UNSW
AUSTRALIA

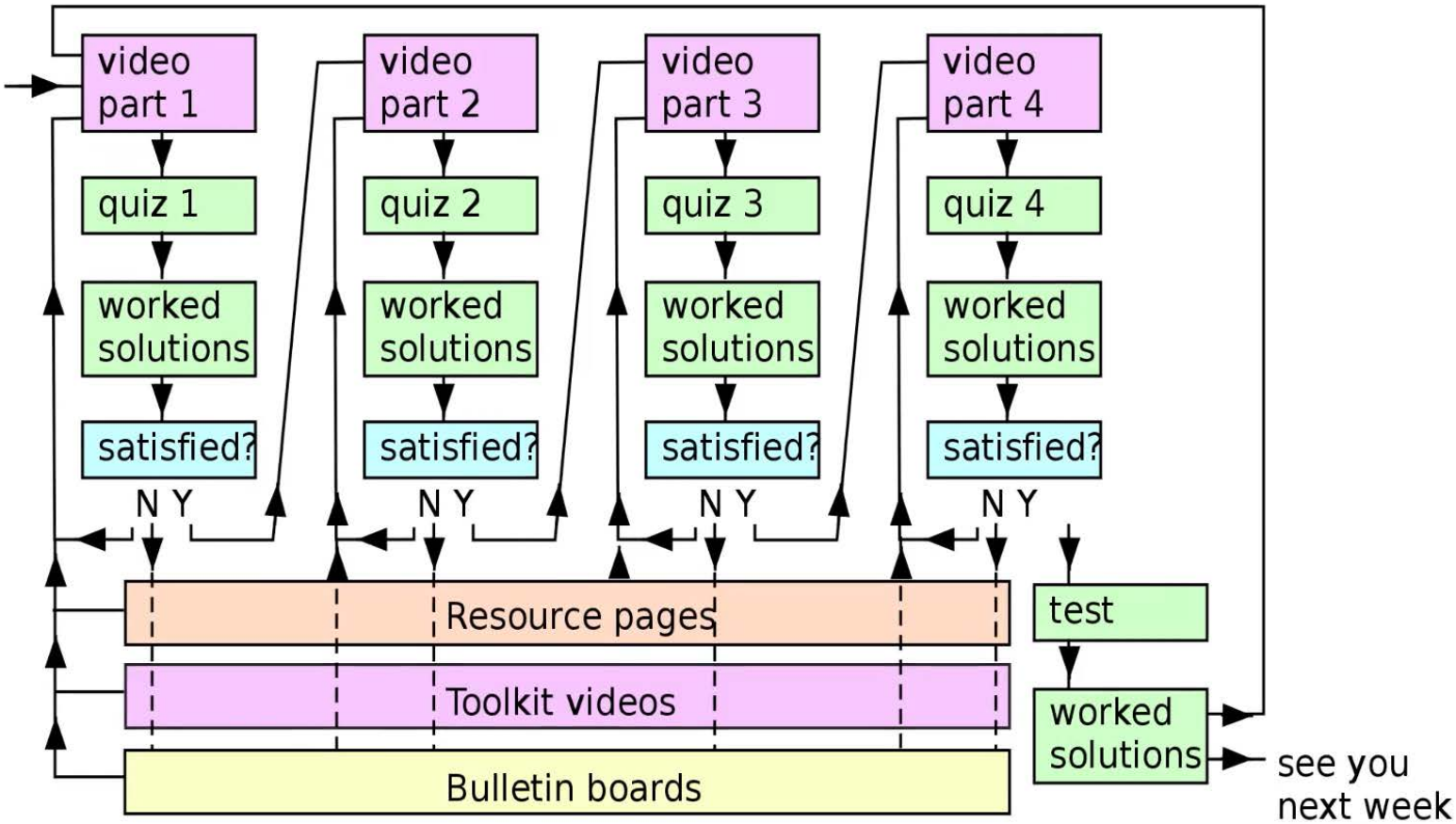
Never Stand Still

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



The age of the universe – significant figures

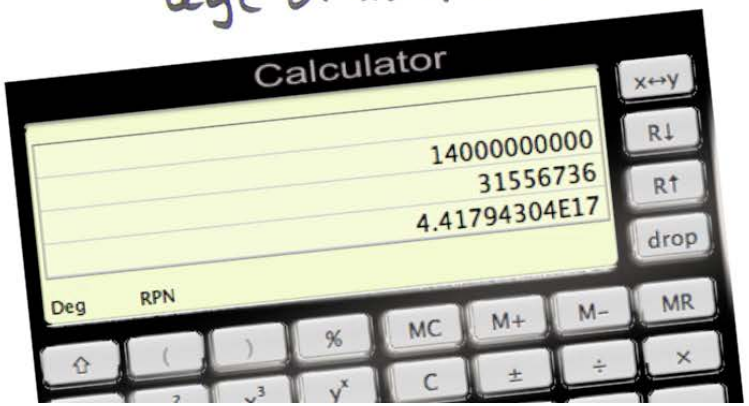
$$1\ \text{yr} = 365.24\ \text{days} \cdot 1 \cdot 1$$

$$= 365.24\ \text{days} \cdot \frac{24\ \text{hours}}{1\ \text{day}} \cdot \frac{3600\ \text{s}}{1\ \text{hour}}$$

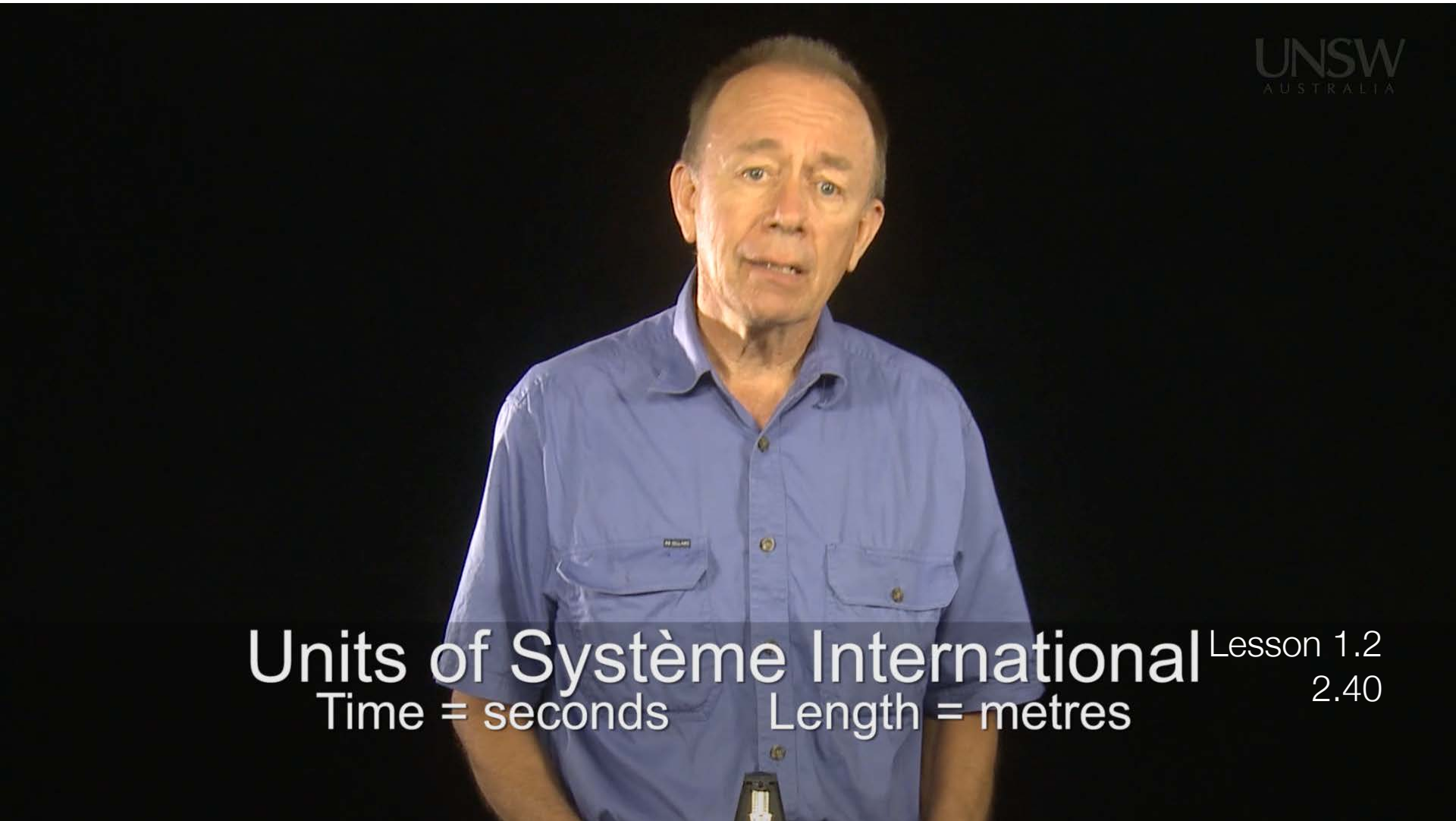
$$= 31\,556\,736\ \text{s}$$

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

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



Units of time and length



The average speed of the train

At this position on the door:

$1.22\ m \rightarrow 764$ pixels

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

If the distance from the camera is fixed,

Door moves 2 pixels $\rightarrow$ 3 mm

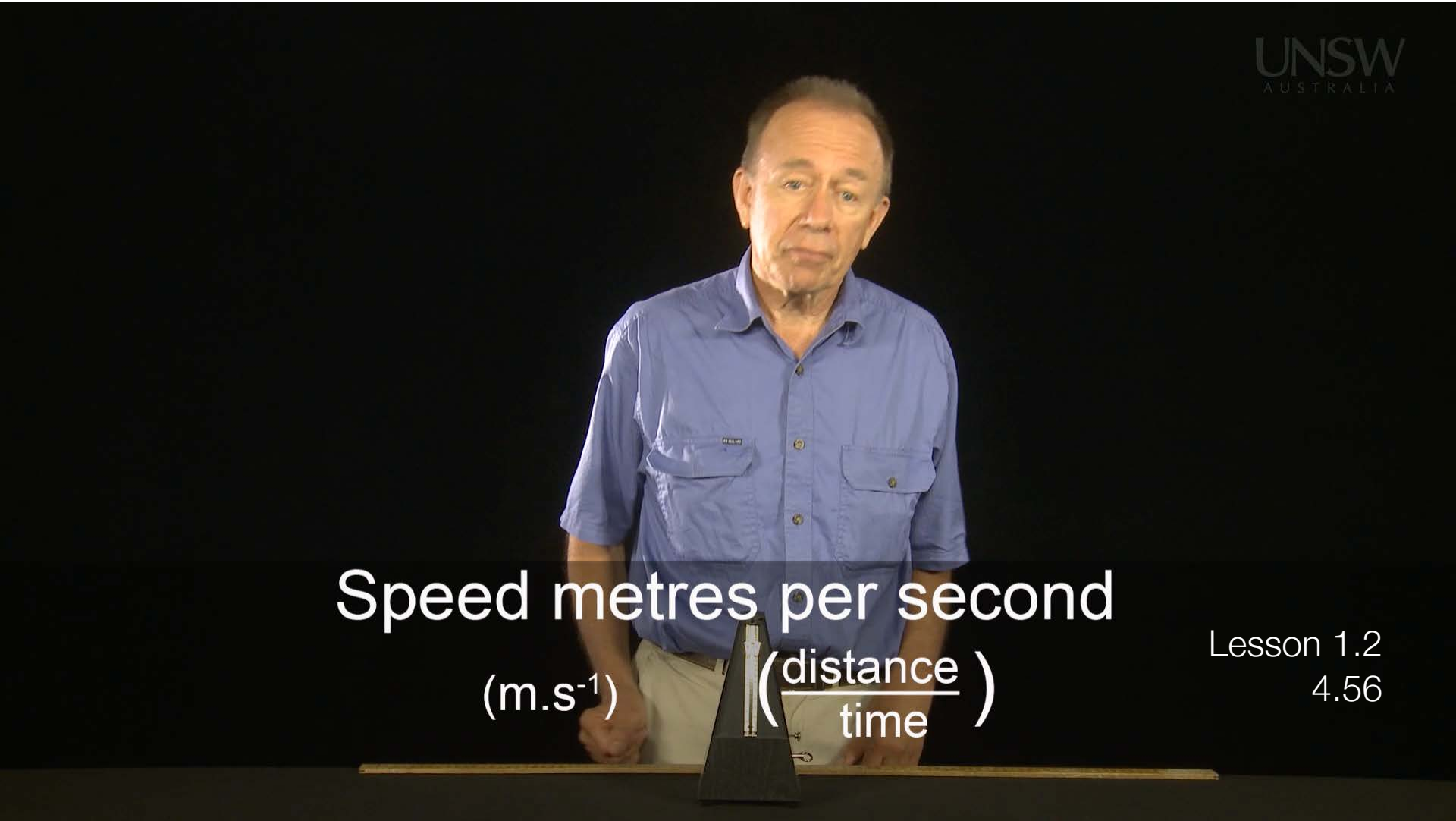
30 frames per s $\rightarrow$ time

$$\text{Average speed} = \frac{\text{distance}}{\text{time}} = \frac{3\ mm}{1/30\ s}$$

$$= 0.09\ m\,s^{-1}$$

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

Speed – metres per second



Metres per second to kilometers per hour

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

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

Kilometers per hour to miles per hour

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

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

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

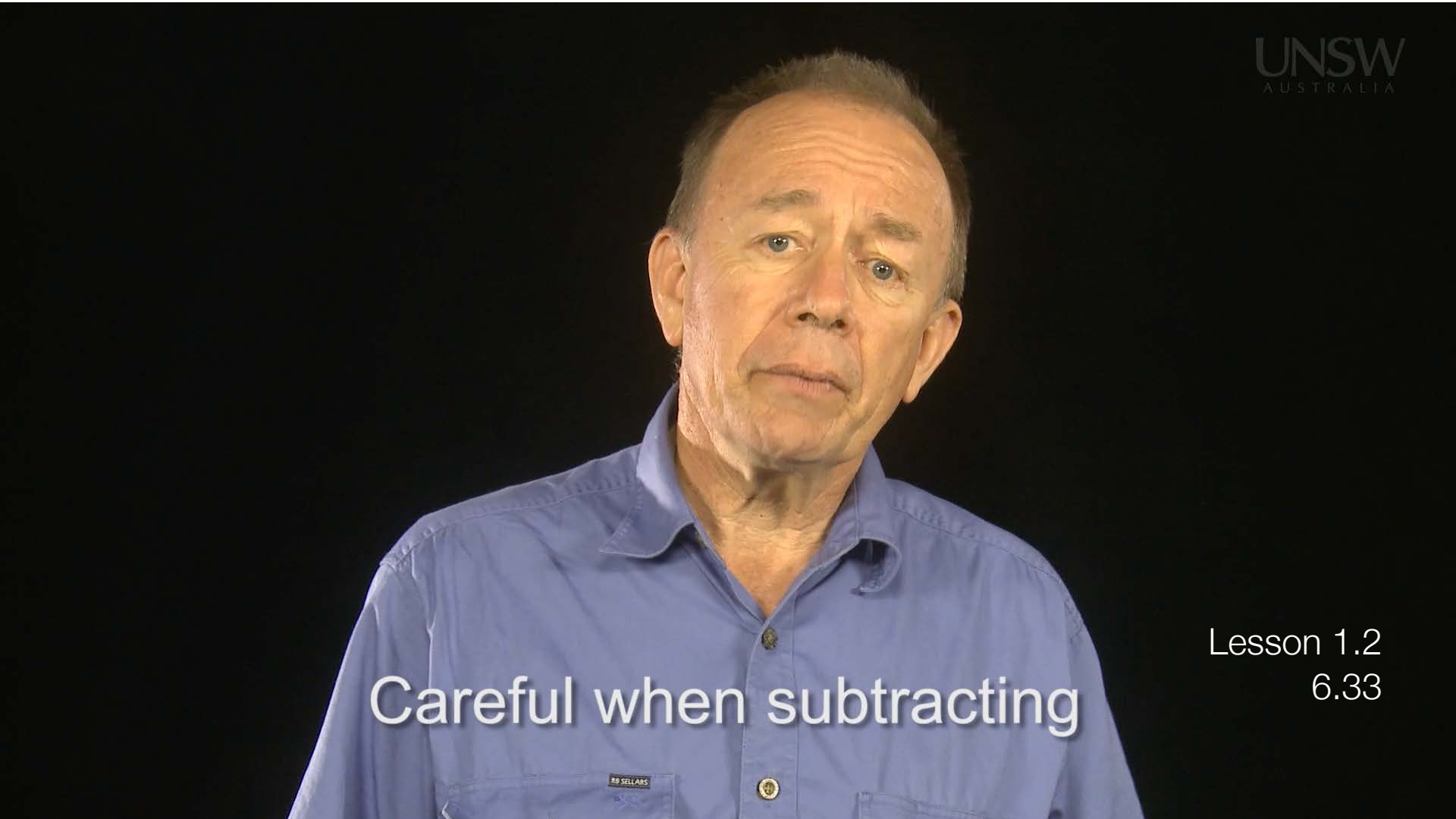
$= 55.1 \text{ miles per hour}$ ✓

$= 55.083\ldots \text{ miles per hour}$ ✗

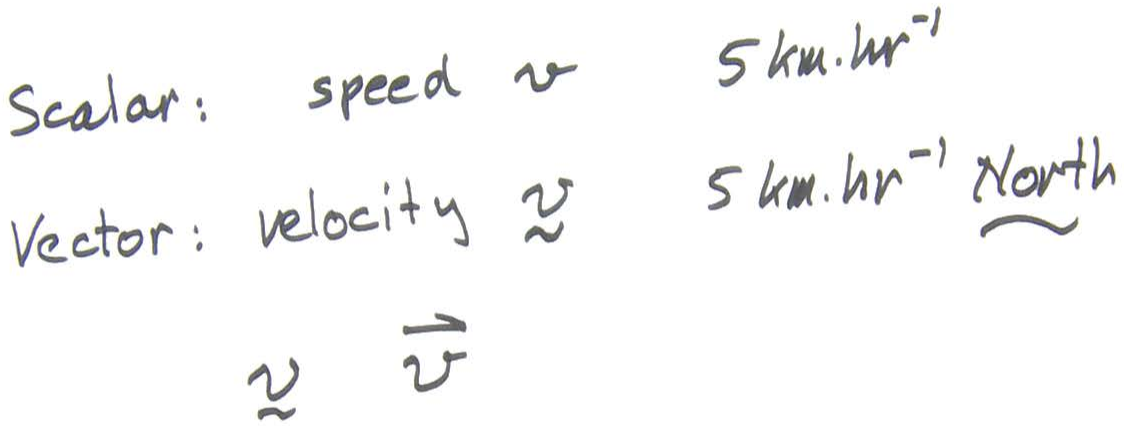
$= 55.1$ ✗

Dimensions of distance over time

Proportional error when subtracting



Scalars and vectors – how they are notated

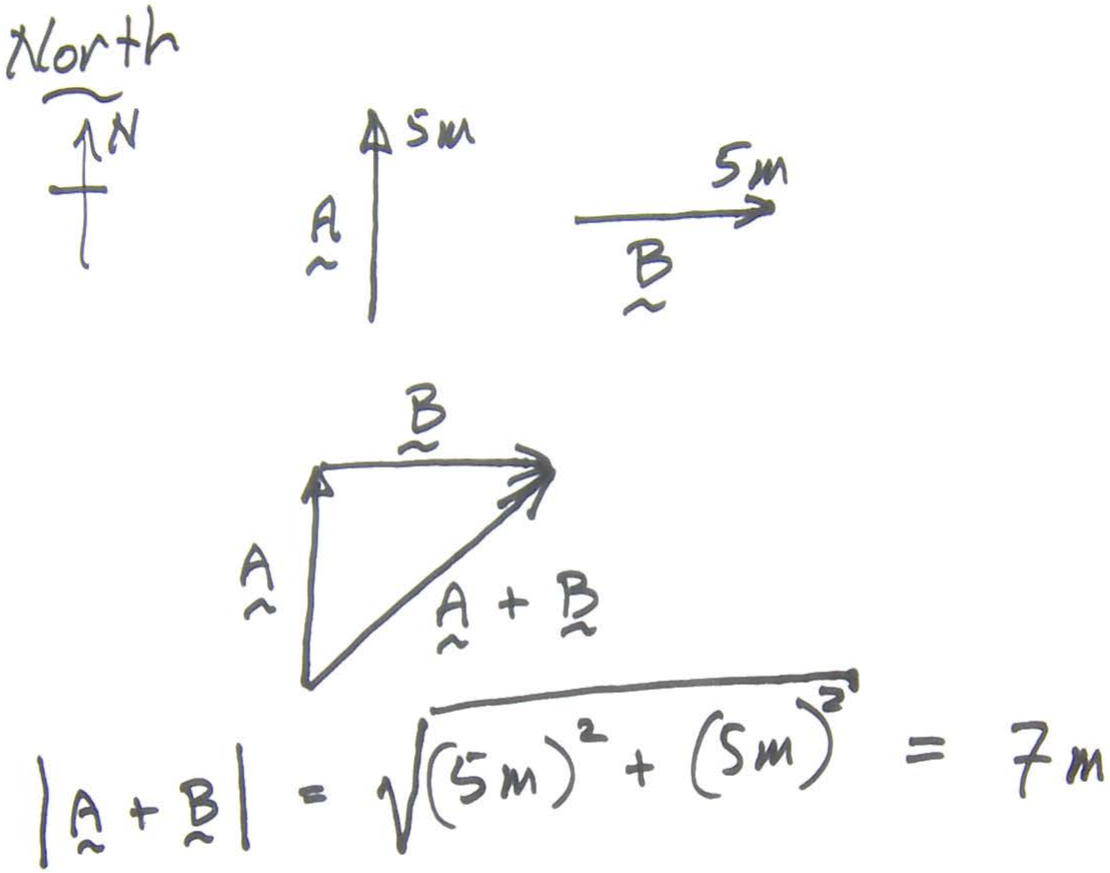


Printing notation

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

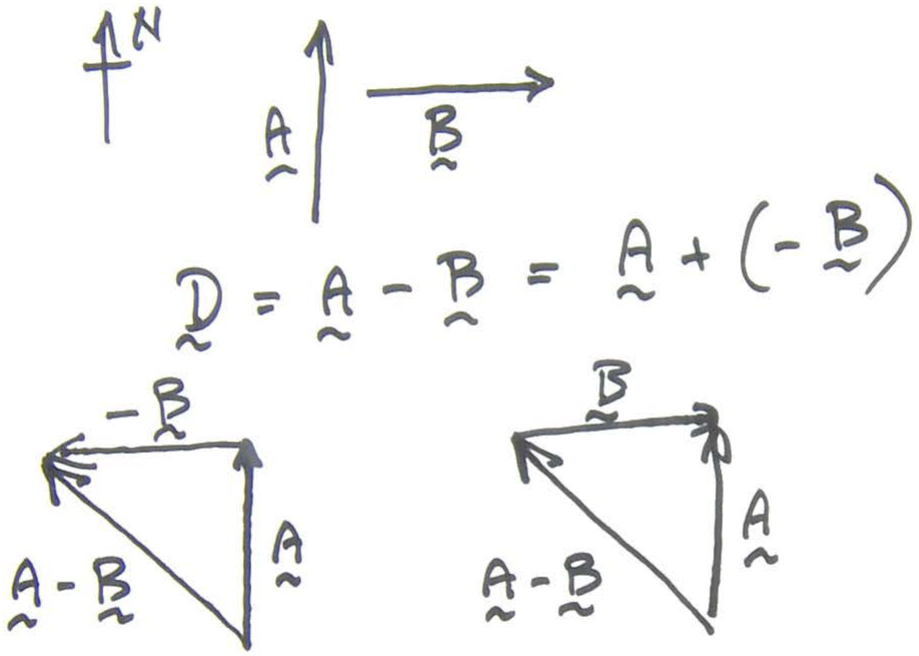
Vector e.g. velocity, **v** 5 km/hr North

Adding vectors



Lesson 1.3
3.02

Subtracting vectors



Lesson 1.3
3.57

Estimation – how many grains of sand?

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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