Exam I Details:

Exam I will take place in HECC 108 (this is the Harrington Education Center near Evans Library) on Thursday, September14th from 7:00pm – 9:00pm. It is a common exam; all sections of PHYS 201 will take the same exam. Please arrive at least 15 minutes early to get settled; we would like to begin exactly on time. If you have any questions during the exam, you may call over one of the proctors monitoring the exam.

Chapters to be covered on exam 1: 1 – 5.3

Springs will not be on exam 1.

Items to bring:

- Black pencil and eraser
- Scientific Calculator or four-function calculator
- Yourself with student ID
- Section number

Items *not* to bring:

- Your own formula sheet (one will be provided on exam)
- Scantron (one will be provided on exam)
- Computerized Calculator (example: Ti-nspire with touchpad keyboard)
- A laptop, tablet, or phone (all computer devices should be kept powered off and left in your bag for the duration of the exam)
- Any other prohibited item

Concepts to review:

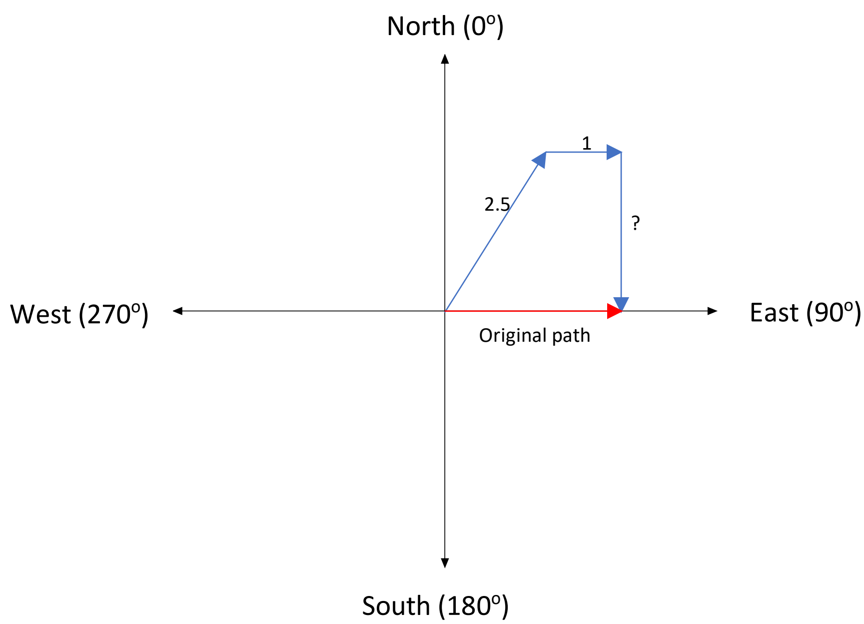
- Units
  - Size prefix's (examples: kilo-, centi-, mili-, etc.)
  - Conversions (example: kilometers to meters)
  - Significant figures
- Vectors
  - Addition and subtraction
  - Components
  - Magnitude and direction
- Equations of Motion
  - Velocity (1D and 2D)
  - Acceleration (1D and 2D)
  - Falling objects (examples: ball dropped from a height, throwing a rock in the air)
  - Projectile motion
  - Objects moving in a flat horizonal plane (examples: block sliding on ice, moving car, stopping distance)

- Newton’s laws
  - Force (examples: gravitational force, tension, normal force, push & pull) and mass
  - First Law, Second Law, Third Law
  - Free-body Diagrams

Practice Questions for the Exam:

1) **Sarah is out hiking and decides to circumnavigate a mountain on the trail rather than cross it. She travels 2.5 miles north-east on a heading of 32°. From there she then travels directly east for 1 mile before turning back directly south to rejoin the main trail. Assuming the trail continued directly east from her original starting point, how long did she have to hike before she encountered the trail again? Assume all of her travel was over flat ground and use the compass headings of North = 0°/360°, East = 90°, South = 180 °, West = 270°.**

Solution:



We first draw the diagram of the path. We see that this gives us three vectors, with 2 vectors consisting of completely known quantities, and the third unknown. Moreover, the information given is also enough to find know the original path vector (ignoring elevation), from which we can find the unknown length of the last part of the path.

First, we must find the North and East components of the first part, p. We are told that it is 2.5 miles in length and has a heading of 32°. Thus…

$$\vec{p} = p_N \cdot \widehat{N} + p_E \cdot \hat{E}$$

$$p_N = |p|\cos(32) = (2.5)(0.84) = 2.1$$

$$p_E = |P|\sin(32) = (2.9)(0.53) = 1.3$$

We know that the second part (which we will call q) is directly east and had a length of 1 mile, so this makes it easy to find. In vector form, it simply has the form $\vec{q} = q_E\hat{E} = 1\vec{E}$.

Since we know that we need to return to the original path, this means the final part of the detour path (we can call it r) must cancel all the northern components completed. Because only the first part of the path had any Northern components, we know that the final part is simply this length, but in the negative

North direction (a.k.a. South). Thus, the final answer is that the unknown length is equal to 2.1 miles in the South direction.

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2) **Tommy is running at 2 m/s when Alice passes him at 4 m/s. Tommy immediately accelerates by 1 m/s^2. How many seconds will it take Tommy to catch up to Alice? When he catches up to her, how far will they have traveled from where Alice first passed Tommy? Assume Alice stayed at the same constant velocity and both are traveling on a straight path.**

Solution:

Because Tommy and Alice are running in the same direction on a straight path, this is a 1-dimensional problem. Moreover, because both runners have constant acceleration (a_T = 1m/s^2 for Tommy, and a_A = 0 for Alice) we can use the constant acceleration kinematic equations we have already learned.

First, we define our origin and starting positions. We will call the starting point at which Alice first passes Tommy to be the origin, and thus can set x_0 = 0 for both runners. We also consider the time at which Alice passes Tommy to be t = 0.

We now need to find a way to relate Tommy's motion with Alice's motion. Because we are looking for the point at which Tommy passes Alice (i.e. when they have the same position again), we can set the kinematic equations for position equal to each other. Calling Tommy's starting velocity v_T = 2 m/s and Alice's velocity as v_A = 4 m/s,

$$x = x_0 + v_T t + \frac{1}{2} a_T t^2 = x_0 + v_A t + \frac{1}{2} a_A t^2$$

We know all variables in this equation except for the time, t. We can solve for it by re-arranging the kinematic equation to find,

$$t = \frac{2(v_A - v_T)}{a_T} = \frac{2(4-2)}{1} = 4$$

This means that it will take 4 seconds for Tommy to reach the same position as Alice, thus giving us the answer to the first question. Now we must find what this position is, and thus, how far they have traveled from where Alice first passed Tommy. We can do this by plugging the time we found (t = 4) back into either Tommy's or Alice's kinematic equation and solving for x. Because Alice's equation only has velocity in it (since x_0 = 0 and a_A=0), we will use her equation.

$$x = y + t = (4)(4) = 16$$

Thus, Tommy and Alice will have traveled 16 meters from the starting point when Tommy catches up to Alice.

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3) Two people of equivalent weight are in an elevator accelerating downward at 3 m/s^2. The weight sensor of the elevator reads that they are exerting a combined force of 1190N on the elevator as it travels down. What is the mass of each person? Assume the acceleration due to gravity to be g = 10m/s^2

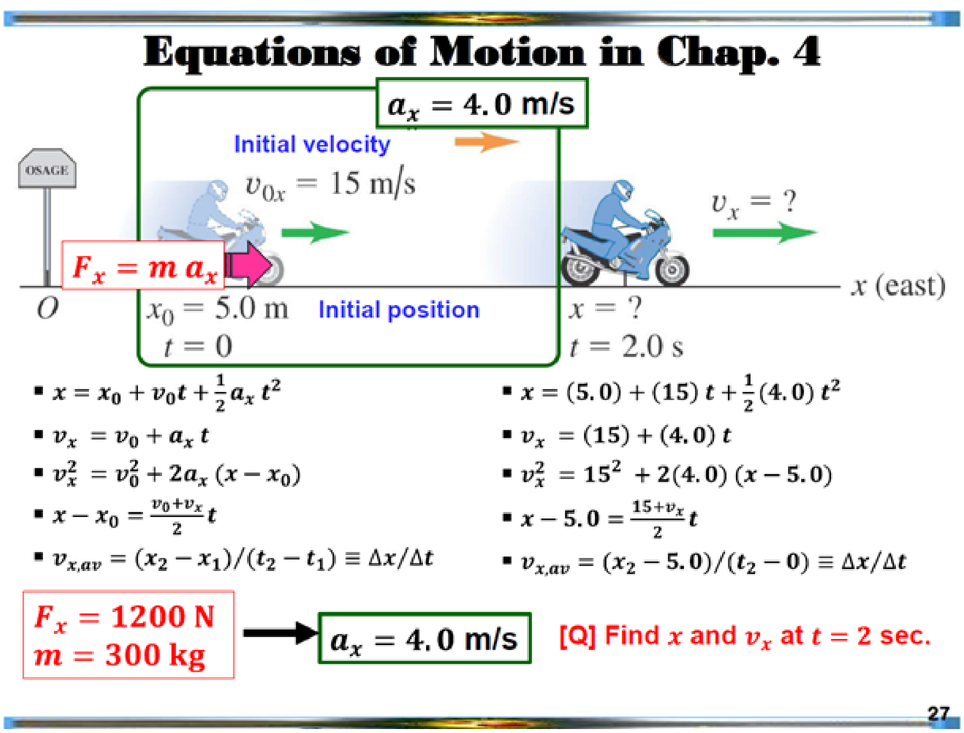
Solution:

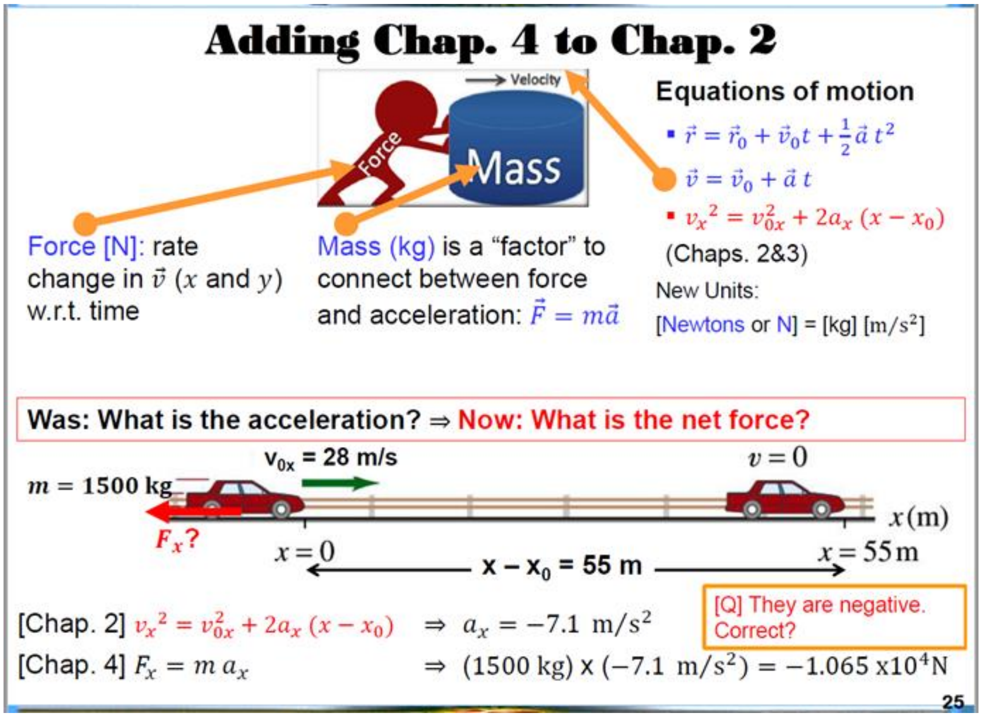
We must first find the effective acceleration on the two people in the elevator. Because the elevator is accelerating downward at 3 m/s^2, this means the total acceleration experienced by the passengers is the acceleration due to gravity minus the acceleration of the elevator. (The reason why the accelerations are subtracted instead of adding is because we are looking for the effective acceleration, i.e. the acceleration they would feel. Because the direction of motion is the same as that of the acceleration of gravity, it reduces the normal force that is exerted from the elevator back onto the passengers.) Thus, the effective acceleration of the passengers is a = 10 m/s^2 - 3 m/s^2 = 7 m/s^2.

Using Newton's second law (F = m*a), and knowing the total force exerted by the passengers on the elevator we can then find their combined mass.

$$M = \frac{F}{a} = \frac{1190}{7} = 170$$

Because the mass's of each passenger are equivalent, we can simply divide the total mass by 2 to find each passenger's individual weight. <u>Thus, we find that the weight of each passenger is 85kg</u>.




Adding Chap. 4 to Chap. 2
Velocity
Force
Mass
Equations of motion
$\vec{r} = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}\,t^2$
$\vec{v} = \vec{v}_0 + \vec{a}\,t$
${v_x}^2 = v_{0x}^2 + 2a_x\,(x - x_0)$
(Chaps. 2&3)
Force [N]: rate change in $\vec{v}$ (x and y) w.r.t. time
Mass (kg) is a "factor" to connect between force and acceleration: $\vec{F} = m\vec{a}$
New Units:
[Newtons or N] = [kg] [m/s^2]
Was: What is the acceleration? ⇒ Now: What is the net force?
$m = 1500$ kg
v_{0x} = 28 m/s
$v = 0$
F_x?
x(m)
$x = 0$
$x - x_0$ = 55 m
$x = 55$m
[Q] They are negative. Correct?
[Chap. 2] ${v_x}^2 = v_{0x}^2 + 2a_x\,(x - x_0)$ ⇒ $a_x = -7.1$ m/s^2
[Chap. 4] $F_x = m\,a_x$ ⇒ (1500 kg) x (-7.1 m/s^2) = -1.065 x10^{4}N
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Example of formula sheet provided on exam:

Constant acceleration equations:

$v_x = v_{0x} + a_x t$ $\qquad$ $x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$

$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$ $\qquad$ $x - x_0 = \left(\frac{v_{0x} + v_x}{2}\right)t$

$g = 9.80\ \text{m/s}^2$ $\qquad$ $w = mg$

$\sum F_x = ma_x$ $\qquad$ $\sum F_y = ma_y$

$f_\text{k} = \mu_\text{k} n$ $\qquad$ $f_\text{s} \le \mu_\text{s} n$

$F_\text{spr} = k\Delta L$

quadratic formula: The equation $ax^2 + bx + c = 0$ has

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$