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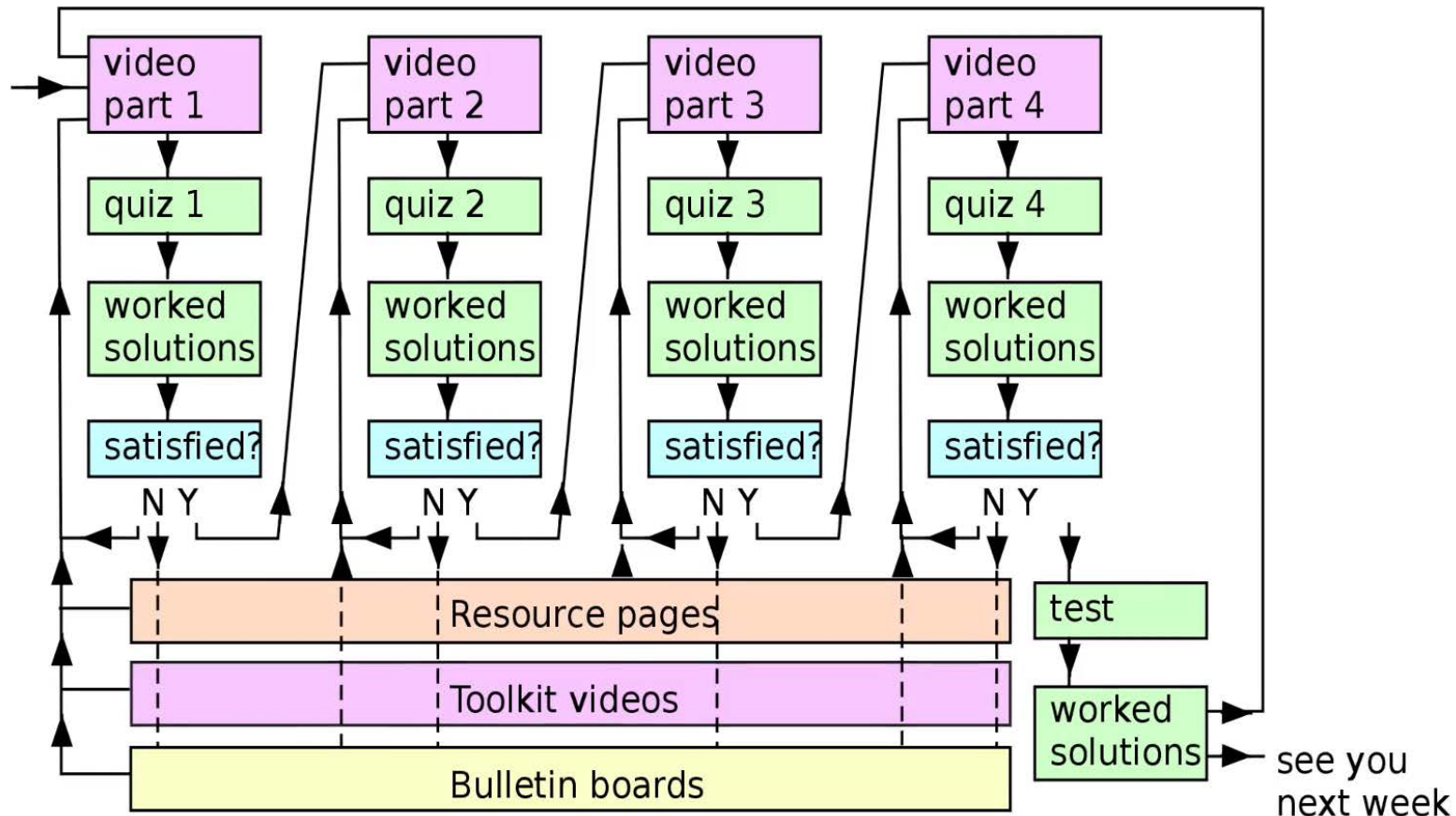
Never Stand Still

# Week 1 notes

# Week 1 Introduction and tools

- Introduction to physics – context, some fun facts and an introduction to the course
- Being quantitative – time, length, units and significant figures
- Vectors vs scalars – velocity vs speed, displacement vs distance
- Estimation and approximation – limitations to classical mechanics

# Navigating the course



Lesson 1.1  
2.52

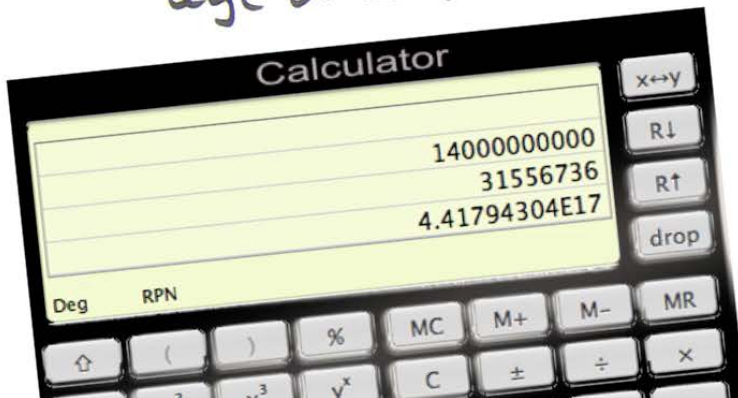
# The age of the universe – significant figures

$$\begin{aligned} 1 \text{ yr} &= 365.24 \text{ days} \cdot 1 \cdot 1 \\ &= 365.24 \text{ days} \cdot \frac{24 \text{ hours}}{1 \text{ day}} \cdot \frac{3600 \text{ s}}{1 \text{ hour}} \end{aligned}$$

$$= 31\,556\,736 \text{ s}$$

$$14 \times 10^9 \text{ yr} = 14 \times 10^9 \text{ yr} \cdot \frac{31\,556\,736 \text{ s}}{1 \text{ yr}}$$

$$\text{age of universe} = 4.4 \times 10^{17} \text{ s}$$



# Units of time and length

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**Units of Système International** Lesson 1.2  
Time = seconds Length = metres 2.40

# The average speed of the train

At this position on the door:

1.22 m  $\rightarrow$  764 pixels

$$\frac{1.22 \text{ m}}{764 \text{ pixels}} = 1.60 \text{ mm} \cdot \text{pixel}^{-1}$$

If the distance from the camera is fixed,  
Door moves 2 pixels  $\rightarrow$  3 mm

30 frames per s  $\rightarrow$  time

$$\begin{aligned} \text{Average speed} &= \frac{\text{distance}}{\text{time}} = \frac{3 \text{ mm}}{1/30 \text{ s}} \\ &= 0.09 \text{ m s}^{-1} \end{aligned}$$

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$$\text{Average speed} = \frac{105 \text{ mm}}{1/30 \text{ s}} = 3.2 \text{ m} \cdot \text{s}^{-1}$$

Lesson 1.2  
4.17



# Speed – metres per second

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Speed metres per second  
(m.s<sup>-1</sup>)  $\left( \frac{\text{distance}}{\text{time}} \right)$

Lesson 1.2  
4.56

# Metres per second to kilometers per hour

$$1 \text{ m} \cdot \text{s}^{-1} = \frac{1 \text{ m}}{1 \text{ s}} \cdot \frac{1 \text{ km}}{1000 \text{ m}} \cdot \frac{3600 \text{ s}}{1 \text{ hr}}$$

$$1 \text{ m} \cdot \text{s}^{-1} = 3.6 \text{ km} \cdot \text{hr}^{-1}, \text{ exactly}$$



# Kilometers per hour to miles per hour

$$1 \text{ (land) mile} = 1.60934 \text{ km}$$

$$1 = \frac{1 \text{ mile}}{1.60934 \text{ km}}$$

$$88.7 \text{ km} \cdot \text{hr}^{-1} = 88.7 \frac{\text{km}}{\text{hr}} \cdot \frac{1 \text{ mile}}{1.60934 \text{ km}}$$

$$= 55.1 \text{ miles per hour} \quad \checkmark$$

$$= 55.083... \text{ miles per hour} \quad \times$$

$$= 55.1 \quad \times$$

# Dimensions of distance over time

A middle-aged man with short, light brown hair, wearing a blue button-down shirt, is speaking. He is positioned in the center of the frame against a black background. The text is overlaid on the bottom half of the image.

**$\text{m.s}^{-1}$  miles.hr $^{-1}$  and km.hr $^{-1}$**   
all have *dimensions* of  $\frac{\text{distance}}{\text{time}}$

# Proportional error when subtracting

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Careful when subtracting

Lesson 1.2  
6.33

# Scalars and vectors – how they are notated

Scalar: speed  $v$   $5 \text{ km} \cdot \text{hr}^{-1}$   
 Vector: velocity  $\underline{v}$   $5 \text{ km} \cdot \text{hr}^{-1} \underline{\text{North}}$   
 $\underline{v}$   $\vec{v}$

Printing notation

Scalar e.g. speed,  $v$  5 km/hr.

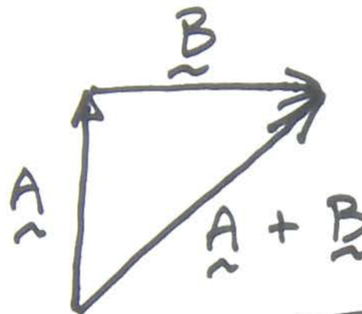
Vector e.g. velocity,  **$v$**  5 km/hr North

# Adding vectors

North  
↑ N

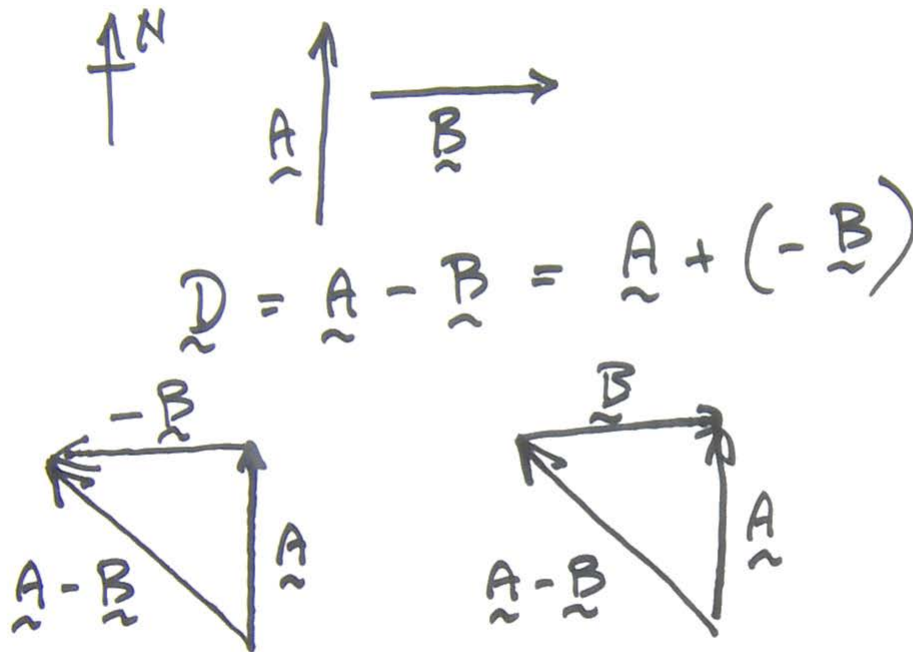
$\vec{A}$  5m

$\vec{B}$  5m



$$|\vec{A} + \vec{B}| = \sqrt{(5\text{m})^2 + (5\text{m})^2} = 7\text{m}$$

# Subtracting vectors





# Estimation – how many grains of sand?



## COOGEE BEACH

How many grains of sand?

Lesson 1.4  
0.53



# Estimation – calculations

$$\text{number of grains} \doteq \frac{\text{volume of sand}}{\text{volume of grain}}$$

$$\sim \frac{\text{length} \cdot \text{breadth} \cdot \text{depth}}{(\text{typical size})^3}$$

ignore air between grains

$$\sim \frac{400\text{m} \cdot 40\text{m} \cdot 3\text{m}}{(3 \times 10^{-4}\text{m})^3} \rightarrow 2 \times 10^{15}$$

$$\sim 10^{15}$$

# Notes

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