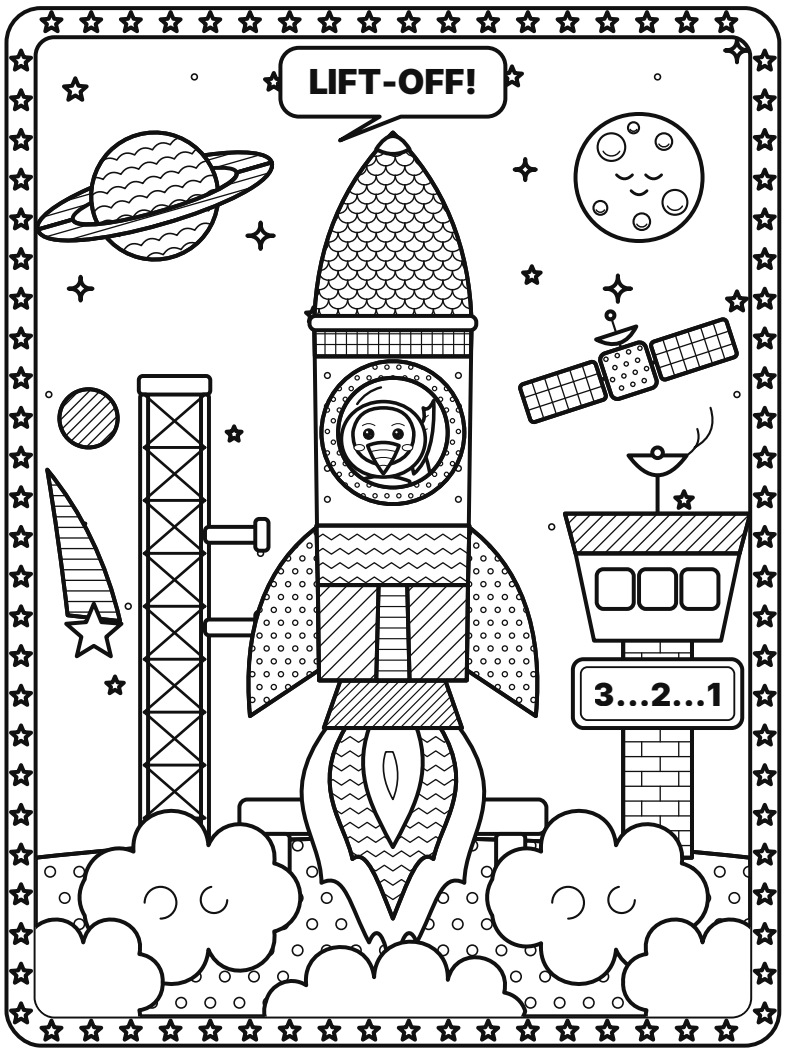
REAL-LIFE PHYSICS

Dynamics and Space

Workbook for National 4 Physics

Unit: Dynamics and Space



C. Blewis

Blewis LEARNING

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How to use this book

This book is about motion and space: how fast things move, what forces do, how satellites stay up, and our place in the universe. 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.

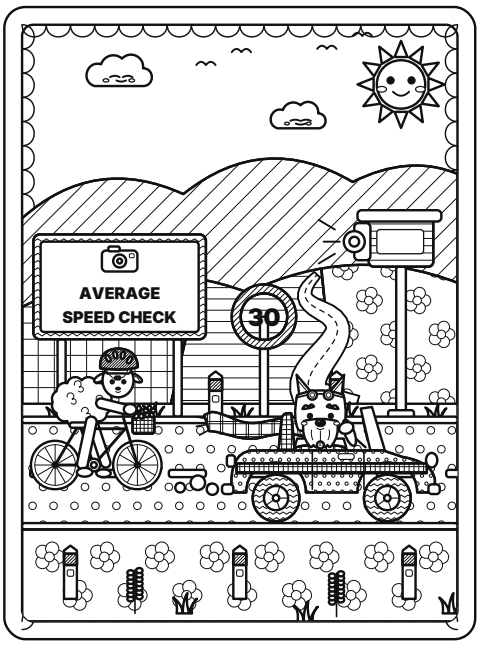
NO LAB TODAY?

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.

Speed, distance and time



Everything that moves has a speed. Physicists measure it in metres per second. In this topic you will find out how to work it out.

Theme: road safety week. It is road safety week at Glen Arrin School. Finn and Zara want to show how fast cars, bikes and buses really move past the school gate. First they need to know how to measure and calculate speed.

IN THIS TOPIC YOU WILL LEARN TO

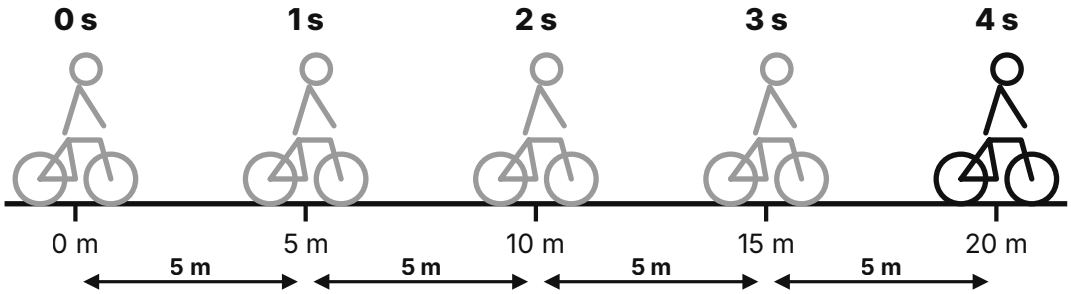
Skill 1	calculate speed, distance or time using d = v t
Skill 2	change minutes and hours into seconds and use the right units
Skill 3	plan and carry out a test to measure average speed

KEY WORDS

Speed	how far something travels in each second (or each hour)
Distance	how far something travels, measured in metres (m)
Time	how long something takes, measured in seconds (s)
Average speed	total distance travelled ÷ total time taken
m/s	metres per second: the unit of speed used in physics
km/h	kilometres per hour: used for longer journeys

❶ What is speed?

Speed tells you how far something travels in a certain time. Zara cycles past the school. Every second she moves another **5 metres**, so her speed is **5 metres per second**, written **5 m/s**.



In physics we measure speed in **metres per second (m/s)**. For long journeys, **kilometres per hour (km/h)** is often used. UK road signs use **miles per hour (mph)**. You only need to recognise mph.

Moving thing	Typical speed
Person walking	1.5 m/s
Person cycling	5 m/s
Car in a 30 mph zone	13 m/s
Fast train	56 m/s (200 km/h)
Sound in air	340 m/s
Light	300 000 000 m/s

1 Circle the **three** units of speed.

(m/s) (kg) (km/h) (s) (mph) (m)

2 Finn walks 3 metres every second. What is his speed?

Answer: .....

3 Use the table. About how many times faster than a cyclist is a fast train?

Answer: .....

4 Finn says a speed of 13 m/s is faster than 13 km/h. Is he right? Explain your answer.

Answer: .....

.....

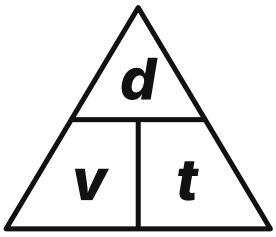
❷ The speed relationship

Distance, speed and time are linked by one relationship. If you know two of them, you can work out the third.

RELATIONSHIP

$$d = v\,t$$

d	distance in metres (m)
v	speed in metres per second (m/s)
t	time in seconds (s)



Rearranging. Cover the one you want in the triangle:

speed $\mathbf{v = \frac{d}{t}}$ time $\mathbf{t = \frac{d}{v}}$ distance $\mathbf{d = v \times t}$

Always show three steps: write the relationship, substitute the numbers, then give the answer with its unit.

WORKED EXAMPLE

Ava cycles at 5.0 m/s for 40 s. How far does she go?

Relationship d = v t

Substitute d = 5.0 × 40

Answer **d = 200 m**

WORKED EXAMPLE

Isla runs 100 m in 16 s. What is her average speed?

Relationship $v = \frac{d}{t}$

Substitute $v = \frac{100}{16}$

Answer **v = 6.25 m/s**

1 Jay walks at 1.5 m/s for 80 s. How far does he walk?

Relationship

Substitute

Answer

2 A bus travels 600 m in 50 s. What is its average speed?

Relationship

Substitute

Answer

PRACTICAL 1

Plan it: how fast does a trolley roll?

AIM To find out how the **HEIGHT OF A RAMP** affects the **AVERAGE SPEED** of a trolley rolling down it.

1 Variables

A fair test changes **one** thing and keeps everything else the same.

I will change the independent variable	
I will measure the dependent variable	
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 or board**


☐ **Books or blocks**


☐ **Metre stick**


☐ **Stopwatch**


☐ **Thermometer**


☐ **Balance**

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 rolling off the end of the ramp or bench	It falls and hurts someone's foot	Put a stop (a bag or a block) at the bottom. Catch the trolley.

Method and results

5 Write your method

Write clear steps someone else could follow.

1. How will you set up the ramp and change its height? How will you measure the height?

2. How will you mark the start and finish lines? How far apart will they be?

3. How will you release the trolley and time it? Who does what?

4. How many times will you repeat each height? How will you work out the average speed?

6 Results

Complete the headings, including units. Then fill in your results.

				Average time	Average speed

WORKING OUT THE AVERAGE SPEED

Average the three times: $\frac{1.38 + 1.44 + 1.41}{3} = \frac{4.23}{3} = 1.41$ s. Then $\mathbf{v = \frac{d}{t}} = \frac{1.00}{1.41}$ = **0.71 m/s**.

NO LAB TODAY? USE THESE RESULTS

Height (cm)	Time 1 (s)	Time 2 (s)	Time 3 (s)	Average time (s)	Average speed (m/s)
5	2.41	2.35	2.47		
10	1.72	1.66	1.75		
15	1.38	1.44	1.41		
20	1.22	1.17	1.24		
25	1.06	1.10	1.02		

Start and finish lines 1.00 m apart. The trolley was released from rest at the start line. Work out the averages yourself.

Analyse and evaluate

7 Draw a line graph

Choose your own scales. Label both axes with units. Plot the average speeds and draw a smooth line.



8 Conclusion

As the height of the ramp increased,

9 Explain

This happens because

10 Evaluate

a Were your repeat times close together? What does this tell you?

Answer:

b Your reaction time affects the stopwatch reading. Give one improvement and explain how it would make the results more accurate.

Answer:

FREE SAMPLE

Dynamics and Space (N4 Physics)

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

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