Student Workbook

MEET ELIUD KIPCHOGE

On a misty Saturday morning in Vienna, on 12 October 2019, the INEOS 1:59 Challenge took place.

Kenyan Eliud Kipchoge, an eight-time major marathon winner and three-time Olympic medallist, became the first person to break the last barrier in modern athletics, by running a sub-two hour marathon. He completed the gruelling 26.2 miles in 1 hour 59 minutes and 40 seconds!

For an athlete to achieve this amazing sporting feat is truly remarkable. Behind the scenes was an incredible support team of 150 staff, plus 41 pacemakers all working within STEM. From the Performance Manager, to Eliud's long-term Coach, Data Scientists, Nutritionist, Physiotherapist, Sports Doctor, Performance Analysts, Marketeers and many more, all with one mutual goal, to support Eliud in achieving sporting history whilst proving one of his favourite phrases that 'No Human is Limited'.

JOIN THE TEAM!

You are part of the team working for INEOS 1:59. You are going to step inside the shoes of a 1:59 Data Scientist. Your task is to repeat a sub-2 hour marathon with your team. You will need to carry out a series of experimental investigations in order to meet this challenge and there are three areas to consider:

- Pacemakers
- Nutrition and
- Course Selection.

HOW TO BEGIN

- The following details will give you background information to help you consider each of the areas so you can make your recommendation at the end of this workbook.

Videos

Watch the following videos for background information on Eliud's 1:59 challenge:

- From London to Eldoret: INEOS 1:59 Challenge Documentary – Part One
- Preparing to create history: INEOS 1:59 Challenge Documentary Part Two
- The Road to Vienna: INEOS 1:59 Challenge Documentary – Part Three
- Arriving in Vienna: INEOS 1:59 Challenge Documentary – Part Four
- 1:59 Challenge Live
- Sub 2 hour Marathon – NIKE #Breaking2 Attempt
- The Role of the INEOS 1:59 Challenge Pacemakers
- Explaining the INEOS 1:59 Challenge Pacemaker Formation
- Interview with 1:59 Nutrionist Armand Bettonviel

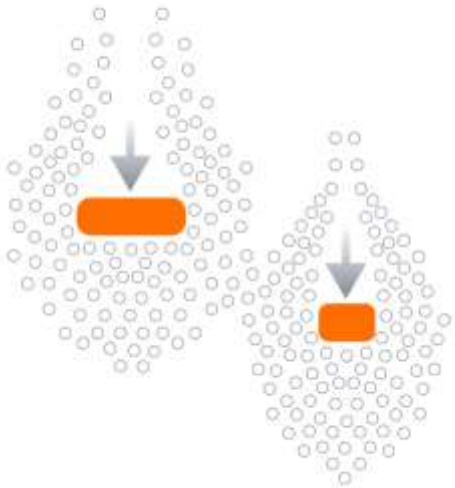
PACEMAKERS

Marathons

- The average time to complete a marathon for men is 4 hours 30 min and for women 4 hours 45 min.

Air Resistance

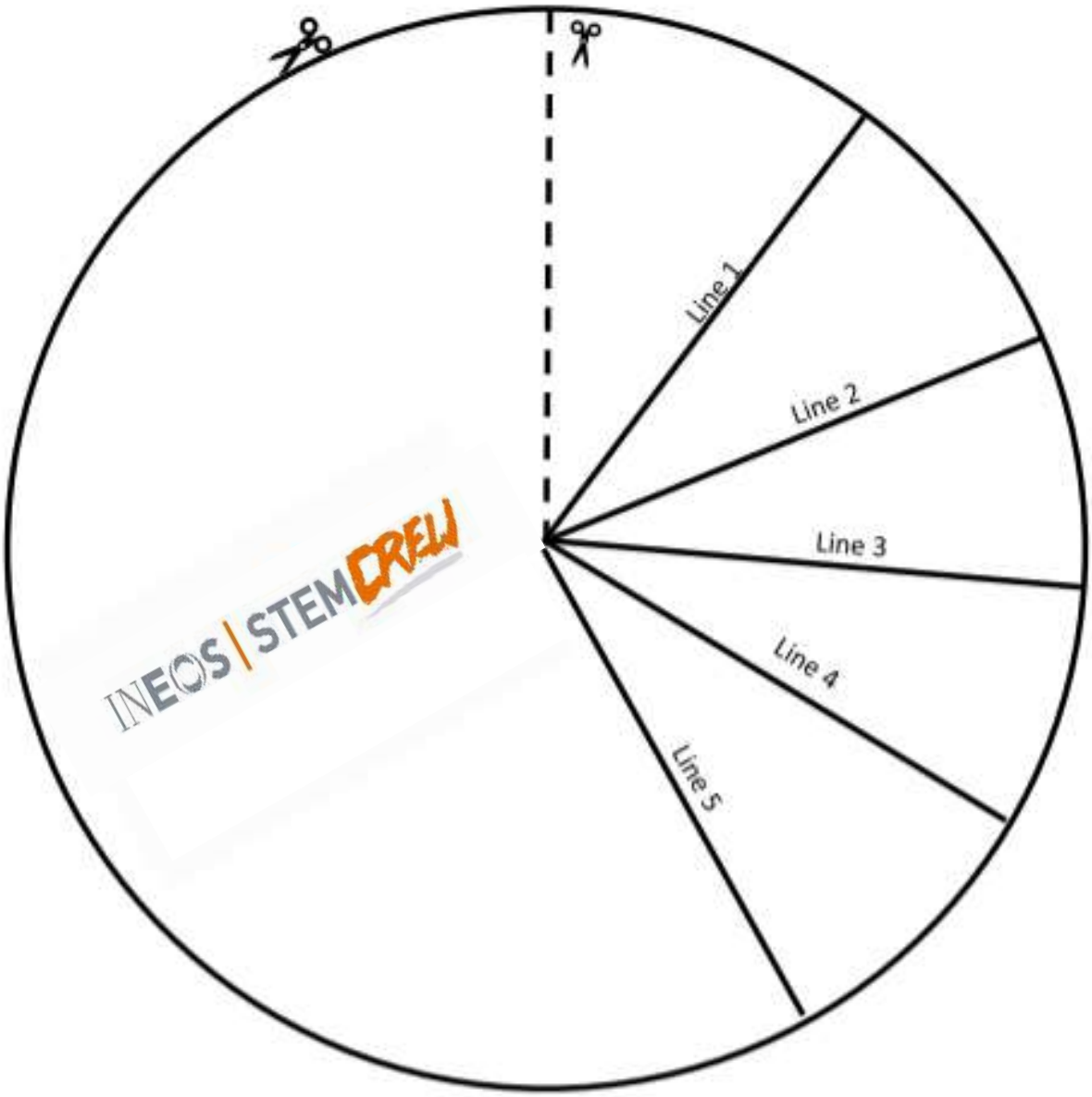
- Wind, temperature, and altitude all have a common link, they all affect the air resistance acting on the runner.
- Whenever an object moves through air it hits air particles. The larger the object the more particles hit the object.



What effect do these particles have on the speed of a moving object?

Quick Forces Activity

- For this activity you will need to print out this 'cone' sheet and follow the instructions.



To make your cone:

1. Cut out the circle carefully.
2. Cut along the dashed line to the centre of the circle.
3. Fold the straight edge round to Line 1 and fix with a **small** piece of masking tape.
4. To make a tighter cone – fold round to Line 2, 3, 4 and 5, fixing with the tape.
5. DO NOT CUT THE PAPER AGAIN WHEN CHANGING THE "SIZE" OF THE CONE.

Which shape of cone do you predict will have the lowest air resistance and why?

What sort of height would give the most accurate results? Why is this important?

How else can we ensure the accuracy of our results?

How else can we ensure the accuracy of our results?

Record your results from the Forces Cone Drop Activity in this table:

Height dropped: _____metres

Cone Size	Attempt 1 (Metres per Second)	Attempt 2	Attempt 3
Line 1	**m/s**	**m/s**	**m/s**
Line 2	**m/s**	**m/s**	**m/s**
Line 3	**m/s**	**m/s**	**m/s**
Line 4	**m/s**	**m/s**	**m/s**
Line 5	**m/s**	**m/s**	**m/s**

- The activity demonstrates that although we can't see air particles, air resistance makes a big difference to the speed of an object moving through it.

2:50 minute challenge - You have got the time it takes Eluid to run 1km to work with your talking partner to think of as many factors that affect running speed as possible.

Task: Air Resistance Investigation

Task: with your partner/team write a prediction about your pacemaker formation e.g.: I predict an 'inverted v' will minimise air resistance the most.

Remember – your prediction may be proved or disproved in your investigation

Use the following table to record your results in:

Formation	Location of runner at start	Location of runner trial 1	No. of mm	Location of runner trial 2	No. of mm	Location of runner trial 3	No. of mm	Average of 3 trials (mm)

Use this graph paper to draw your graph 'Pacemaker Formation V Runner Movement'.

How do you know which formation was the most effective at minimising air resistance?

Pacemaker: Conclusion

Tips!

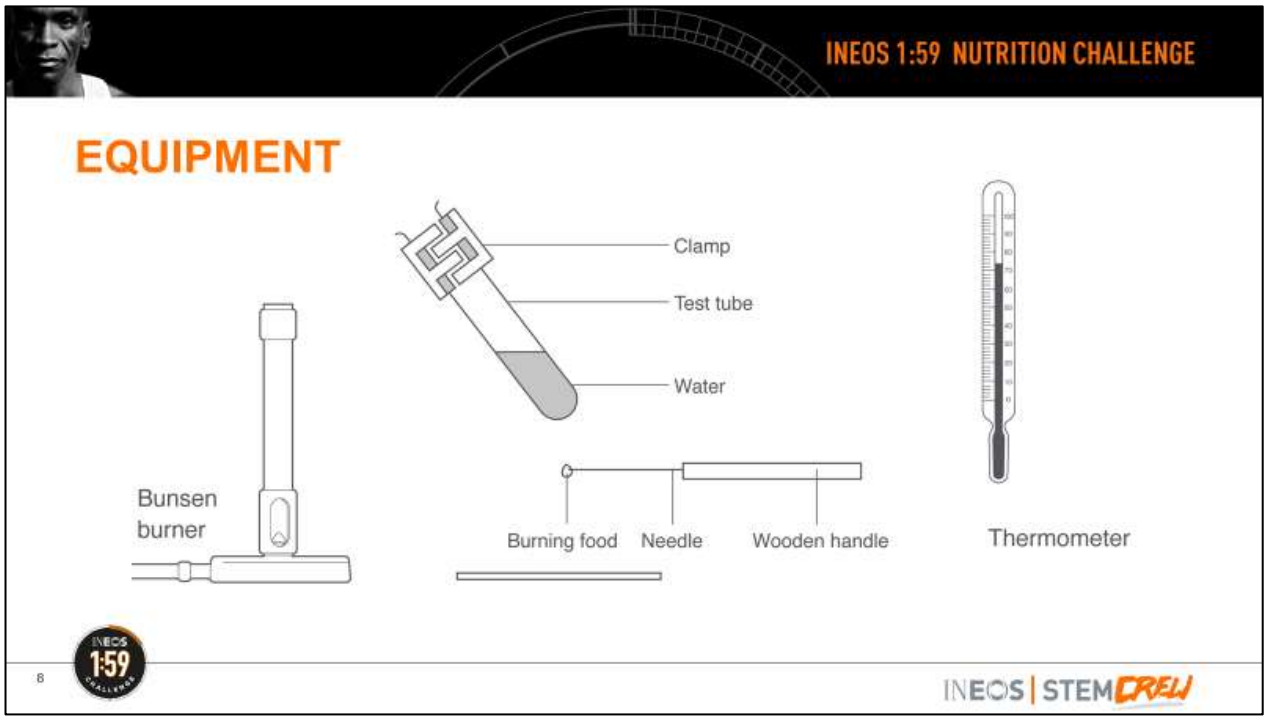
- Remember that your conclusion should have 2 parts.
- State your findings and then the counter argument to your findings.
- Ensure you've answered the original questions posed at the start of your investigation.

Task: Use this space to write your conclusion.

NUTRITION

Task

- To plan what food should be eaten in order to complete a sub-2 hour marathon.
- Imagine you're the nutritionist for Team 1:59 Your task is to work out which foods have the most amount of energy stored in them.
- You have the following equipment available to you;



In your talking pair discuss: How could you work out which foods would contain the most energy? Write your thoughts below.

Recording Results

Tips!

- *You may wish to repeat the experiment approximately three times for each food in order to get an average temperature change.*
- *You will need to measure the mass of water in grams beforehand.*

Food 1:

Test	Mass of water (g)	Temperature of the water before (^{0}C)	Temperature of the water after (^{0}C)	Temperature change (^{0}C)
Test 1				
Test 2				
Test 3				

Food 2:

Name of food	Mass of water (g)	Temperature of the water before (^{0}C)	Temperature of the water after (^{0}C)	Temperature change (^{0}C)
Test 1				
Test 2				
Test 3				

Food 3:

Name of food	Mass of water (g)	Temperature of the water before (^{0}C)	Temperature of the water after (^{0}C)	Temperature change (^{0}C)
Test 1				
Test 2				
Test 3				

Food 4:

Name of food	Mass of water (g)	Temperature of the water before (^{0}C)	Temperature of the water after (^{0}C)	Temperature change (^{0}C)
Test 1				
Test 2				
Test 3				

Food 5:

Name of food	Mass of water (g)	Temperature of the water before (^{0}C)	Temperature of the water after (^{0}C)	Temperature change (^{0}C)
Test 1				
Test 2				
Test 3				

Calculating Energy Released

Calculate the energy released by each food type using this equation:

ENERGY RELEASED (J) = MASS OF WATER (G) X RISE IN TEMPERATURE (°C) X 4.2

Task: Use the space to show your calculations and then record the answers in the table.

Food Type	Energy Released (J)

Create a Graph Checklist

With a partner, create a checklist for the perfect graph. You should have at least four points on your list:

IN PAIRS-

The perfect graph should include:

- ✓ Title:
- ✓
- ✓
- ✓
- ✓
- ✓

Create your own graph of your results

Use this graph paper to draw your graph 'Food Type V Energy Released'.

- What data will you be plotting on the X-Axis?
- What data will you plot on the Y-Axis?

Nutrition: Conclusion

Tips!

- Remember that your conclusion should have 2 parts.
- State your findings and then the counter argument to your findings.
- Ensure you've answered the original questions posed at the start of your investigation.

Task: Use this space to write your conclusion.

COURSE SELECTION

To run a sub- 2 hour marathon you need to be able to run at a speed greater than 5.86 m/sec.

Running Challenge

- Can you run at a sub- 2 hour marathon pace for just 40m?
- Before you go out, calculate the time is should take you to run 40m at 5.86m/s (metres per second) pace. Record your answer to one decimal place.

DISTANCE ÷ SPEED = TIME

Use the space below to show your calculation and answer.

How did you get on?

- Did you manage to run at or above 5.86m/s pace? YES/NO
- Was it faster running in a straight line or round the square course? STRAIGHT LINE/SQUARE COURSE
- Record your time here:

Task

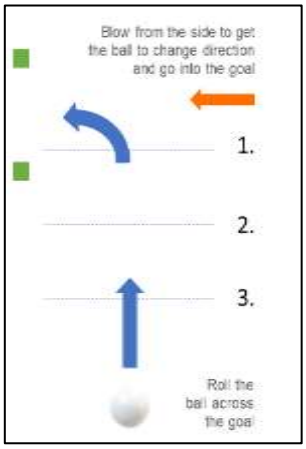
- You ran 40m, a marathon is 26.2 miles or 42,195m!
- How many times would you have to run a 40m course to complete a marathon?

Use this space to show your calculation and answer.

Changes in direction, radius of turns

From the marble activity you've just done. Answer the following:

- Which is easier?



- Why?

- Which requires more energy?

- We all know it is harder to run up hill but what difference does going round corners make?

- From what you have just learnt, how might it effect your design of a marathon course?

Calculating Angles

Look at Course 1 and answer the following:

- In the 10m square course 1, how many degrees does the runner turn at each corner?

- How many degrees does the runner turn in total on when completing one lap of course 1?

Look at Course 2 and answer the following:

- How many degrees do you turn in course 2?

- Which is the quicker course to run and why?

Calculating Angles Challenge

- The event team have measured the angles of potential running routes in Prater Park in Vienna.

Calculate the missing angles from the information they have provided?

Use the spaces to show your answers:

Using Bearings

What is the bearing of the return run from B to A?

YOUR RECOMMENDATIONS

It's your chance now as a member of the 1:59 team, to make your recommendation to the rest of the INEOS 1:59 project team.

Use the spaces below to share what your recommendation is and why you have chosen it.

My Pacemaker Formation recommendation:

My Nutrition/Food recommendation:

My Course selection recommendation:

MEET THE 1:59 CHALLENGE TEAM

Behind the 1:59 challenge, there was a support team of 150 staff, plus 24 pacemakers all working within STEM. Read the following profiles which might inspire you to get into a career in STEM!

Sir Dave Brailsford, General Manager of Team INEOS

Sir Dave Brailsford is a British cycling coach. He was formerly performance Director of British Cycling and is currently the General Manager of Team INEOS. Want to know more? View Sir Dave Brailsford's career profile.

Fran Millar, CEO Team INEOS

Fran Millar has recently been appointed as CEO of Team INEOS where she leads on the development of the Team's operational and governance systems alongside all of the business and engagement strategies. Fran has been with the Team from the very beginning and during this time she has played a key role in the successes and gained considerable experience in all areas of the team. Read on to learn more about Fran Millar's career.

Robby Ketchell, Performance Scientist

Robby has worked at the forefront of sport technology and data science for a decade. He was the Data Scientist for Team Sky, helping the team win three Tour de France titles. Among his many technological achievements, Ketchell is the creator of the fastest speed suit in the world, the BAT Box (the world's first on-board measuring device to replace a wind tunnel) and Platypus (cycling's first big data analytics tool). Want to learn more? View Robby Ketchell's career profile.

Tim Kerrison, Head Coach

Joining Sky Pro Cycling ahead of its first season on the road, Tim helped revolutionise the team's training methods, with success soon following in the form of Grand Tour victories. In addition to his role as Head Coach at Team INEOS, Kerrison is one of the most decorated coaches in sport. Want to learn more? Check out Tim Kerrison's full career profile.