Excel

in Physics

Dr Andrew French. 2020. http://www.eclecticon.info/physics_notes.htm
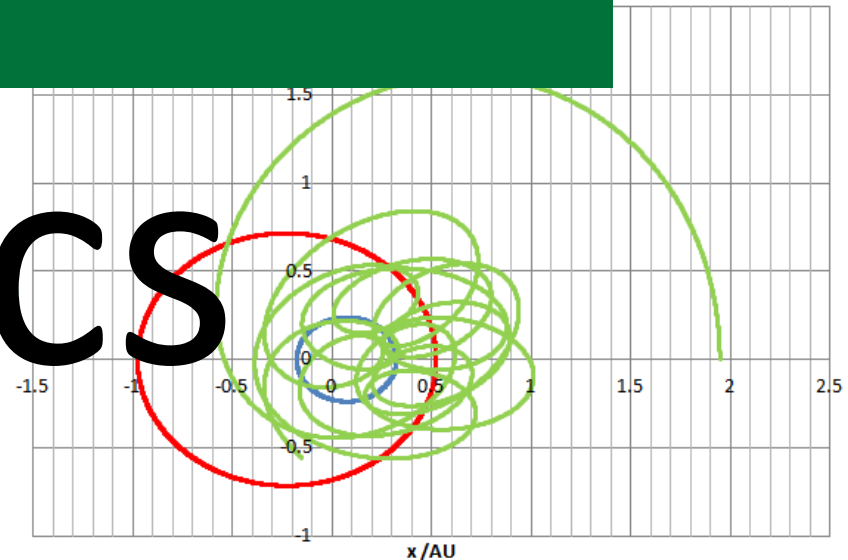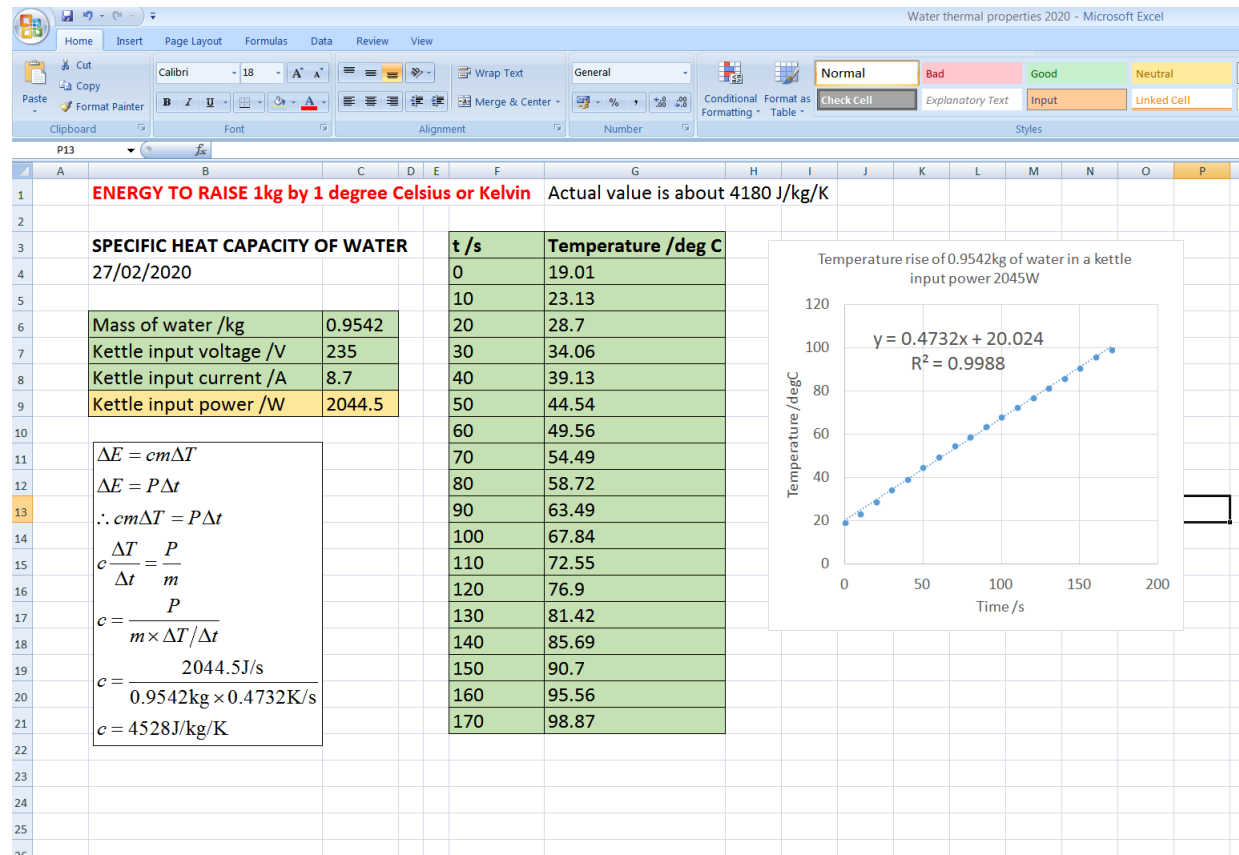
In a practical sense, Physics is all about performing calculations that relate to physical properties of our world. The *numbers matter*, and we need appropriate **tools** to:

• **Perform calculations rapidly**

• Present our **inputs**, **workings**, **outputs**, **graphs** etc **clearly** so *everything* can be checked visually.

For relatively *small* amounts of data, a **spreadsheet** is a superb tool. Spreadsheet techniques (in **Microsoft Excel**) *are the subject of this course*. For more complex simulations and analysis of larger data sets, a *programming environment* like MATLAB is recommended. But that is for another course....

Excel spreadsheet: "Water thermal properties 2020 - Microsoft Excel"

ENERGY TO RAISE 1kg by 1 degree Celsius or Kelvin Actual value is about 4180 J/kg/K

SPECIFIC HEAT CAPACITY OF WATER
27/02/2020

		t /s	Temperature /deg C
		0	19.01
		10	23.13
Mass of water /kg	0.9542	20	28.7
Kettle input voltage /V	235	30	34.06
Kettle input current /A	8.7	40	39.13
Kettle input power /W	2044.5	50	44.54
		60	49.56
		70	54.49
		80	58.72
		90	63.49
		100	67.84
		110	72.55
		120	76.9
		130	81.42
		140	85.69
		150	90.7
		160	95.56
		170	98.87

$$\Delta E = cm\Delta T$$
$$\Delta E = P\Delta t$$
$$\therefore cm\Delta T = P\Delta t$$
$$c\frac{\Delta T}{\Delta t} = \frac{P}{m}$$
$$c = \frac{P}{m \times \Delta T/\Delta t}$$
$$c = \frac{2044.5 \text{J/s}}{0.9542 \text{kg} \times 0.4732 \text{K/s}}$$
$$c = 4528 \text{J/kg/K}$$

Chart: Temperature rise of 0.9542kg of water in a kettle input power 2045W
$y = 0.4732x + 20.024$
$R^2 = 0.9988$
(Temperature /degC vs Time /s)

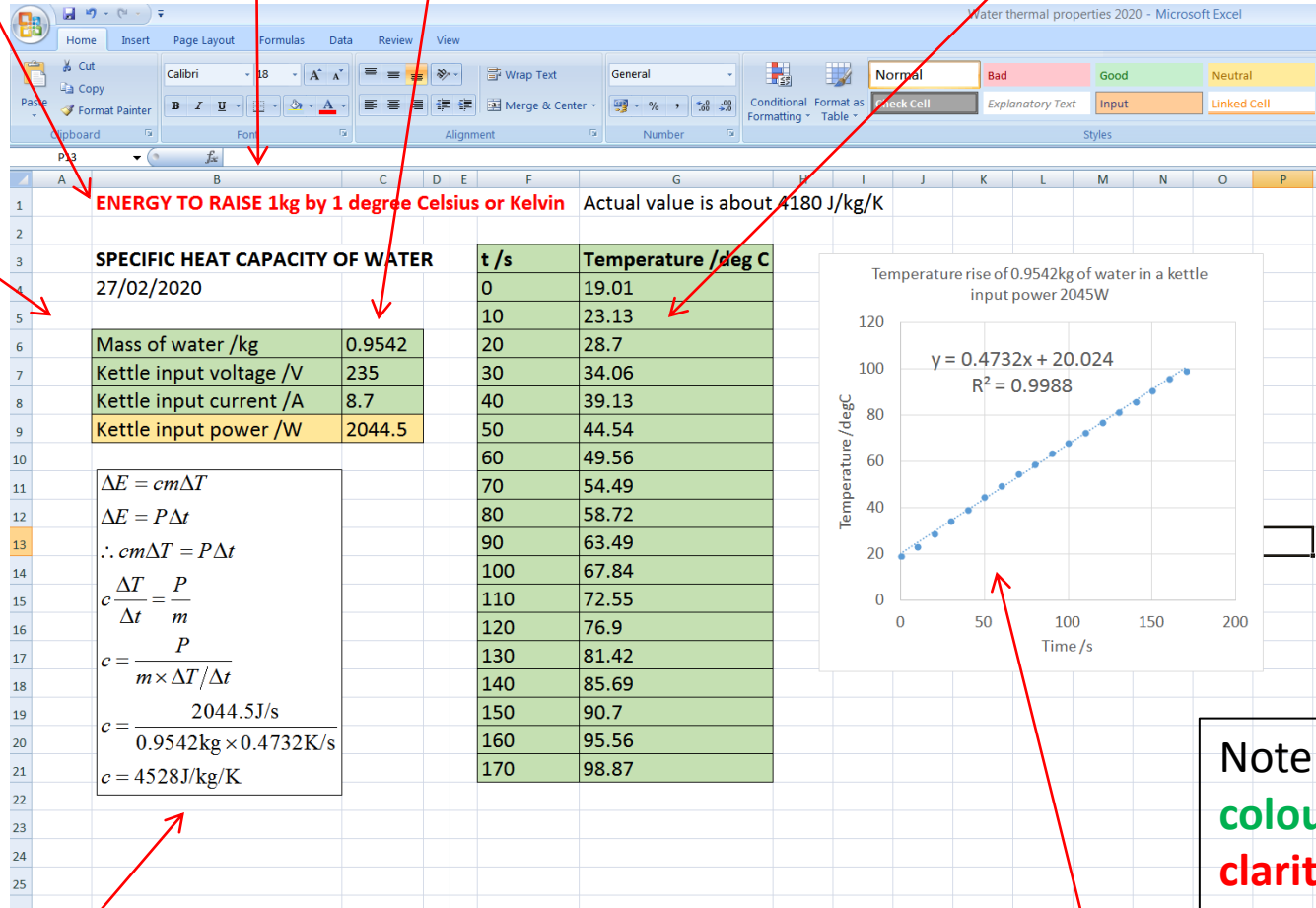# Anatomy of a spreadsheet

Text description

Formula bar

Constants / inputs etc

Data & calculations

cells
e.g. A5

rows
(1,2,3...)

columns
(A,B,C...)

Embedded graphics,
Mathtype equations etc

Graph + line of bets fit

Note use of **colour** for **clarity**

Water thermal properties 2020 - Microsoft Excel

Home | Insert | Page Layout | Formulas | Data | Review | View

ENERGY TO RAISE 1kg by 1 degree Celsius or Kelvin — Actual value is about 4180 J/kg/K

	t /s	Temperature /deg C
SPECIFIC HEAT CAPACITY OF WATER	0	19.01
27/02/2020	10	23.13
	20	28.7
Mass of water /kg — 0.9542	30	34.06
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Kettle input current /A — 8.7	50	44.54
Kettle input power /W — 2044.5	60	49.56
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Temperature rise of 0.9542kg of water in a kettle input power 2045W

$$y = 0.4732x + 20.024$$
$$R^2 = 0.9988$$

Temperature /degC vs Time /s

Course scope: About 5 weeks. A few hours of contact time + several hours of independent work. Or you could do the whole thing independently!
The idea is to work through a **progression of examples** which will incentivise the acquisition of Excel techniques for Physics. You will assemble a **portfolio** of project work.

TECHNIQUES

Key Excel techniques for Physics

- Number & text formatting
- Formulae & replication
- Using $ prefix constants
- Plotting scatter graphs
- Under-laying model curves
- Lines of best fit
- Plotting error bars
- IF statements in formulae
- Printing to PDFs
- Exporting PNG screenshots

Background maths
- Error analysis and some basic statistics
- Lines of best fit

EXAMPLES

Simple calculators to get used to Excel
(Speed converter, Snell's law of refraction, Radio frequency and wavelength)

Analysis of virtual experiments
i.e. watch a video, then analyse the data
- Intro using limited data
(Specific heat capacity of water, Ball vs Parachute, Faraday's Law, Solar system, Ball projectile, Beta decay of Pa)
- Test your skills with lots of data points
(Hubble law, Kepler III for Exoplanets, Capacitor discharge)

Simulations
(Gravity drop + drag, Epidemics, Rocket, Projectile + drag, Two stars & one planet)

Watch **How to?..** YouTube videos ▶

Excel in Physics Projects vs Skills matrix

Choose a path through examples that require an increasing repertoire of Excel skills.
If you are not sure if you have mastered a particular skill, then choose a another
example which requires a similar blend of skills.

EXCEL IN PHYSICS PROJECTS VS SKILLS MATRIX

Skills

Skill	Calculators			Experiments									Simulations					Maths		
Excel techniques	Speed converter	Snell's law	Radio frequency to wavelength	Specific heat capacity	Ball vs parachute	Faraday's law	Solar System	Ball projectile	Beta decay of Pa	Hubble law	Kepler II for Exoplanets	Capacitor discharge	Gravity drop + drag	Epidemics	Rocket	Projectile + drag	Two stars & one planet	Basics stats	y = mx + c best fit	y = mx best fit
Number & text formatting	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Formulae & replication	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Using $ prefix constants	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Plotting scatter graphs				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES		YES	YES
Under-laying model curves				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES			
Lines of best fit			YES	YES	YES	YES	YES	YES	YES	YES	YES	YES		YES					YES	YES
Plotting error bars					YES				YES			YES								
IF statements in formulae															YES	YES	YES			
Printing to PDFs				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES		YES	YES
Exporting PNG screenshots				YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES		YES	YES
Tips for dealing with lots of data									YES		YES	YES		YES					YES	YES
Standard maths techniques																				
Using formulae	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Using exponentials & logarithms									YES		YES	YES		YES						
Means & standard deviation																		YES		
Linearizing models				YES			YES	YES	YES		YES	YES		YES						
Lines of best fit				YES	YES	YES	YES	YES	YES	YES	YES	YES		YES					YES	YES
Other analysis techniques																				
Motion capture from video frames					YES			YES												
Euler solver of rate equations															YES					
Verlet solver of acceleration equations													YES		YES	YES	YES			
Complexity (1 simple, 5 quite involved)	1	1	1	2	3	2	2	3	3	3	4	3	3	4	4	4	5	1	3	3

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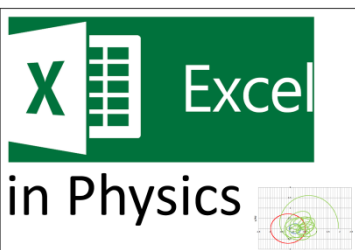
Look at the PDF for a zoomed in view!