

Frontiers of science

UNIT OBJECTIVES

Why is it important to keep making progress in science?

In this unit, you will:

Investigate

- ▶ Read a science article about biomimicry.
- ▶ Listen to a radio show about AI.
- ▶ Participate in a dialogue to explain what went wrong.
- ▶ Write a report on a scientific experiment.

Apply

- ▶ Produce a creative solution to a science problem.

9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



Discuss your opinions in class.

- 1 What was the most important historical invention or discovery?
- 2 What has been the most important scientific advance in recent years?
- 3 What is a scientific advance you hope will happen in your lifetime?

Kahoot!

The wonderful world of ...

VENOM?

Scientists in Australia were delighted when someone spotted an eight centimetre funnel-web spider, who became known as Hercules.

Amazingly, these terrifying animals can be found in normal gardens in the Sydney area. Working **carefully**, scientists can milk the spiders' venom to provide antidotes for hundreds of people suffering snake bites.

Interestingly, venomics – the study of venom – is **possibly** one of the most exciting areas of scientific development today. Over 200,000 species of animals, from spiders to snakes and frogs, produce venom which is **perfectly** created to target victims with deadly effect. Scientists say that understanding how venom works will **probably** enable us to create much better drugs to treat human illness.



Activate Look at the adjectives in the box and write the adverb form.

slow • good • fast • noisy • friendly

1 Put the adverbs in the box in order of probability.



31

almost certainly • definitely • maybe • perhaps • possibly • potentially • probably

definitely, ...

2 Read the text and answer the questions.

- Why was the discovery of Hercules important?
- How can venomous animals help humans?

3 Copy and complete the table with the three types of adverbs in bold in the text.

Probability (how possible)	Manner (how we do it)	Opinion (what we think)

4 Complete the table in exercise 3 with the words in the box.

angrily • definitely • exactly • fast • perhaps • surprisingly • unfortunately

5 32 Listen and check.

Vocabulary practice



4 Reading A science article

1 Quickly read the article title and section headings but don't read the complete text. Look at the photos. Then choose the sentences that are true.

- The article is about something called biomedicine.
- It connects nature and human inventions.
- It's only about learning from plants.

LEARNING TO LEARN

After reading the questions, scan the photos and section headings to find where the answers are. Then read the section in detail to find the answer.

2 Read questions 1–6. Without reading the article in detail, write where you think you can find the answer: in section A, B, C or D or in the photos.

- Is biomimicry a recent idea?
- What animal helped break Olympic records?
- When using biomimicry, how do scientists get ideas?
- Where did secondary school students in Singapore get inspiration?
- What aspects of train design were improved by observing birds?
- Who innovates using biomimicry?

NATURE *did it first!*

A WHAT IS BIOMIMICRY?

In short, the idea behind biomimicry is 'innovation inspired by nature'. Scientists look at how exactly nature does things and apply those ideas to solving human problems. Nature has taken 3.8 billion years to come up with the best solutions for life on this planet, so logically it's a great starting point for human innovation. As one expert said, 'The answers to the questions we've been asking are all around us.' Scientists could look at a leaf to design the best solar cell or see how animal skin resists water to design material for a coat.



Scientists invented Velcro® after observing how some plants stick their seeds to animals' coats.

B WHO USES BIOMIMICRY?

The answer is pretty much any scientist, from medical researchers to inventors to architects. The important thing is to observe how nature does things. Interestingly, some of the most successful innovators are scientists who are nature lovers in their free time.



Studying shark skin helped designers produce faster Olympic swimwear.

C IS BIOMIMICRY NEW?

Not at all. Although people probably started using the word biomimicry in about 1997, the idea has been around for centuries. Early humans learnt how to hunt and stay warm by copying animals. Leonardo da Vinci observed flowers falling from trees to design a helicopter and the Wright Brothers built their plane after watching pigeons fly.

D WHAT ABOUT YOUNG SCIENTISTS?

The Biomimicry Institute runs a Youth Challenge for secondary school students, who have to find bio-inspired solutions to real-world problems. Over 12,000 students from 21 countries have taken part. Recent winners include students from Singapore who observed a desert plant from South Africa and came up with a more efficient type of solar panel, and students from Islamabad, Pakistan, who copied the body structure of ants and snails which live in extreme heat to produce a new architectural design for houses. Maybe you could be the next winner!



Japanese engineer Eiji Nakatsu was also a birdwatcher. By studying birds which fish, he helped re-design the bullet train to reduce noise and electricity use.

- 3 **33 Read and listen to the article. Answer the questions from exercise 2.**
- 4 **Can you think of any other examples of biomimicry?**
- 5 **A student has thought about how the characteristics of an elephant could help science. Read the notes and think of another animal or plant. Write your own notes.**

Trunk: amazingly flexible – could be a model for robot arms

Skin: we can learn how to make water and heat-resistant materials by studying their thick skin

Feet: they look so small but they can carry a heavy elephant – architects can learn from this

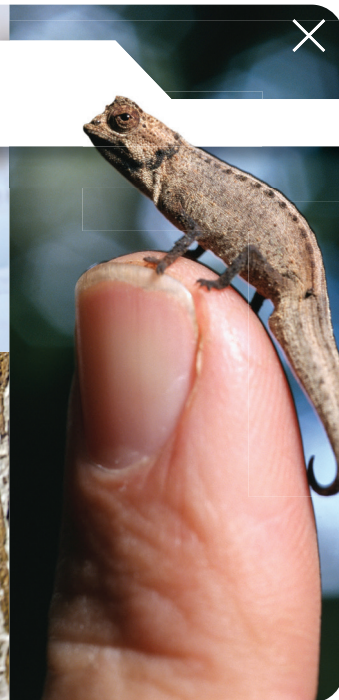
Project pathway 1

How do you generate new ideas? Make a mind map with strategies you can use to be creative.

Workbook Project preparation



WILD WORLD PODCAST



1 34 Listen to an advertisement for a podcast and choose the best title.

- 1 The risk of extinction
- 2 The undiscovered millions
- 3 Life in the rainforest

2 Complete the extracts from the podcast with the words in the box. Then listen again and check.

can't have discovered • could add • may exist •
may have gone • might be • must contain

- 1 Scientists estimate that we ____ more than 20% of all the species on Earth.
- 2 Tropical forests in Brazil, Indonesia and Madagascar ____ a lot of unidentified species.
- 3 Many more undiscovered animals ____ deep in the Earth and its oceans.
- 4 Scientists say there ____ nine million undiscovered animals and plants.
- 5 Including bacteria this ____ another trillion.
- 6 Some amphibians and reptiles ____ extinct without ever being identified.

3 Copy and complete parts 1–6 of the table with the expressions used to speculate in exercise 2.

	Past	Present
Very improbable	1	<i>can't be</i>
Possible	2	3 4 5
Very probable	<i>must have seen</i>	6

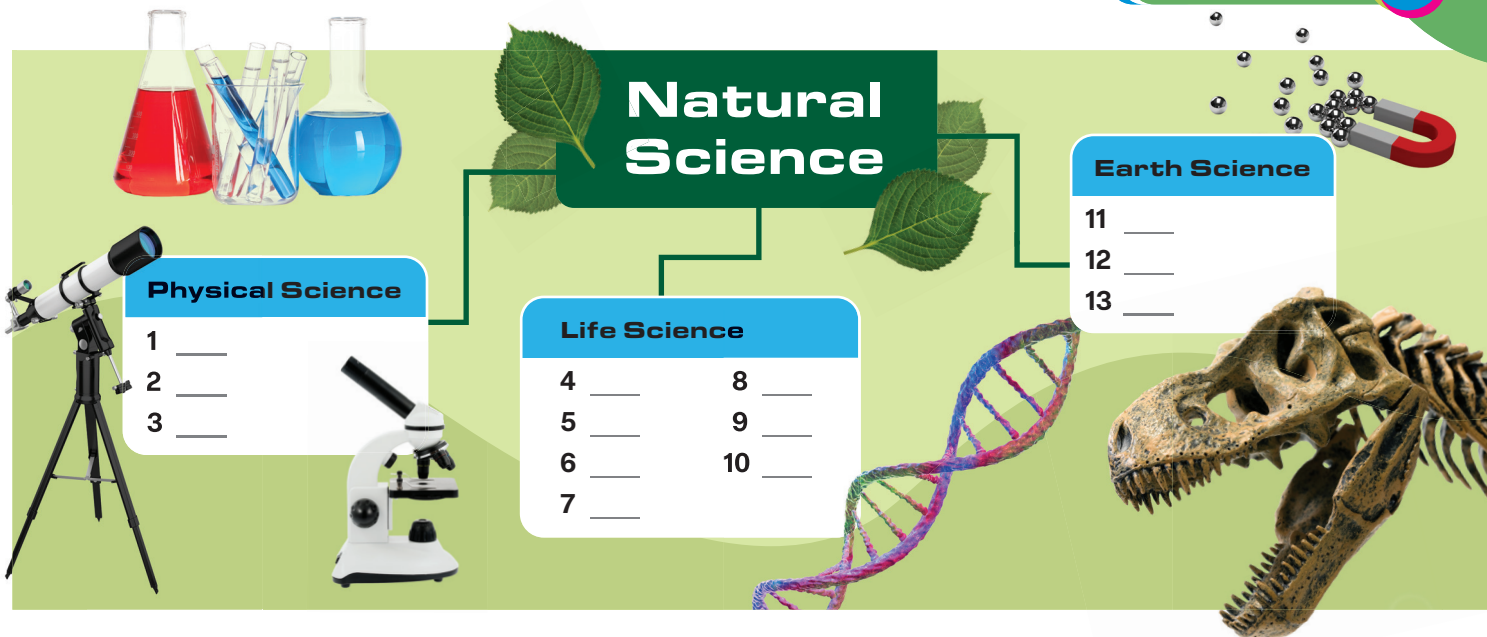
4 Choose the correct option.

- 1 I don't know where my phone is. I **might have left/ might leave** it at school.
- 2 Mrs Craig **must be/may be** here. Her car's in the car park.
- 3 You **must have seen/can't have seen** Jack: he wasn't in class today.
- 4 Mia **can't be/might be** in the library. We've got an exam tomorrow.
- 5 You **must have been/may be** delighted when you got your exam results.

5 School starts at 9:00 and at 9:15 Pablo is not in class. Write two sentences in the past tense and two sentences in the present tense speculating about the situation.

He might have missed the bus.





1 Complete the diagram with the branches of science in the box.



35
astronomy • biology • botany • chemistry •
ecology • genetics • geology • medicine •
meteorology • paleontology • physics •
psychology • zoology

Plurilingual competence Look at the endings of the words in exercise 1. How do we often translate nouns with these endings? Do all these words follow these patterns?

2 You have two minutes. Can you name the branches of science being described?

- 1 the relation between plants, animals and the environment
- 2 the study and treatment of illness and injuries
- 3 the scientific study of all living things
- 4 the study of the mind and of behaviour
- 5 the study of fossils and what they tell us
- 6 the science of matter, energy and their interactions

3 36 Listen to seven experts. Which branch of science does each person come from?

4 Which subject would you most and least like to study and why?

Now take a break and...

Vocabulary practice

YOU CHOOSE



Fun and games

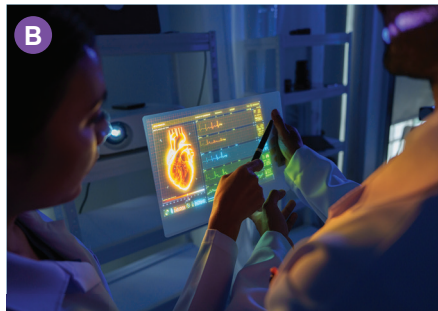
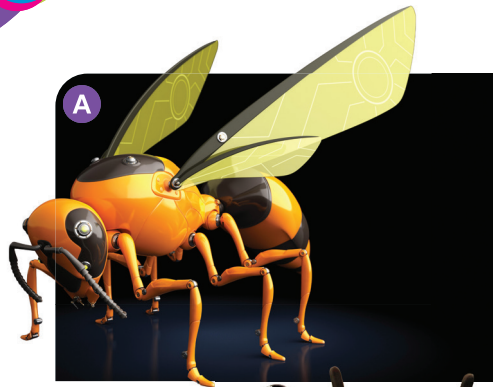
Game



Me time

Get creative!

What's trending?



1 Answer the questions.

- 1 What do you think the photos show us?
- 2 What is the connection between each image and Artificial Intelligence (AI)?

2 37 Listen to an extract from a radio show and put photos A–E in the order in which they are mentioned.

LEARNING TO LEARN

To verify information in summarising sentences, first read the information carefully. Then listen and underline differences, noting the correct information.

3 Listen again and find the mistakes in the summaries of what the experts said.

- 1 The presenter's name is Alexa and the first chatbot was called Maria.
- 2 AI is useful for detecting illness but can only work 12 hours a day.
- 3 With a smart toothbrush, people won't get bacteria in their mouths.
- 4 Some plants are becoming extinct so it's not important if bees disappear.
- 5 A Pet Bot looks and feels real and you also have to take it to the vet.

4 Correct the mistakes in exercise 3.

5 Discuss the questions.

- 1 Which use of AI described in the listening do you think is the most interesting?
- 2 Were there any ideas which you didn't like or didn't think were useful?

Social and emotional learning

Responsible decision making

Making positive choices can help you build your dreams.



6 Read the questions and write your answers.

Compare your answers with a partner.

- 1 Do you use AI to help with your studies? What programs do you use? How do you use them?
- 2 Does your school have rules about using AI?
- 3 What are the advantages and disadvantages of using AI in education?

Mediation Your uncle dislikes new technology. Send him a voice note with details about one of the innovations on the radio show which you think will make a positive impact on the world. Use the **Mediation guide**.





Daniel

Harriet

OK, so let's find out if we got it right. Oh no! The door won't open.

What??!!! What did we do **1** ____? I thought we followed all the instructions.

We were **2** ____ to decode the message, so that **3** ____ be it.

And we **4** ____ to find the three keys.

Yes, but we must have done something wrong ...

What **5** ____ the puzzle with the lights? I'm not sure we got that right.

Mmm, maybe we **6** ____ have started with blue like you said.

7 ____ we try again?

Yes, let's go for it.

- 1** Watch the conversation between Harriet and Daniel in an escape room. What do they think they did wrong?

Phrase bank

Thinking about potential problems

What did we do wrong? What happened?

What about the *puzzle* ...?

Maybe we should have *started with blue*.

Ruling out possible problems

We were able to do ... so that can't be it.

We managed to do ...

Continuing

Shall we try again?

Shall we give it another try?

- 2** Watch again. Which two expressions in the Phrase bank do you NOT hear?

- 3** Complete the dialogue with the missing expressions.

LEARNING TO LEARN

We use expressions to keep the conversation focused and avoid distractions.

- 4** Match the two parts of expressions from the text which are used to avoid distractions and keep things focused.

- | | |
|---------|-------------|
| 1 Let's | a about ... |
| 2 Yes, | b see ... |
| 3 What | c but ... |

- 5** Now practise this skill.

It's your turn

Work in pairs. Go to the Workbook and choose how much help you need. Create a dialogue discussing why something went wrong.



Watch the tips in the video.

SKILLS EXPERT

Prepare

Do

A lot of help

A little help

No help

Share

Evaluate

Workbook Speaking scaffolding

Project pathway **1**

Make a chart with the pros and cons of working with someone else when you want to solve a problem.

Workbook Project preparation

The world's greatest **ACCIDENTAL** inventions : #96 The microwave

1 One day, American engineer Percy Spencer was working in his lab producing electromagnetic waves.

2 Feeling hungry, he felt in his pocket for the peanut snack bar he **had put** there earlier.

3 **Yeeeeuch!** To his surprise, he discovered that the bar **had melted**.

1 Read the comic and put Spencer's story in the correct order.

- He felt hungry.
- He invented the microwave oven.
- He started working on the electromagnetic waves.
- He realised the waves could cook food.
- He put the snack bar in his pocket.
- The waves melted his bar.
- He found the melted bar in his pocket.

2 Look at the examples of the past perfect in bold in the comic and complete the rules with the expressions in the box.

earlier • time expressions •
had/hadn't • past simple

- We form the past perfect with ____ + past participle.
- We use the past perfect when talking about the past to describe an ____ past time.
- The past perfect is often used in contrast with the ____.
- When, before, after, ever, never, already* and *by the time* are ____ often used with the past perfect.

4 He realised that the electromagnetic waves **had cooked** the bar. And so – the microwave oven was born!

3 Write the past perfect form of the verbs *be, develop, not grow, kill, disappear*.

4  **38 Listen to the story of another accidental discovery. Say the verbs from exercise 3 to complete the story.**

5 Put the time expressions in brackets in a logical position in each sentence.

- Pia arrived at school, she realised she had forgotten her homework. (**when**)
- I had been to an escape room and I loved it. (**never**)
- Joe felt better he had done the exam. (**after**)
- Some fans left the match had finished. (**before**)
- We got to the cinema, the film had started. (**by the time, already**)

Checkpoint

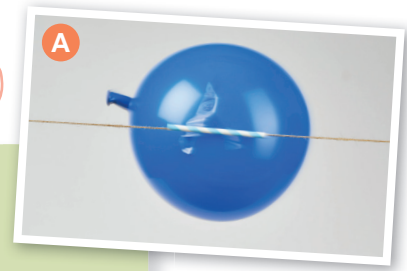
1 2 3 4 5 6 7 8

The twenty-three-year-old Kenyan inventor Richard Turere **1 can't have been/ must have been** proud to win the Young Inventor's Prize recently. But **2 few/a few** inventors start as young as Richard. By the age of 11, Richard **3 had created/ created** a solar-powered light system to stop lions **4 to attack/attacking** his family's animals. He came up with the idea **5 himself/themselves**, without access to technical information. Richard went on **6 to study/studying** wildlife conservation at the African Leadership University.

Turere's invention, **7 what was/which was** initially used in Africa, is now also being used in India and Argentina.

1 Look at the two photos. Which one shows the experiment in the science report?

give your experiment a clear title



Title of Experiment: Creating gas with baking soda

Aim: To observe what happens when an acid and a carbonate react

Hypothesis: Mixing an acid and a carbonate produces carbon dioxide and creates 'lava'

Materials:

2 spoonfuls bicarbonate of soda (baking soda)	¼ cup vinegar	½ cup water	food colouring
	¼ cup detergent	a tall glass	protective material

Method:

- 1 The table was cleared and covered in protective material (a plastic tablecloth).
- 2 The baking soda, water and detergent were put into the glass and mixed together for a few seconds. The vinegar was NOT added at this stage.
- 3 The food colouring was added to the mixture.
- 4 The vinegar was added to the glass.

use clear section headings in bold or underlined

break down the experiment into clear, numbered steps

keep language objective and factual



Result: Gas was created, the mixture quickly expanded and overflowed out of the glass.

Conclusion: Bicarbonate of soda is a compound of sodium, hydrogen, carbon and oxygen. When in contact with vinegar (an acid), the carbonate breaks up to produce water, salt and carbon dioxide. This gas enters the detergent and creates a baking soda 'volcano'.

2 Which sections of the report are written ...

- | | |
|---------------|---------------------|
| 1 as a list | 3 in the present |
| 2 in the past | 4 in the infinitive |

3 Notice the use of the passive in the Method section. Then change sentences a–d to the passive.

- a She attached a straw to the balloon.
- b She passed a long string through the straw.
- c She filled the balloon with air.
- d She let the air out of the balloon.

LEARNING TO LEARN

When we write about science, we try to use an objective, neutral tone, often using the passive.

Mediation Send a voice message to someone in your family telling them about the experiment you read about in class and suggesting you try it together. Use the **Mediation guide**.

It's your turn

Write a science report about a simple experiment. Go to the Workbook and choose how much help you need.

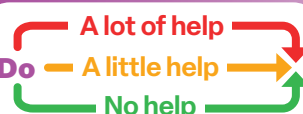


Watch the tips in the video.

SKILLS EXPERT



Prepare



Share

Evaluate

Workbook Writing scaffolding

Project pathway **1**

Go online and find an experiment that includes pictures. Analyse the kinds of things the pictures show.

Workbook Project preparation

Context: A popular science channel has challenged teenagers to solve a problem in a creative way to win a prize.

Task: Produce a creative solution to a science problem.

Use your Workbook to develop your ideas.

Workbook Project preparation

Review

1

2

3

- 1 Look back at your notes from the Project pathway exercises. Use them to help you complete the task.



Watch an example of how to solve a science problem.

Plan

- 2 Look at the instructions for the egg drop experiment on page 57, and some students' notes about what happened. This will give you an example of what to do in the next step.
- 3 You are going to try the Marshmallow challenge and make your own notes about it. Read the instructions, do the experiment and then make notes about what happened.

THE MARSHMALLOW CHALLENGE

Materials: 20 sticks of spaghetti, 1 metre of masking tape, 1 metre of string, 1 marshmallow

Objective: to build the highest free-standing structure with the marshmallow at the top

RULES:

- You can break the spaghetti and cut the tape and string as much as you want.
- You can't break the marshmallow.
- You can hold the structure during preparation, but it must stand on its own when finished.



Model project

A science challenge: The great egg drop

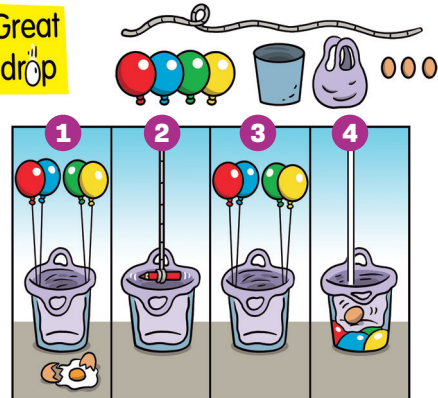
Materials: 4 balloons, a waste bin, a plastic bag, 3 eggs, 2 metres of string

Objective: to drop the egg into the bin without breaking it

Rules:

- You have two eggs to practise with and one for the competition.
- You can't touch the egg after dropping it.

The Great egg drop



The great eggdrop

- 1 We put the bag in the waste bin and used the balloons for decoration. But the egg missed the bin. It broke! (Egg number 1)
- 2 We tied a pencil on the string to check the correct position to throw the egg from.
- 3 This time, the egg fell into the bin, but the bag fell in. The egg broke on the bottom of the bin! (Egg number 2)
- 4 We put the balloons under the bag to protect the egg. We dropped it! It went into the bin but it didn't break! (The competition egg)

Create

4 Discuss the Marshmallow Challenge and make a report describing your creative solution. Use the video to help you.

5 Present your report to your class.

Peer assessment

Complete the checklist as you look at another group's project.

Creativity: Did they think of a creative solution for the challenge?

Content: Did they follow all the rules?

Presentation: Is the blueprint clear and informative?

Language: Is grammar and vocabulary used correctly? Give examples.

9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



Reflect Think about Unit 4 and answer the question.

Why is it important to keep making progress in science?

Grammar

Modal verbs of speculation

We use *must* when we think that something is definitely true.

We use *could*, *may* and *might* when we think something is possibly true.

We use *can't* when we think something is definitely not true.

Present

That **must be** true; it's so logical.

This answer is too easy, so it **can't be** right.

Past

Someone **must have left** the parcel as a surprise.

Our neighbour **might have seen** something.

It **could have been** anyone.

It **can't have been/couldn't have been** Maria; she's on holiday.

Past perfect

We use the past perfect to talk about an action that happened before another action in the past.

After I **had opened** the door, I saw the parcel.

When Ellen arrived, I still **hadn't opened** the box.

Had someone **left** the box as a surprise?

Past time expressions

We often use these time expressions with the past perfect: *before*, *after*, *by the time*, *already*, *never*, *until*, *once*, *twice*, *when*.

He'd failed his physics exam twice **before** he managed to pass it.

They'd never been interested in astronomy **until** they went to a talk about it.

Vocabulary

39 Adverbs of possibility, manner and opinion

almost certainly	fast	potentially
amazingly	interestingly	probably
angrily	maybe	surprisingly
carefully	perfectly	unfortunately
definitely	perhaps	
exactly	possibly	

40 Branches of science: word hierarchies

astronomy	genetics	physics
biology	geology	psychology
botany	medicine	zoology
chemistry	meteorology	
ecology	paleontology	

Self-evaluation

Tell your partner one thing from the unit that a) you learnt, b) was easy, c) was difficult, d) was interesting.

Communication	Learning to Learn	Plurilingual Competence	Critical Thinker
Reading: p49, ex 5 Vocabulary: p51, ex 2 & 4 Listening: p52, ex 5 & 6	Reading: p48 Listening: p52 Speaking: p53 Writing: p55	Vocabulary: p51	
Mediation	Digital Literacy	Video Literacy	Global Citizen
Listening: p52 Writing: p55			

Go to the Workbook. Complete your Self-evaluation tracker and create your Action plan.

Workbook Self-evaluation tracker