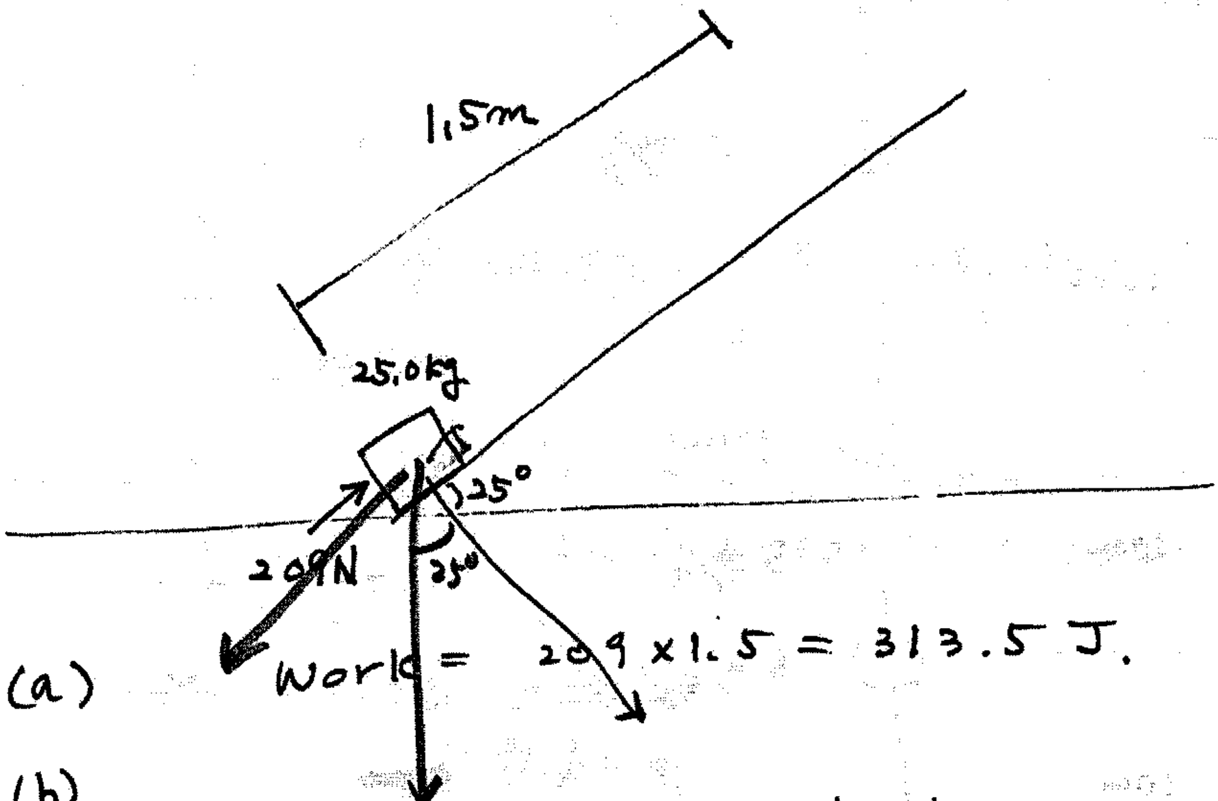
$$\therefore \text{net } F = \sqrt{2.13^2 + 3.16^2} = 3.81.$$

$\therefore$ Work = net Force x distance

$$= 3.81 \times 4$$

$$= 15.24 \text{ J}.$$

3.



(a) Work = 209 x 1.5 = 313.5 J.

(b). Weight = 25x10 = 250N

Work = − 250x sin 25° x 1.5

= − 158.5 J

(c). 0 X

(d). 313.5 − 158.5 = 155 J.

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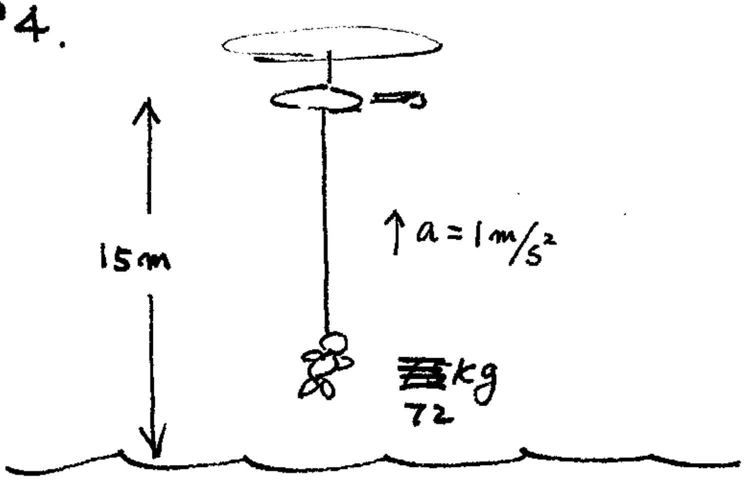
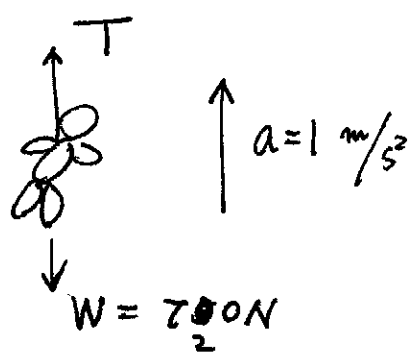
*4.



(a)



$F = ma.$

$T - 750 = 75 \times 1.$

$T = 72 + 720$

$= 792\,N$

(b). $W =$ Force x distance

$= 792 \times 15 = 11880\,J.$

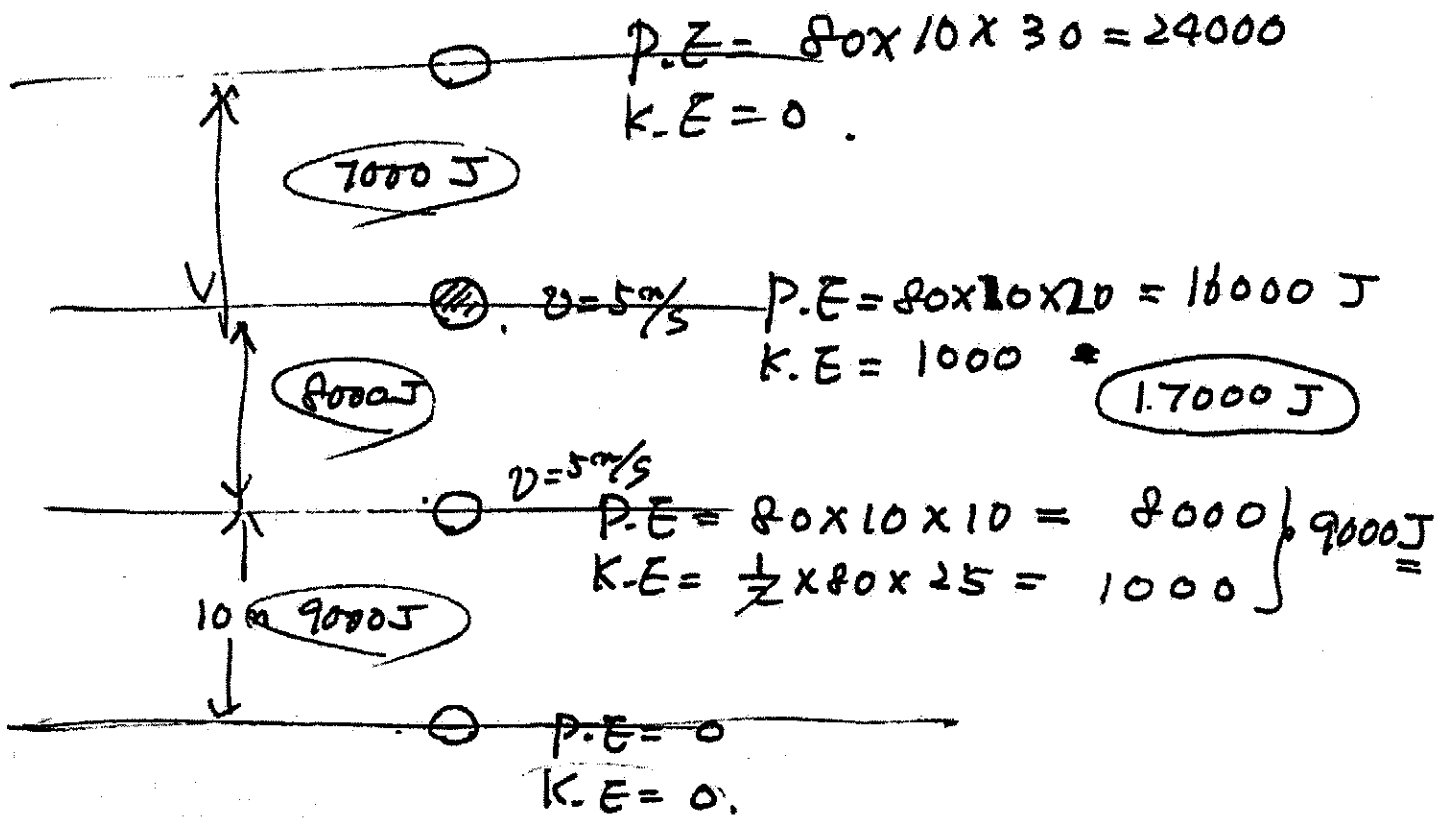
(c). $W = -720 \times 15 = -10800\,J$

(d). $v = v_0 + at$

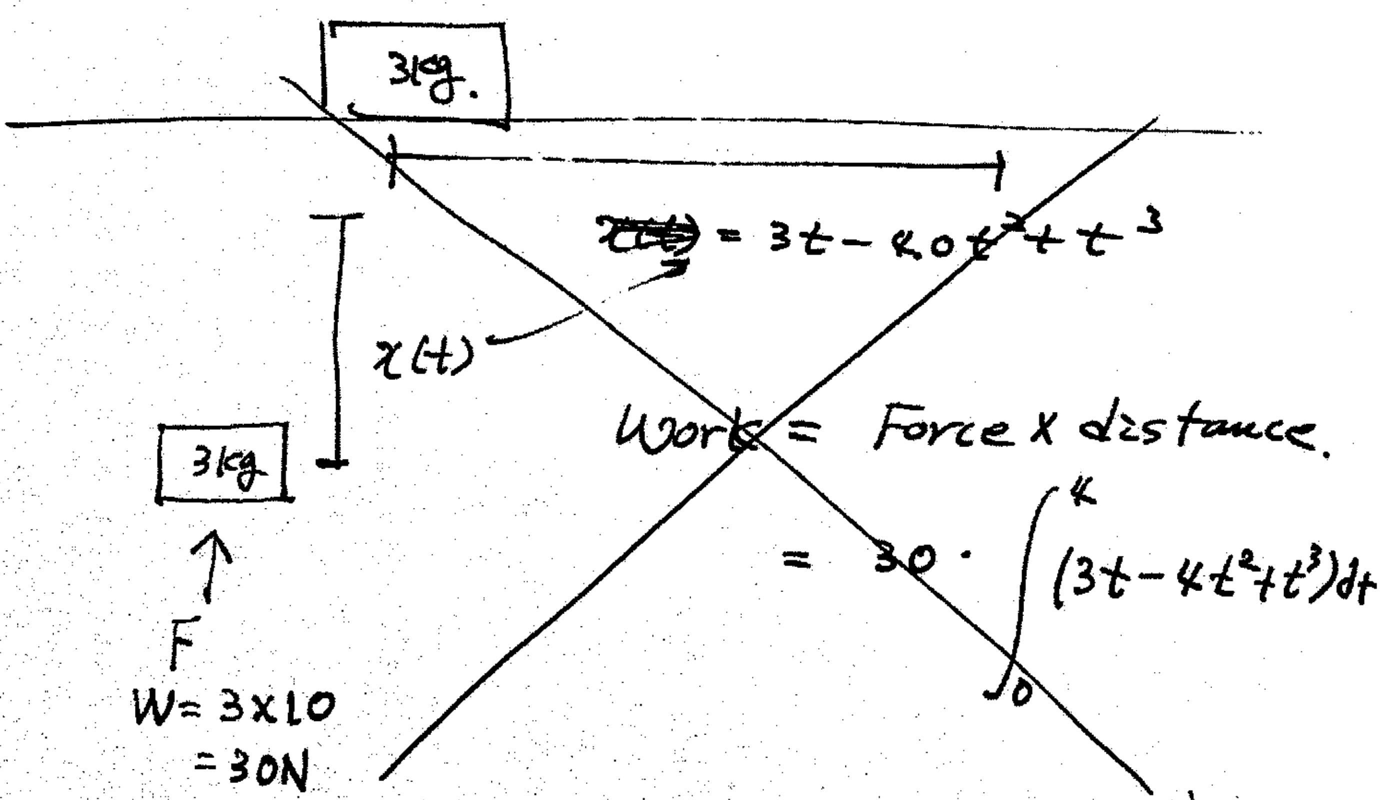
$2ax = v^2 - v_0^2$

$2 \times 1 \times 15 = v^2$ $\qquad v = \sqrt{30} = 5.48\ m/s$

5


P.E = 80 x 10 x 30 = 24000
K.E = 0.
7000 J
v = 5 m/s
P.E = 80 x 10 x 20 = 16000 J
K.E = 1000
17000 J
8000 J
v = 5 m/s
P.E = 80 x 10 x 10 = 8000
K.E = ½ x 80 x 25 = 1000
9000 J
10 m
9000 J
P.E = 0
K.E = 0.

7.


3kg.
= 3t − 4.0t² + t³
x(t)
3kg
F
W = 3 x 10
= 30N
Work = Force x distance.
= 30 · ∫₀⁴ (3t − 4t² + t³) dt

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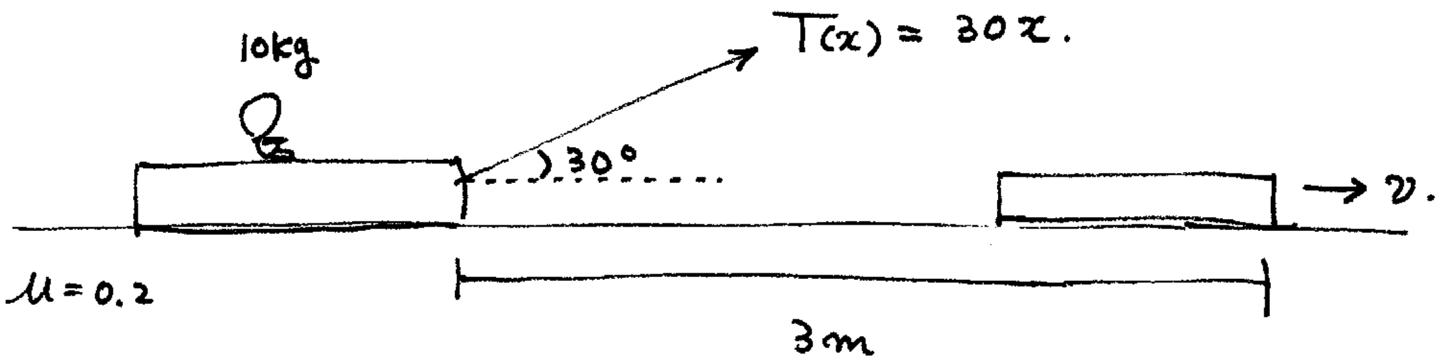
6.



$$\underset{\text{by force.}}{\text{Work}} = \int_0^3 30x \cdot \cos 30° \cdot dx.$$

$$= 30 \cdot \cos 30° \left[\frac{1}{2} x^2 \right]_0^3 = 15 \cos 30° \{9\}.$$

$$= 117 \text{ J}$$

$$\text{Work by friction} = -\mu \cdot N \cdot d$$

$$= 0.2 \times 100 \times -3 = -60 \text{ J}.$$

$$\therefore \text{Total work} = 117 - 60 = 57 \text{ J}.$$

$$\therefore 57 = \frac{1}{2} \times 10 \times v^2 \Rightarrow v = \sqrt{\frac{57}{5}} = 3.38 \text{ m/s}.$$

7.

$$\int^{4} 3\times 10 \times x(t) = 30\cdot\int_0^4 (3t - 4t^2 + t^3)\,dt$$

$$x(t) = 3.0t - 4t^2 + t^3$$

$$v(t) = 3 - 8t + 3t^2$$

$$v(0) = 3\ \text{m/s} \quad \rightarrow \quad K.E. = \frac{1}{2}\cdot 3\cdot 3^2 = \frac{27}{2}\ \text{J}$$

$$v(4) = 3 - 8\cdot 4 + 3\cdot 4^2 = 19\ \text{m/s} \rightarrow KE = \frac{1}{2}\cdot 3\cdot 19^2$$

$$= \frac{1083}{2}\ \text{J}$$

$$\therefore \quad \frac{1083}{2} - \frac{27}{2} = 528\ \text{J}.$$

9.

$$F_s = -10x + 100x^3$$

$$\text{Work} = \int_0^{0.1} F_s \cdot dx = \int_0^{0.1} (-10x + 100x^3)\,dx$$

$$= \left[-5x^2 + 25x^4\right]_0^{0.1}$$

$$= -0.0475\ \text{J}$$

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8. $F(x) = 2.1x^3 - 89.$

$$\text{Work} = \int_4^7 (2.1x^3 - 89)\,dx$$

$$= 859.13\ \text{J}.$$

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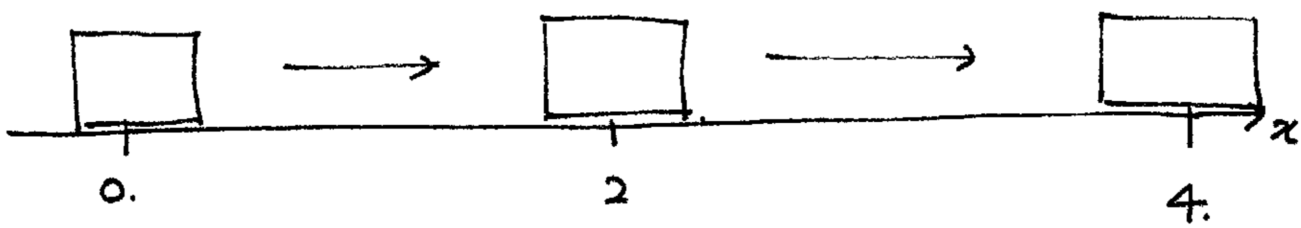
10. $v = 4$ m/s $x = 0$.

$v_2 = ?$ $x = 2$.

$v_4 = ?$ $x = 4$



$K.E. = \frac{1}{2} m \cdot 4^2$

$= 16J$

↕ add work (Energy)

F·x Area

$= \frac{1}{2} \times 10 \times 2$

$= 10J.$

$KE. = 26$

$= \frac{1}{2} \cdot 2 \cdot v_2^2$

$\therefore v_2 = \sqrt{26}$

$= 5.1$ m/s.

↑ add work

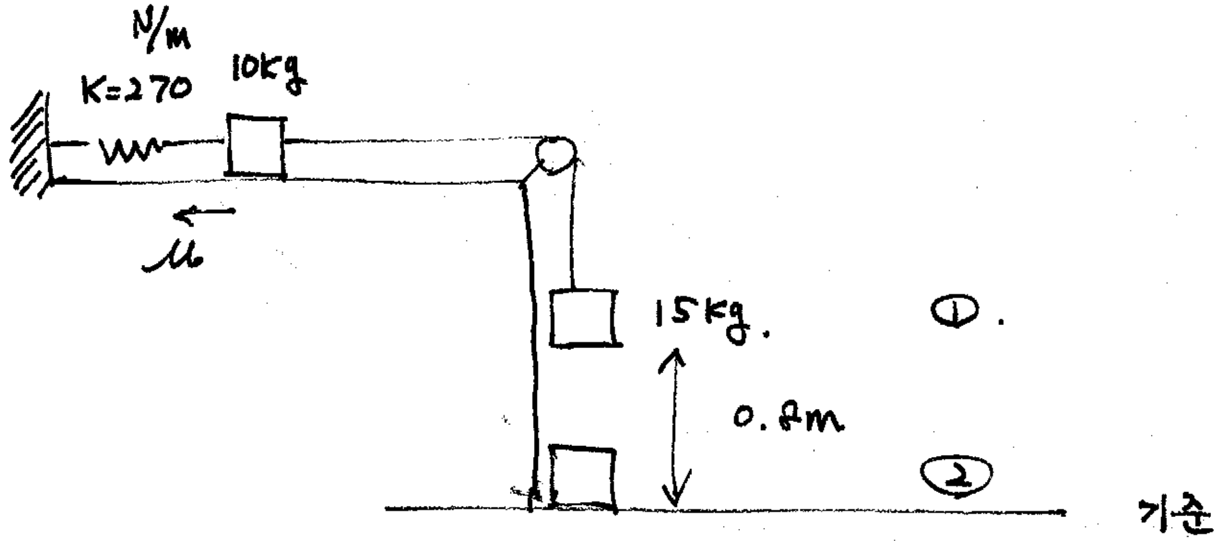
$= -\frac{1}{2} \cdot 10 \cdot 2$

$= -10J$

$KE = 16J$

$\therefore v_4 = 4$ m/s

11.



①. $P.E. = U_g = mgh = 15 \times 10 \times 0.8 = 120\ J.$

$K.E. = 0.$

$P.E._{spring} = 0$

Total Energy = 120 J.

② $P.E. = 0$

$K.E. = 0.$

$P.E._{spring} = \frac{1}{2} \times K \times x^2 = \frac{1}{2} \times 270 \times 0.8^2 = 86.4\ J.$

∴ Total Energy = 86.4 J.

the difference is. $(120 - 86.4 = 33.6\ J)$

lost by friction.

∴ $33.6 = \text{friction} \times 0.8 = \mu \cdot 100 \cdot 0.8$

∴ $\mu = \frac{33.6}{100 \cdot 0.8} = 0.42.$

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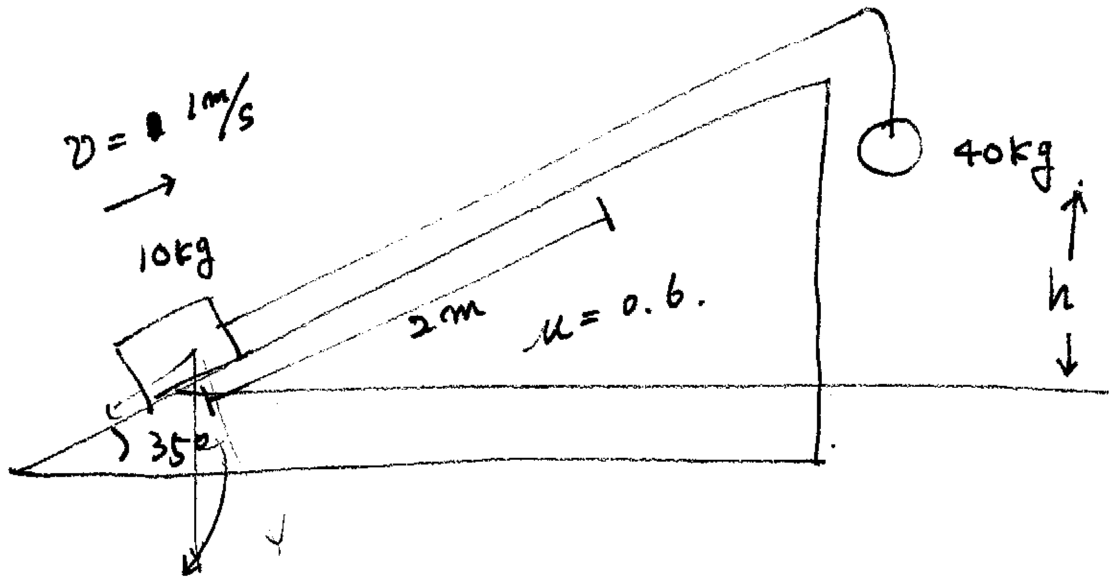
12.



before
$P.E = 0.$
$K.E = \frac{1}{2} \times 10 \times 1^2 = 5\ J.$
$P.E. = 40 \times 10 \times h = 400h\ J.$
} $5 + 400h.$

after
$P.E. = 10 \times 10 \times 2 \times \sin 35° = 114.7\ J$
$K.E. = \frac{1}{2} \times 10 \times v^2 = 5v^2$

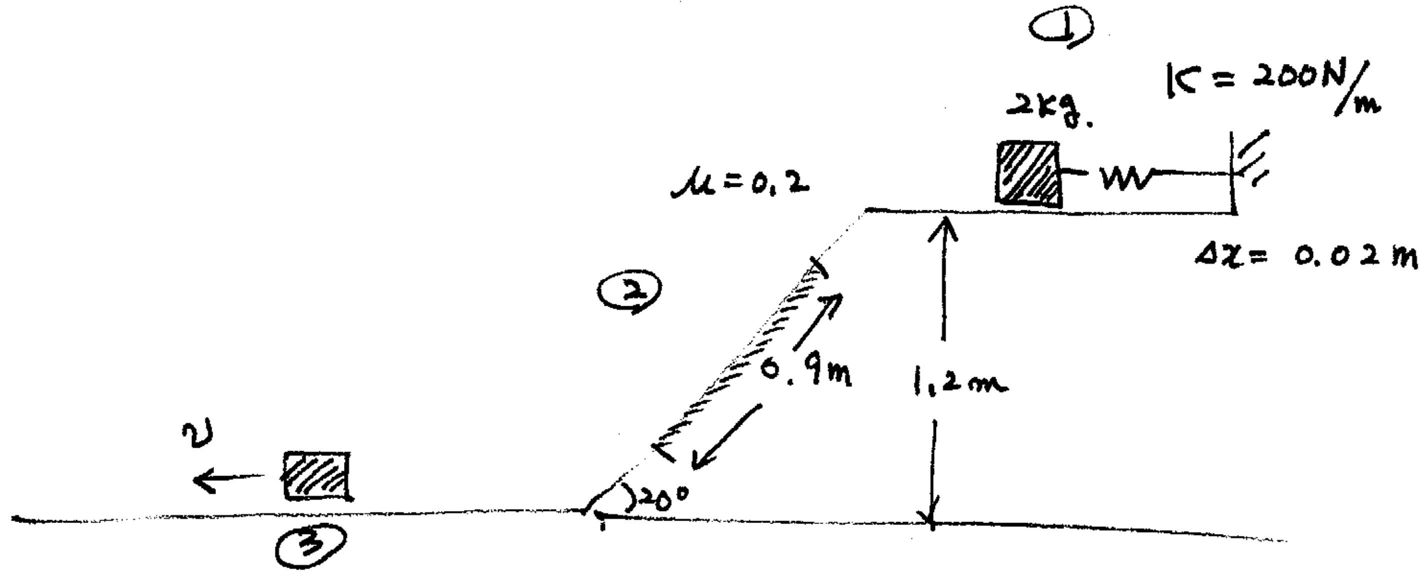
$P.E. = 40 \times 10 \times (h-2) = 400h - 800$
$K.E. = \frac{1}{2} \times 40 \times v^2 = 20v^2$
friction Work $= 100 \cos 35° \cdot 0.6 \cdot 2$
$= 98.3\ J$

$\therefore\ 5 + \cancel{400h} = 114.7 + 5v^2 + \cancel{400h} - 800 + 98.3 + 20v^2$

$25v^2 = 5 - 114.7 + 800 - 98.3 = 592$

$v = \sqrt{\frac{592}{25}} = 4.9\ m/s$

13.



① P.E. = mgh = 2×10×1.2 = 24 J.

P.E.spring = $\frac{1}{2} \times 200 \times 0.02^2 = 0.04$ J.

K.E. = 0.

Total Energy = 24.04 J.

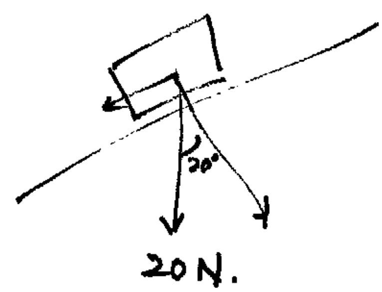
② friction work.

W = friction × distance.

= μ·N × 0.9

= 0.2×20×cos20°×0.9

= 3.3829 J.



③. P.E.=0 = PE.spring

KE = $\frac{1}{2}mv^2 = \frac{1}{2} \times 2 \times v^2 = v^2$.

Total Energy = v^2

∴ $v^2 + 3.3829 = 24.04$

$v = 4.55$ m/s

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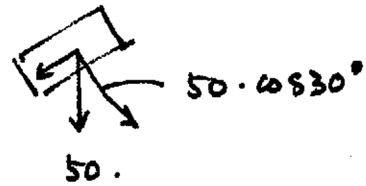
14. $m = 5\,kg$. $\theta = 30°$ $\mu = 0.3$ $d = 5m$

$K = 100\,N/m$.



(a). Point A

P.E. = ~~5 × 10 × 5 × sin30°~~ = ~~125~~.

$5 \times 10 \times (5+x)\sin 30° = 25(5+x)$.

Compressed Point

P.E. = 0.

K.E. = 0.

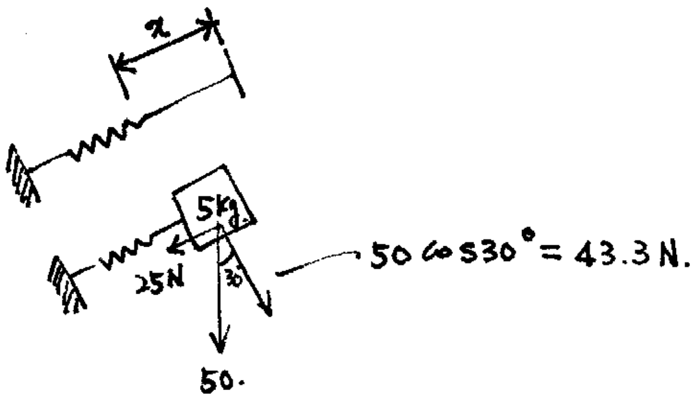
$P.E._{spring} = \frac{1}{2} \cdot 100 \cdot x^2 = 50x^2$

$Work_{friction} = 0.3 \times 50 \times \cos 30° \times (5+x) = 13(5+x)$

$\therefore \quad 25(5+x) = 50x^2 + 13(5+x)$

$\therefore x = 1.22\,m$

(b).



$F = Kx$.

$25 - 0.3 \times 43.3 = 100 \cdot x$.

$12.01 = 100x$.

$x = 0.12\,m$.

$P.E. = 5 \times 10 \times (1.22 - 0.12)\sin 30^\circ = 27.5$

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

$P.E._{spring} = \frac{1}{2} \times 100 \times 0.12^2 = 0.72$

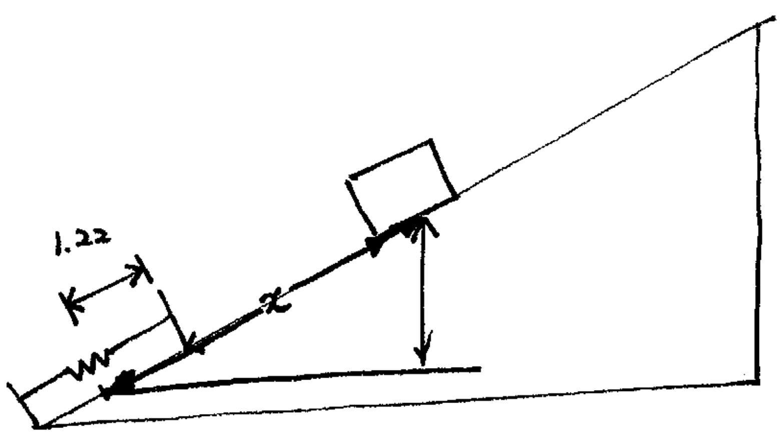
$Work_{friction} = 13(5 + 0.12) = 66.56.$

$\therefore \quad 27.5 + \frac{5}{2}v^2 + 0.72 + 66.56 = 25(5 + 1.22)$

$v = 4.93 \ m/s.$

(c).

$To.\ P.E. = 25(5+1.22) = 155.5$



$PE = 5 \times 10 \times (1.22 + x) \cdot \sin 30^\circ$

$= 25(1.22 + x)$

$KE = 0$

$PE_{spring} = 0$

$Work_{friction} = 13(5 + 1.22) + 13(1.22 + x)$

$= 96.72 + 13x$

$155.5 = 30.5 + 25x + 96.72 + 13x.$

$x = 0.74 \ m$