Tutoring Lesson Notes: Lesson 1 (5/4)

Topics: Overview & introduction, Newton's Laws, inclined slope question, introduction to energy.

Scalars & Vectors:

- SCALAR – a magnitude

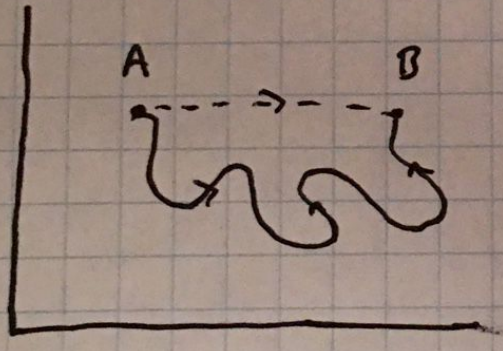
Examples: time, speed, mass

- VECTOR – a magnitude with a direction

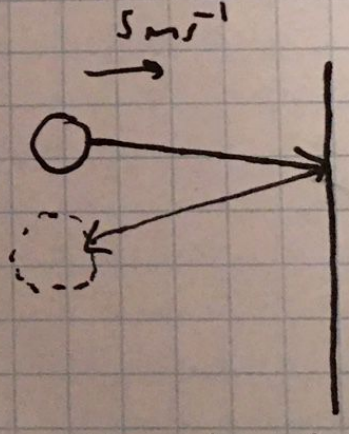
Examples: velocity, acceleration, force

velocity = speed with direction

displacement = distance with direction



Here my distance travelled is the squiggly line (say, 4 miles) while my displacement is 2 miles from A to B (the dotted line)



Here the ball starts with a velocity of $5ms^{-1}$ to the right, but changes velocity ($5ms^{-1}$ to the left).

The speed is a constant, the velocity is not.

Relationship:

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{velocity} = \frac{\text{displacement}}{\text{time}}$$

↳ focus on this equation! More useful!

Ex 1. If a car moves at speed 30 miles per hour for 2 hours, what distance does the car move?

$$\text{Speed} = \frac{\text{distance}}{\text{time}} \Rightarrow s = \frac{d}{t} \Rightarrow d = st = 30 \times 2 = 60 \text{ miles}$$

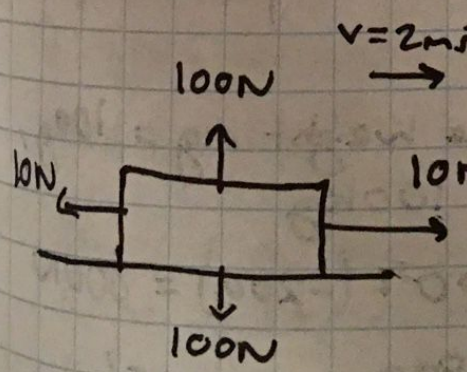
Make sure units are correct!

$$\text{acceleration} = \frac{\text{velocity}}{\text{time}}$$

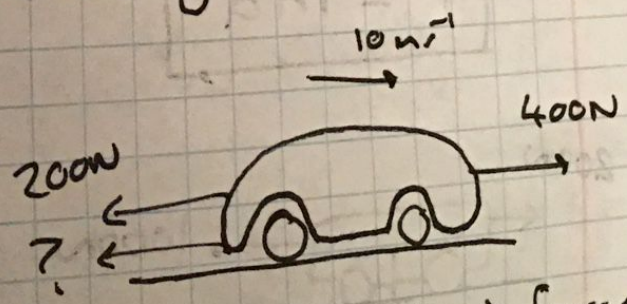
or in words: acceleration is the rate of change of velocity.

NEWTON'S LAWS:

- 1st Law – if the total forces acting on an object sum to zero, then the velocity is constant.



The forces are equal and cancel out = constant velocity (in this case, $2 ms^{-1}$)

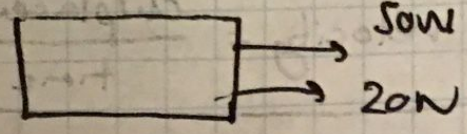


Constant velocity ⇒ forces sum to zero

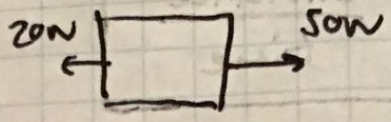
⇒ 400 + (−200) + (−?)

⇒ −200N ⇒ 200N to the left.

Note how forces add:

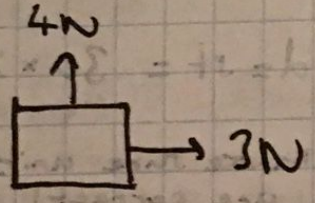


$F = 50 + 20 = 70N$

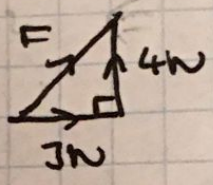


$50N + (-20N) = 70N$

here a force is positive if it goes to the right, negative if to the left

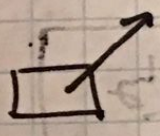


$\Rightarrow$



$F = \sqrt{3^2 + 4^2} = 5N$

$\Rightarrow$



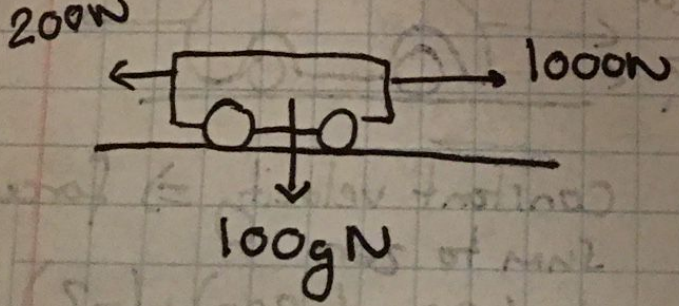
We can look at this more next week!

- <u>2nd Law</u> – the opposite!

If the forces don't sum to zero, then the velocity is not constant! There is an acceleration:

$$\boxed{F = ma}$$

F is the overall force



Here the weight $mg = 100g$, so $m = 100kg$

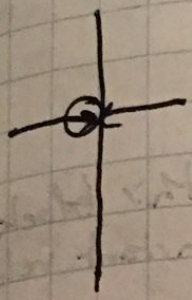
$F = 1000 + (-200) = 800N$

$\Rightarrow a = \frac{800}{100} = 8\,ms^{-2}$

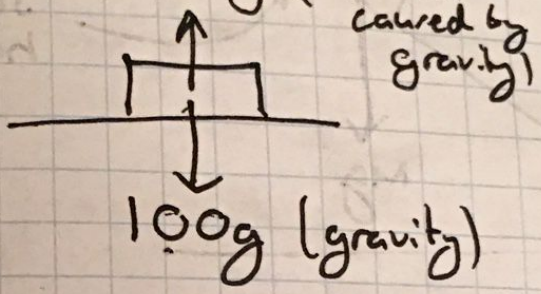
Quick note: Look at $F=ma$. If $F=0$, then $a=0$ [assuming $m>0$]. Thus we have Newton's 1st Law!

3rd Law - every action has an EQUAL and OPPOSITE reaction.

Examples:



Force ball exerts on wall = -Force wall exerts on ball.



There are nuances here, but don't overthink this one. Just think of these examples.

Imagine that there must be a surface for this to hold if it helps (the only care in the GAMSAT as far as I know where this will be useful).

Questions:

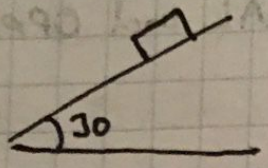
1. If a car has a driving force 1000N, air resistance 100N and friction 200N, and a weight of 7000kg, what is its acceleration?

2. Suppose a block has two forces acting on it, : 11N and
What values can the net force take?

[think about this one]

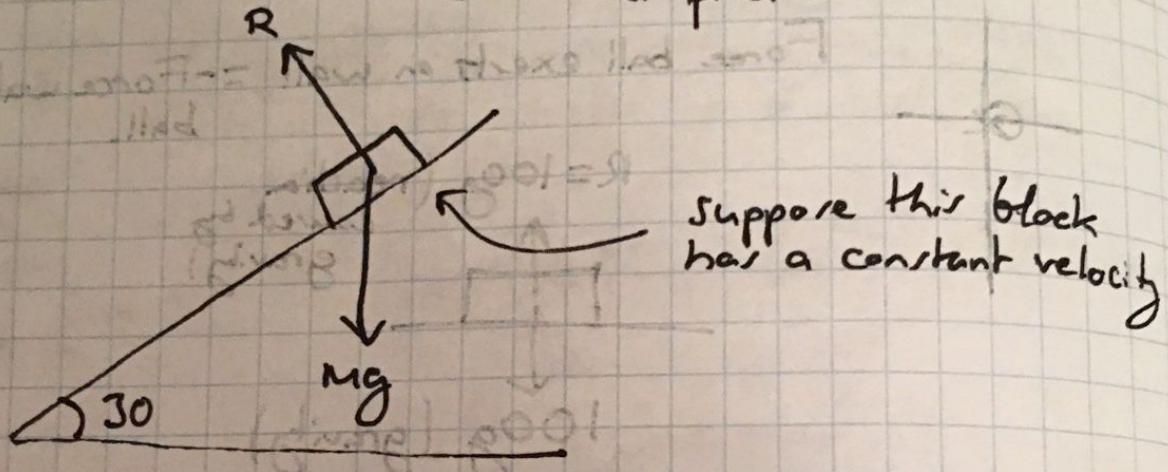
Inclined Slope!

Consider the following:



What are the forces?

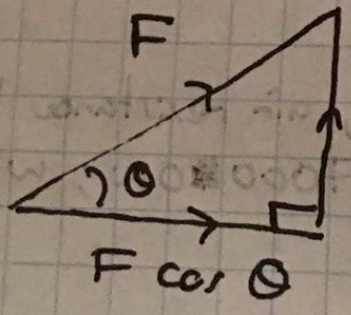
- Gravity (straight down)
- Reaction (perpendicular to surface)
- Sometimes friction



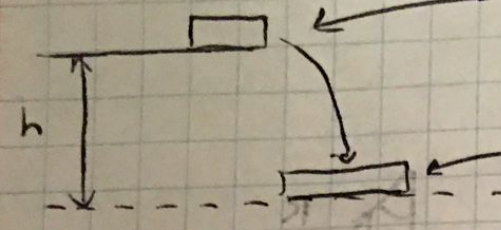
By Newton's 1st Law:

Forces up = Forces down.

To solve this, we need to resolve the reaction force R into its vertical and horizontal components. How? Here's a trick:



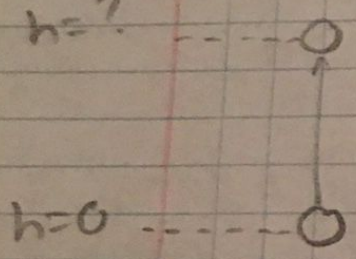
[Remember: Along the Corridor (cos), Up the Stairs (sin)]



Here $v=0$, $h=h$
All gpe, no ke.

Just before hitting ground
All ke, no gpe
$(h=0)$

Suppose a 2kg ball is thrown vertically upwards at $10ms^{-1}$. What is its maximum height?



$$ke = \frac{1}{2}\cdot 2\cdot 10^2 = 100J$$

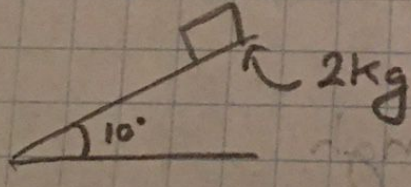
At max height, $v=0 \Rightarrow ke=0$

As energy conserved, then

$$gpe = 100J$$
$$\Rightarrow 100 = mgh$$
$$\Rightarrow 100 = 2\cdot 10\cdot h \rightarrow \underline{h=5m}$$

Questions (to ponder)

1.



Find R

2. A box sits on an inclined plane without sliding. As the angle of the plane increases, the normal force (the reaction force, R)
   a) Increases linearly
   b) Increases non linearly
   c) Decreases linearly
   d) Decreases non-linearly
   e) No change

3. A book is at height 6m and is dropped. If the book is 2kg, what is the final speed of the book before it hits the ground?