



## MEETING MAXWELL

This booklet for schools accompanies *A Sense of Wonder*, a new film narrated by poet Rab Wilson, about Scotland's greatest scientist, James Clerk Maxwell.

The pack includes science and literacy activities for P7 to S2 pupils.

**MAXWELL MADE THE MODERN WORLD**

**Task 1** - A viewing of the film <https://youtu.be/ANIkxDm8bF4>

**Tasks 2 - 4** - At the end of this booklet there is a worksheet. It forms the basis for follow-up lessons.

**Task 2** - Close viewing of the film (analogous to close reading).

**Task 3** - Pupils practice five active learning techniques.

**Task 4** - Registration for 3ml, a free Literacy across Learning and Topical Science resource. This includes a library of stories about Maxwell and links to modern physics.

**Task 5** - A story competition with a £50 prize in book tokens.

**Task 6** - A poem competition with a £50 prize.

**Task 7** – Making a Maxwell puppet with a microwave detector.

**Task 8** - The Night Sky.

**Task 9** - Light mixing experiment.

**Task 10** - Competition to design a poster with a £50 prize for the best artwork.

# SENSE OF WONDER

A FILM COMMISSIONED BY WIGTOWN FESTIVAL COMPANY

The locals in Parton, a small Galloway village, have filled the church hall tonight, to watch a new film about their most famous son. They at least know who he is.

“We are interested in a guy called James Clerk Maxwell,” says the man with the microphone at the start of the film.

“Never heard of him,” replies an elderly gent on a bench in Dumfries.

“I come from ten miles from Parton,” says a blue-shirted pedestrian.

“And I’ve never heard of him.”

The brown eyes of the man with the mike look straight at us. “Like most people I did not have a clue who James Clerk Maxwell was,” Rab Wilson tells us. “Yet he is one of the most important human beings who ever lived, I’ve been told - and one of the greatest scientists of all time.

“I am a poet and a Scots everyman. So I have decided to go on this journey to find out more about James Clerk Maxwell and the impact he has had on the modern world.”

Rab’s quest takes him first to a town-house in Edinburgh, now home to the James Clerk Maxwell Foundation. “James was born here in 1831,” says Professor David Ritchie. “Full of life, full of interest in everything about him. He bombarded his elders with questions.”

The questions continued throughout Maxwell’s relatively short life - he died at the age of 48. In time they became too difficult for anyone else to answer, so James sought understanding in science and philosophy - in theory, experiment and his own immensely creative mind.

Maxwell was a master of profound thought, says Professor Martin Hendry, head of physics and astronomy at Glasgow University. “He brought deep theoretical thinking to make sense of experiment and to make startling predictions.”

The most important of these was that light was a form of electromagnetic wave - and there must be many more. The whole of modern technology - from radio and television, to computers, mobile

## TASK 1



Hand round the popcorn. Turn down the lights. Enjoy the film. Tell the pupils, before the curtain rises, that they have a little job to do, while watching. They must think up one question they’d like to ask the narrator Rab Wilson, any other person in the film, or Maxwell himself.



phones, X-ray machines and the Internet - is built on this extraordinary scientific insight.

Maxwell's legacy in technology is immense. But his role in showing how the world works is even greater. "One scientific epoch ended and another began with James Clerk Maxwell," said Albert Einstein, whose own theories were developed by pondering the meaning of Maxwell's equations.

As Rab Wilson learns all this from the experts, his growing appreciation of Maxwell the scientist pleases him. But he is delighted when he learns that James composed poems all his life. "He wrote them for fun," Rab says. "He had this childlike sense of wonder about the universe, and the world around him."

To round out Rab's understanding of James Clerk Maxwell - brilliant scientist, profound thinker, religious man, good friend, loving husband - he seeks out scientists, musicians, teachers and pupils. He visits Glenlair and talks to Duncan Ferguson, the owner of the estate that was Maxwell's home, all his life.

A former ship's engineer, Captain Ferguson is determined to preserve Maxwell's memory, he says. "I go out and give talks. I show groups around Glenlair. I tell them about his life here, as a boy and a man. The Americans in particular are very interested in Maxwell. They appreciate what he did far more than we do in this country."

Teachers of all subjects and stages are, however, beginning to realise the classroom potential of James Clerk Maxwell, the country lad, nicknamed "Daftie" at school, who grew to become one of the world's great scientists.

"You can't impress it on people enough," says teacher and songwriter Alan McClure. "The things we enjoy today did not appear out of thin air. They have come from a long line of discoveries and augmentations by generations - and then the occasional blazing star like James Clerk Maxwell."

As Rab Wilson reaches the end of his quest, the abiding impression, he says, is of the breadth and depth of the man from Glenlair. "He is a true Renaissance Man. He embraced the sciences. He loved music and culture. He wrote poetry."

The boy with rough clothes and rural ways became a distinguished professor in Aberdeen, London and Cambridge. But Glenlair remained his home throughout his life. And one other aspect never altered, says Rab Wilson, as the boy matured into a man who will be remembered for as long as human culture lasts.

"James Clerk Maxwell never lost his sense of wonder."

**TASKS 2-4: A SENSE OF WONDER WORKSHEET** forms the basis for follow-up lessons, after having watched the film. Task 2 of the worksheet is a close viewing of the film (analogous to close reading), with timings to help pupils with hard questions, by listening in the film for the words used in the question. Task 3 uses the film to practise five active learning techniques. Task 4 suggests registration for Three Minute Learning, a free Literacy across Learning and Topical Science resource for schools, which includes a library of Maxwell-related stories.

## JAMES THE BOY

At the age of 8, James was sent by his father from the Galloway countryside he loved to a top school in Edinburgh. His classmates nicknamed him “Daftie” for his rustic appearance, country manners, constant questions and homemade shoes.

In time Maxwell was accepted by his classmates and teachers. He began doing original science while still a teenager. James loved literature, particularly Scottish poetry, and would memorise other people’s poems and write many of his own.

At the age of 16, he began his studies at Edinburgh University. In those days Scottish Universities closed from April till November, so that students could go home and help with the farming.

That meant James was back home in Glenlair every summer and autumn. He loved it there and delighted in the company of his dad. He was more like an older brother than a father, Basil Mahon tells us, in his book *The Man Who Changed Everything*.

“James helped in the fields and spent time with the local lads. On hot days he tried to persuade them to join him swimming in the peat-brown pool where two rivers joined.

“But they were afraid of the eels.”

### TASK 5: TIME TRAVEL STORY COMPETITION

One day you find a time machine in the school cupboard, probably invented by the physics teacher. It is set to 1839, the year James, an 8-year-old country boy, was sent off to a private school in Edinburgh. Read *Maxwell the Boy* and write a short story about what happens to you and James when you meet.

A prize of £50 in book tokens goes to the best story. Send yours to

[rebecca.crawford@glasgow.ac.uk](mailto:rebecca.crawford@glasgow.ac.uk)



## MAXWELL THE SCIENTIST

James Clerk Maxwell's elegant science shaped the modern world. "The work of James Clerk Maxwell changed the world forever," said Albert Einstein, who kept pictures of Maxwell on the walls of his study.



James was born in Edinburgh on 13 June 1831. The family moved soon afterwards to Glenlair House which his parents had built on a Galloway estate of green fields, tall trees and rushing rivers. It remained his home until his death at the age of only 48, in 1879.

Maxwell ranks very highly in the physics hall of fame. His reputation rests largely on his research into electricity and magnetism. He showed that these are two aspects of the same thing - electromagnetism. Then he used his equations to prove that electromagnetic waves would exist and would travel at the speed of light.

This strongly suggested that light is an electromagnetic wave. And it showed that there would be many others, with different wavelengths, all travelling at the same speed - the speed of light.

Technologies such as radio, television, wireless internet, mobile phones and bluetooth - as well as almost all forms of astronomy - rely on the deep understanding of the physical world that Maxwell gave us.

**TASK 6: WHAT DOES CREATIVITY MEAN TO YOU?** An acrostic is a poem in which the first letter of each line spells out a word. Write an acrostic using the word CREATIVITY about what creativity in science or the arts means to you. There is a prize of a £50 book token for our favourite. Send entries to [rebecca.crawford@glasgow.ac.uk](mailto:rebecca.crawford@glasgow.ac.uk)

## JAMES THE MAN

James met Katherine Dewar, daughter of the principal of Marischal College - later Aberdeen University - while he was the professor of physics there. They were married in Aberdeen in 1858. One of his biographers described the marriage as “one of unexampled devotion”.

Despite Maxwell’s scientific achievements, it was his kindness and humanity that made “the biggest impression on his contemporaries,” writes David Forfar of the James Clerk Maxwell Foundation.

“Such complete unselfishness and tender consideration as he exhibited for those around him, and especially for those under his control, are seldom to be met with,” Forfar writes, quoting one of those contemporaries.

Forfar goes on to talk about Maxwell’s “scientific industry, philosophic insight, poetic feeling, imagination and overflowing humour and sincerity”.

“The regard and affection in which he was held by his friends was remarkable,” Forfar concludes.

## TASK 7: MAXWELL PUPPET

In this craft and science activity, pupils make a Maxwell hand puppet. They then use a wireless radio detector (costs from £1 to £3) to demonstrate electromagnetic waves.

The worksheets can be found on the Meeting Maxwell website:

<http://tinyurl.com/p7yof59>



**TASK 8: THE NIGHT SKY** Maxwell studied the rings of Saturn. His calculations showed they could not possibly be complete solid ringlets, which was suggested by some scientists. They must instead be lots of smaller solids, in orbit around the planet. Find out where and when to study Saturn and other planets at EarthSky (<http://earthsky.org/astronomy-essentials/visible-planets-tonight-mars-jupiter-venus-saturn-mercury>) or Jodrell Bank ([www.jb.man.ac.uk/astronomy/nightsky](http://www.jb.man.ac.uk/astronomy/nightsky)). Encourage pupils to become amateur astronomers. Local astronomy contacts include [www.scottishdarkskiesobservatory.org.uk](http://www.scottishdarkskiesobservatory.org.uk)

## MAXWELL VERSE

He learned the work of Faraday, which made him  
wonder whether,

Magnetic and electric waves must fly through space  
together,

And figured since they fly along at light speed, if you  
let them,

That light we see is part of the electromagnetic  
spectrum

From a song about James Clerk Maxwell written by Alan McClure

## MAXWELL HEADLINES

A headline in a newspaper says something succinctly  
and grabs your attention. Here are some headlines on  
James Clerk Maxwell's work:

Maxwell made the modern world

Mobile phones use Maxwell's waves

James jumpstarted engineering

Technology flows from Maxwell's waves

Wireless works with Maxwell's waves

TVs tune into Maxwell's waves

## TASK 9: LIGHT MIXING

Maxwell experimented with light and showed how coloured light mixed to create other colours.

Try it for yourself, with coloured shadows and cellophane, as described here:

<http://tinyurl.com/pkncosz>

## TASK 10: POSTER DESIGN

Design and make a colourful poster to illustrate either the verse or one of the headlines.

There is a £50 prize for the best artwork.

Send entries to:

[rebecca.crawford@glasgow.ac.uk](mailto:rebecca.crawford@glasgow.ac.uk)



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Science Connect and STEM Ambassadors [www.scienceconnects.org.uk](http://www.scienceconnects.org.uk)

Dumfries & Galloway Science Festival [www.dgsciencefestival.org.uk](http://www.dgsciencefestival.org.uk)

Glasgow Science Festival [www.glasgowsciencefestival.org.uk](http://www.glasgowsciencefestival.org.uk)

Meeting Maxwell [www.meetingmaxwell.tumblr.com/](http://www.meetingmaxwell.tumblr.com/)

Principia 3ml [www.principia.org.uk/activity/3ml/](http://www.principia.org.uk/activity/3ml/)



connecting schools to science, technology, engineering and maths

# A SENSE OF WONDER WORKSHEET

## TASK 1: YOUR QUESTION

Write here the question you want to ask Rab or any other person in the film.

## TASK 2: QUESTIONS TO ANSWER BY WATCHING THE FILM

Question	Film time	Your answer
What kind of writer is Rab Wilson?	1 to 2 minutes	
Where was James born?	1 to 2 mins	
Which university does Rab visit to “get his head round” Maxwell’s theories?	3 to 4 mins	
What does the word <i>electromagnetism</i> tell us?	4 to 5 mins	
Aidan demonstrates 3 things about electromagnetism. What is the first?	5 to 5:44 mins	
Next he shows how to generate electricity with a magnet. How does he do that?	5:44 to 6 mins	
Maxwell was looking for equations to explain experiments. What was the great prediction of his equations?	6 to 6:30 mins	
What surprising colour do you get if you mix red, blue and green light?	7 to 8 mins	
What was the name of the house and estate where Maxwell lived?	9 to 10 mins	
How many brothers and sisters did Maxwell have?	9 to 10 mins	
What does Rab think about great science and creative art?	11 to 12 mins	
Maxwell wrote poetry. What does Rab think of his poems?	12 to 12:30 mins	
How did the film get its name - <i>A Sense of Wonder</i> ?	13 to 14 mins	
Wendy has written harp music inspired by Maxwell. List three things about the man and his theories that she has tried to put into her music.	14:45 to 16:30 mins	

What does music do to Rab's mind?	16:30 to 17:30 mins	
Where does Wendy say science comes from?	18:00 to 19:00 mins	
Maxwell and Rab have different views about religion. In what way?	18 to 19 mins	
Martin talks about Maxwell's way of doing science, "which we still see very much at work today". What does he say about theory and experiment?	20 to 21 mins	
What language did Maxwell speak?	23:30 to 24:30 mins	
What did the Edinburgh Academy lads call Maxwell, when he went to school there?	24 to 25 mins	
Alan tells us that the modern world came from a long line of small discoveries and the occasional ----- ---- like Maxwell.	25 to 26 mins	
Rab calls Maxwell "a true Renaissance Man" . Listen to what he says next and try to work out what that means.	25:30 to 26:30 mins	
How do you think Maxwell's home might have helped him create his theories?	9 to 11 mins	
Key leaps forward in science have happened how, according to Martin?	8:30 to 9:30 mins	
Why do you think so few people today know about James Clerk Maxwell?	Whole film	
If you were given the job of making Maxwell better known in Scotland, what would you do?	Whole film	

### TASK 3: ACTIVE LEARNING

A number of activities happen inside good learners' heads. We can all practise these to become better learners.

#### CONNECT

Making connections helps you understand and remember. Connect something in the film with something already in your own mind. This can be a fact about your life, or something you've read, or something in the world.

#### VISUALISE

What was the film's most memorable image for you? This can be either a real image or an image in your mind created by something said in the film.

#### QUESTION

You have come up with one of these already. Now you've had time to think about the film a little more, write down two other questions you'd like to ask anyone in the film, or even James Clerk Maxwell himself.

#### SUMMARISE

Good learners summarise in their minds what they read, see or hear. So have a go please at summarising this film. Tell us in two sentences what it is about and what you would like to remember from the film.

## CLARIFY

As we are learning or reading we often hear or see words we don't know. Good learners don't let this stop them. They *clarify*. This means they figure out roughly what the word means, and they keep on learning.

There are several things to try, to help clarify what a word means. They include: 1) Read a sentence or two before and after the hard word to see if it is explained. 2) Look for words or parts of words inside the hard word. 3) Try replacing the hard word with another that seems to make sense there.

Here are a few words used in the film whose meaning you might not be sure about. Use any or all of the Clarify methods to figure out what they mean.

Word	Where in the film	What you think it means	And why
everyman	1:10 mins		
electromagnetism	4 mins		
upbringing	9:15 mins		
flipsides	11:34 mins		
versifier	12:12 mins		
distinctive	24:06 mins		

## TASK 4: THREE MINUTE LEARNING

This is a free, Literacy across Learning and Topical Science online resource for schools.

3ml contains hundreds of articles, covering every curricular area, together with a set of learning activities and a computer games structure that keeps learners engaged.

To register and use 3ml, contact [admin@three-minute-learning.org](mailto:admin@three-minute-learning.org)

[www.my3ml.org](http://www.my3ml.org)

