You can draw here

Physics 111 - Class 12A
Test 4 Reflection

Do not draw in/on this box!

November 22, 2021

You can draw here

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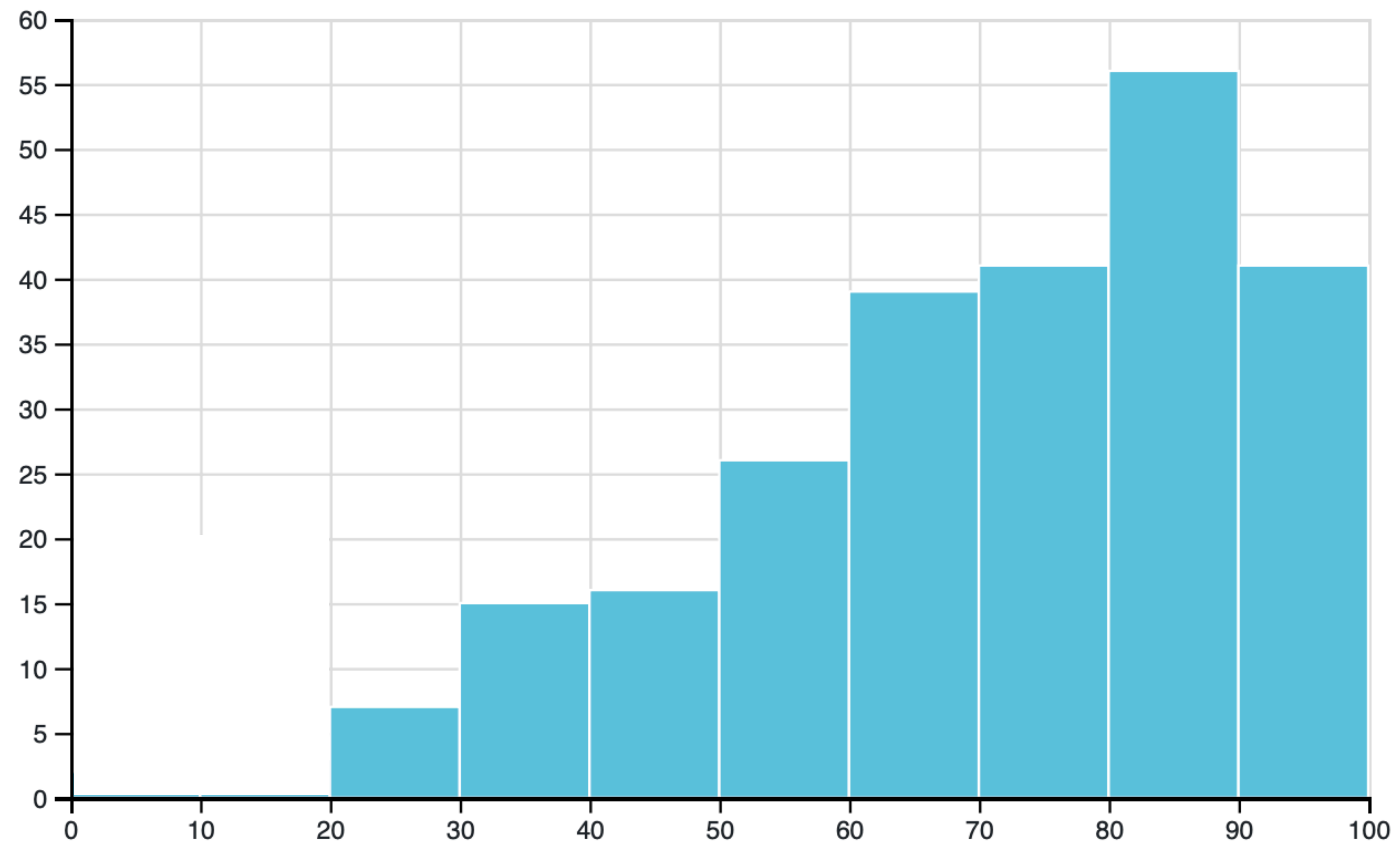
We interrupt the regularly scheduled programming with....

Test 4 Reflection

Tests and Bonus Tests 4-Bonus: Score statistics



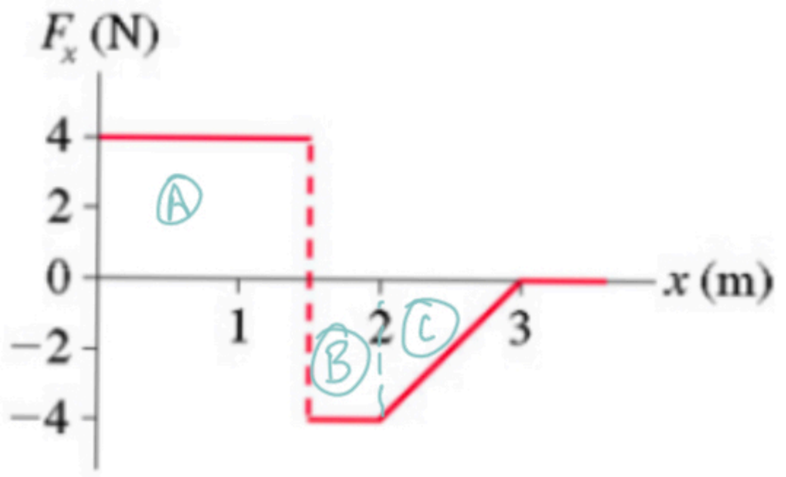
Number of students	246
Mean score	70%

- Bonus Test 4 was exactly the same length as Test 4
    - Time was not a factor
- A couple of key misconceptions…
- Test has been scaled for difficulty (percentage is accurate)

10.1. Force vs Position Graph	49%
13. Power of a Biker	46%
14. Cut The Rope	44%

Force vs Position Graph

The graph below shows the net force on a particle as a function of its position. The mass of the particle is $m = 1.5\ kg$.



First calculate areas:

Ⓐ: $1.5 m \cdot 4N = 6 J$

Ⓑ: $0.5 m \cdot -4N = -2 J$

Ⓒ: $\frac{1}{2}(1.0 m \cdot -4 N) = -2 J$

Part 1

What is the total work done on the particle?

$W =$ number (rtol=0.05, atol=1e-08) J

$W = A + B + C = 2 J$ → Area under curve.

Part 2

If the particle has a velocity of $v_x = 2\ m/s$ when $x = 0\ m$, what is the particle's velocity when $x = 0.5\ m$?

So, for me, $W_2 = 4N \cdot 0.5m = 2J$

$v_x =$ number (rtol=0.05, atol=1e-08) m/s 2.58 m/s

$W = \Delta KE = \frac{1}{2} m (v_f^2 - v_0^2)$

$v_f^2 = \frac{2 W_2}{m} + v_0^2$

$= \frac{2 \cdot 2}{m} + (2 m/s)^2$

$v_f = 2.58\ m/s$

Remember W depends on your x!

Part 3

At what value of x (in meters) does the particle have the maximum kinetic energy?

$x =$ number (rtol=0.05, atol=1e-08) m X = 1.5 m

Kinetic energy is max when x = 1.5 m (since KE is increasing until x = 1.5 m)

Part 4

What is the particle's maximum kinetic energy?

$K =$ number (rtol=0.05, atol=1e-08) J $K_E = 9 J$

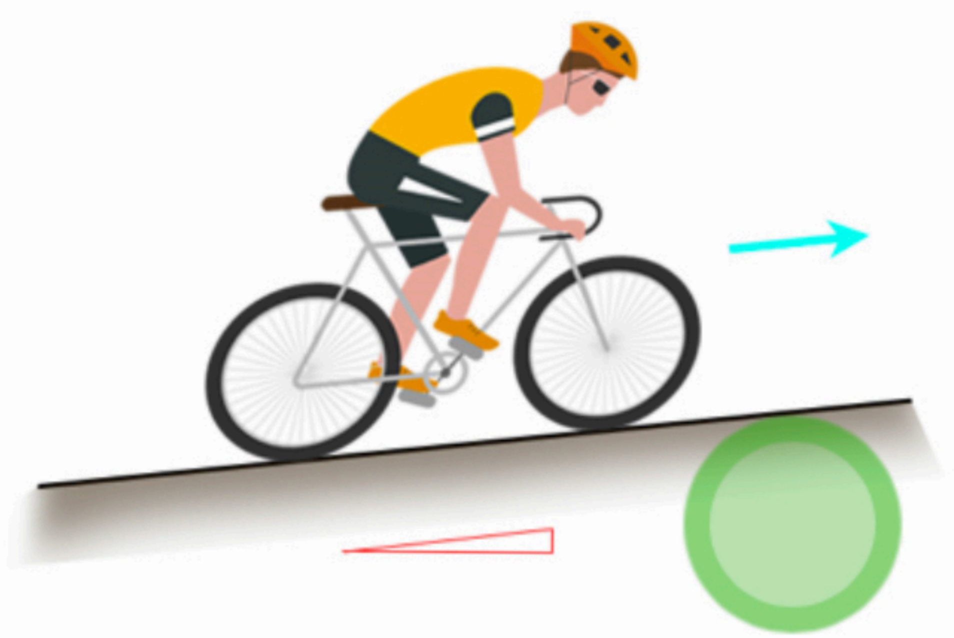
$K_{E\text{-}max} = W_A + \frac{1}{2} m v_0^2$

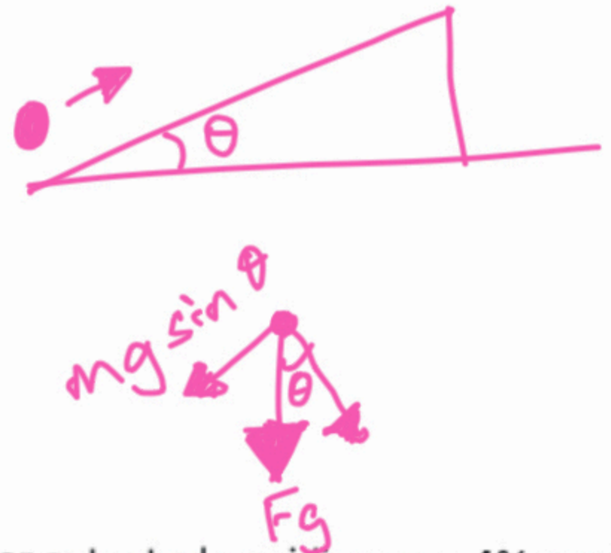
↑ max kinetic energy

$KE_{max} = 6 + \frac{1}{2} m \cdot (2 m/s)^2$

$KE_{max} = 9 J$

Power of a Biker

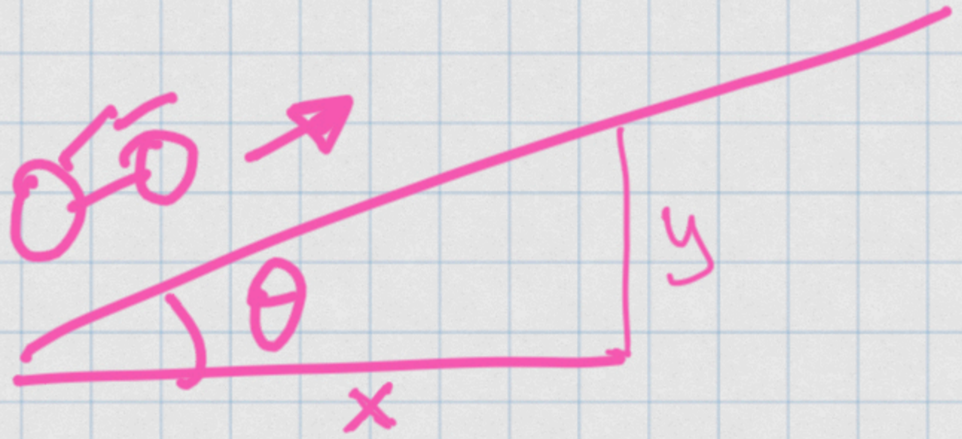




A biker and bicycle together weigh 95 kg. What power does the biker output when riding up a 4% grade at a speed of 11 km/hr?

$P =$ number (rtol=0.05, atol=1e-08) W

The "grade" of a hill can be converted to an angle using trig:



$\tan\theta = \frac{y}{x}$ → grade!

$\tan\theta = 0.04$

$\theta = \text{atan}(0.04)$

$v = 11\,\frac{km}{h} \times \frac{1\,h}{3600\,s} \times \frac{1000\,m}{1\,km} = 3.06\,m/s$

$\text{Power} = \vec{F} \cdot \vec{v}$

The force here is $\vec{F_g}$ in the vertical direction

$\text{Power} = (mg\sin\theta) \cdot \vec{v}$

$= mg\sin(\text{atan}(0.04)) \cdot v$

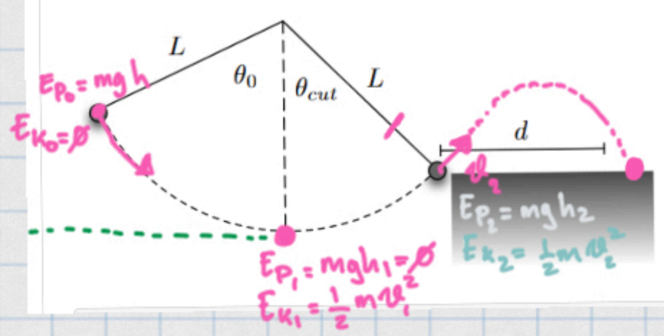
$= 113.86$

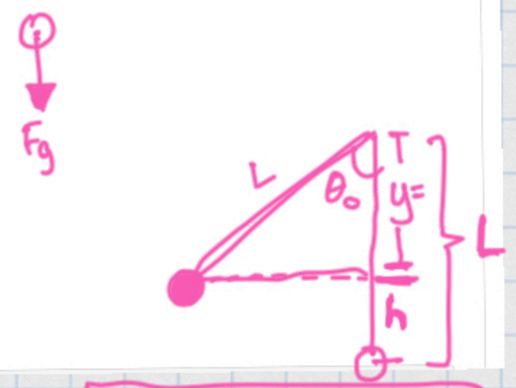
$P = 114\ W$

Cut The Rope

In the mobile app "Cut the Rope", a mass (of candy) swings on a rope and the game player selects a point to cut the rope so it lands in a cute little monster's mouth. Imagine that the mass is suspended from a fixed pivot point by a massless string of length $L = 0.9$ m. It is released from an angle $\theta_0 = 41^\circ$, swings through its lowest point, and is then cut on the other side at $\theta_{cut} = 13^\circ$. Once cut, the mass flies free (no drag) and lands on a surface a distance d away from the point where it was when the rope was cut. The surface is at the same height as the mass when the rope is cut.

The figure below shows the situation described above.





$h = L - L\cos\theta$

$\theta = 90^\circ$, $h = L$

$\theta = \emptyset$, $h = \emptyset$

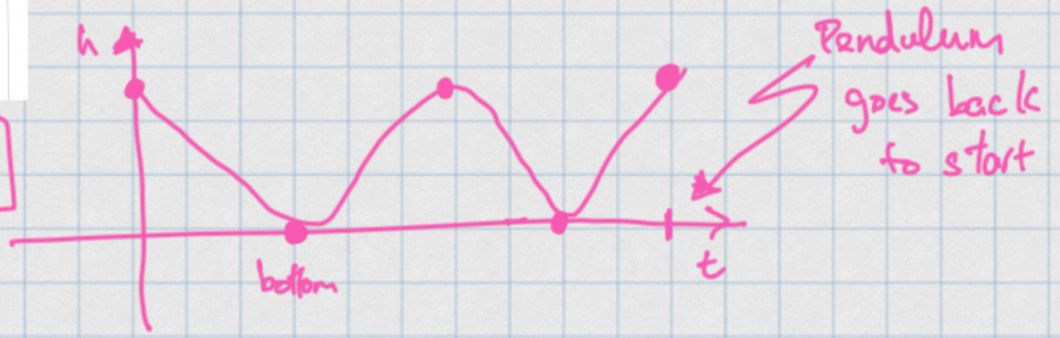
$\cos\theta = \frac{y}{L}$

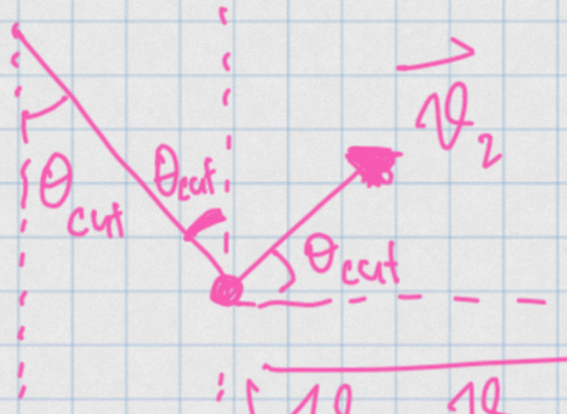
$y = L\cos\theta$

$h = L - L\cos\theta$ (max)

$h = 0$ (min)

$L\cos\theta + h = L$





$v_x = v_2 \cos\theta_{cut}$

a) By conservation of energy:

$E_{P_0} + E_{K_0} = E_{P_2} + E_{K_2} = E_{P_1} + E_{K_1}$

$mgh_0 = mgh_2 + \frac{1}{2}mv_2^2$

$v_2^2 = 2(gh_0 - gh_2)$

$= 2g[h_0 - h_2]$ $h_0: \theta = \theta_0$, $h_2: \theta = \theta_{cut}$

$= 2g[(L - L\cos\theta_0) - (L - L\cos\theta_{cut})]$

$= 2gL[(1-\cos\theta_0) - (1-\cos\theta_{cut})]$

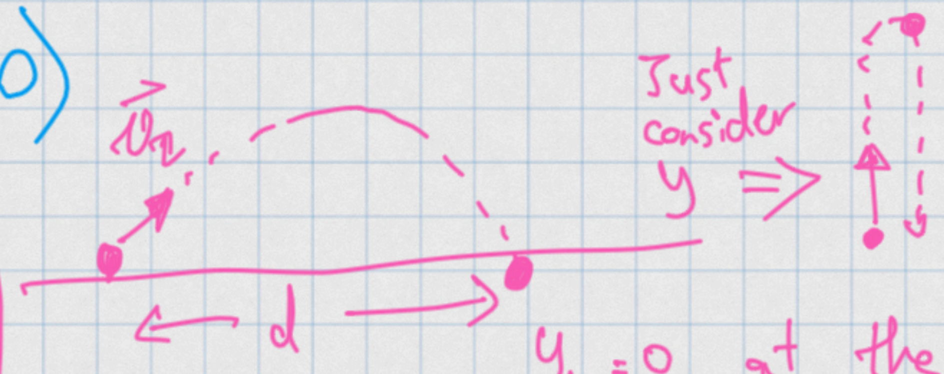
$= 2gL[-\cos\theta_0 - -\cos\theta_{cut}]$

$v_2 = \sqrt{2gL(\cos\theta_{cut} - \cos\theta_0)}$

In class I had an extra negative sign here! Sorry!

$v_2 = 1.24$ m/s

b)



$y_h = 0$ at the top

$y_h = v_y \Delta t - \frac{1}{2}g\Delta t^2$

$0 = v_y - \frac{1}{2}g\Delta t$

$\Delta t = \frac{2v_y}{g}$

Alternate Way

$v_f^2 = v_y^2 - 2gy_h$

$v_y^2 = 2gy_h$

$y_h = \frac{v_y^2}{2g}$

how long does it take for candy to fall a distance y_h?

$y_h = v_y \Delta t + \frac{1}{2}g\Delta t^2$

$\frac{v_y^2}{2g} = \frac{1}{2}g\Delta t^2$

$\Delta t^2 = \frac{2v_y^2}{2g^2} = \frac{v_y^2}{g^2}$

$\Delta t = \frac{v_y}{g}$

Don't forget to multiply by 2 since we assumed $v_0 = 0$

c) $d = (v_x) \cdot \Delta t$

See you next class!