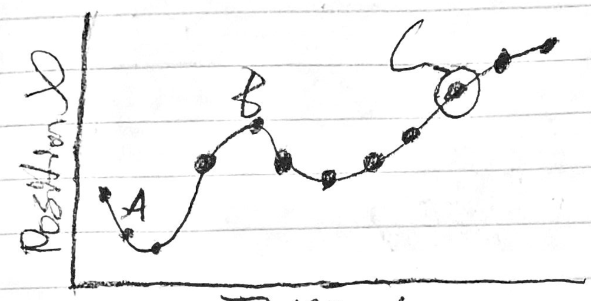
Santiago Bermudez
11-10-20
Phys Ut

Midterm 1 Corrections

1. The figure below shows the position vs. time graph for an object moving in 1-D.



Rank the speed of the objects from slowest to fastest.

(A) $V_B < V_A < V_C$

(B) $V_C < V_A < V_B$

(C) $V_A < V_C < V_B$

(D) $V_A = V_B = V_C$

(E) $V_A < V_B < V_C$

We are asked to rank the speed of the object, not velocity, so we don't take direction into consideration. If you look at the slopes, B has a horizontal slope, meaning the object was temporarily stopped, making it the slowest speed. Point A is steeper, but not the steepest, placing it between B and C in terms of velocity. C is no doubt the fastest due to how steep the slope is at that point.

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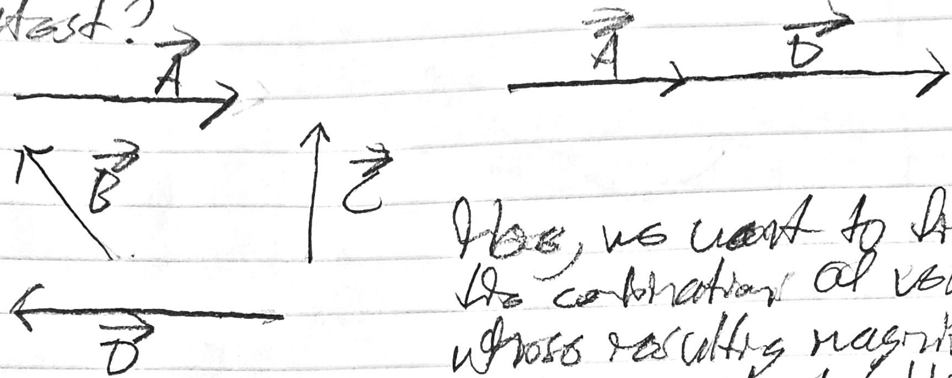
2. In the figure below, 4 vectors are given. For which combination of the four vectors is the magnitude of the resulting vector the greatest?



(A) $\vec{A}+\vec{C}$

(B) $\vec{A}-\vec{D}$

(C) $\vec{D}+\vec{A}$

(D) $\vec{A}+\vec{B}$

(E) $\vec{B}+\vec{C}$

Here, we want to find the combination of vectors whose resulting magnitude is the greatest. Subtracting a vector simply reverses its direction. Here, $\vec{A}-\vec{D}$ is the greatest terms of magnitude as it not only combines the largest vectors but makes it a purely horizontal addition as well, succeeding any other possible combination.

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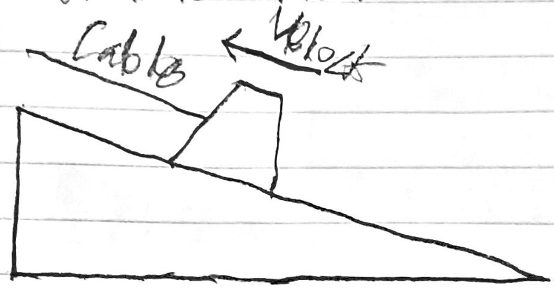
3. A block is being dragged up a hill by a cable with constant velocity as shown in the figure. Which statement about the normal force acting on the block is true.



A) The magnitude of the normal force is less than the magnitude of the gravitational force (Weight)

B) The magnitude of the normal force is equal to the magnitude of the gravitational force (Weight)

C) The magnitude of the normal force is zero

D) The magnitude of the normal force is equal to the magnitude of the kinetic frictional force

E) The magnitude of the normal force is greater than the magnitude of the gravitational force (Weight)

★ It would be more accurate to describe the magnitude of the normal force as being less than the magnitude of the gravitational force as the object is being pulled along an incline which not only shifts its center of mass, but makes the object easier to slide as well.

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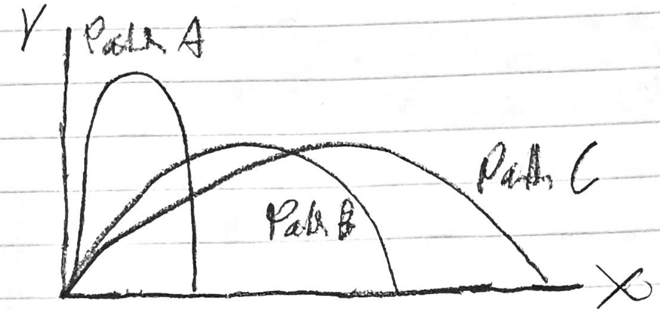
4. Three projectiles are launched such that their paths follow the trajectories shown below. What can you say about the total time that each projectile is in the air t_1, t_2, and t_3? Ignore



(A) $t_1 = t_2 > t_3$

(B) $t_3 > t_2 > t_1$

(C) $t_1 > t_2 = t_3$

(D) $t_3 = t_2 > t_1$

The total time that a projectile spends in the air depends on the height of its trajectory, assuming we could ignore air resistance. The horizontal distance a projectile covers has no affect in this regard.

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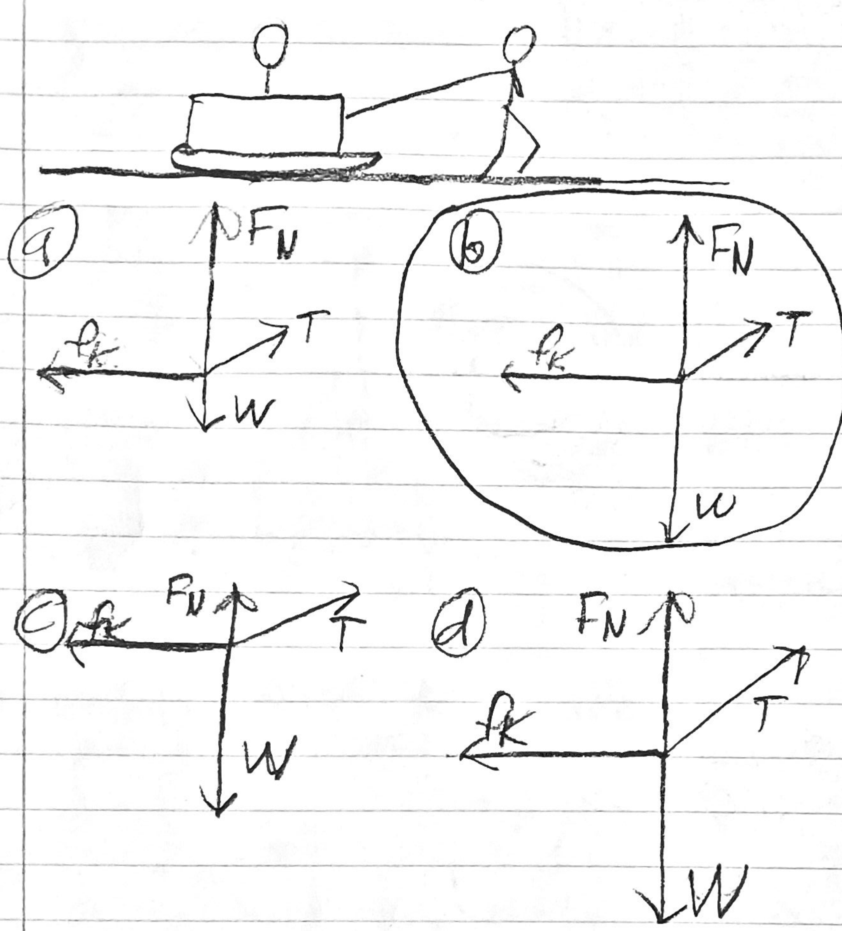
5. A child is pulling [illegible] on a sled across a level field as shown in the figure. The sled's velocity is decreasing as the parent tires out. What is the correct free body diagram for this situation?



For the sled, seeing how it remains still vertically, that would imply that the force of gravity and normal force acting on it are the same. The sled is slowing down, so it can be said that horizontally, the force of kinetic friction is greater than tension during this moment.

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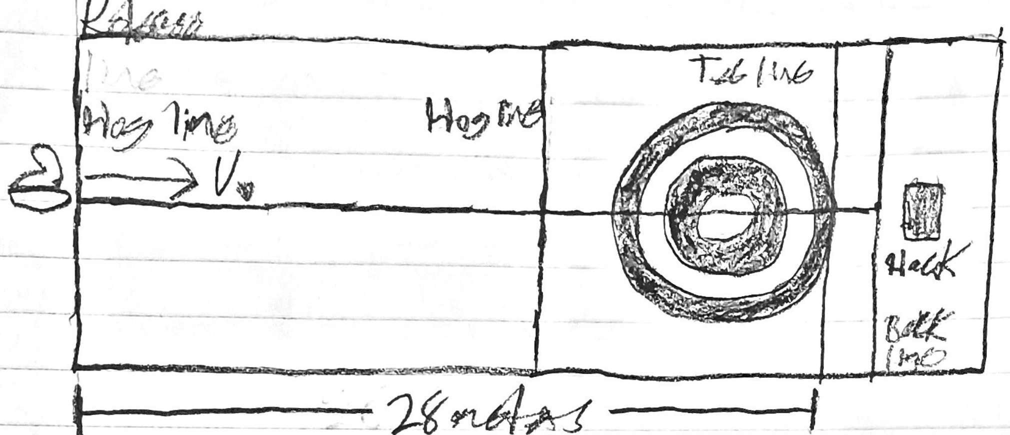
6. In the sport of curling a 20kg is pushed across a sheet of ice with the goal of having it stop at the center of a target. A player pushes the stone until the release line, then lets the stone go. The figure shows the layout of the ice. Be sure to answer both parts A and B here.



A) If the player releases the stone with an initial velocity of 5m/s and the friction between the stone and the ice gives the stone a constant acceleration of $-1.3 m/s^2$ (assuming motion to the right is in the +x direction), how far from the target does the stone stop? Assume only motion in one dimension.

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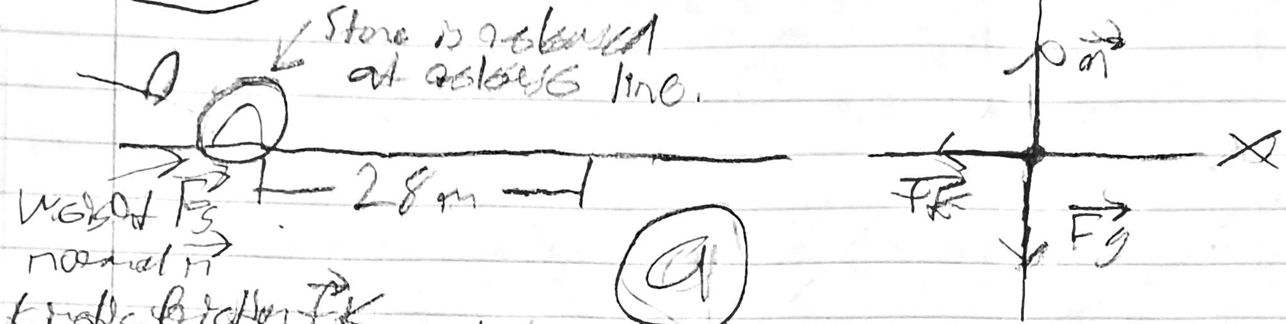

Weight $\vec{F_g}$
normal $\vec{n}$
Kinetic friction $\vec{f_k}$

a

$W = mg$

$W = 20\,kg$
$x_0 = 0\,m$
$x_f = ?$
$v_0 = 5\,m/s$
$v_f = 0\,m/s$
$a = -1.3\,m/s^2$

$t_0 = 0\,s$
$t_f = ?$

$x_1 = x_0 + v_0 t + \frac{1}{2} a t^2$

$a = \frac{\Delta v}{\Delta t} \rightarrow \Delta t = \frac{\Delta v}{a}$

$t = \frac{\Delta v}{a} = \frac{5}{-1.3} = 3.84\,s$ *We can ignore the negative sign

$x_1 = 0 + 5(3.84) + \frac{1}{2}(-1.3)(3.84)^2$

$x_1 = 19.2 - 9.6$ $\quad 28 - 9.6 = \boxed{18.38\,m}$

$\boxed{x_1 \approx 9.6\,m}$ ← 1

a

B $a = \frac{\Delta v}{\Delta t} \rightarrow \Delta t = \frac{\Delta v}{a}$

$t = \frac{5\,m/s}{-1.3\,m/s^2} \rightarrow \boxed{t \approx 3.84\,s}$

we can ignore the negative.

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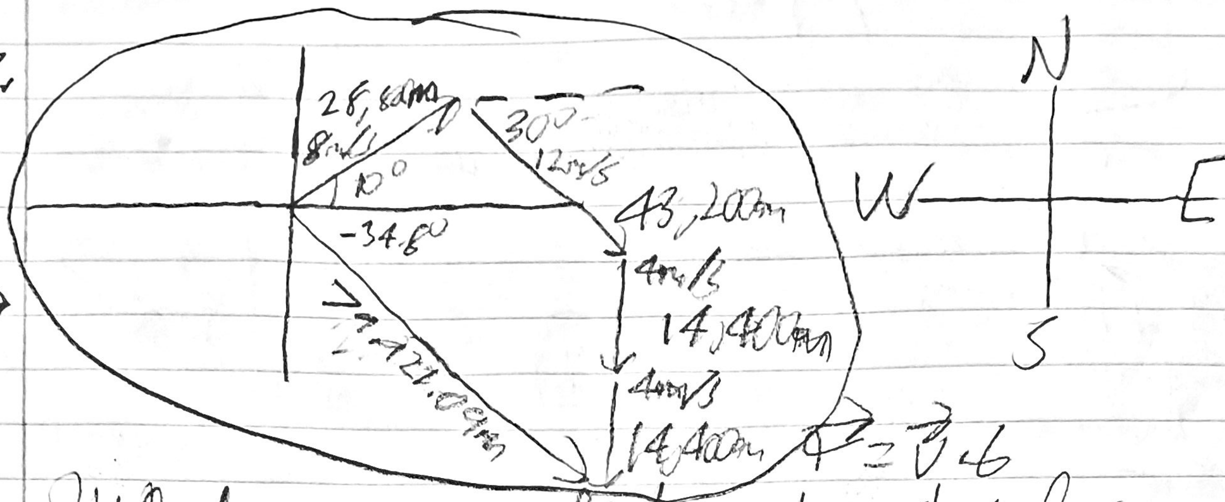
7.

(B) →



$\vec{r}_3 = \vec{v} \cdot 6$

a) What are your displacement vectors for each of the three legs of your journey, $\vec{r}_1$, $\vec{r}_2$ and $\vec{r}_3$? Write the 3 vectors

$\vec{r}_1 = r_{1x}\hat{i} + r_{1y}\hat{j}$

$8 * 60 = 480 * 60 = 28,800m$

$12 * 60 = 720 * 60 = 43,200m$

$4 * 60 = 240 * 60 = 14,400m$

$\vec{r}_{1x} = 28,800m \cos(10°) = 28,362.46m$
$\vec{r}_{1y} = 28,800m \sin(10°) = 5001.07m$

$\vec{r}_{2x} = 43,200m \cos(330°) = 37,412.30m$
$\vec{r}_{2y} = 43,200m \sin(330°) = -21,600m$

$\vec{r}_{3x} = 14,400 \cos(270°) = 0m$
$\vec{r}_{3y} = 14,400 \sin(270°) = -14,400m$

← 2 hours instead of 1, so we multiply by 2

(a) →

$$\boxed{\begin{aligned} \vec{r}_1 &= 28,362.46\hat{i} + 5,001.07\hat{j} \\ \vec{r}_2 &= 37,412.30\hat{i} + (-21,600)\hat{j} \\ \vec{r}_3 &= 0\hat{i} + (-28,800)\hat{j} \end{aligned}}$$

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9) $28,362.46 + 37,412.30 + 0 \approx 65,774.76$ x

$5,001.07 + (-21,600) + (-28,800) \approx -45,398.93$ y

$\theta = \tan^{-1}\left(\frac{-45,398.93}{65,774.76}\right) = -34.6^{0}$

$\sqrt{(65,774.76)^2 + (-45,398.93)^2} \approx 79,921.09$

c) $\rightarrow \boxed{79,921.09m, -34.8^{0}}$

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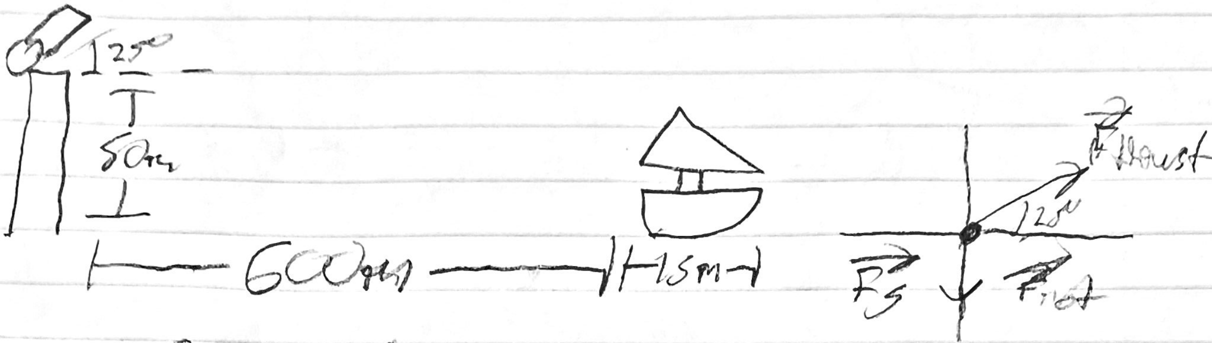
8.



$X_0 = 0m$ ~~cos(25) =~~ $\qquad Y_0 = 80m$

$V_{0x} = 150m/s \cos(25°) = 135.9m/s \qquad t_0 = 0s$

$V_{0y} = 150m/s \sin(25°) = 63.39m/s \qquad t_1 = \Delta t$

$a_{0x} = 0m/s^2$

$a_{0y} = -9.8m/s^2$

a) $x(t) = x_0 + V_{0x}(t_1 - t_0) + \frac{1}{2}a_{0x}(t_1 - t_0)^2$

$y(t) = y_0 + V_{0y}(t_1 - t_0) + \frac{1}{2}a_{0y}(t_1 - t_2)^2$

$x(t) = 0 + 135.9(\Delta t) + \cancel{\frac{1}{2}0(\Delta t)^2}$

a) →

$$\boxed{\begin{aligned} x(t) &= 135.9(\Delta t) \\ y(t) &= 80 + 63.39(\Delta t) + \frac{1}{2}(-9.8)(\Delta t)^2 \end{aligned}}$$

b) $V_x(t) = V_{0x} + a_{0x}\Delta t$

$V_y(t) = V_{0y} + a_{0y}\Delta t$

$V_x(t) = 135.9 + \cancel{0(\Delta t)}$

$V_y(t) = 63.39 + (-9.8)(\Delta t)$ →

b) →

$$\boxed{\begin{aligned} V_x(t) &= 135.9m/s \\ V_y(t) &= 63.39 + (9.8)(\Delta t) \end{aligned}}$$

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Cont'd

(a) $y(t) = 80 + 63.39(\Delta t) + \frac{1}{2}(-9.8)(\Delta t)^2$

$y(t) = 50 + 63.39(\Delta t) + -4.9(\Delta t)^2$

$-y(t) = 236$ quadratic formula

we get 13.68s

$x(t) = 135.9(4.5) = 611.55m$

$\boxed{\text{(b) No, the cannonball does not ever hit the ship. It may reach the horizontally in the time given but vertically, the ball would go over the ship.}}$

(c) $y(t) = y_0 + V_{oy}(\Delta t) + \frac{1}{2} a_{oy}(\Delta t)^2$

V_{oy} ? $\Rightarrow$ we can try guessing for an angle

$7.5°$

$180\cos(7.5°) = 148.71$

$180\sin(7.5°) = 149.58$

$y(t) = 0 + 149.58(\Delta t) + \frac{1}{2}(9.8)(\Delta t)^2$

About 3.99s from quad formula

$x(t) = 148.71(3.99) \approx 593m$

$\boxed{\text{(d) The cannon should be at about } 7.5° \text{ to hit the ship.}}$

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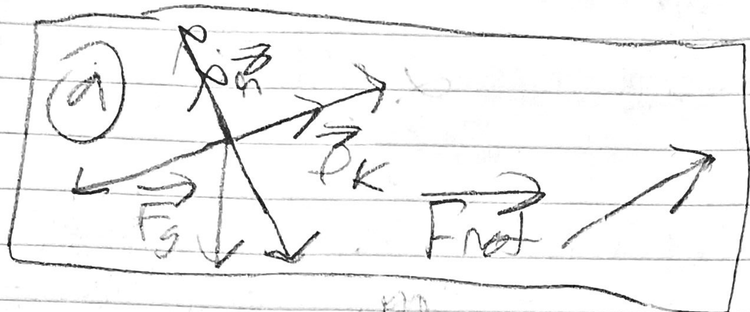
9.



b) $F = ma$ $w = mg = 1250\,kg \cdot 9.8\,m/s^2$

$F = 1250\,(a)$

$F = 1250\,(8)$ $a = \frac{\Delta v}{\Delta t} = \frac{20\,m/s}{2.5\,s} = 8\,m/s^2$

$F = 1250(8) = \boxed{10{,}000\,N}$ c