Problem Set #2

① Yes, the rocket must have a fairly large acceleration at takeoff
A because it goes from 0 velocity to more velocity. $a = \frac{\Delta v}{\Delta t}$. After it takes off it will begin to decelerate due to the force of gravity ⇒ only force acting on it. After take-off, its acceleration should be more than g, because it continues to move upward for some time. v can be up while a is down. (A typical person can handle about $49\frac{m}{s^2}$, so this is a lot of acceleration!)

takeoff acceleration $= \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i} = \frac{65\frac{m}{s} - 0\frac{m}{s}}{\frac{1}{10}s - 0s} = \frac{65\frac{m}{s}}{\frac{1}{10}s} = 650\,m/s^2$ ← much greater than g

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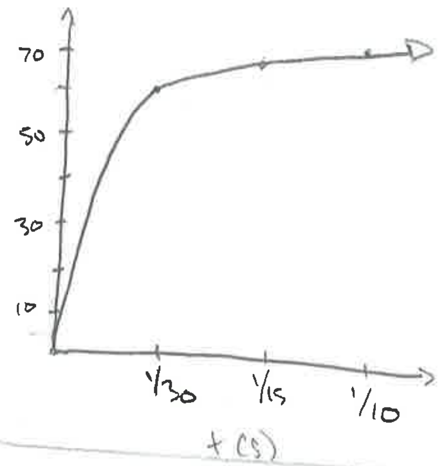
② a. Kinematics: $a = \frac{\Delta v}{\Delta t} = \frac{1\frac{m}{s} - 0\frac{m}{s}}{5s} = \frac{1}{5}\frac{m}{s^2}$

A b. Dynamics: $F = ma = (1000kg)(\frac{1}{5}\frac{m}{s^2})$
$= 200\,\frac{kg\,m}{s} = N$

c. Dynamics. $F_g = mg = (55kg)(-10\frac{m}{s^2}) = 550N$
force on car is less than force of gravity on your body.



d. Yes, since it'd be pushing very slowly

* A Newton is $= \frac{kg\,m}{s}$

e. Energy $P = \frac{\Delta E}{\Delta t} = \frac{KE_f}{5s} = \frac{\frac{1}{2}mv^2}{5s} = \frac{\frac{1}{2}(55kg)(\frac{1}{5}\frac{m}{s})}{5s} = 1.1\,W$

③ This tells us that conservation of only kinetic energy doesn't exist always
A due to thermal energy often produced, however, total energy (incl. kinetic and thermal) will be conserved.

④ Cart A   A   Cart B

$KE = \frac{1}{2}mv^2$ $KE = \frac{1}{2}m_b v_b^2$

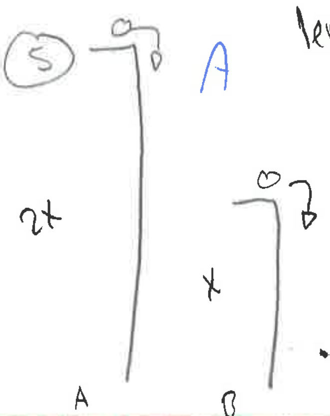
$KE = \frac{1}{2}(2m_b)(3v_b)^2$

$KE = \frac{1}{2}(18)mv^2$

$\boxed{E_{KA} = 18\,E_{KB}}$

We don't use ½ because both have it.

⑤ A



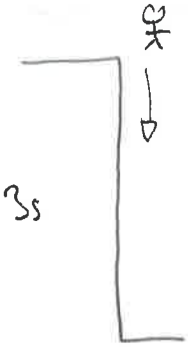
lens: Energy is conserved

A: $\frac{1}{2}mv_f^2 = mgh$
$\frac{1}{2}v_f^2 = (10\frac{m}{s^2})(2)$ $v_f = \sqrt{40}\,\frac{m}{s}$
$v_f \approx 6.3\frac{m}{s}$

B: $\frac{1}{2}mv_f^2 = mgh$
$\frac{1}{2}v_f^2 = (10)(1)$ $\boxed{v_{fA} = \sqrt{2}\,v_{fB}}$
$v_f = \sqrt{20} \approx 4.5\,m/s$

(6)

$t = 3s$



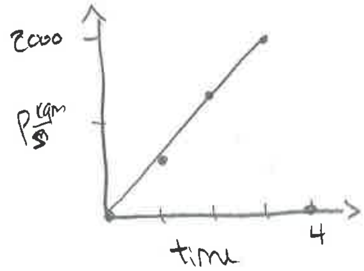
a. <u>momentum</u>

$\Delta P = m \Delta V$

$\Delta P = (65kg)(30\frac{m}{s})$

$\Delta P = 1950 \frac{kgm}{s}$

This change occurs because P is exchanged w/ Earth



Yes, momentum is always conserved within this system which includes earth and him.

b. <u>Energy</u> : Energy transitions from GPE to KE and then to thermal at the collision.

$E_i = GPE = mgh = (65kg)(10\frac{m}{s^2})(90m) = 58,500 J$

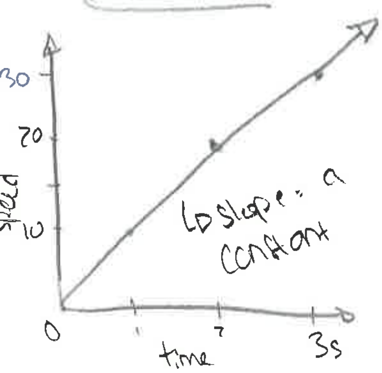
$E_f = E_{th} = GPE - KE = 29,250 J$

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(65kg)(30\frac{m}{s})^2 = 29,250 J$

Yes, energy was conserved, because $E_i(GPE) = E_f(KE + E_{th})$

c. <u>Forces</u> : The only force acting on him is the force of gravity. The force of gravity is between the earth on him. Both have equal and opposite momentums. $m_1v_1 = m_2v_2$. Since the mass of earth is so massive, it has almost no v but he has a small mass and therefore a large velocity towards earth.

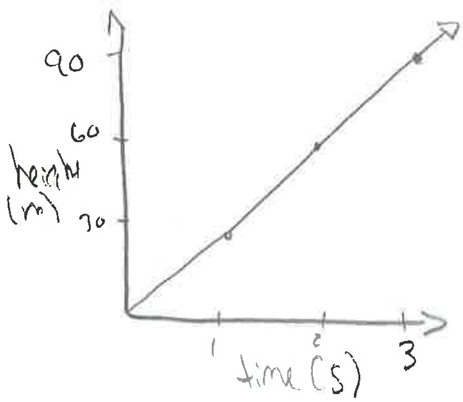
d. <u>Kinematics</u>:

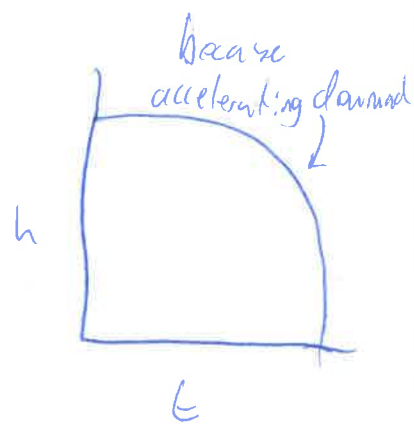


$a = \frac{\Delta V}{\Delta t}$

$-10\frac{m}{s^2} = \frac{V_f - V_i}{3s}$

$-30\frac{m}{s} = V_f$





(7) a. momentum: Since there is a change in v, there is ΔP.

<u>Energy</u>: Energy is converted from GPE → KE

<u>Dynamics</u>: There is Fg and acceleration acting on the box

other forces?

<u>Kinematics</u>: We have info related to box motion as function of time

b. ~~f~~ most helpful)

c. $E_f = E_i$

$KE = GPE$

$\frac{1}{2}\cancel{m}v^2 = \cancel{m}gh$

$\frac{1}{2}v_i^2 = (10\frac{m}{s^2})(60m)$

$V_f^2 = 120 \frac{m^2}{s^2}$

$V_f \approx 11 m/s$

d. They should all yield the same final speed because Energy is conserved GPE = KE and the means by getting to the endpoint aren't accounted for in equation.

e. Energy lens: the halfway point varies for each. Path A will have the greatest h halfway and therefor the highest V at the end.. B is next, an C: will have the least.

f. Dynamics: Since F=ma, assuming they have the same masses, we know $a_y = g$ which is also the same. It accelerates same in downward direction and start at same time, therefor must finish at same time.

⑨ A Biker moving up an incline and braking. A football player tackling someone. Throwing / dropping balls from the same height.

ⓐ 1283 m/s² → did w/ Tracker

⑩ a. Kinematics lens → speed looks very high because photo couldn't capture one frame since its frames weren't high enough.

b. Kinematics → moves fastest right before making contact w/ the golf ball because it is accelerating over time

c. Speeds up as it approaches the ball, slows down after making contact w/ the ball

d. speed will be higher because it has less mass. Momentum must be conserved $m_1v_1 = m_2v_2$.

e. Not far behind it, but slowing down and getting farther from it.

f. $\approx$ 8m/s

h. Momentum, the speed will decrease since momentum is conserved

i. maybe 10:1 or something? the club has to be significantly more massive to allow the ball to hit such high speeds

j. $\approx$ 0.5 milliseconds

k. $f = ma = \frac{\Delta p}{\Delta t} = \frac{8}{.01} = 800N$ roughly? not sure what values to use...

$\Delta p = m\Delta v = (0.1kg)(80) = 8N$

l. $Power = \frac{\Delta E}{\Delta t} = \frac{W}{\Delta t} = \frac{F\Delta d}{\Delta t} = \frac{(800)(.0001)}{.01} = 8W$ got very confused on these two → help!