

PS# Solutions

- MT #2. Please repeat the work of your midterm adding the small extra questions I put in.
- 7.0 Exercise 1

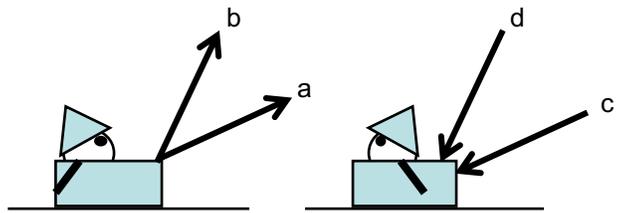
②

Kinematics in 2D:
why?
our vectors: person on a bridge above will see the boat traveling 5m/s north west

directions?
 $V_y = \frac{\Delta y}{t}$
 $4m/s = \frac{100m}{t}$
 $t = 25s$
 $V_x = \frac{\Delta x}{t}$
 $3m/s = \frac{\Delta x}{25s}$
 $75m = \Delta x$ (West)

→ 100m North, 75m West, 125m total overall.

- My daughter is sledding (total mass = 20 kg), and I am applying a force of 120 N to her sled. I have 4 different options (pushing and pulling at two different angles) and I try all of them. Make sure to pick a lens and do a good FBD indicating directions.



- For each scenario, estimate both the acceleration of the sled and the normal force between the sled and the frictionless snow.

③ A+

total overall.

a) Dynamics lens → dealing with force and accelerations.

$\sum \vec{F} = m\vec{a}$ $\sum \vec{F}_x = m\vec{a}_x$ $\sum \vec{F}_y = m\vec{a}_y$	<p>A</p> $100N = 20kg a_x$ $a_x = 5m/s^2$	$\sum F_y = 0$ $mg - Fn - 40N = 0$ $200N - 40N = F_n$ $F_n = 160N$	<p>B</p> $\sum \vec{F}_x = m\vec{a}_x$ $40N = 20kg a_x$ $a_x = 2m/s^2$
<p>C</p> $\sum \vec{F}_x = m\vec{a}_x$ $100N = 20kg a_x$ $a_x = 5m/s^2$	<p>D</p> $\sum \vec{F}_x = m\vec{a}_x$ $40N = 20kg a_x$ $2m/s^2 = a_x$	$\sum \vec{F}_y = 0$ $mg + 100N - F_n = 0$ $200N + 100N = F_n = 300N$	$\sum \vec{F}_y = 0$ $mg - F_n - 100N = 0$ $200N - 100N = F_n$ $F_n = 100N$

b) A + C have higher and same.
B + D are less and same.

- b) Now, please rank the different force scenarios in order of least acceleration to greatest acceleration. If some accelerations are the same, please indicate that.
- c) Now, let's say that the coefficient of friction of the snow is *actually* 0.2. How does this change things? Please rank again the different force scenarios in order of least acceleration to greatest acceleration.

c) If the coefficient of kinetic friction is 0.2, then

$$F_{fr} = (0.2)(F_N)$$

<p><u>A</u></p> $F_{fr} = (0.2)(160N) = 32N$ $\Sigma F_x = m\vec{a}_x$ $100N - 32N = 20kg a_x$ $68N = 20kg a_x \quad \boxed{a_x = 3.4 m/s^2}$	<p><u>B</u></p> $F_{fr} = (0.2)(100N) = 20N$ $\Sigma F_x = m\vec{a}$ $40N - 20N = (20kg) a_x$ $20N = 20kg a_x \quad \boxed{a_x = 1 m/s^2}$
<p><u>C</u></p> $F_{fr} = (0.2)(240N) = 48N$ $\Sigma F_x = m\vec{a}_x$ $100N - 48N = (20kg) \vec{a}_x$ $52N = (20kg) a_x \quad \boxed{a_x = 2.6 m/s^2}$	<p><u>D</u></p> $F_{fr} = (0.2)(300N) = 60N$ $\Sigma F_x = m\vec{a}_x$ $40N - 60N = (20kg) a_x$ $-20N = (20kg) a_x \quad \boxed{a_x = -1 m/s^2}$ <p style="font-size: small;">Friction is resistive so it can't accelerate the object backwards.</p>

- d) Have you ever pushed a lawn mower (or watched someone do it)... you are using force scenario d, pushing along the handle. When you run into some thick grass the "coefficient of friction" might be high enough to stop you cold. What scenario can you change to, and why does this work?

d) You can change to scenario C because you are applying less downward force and therefore there is a smaller normal force and thus a smaller friction too which increases the ΣF_x .

Yes, that idea is the first thing you will do... lower the handle to reduce the downward component of the pushing force.... but my guess is you have never mowed a thick lawn in Buffalo N.Y. when it's been raining a lot. Scenario "C" is not enough. Eventually, you would turn the lawn mower around and pull it in scenario "A".