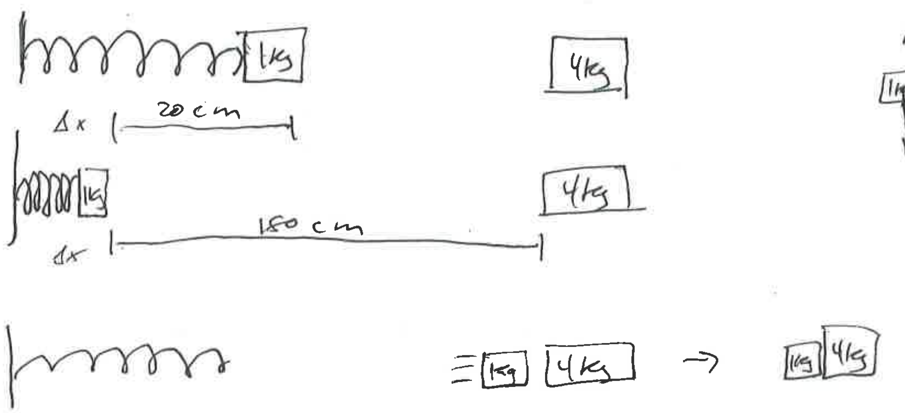
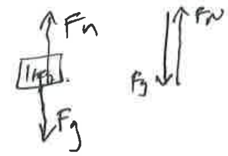
Graded on ***COMMUNICATION*** of physics

Graded on ***COMMUNICATION*** of physics

A+

1) Two blocks: 1 kg and 4 kg, have a coefficient of friction, $\mu = 0.2$ with the floor. A spring ($K = 500$ N/m) rests on the floor with one end connected to a wall. I press the 1 kg block against the free end of the spring, compressing the spring 20 cm against the wall. Then I let it go! The 1 kg block skids 180 cm (including the 20 cm being pushed by the spring) across the floor. Then it hits and sticks to the 4 kg block. How fast are the blocks moving immediately after the collision? *You are **not** going to solve this problem* to find a numerical answer. Instead, please set up the problem and explain your strategy with complete sentences. Establish the equations and explain how you will find each term, but don't solve the equations or substitute in any numbers.





$\Sigma F = ma = 0$

$F_g - F_N = 0$

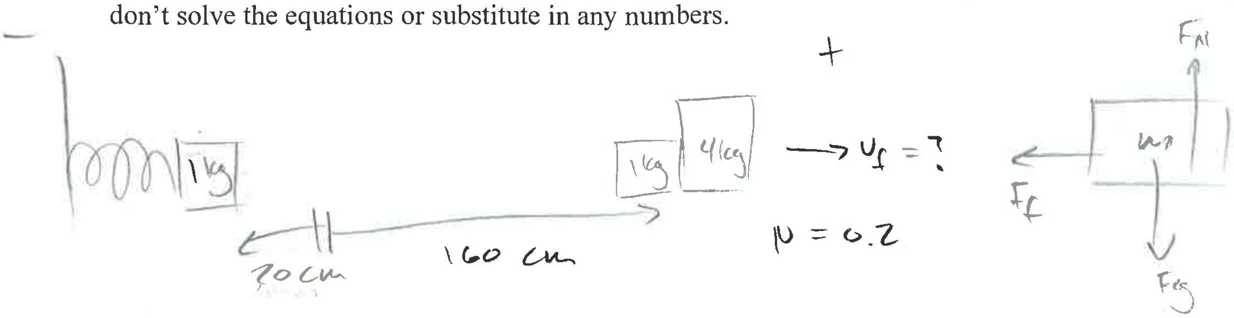
$F_g = F_N = mg$

A+

This problem will start with an energy lense. This is because the ~~spring~~ compressed spring has potential energy that gets transferred to kinetic energy in the box. To find that KE, use $W_s = \frac{1}{2}kx^2$ for the work the spring does and set it equal to KE, which is $\frac{1}{2}mv^2$. So, $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$. Then we will switch to a dynamics lens, because the force of friction is slowing down the box. We can calculate the normal force on the box by noting that $F_N = F_g = mg$, as stated above. We can plug this in to $F_f = \mu F_N$ to get the force of friction. We will switch to an energy lens now, because this force can be used to find work done on the box. $W = F \cdot d$, and this work, in Joules, will be subtracted from the boxes initial KE to find KE at the moment of impact. We can solve for velocity using $KE = \frac{1}{2}mv^2$. Finally, we switch to a momentum lense because there is a collision, and we know enough to solve for final velocity with $m_1v_1 + m_2v_2 = (m_1 + m_2)v_f$.

Graded on **COMMUNICATION** of physics 1/2 No calculator! B+

1) Two blocks: 1 kg and 4 kg, have a coefficient of friction, $\mu = 0.2$ with the floor. A spring ($K = 500$ N/m) rests on the floor with one end connected to a wall. I press the 1 kg block against the free end of the spring, compressing the spring 20 cm against the wall. Then I let it go! The 1 kg block skids 180 cm (including the 20 cm being pushed by the spring) across the floor. Then it hits and sticks to the 4 kg block. How fast are the blocks moving immediately after the collision? *You are **not** going to solve this problem* to find a numerical answer. Instead, please set up the problem and explain your strategy with complete sentences. Establish the equations and explain how you will find each term, but don't solve the equations or substitute in any numbers.



Nice!

Uses: Energy, Momentum and Dynamics.

Initially, all the system's energy is in the spring. We can know how much since $PE_s = \frac{1}{2} k \Delta x^2$. This energy is converted to kinetic energy when the spring is released, and since there is friction, energy is lost to heat. Friction applies a deceleration to the 1 kg box, which lowers the kinetic energy.

A

$$PE_s \Rightarrow KE_B + \text{Heat} = KE_{Box} - \text{work}_{friction}$$

The kinetic energy of the ball is easy to find once we know how much heat is lost through friction over the 180 cm. ($\text{work}_f = \Delta E = \vec{F_f} \cdot \vec{\Delta x} = \mu F_N \cdot \vec{\Delta x}$). $=?$

The collision is inelastic and doesn't conserve KE, but conserves momentum. We can find the smaller box's momentum through

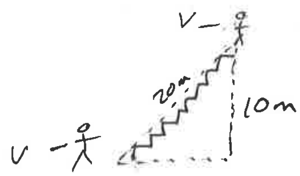
$P_{Box} = (2m\, KE_{Box})^{1/2}$. Momentum is conserved, so

$$m_{box} v_{f,Box} = P_{Box} = P_{system} = m_{system} v_{system}$$

$$v_{system} = \frac{P_{box}}{m_T} = \text{speed after collision.}$$

4) I run up some stairs at constant speed. My mass is 70 kg and I run a distance of 20 m, increasing my elevation only 10 m. It takes me 5 s. What is my rate of power production?

a) I stated "constant speed". How does this change the problem from if I'd started from rest?
b) Find my power output please! Remember to reflect on whether this makes sense.

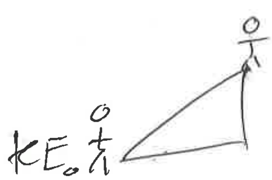


a) From an energy lens, due to the fact that I will have different kinetic energies depending on ~~where~~ at what velocity I start, I will need to exert greater energy if I start at rest because my change in energy will be much greater than if I run at constant velocity, where my KE will be the same.

A

b) I need an energy lense, as I will be trying to find power, and will be able to find work done using change in energy. ~~over distance travelled~~ ~~forces~~

$KE_0 + PE$ $W = \Delta E = PE = mgh = (70kg)(10 m/s^2)(10m) = 7000J$



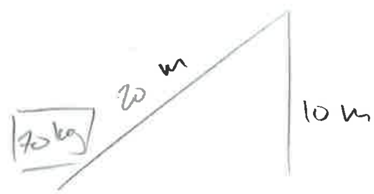
$$P = \frac{\Delta E}{t} = \frac{7000J}{5s} = \boxed{1400 \text{ watts}}$$

1400
5)7000
-5
20

$$\frac{1400 \text{ watts}}{} \Big| \frac{1 \text{ Hp}}{746 \text{ watts}} \approx 1.9 \text{ Hp}$$

This is a lot of power for a person to do — its almost the same amount two horses combined would exert, so this seems unreasonable. This would be like running up ~~3~~ 2 stories in 5 seconds, which seems way too fast.

2) I run up some stairs at constant speed. My mass is 70 kg and I run a distance of 20 m, increa elevation only 10 m. It takes me 5 s. What is my rate of power production?
   a) I stated "constant speed". How does this change the problem from if I'd started from
   b) Find my power output please! Remember to reflect on whether this makes sense.



Lens: Energy.

Power is change in energy over change in time and energy is converted and conserved

yes!

Since we have constant speed, $KE_0 = KE_f$, so the only ΔE is in PE. KE doesn't change

$$\text{Power} = \frac{(70\,kg \cdot 10\,m/s^2 \cdot 10\,m) - (70\,kg \cdot 10\,m/s^2 \cdot 0\,m)}{5\,s} = \frac{\cancel{7000}\,J - 0\,J}{5\,s}$$

$$\boxed{P = 1400 \text{ watts}}$$

A

a) Lens: Energy.

If you started from rest, you would have $KE_0 = 0$ and $PE_0 = 0$, so both KE and PE would change as you went up the stairs. With a constant speed, KE stays the same:

$$E_{total} = KE_i + \cancel{PE}^{0} \Rightarrow KE + PE_f$$

$$E_T = KE = KE + PE_f$$

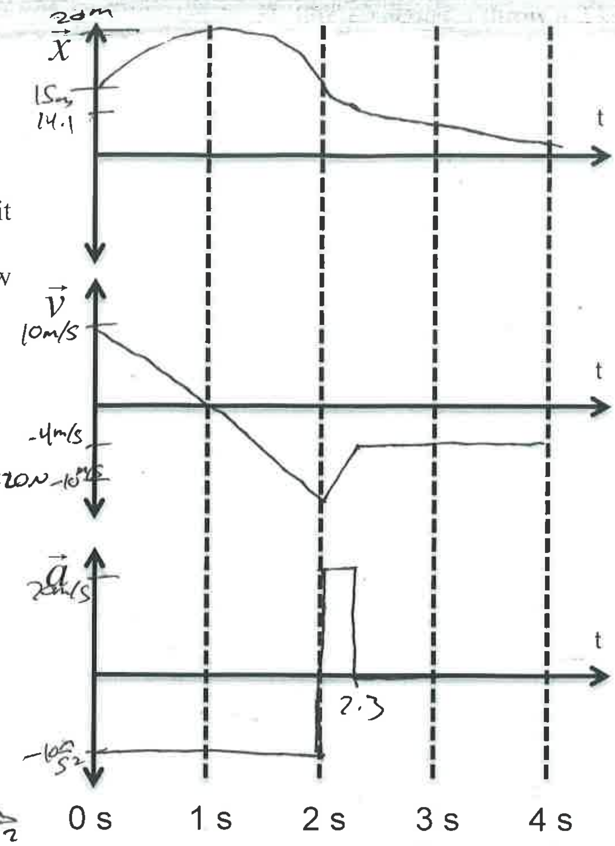
$$E_T = PE_f$$

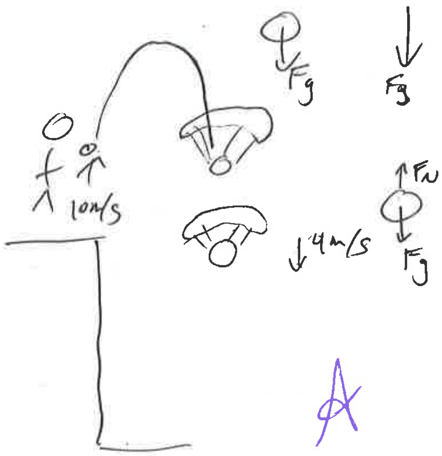
If you started from rest you would have put out more power because both KE and PE would have increased.

b.) $P_{avg} = 1.4$ kWatts (see top of page)

seems like a reasonable amount of power (About 2 Horse power).

3) Off a balcony, I throw a 2 kg rock directly upwards. At t = 0s, the rock leaves my hand at 15 m elevation, with upward velocity 10 m/s. It lands on the ground (elevation = 0), but when its velocity is 10 m/s *downward*, a parachute opens. In 0.3 s, the rock evenly slows to 4 m/s and subsequently continues downward at 4 m/s until it hits the ground. Please graph the velocity, displacement, and acceleration from when I throw the rock until 4 seconds afterwards. If possible, estimate when the rock hits the ground or its elevation at 4s.





$\Sigma F = ma$

$F_g = mg$

$= 2kg(10\frac{m}{s^2}) = 20N$

$\cancel{\Sigma F = ma}$

$F_g - F_N = ma$

$mg - ma_1 = ma_2$

$g - a_1 = a_2$

$g - a_2 = a_1$

$\cancel{10\frac{m}{s^2} - 4\frac{m}{s^2} = 6\frac{m}{s^2}}$

The first lens we use is kinematics because there is change in position as well as change in time. ~~Dynamics is also used because there is a change in~~

$v = v_0 + at$

$0\frac{m}{s} = 10\frac{m}{s} - 10\frac{m}{s^2}t$

$10\frac{m}{s^2}t = 10\frac{m}{s}$

$t = 1s$

@ max lenght

accel: $a = \frac{\Delta v}{\Delta t}$

$a = \frac{-4m/s - (-10m/s)}{2.3 - 2.0}$

$a = \frac{6m/s}{.3s}$

$a = 20m/s^2$

$\int_0^1 v\,dt = \frac{1}{2}(10\frac{m}{s})(1s)$

$= 5m$

$15m + 5m = 20$

$\int_2^{2.3} v\,dt = \frac{1}{2}(6)(.3)$

$= .9$

$(-4m/s)t + 14.1m = 0$

$14.1m = 4m/s\ t$

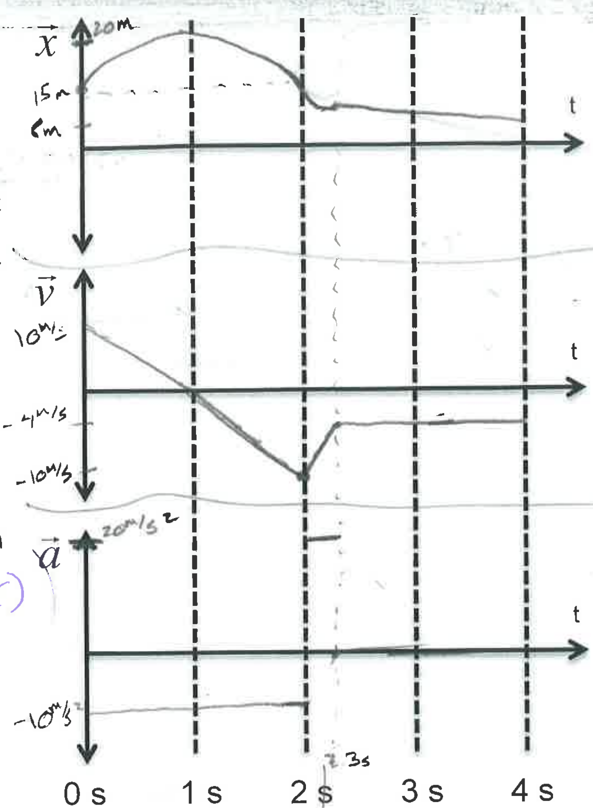
$3.525s = t$

$4\overline{)14.10}$ = 3.525

t hit the ground:

$3.525s + 2.3 = 5.825s$

5) Off a balcony, I throw a 2 kg rock directly upwards. At t = 0s, the rock leaves my hand at 15 m elevation, with upward velocity 10 m/s. It lands on the ground (elevation = 0), but when its velocity is 10 m/s *downward*, a parachute opens. In 0.3 s, the rock evenly slows to 4 m/s and subsequently continues downward at 4 m/s until it hits the ground. Please graph the velocity, displacement, and acceleration from when I throw the rock until 4 seconds afterwards. If possible, estimate when the rock hits the ground or its elevation at 4s.



Kinematics

Strictly V, a, Δx with ~~respect~~ to time (f(t))

$x'' = v' = a$

$a = \frac{\Delta v}{\Delta t} = \frac{-4 - (-10)}{.3}$

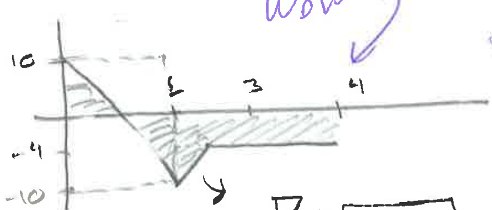
$= \frac{6}{.3} = 20\,m/s^2$

$= 20\,m/s^2$

$\int V = X \Rightarrow$ can calculate total displacement as area under the curve of the velocity graph

A

Wow



explain & ?

First 2 sec → no change in $\vec{a}$

Seconds

ok

$\triangle + \square = \left(\frac{-6 \cdot .3}{2}\right) + (2)(-4) \approx -1 + -6 = -7\,m$

looses 7m in next 2 sec

∴ It's elevation at 4s = $\boxed{8m}$

4) In the previous question, the parachute is connected to the rock with a single string.

a) When is the string under the greatest tension? Why do you know?

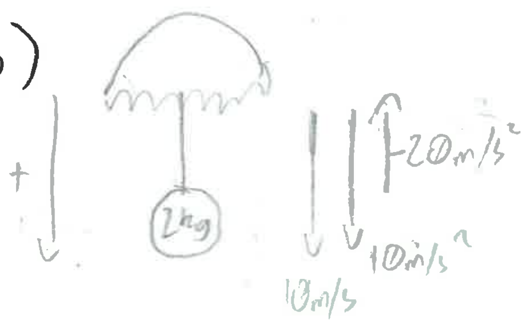
b) Please find the maximum tension that the string must sustain clearly supporting your reasoning.

a) The string is under greatest tension when the parachute opens. At this moment, the parachute is catching air to slow down the rock, which is still going pretty fast. The chute catches air, "pulling" the rock upwards & the rock is still going downwards. At this moment is the maximum force, or tension, on the string.

what's that mean in kinematics

nice

b)



$$\frac{10-4\,m/s}{.3} = a$$

$$\frac{6}{.3} = a$$

$$a = 20\,m/s^2$$

Force, $\sum \vec{F} = m\vec{a}$, there is force (tension) on the string

$$F_T = F_R + F_P$$

$$F_T = (2kg)(10m/s^2) + (2kg)(20m/s^2)$$

$$F_T = 20N + 40N$$

$$\boxed{F_T = 60N}$$

Super!

A+