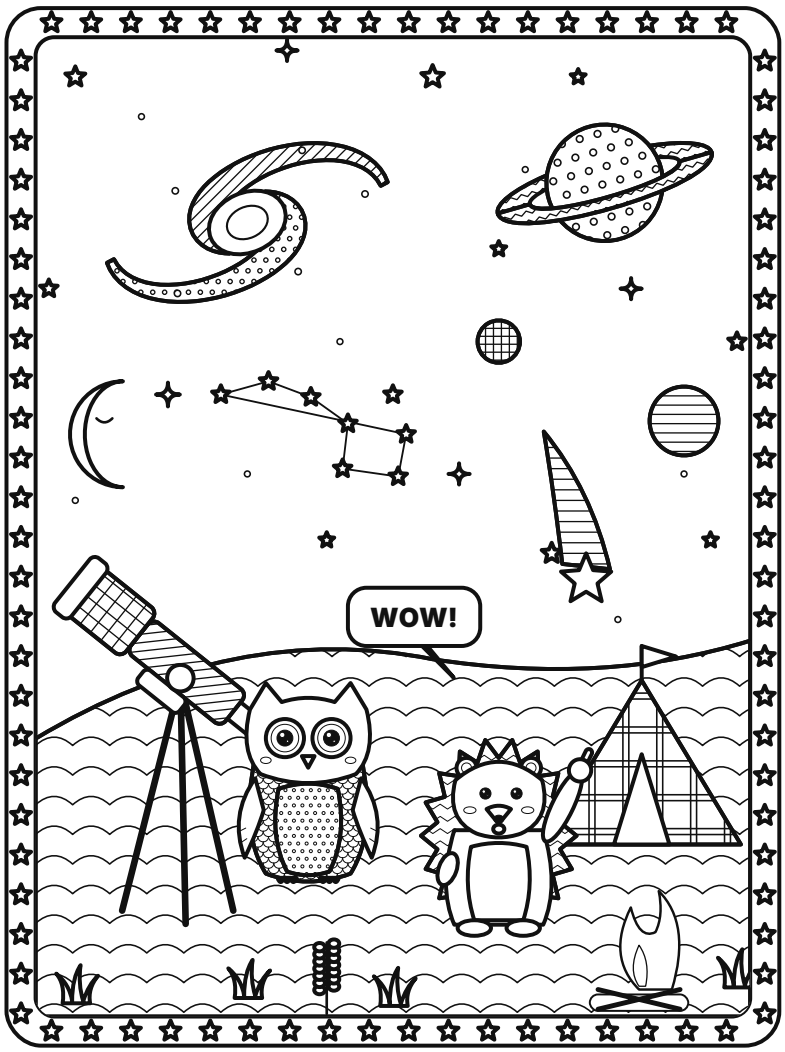
REAL-LIFE PHYSICS

Dynamics and Space

Workbook for National 5 Physics

Unit: Dynamics and Space



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Blewis LEARNING

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How to use this book

This book covers Dynamics and Space for National 5 Physics: vectors, motion graphs, acceleration, forces, energy, projectiles, space exploration and cosmology. Each topic follows the same pattern, so you always know what comes next.

EACH TOPIC HAS

Opener	the story for the topic, what you will learn and the key words
Learn pages	short explanations with diagrams, and questions to try
Practical	You plan the investigation yourself, carry it out safely, take repeat readings, draw a graph and evaluate your method.
Brain break	a calm puzzle or colouring page
Check-up	a few questions to show what you know, and a checklist

PRACTICAL WORK: STAY SAFE

- Only start a practical when an adult says it is OK.
- Read the whole method and the Stay safe table first.
- Tell your teacher about anything that might affect you, like asthma or an allergy.
- Stop and tell an adult if you feel unwell or something goes wrong.

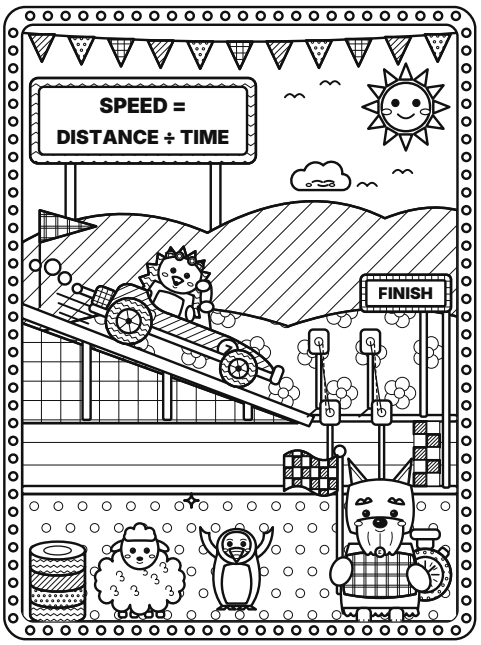
NO LAB TODAY?

Every practical has a set of example results. If you could not do the experiment, use these to finish the results, graph and conclusion.

DOODLE CORNERS

Some pages have a doodle corner. Colour it or doodle in it when you need a short break.

Vectors and scalars



The rescue team walked 9 km to reach a lost hillwalker, but the helicopter flew only 4 km. Which number tells you where the walker is?

Theme: Glen Arrin mountain rescue. Zara is training with the Glen Arrin mountain rescue team. She must describe where people are and how fast they are moving, so the helicopter crew know exactly where to go.

IN THIS TOPIC YOU WILL LEARN TO

Skill 1	sort quantities into scalars and vectors, and tell distance from displacement and speed from velocity
Skill 2	find the resultant of two vectors in a line or at right angles, by calculation or scale diagram
Skill 3	measure average and instantaneous speed, and use $d = \bar{v}\,t$ and $s = \bar{v}\,t$

KEY WORDS

Scalar	size only, e.g. distance, speed, mass
Vector	size and direction, e.g. displacement, velocity, force
Displacement	straight-line length from start to finish, with a direction
Velocity	speed in a stated direction
Resultant	one vector with the same effect as several added together
Bearing	direction clockwise from north, three figures, e.g. 045

❶ Scalars and vectors

A **scalar** has size only. A **vector** has size **and** direction. Distance and speed are scalars; **displacement** and **velocity** are their vector partners. Force, weight and acceleration are vectors. Mass, time and energy are scalars.

DISTANCE OR DISPLACEMENT?

Distance is the total length of the path. Displacement is the straight line from start to finish, with a direction. A runner who finishes one lap where she started has run 400 m but has a displacement of **0 m**.

SPEED OR VELOCITY?

Average speed is distance divided by time. Average velocity is displacement divided by time, in the direction of the displacement. A vector answer is not complete without its direction.

RELATIONSHIPS

$$d = \bar{v}\,t \qquad s = \bar{v}\,t$$

d, s	distance or displacement in metres (m)
$\bar{v}$	average speed or average velocity in m/s
t	time in seconds (s)

1 Write **S** (scalar) or **V** (vector) for each quantity.

distance	force	mass	velocity	energy	acceleration

2 Owen jogs 600 m north along the shore, then 600 m back south to the slipway where he started. It takes 400 s. State his distance and his displacement, then calculate his average speed and average velocity.

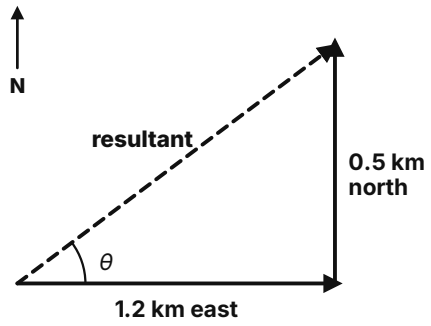
Answer:

3 Explain why weight is a vector but mass is a scalar.

Answer:

2 Adding vectors

In a line: choose one direction as positive and add, e.g. a 700 N push forward and a 250 N drag backward give 450 N forward. **At right angles:** draw the vectors **tip to tail**. The **resultant** joins the start to the finish. Use Pythagoras for its size and tan for its direction, or draw an accurate scale diagram (state the scale, measure the line and the angle).



WORKED EXAMPLE

A rescuer walks 1.2 km east, then 0.5 km north. Find her displacement.

Size	$s = \sqrt{(1.2^2 + 0.5^2)} =$ **1.3 km**
Direction	$\tan\theta = \frac{0.5}{1.2}$, $\theta = 23°$ north of east
Bearing	$90 - 23 =$ **067**

BEARINGS

Bearings are measured clockwise from north, with three figures: 067, not 67. Or give an angle and say what it is from, e.g. 23° north of east.

1 Two forces act on a sledge: 80 N east and 60 N north. Calculate the size and direction of the resultant force.

Size

Direction

Answer

2 A kayak paddles at 3.0 m/s due north across the loch. The wind pushes it 1.0 m/s due east. Calculate its resultant velocity.

Size

Direction

Answer

3 A tug pulls a boat with a force of 900 N forward. The water drags the boat with a force of 350 N backward. What is the resultant force?

Answer:

PRACTICAL 1

Plan it: does the card length change the speed you measure?

AIM To find out how the **LENGTH OF THE CARD** affects the **INSTANTANEOUS SPEED** measured for a trolley released from the same point on a ramp.

1 Variables

I will change the independent variable	
I will measure the dependent variable(s)	
I will keep the same controlled variables (give two)	

2 Prediction

I think that .....

because .....

3 Equipment

Tick the equipment you need. Not everything here is useful.


☐ Trolley


☐ Ramp


☐ Light gate



☐ Timer or logger


☐ Cards

☐ Ruler


☐ Thermometer

4 Stay safe

The first row is done for you. Add two more hazards.

Hazard What could cause harm?	**Risk** What could happen?	**Control** How will I stay safe?
Trolley running off the end of the ramp	It falls on someone's foot	Put a stop at the bottom and catch the trolley.

Method and results

5 Write your method

1. How will you set up the ramp, the start point and the light gate?

2. How will you measure each card and fix it to the trolley?

3. How will you release the trolley so every run is the same?

4. How many repeats? How will you work out the mean speed and its uncertainty?

6 Results

Complete the headings, including units.

				Mean time	Speed

NO LAB TODAY? USE THESE RESULTS

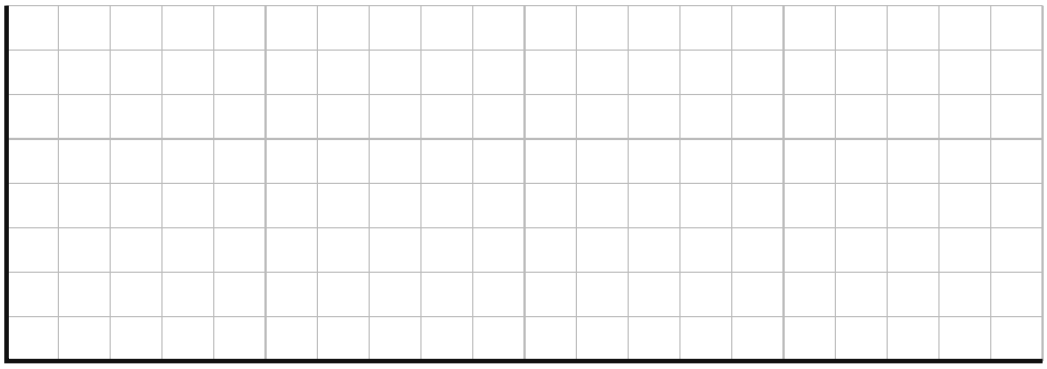
Card length (cm)	Time 1 (s)	Time 2 (s)	Time 3 (s)	Mean time (s)	Speed (m/s)
2.0	0.0250	0.0248	0.0252		
3.0	0.0370	0.0368	0.0372		
4.0	0.0488	0.0486	0.0490		
5.0	0.0602	0.0600	0.0604		
6.0	0.0714	0.0712	0.0716		

Trolley released from the same mark each time; light gate 60 cm down the ramp. Work out the means and speeds yourself.

Analyse and evaluate

7 Draw a line graph

Plot speed against card length. Choose your own scales, label both axes with units and draw a line of best fit.



> **RANDOM UNCERTAINTY**
> Random uncertainty = (largest − smallest) ÷ number of readings. Write the result as mean ± uncertainty with the unit. Times 0.0370, 0.0368 and 0.0372 s: mean 0.0370 s, uncertainty (0.0372 − 0.0368) divided by 3 = ±0.0001 s. Work out the uncertainty for your 4.0 cm card.

Answer:

8 Conclusion

As the card length increased, the measured speed

9 Evaluate

a Which card gives the best value for the instantaneous speed? Explain.

Answer:

b Give one way to make the results more reliable, and one way to make them more accurate.

Answer:

> **ASSIGNMENT LINK**
> For an assignment you would compare your speed with a value from another source (for example a data logger or a published value) and give a reference for that source.

FREE SAMPLE

Dynamics and Space (N5 Physics)

This sample shows a few pages. The full printed workbook is available from Amazon.

blewislearning.co.uk

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