

Spaced Repetition

What Use in Physics?

Dr Alison Voice

School of Physics & Astronomy
University of Leeds

Overview

- Introduce the concept (with references)
- How students learn (survey results)
- Practical suggestions
- ‘Ask the audience’ – share ideas

Repetition to Learn

'Practice makes perfect'

- Learn a language
- Learn to drive
- Play sport
- Musical instrument
- Times tables



In all these we need regular, cumulative, repeated practice.

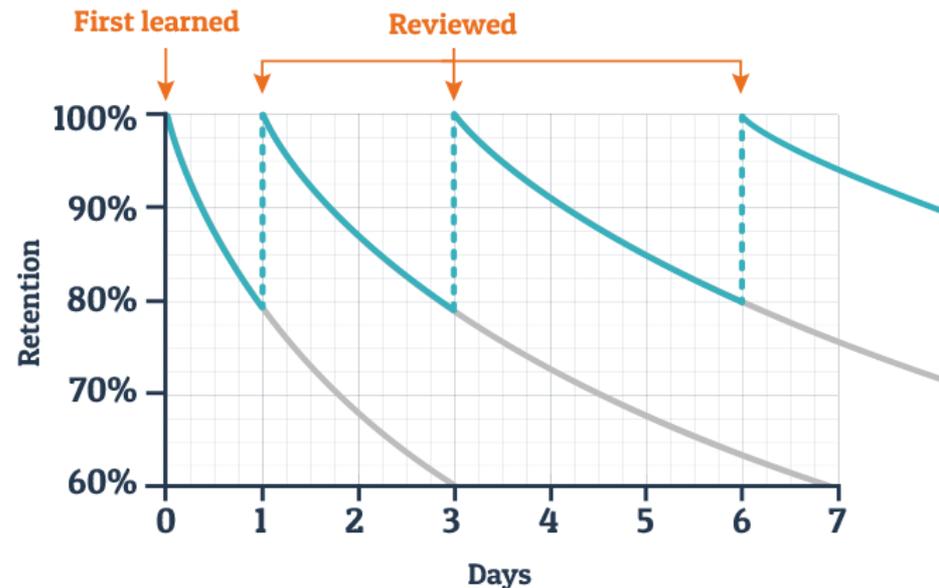
Repetition not to Forget

'Use it or lose it'

- First systematic investigation of memory in experimental psychology
- With each 'top up' the decay rate decreases
- Top up intervals widen

Typical Forgetting Curve for Newly Learned Information

<https://blog.wranx.com/ebbinghaus-forgetting-curve>



Ebbinghaus forgetting curve

Memory: A Contribution to Experimental Psychology 1885

Massed vs Spaced

'Massed'

Practice occurs all at once

'Spaced'

Practice spread out at intervals

- ❑ Many studies show enhanced **long-term memory** with spaced practice.

Ebbinghaus 1913

Dempster 1988

Karpicke 2008

Cepeda 2006

Carpenter 2012

- ❑ Optimal spacing gap depends on when the information should be recalled.
Short spaces for **short** retention time. **Long** spaces for **long** retention time.

Cepeda 2006

- ❑ Many students and staff wrongly assume that massed practice is better due to the short-term memory gain. *Kornell 2007*

Test is Best

'Active' repetition is better than 'Passive'

i.e. recall/testing is better than reading notes

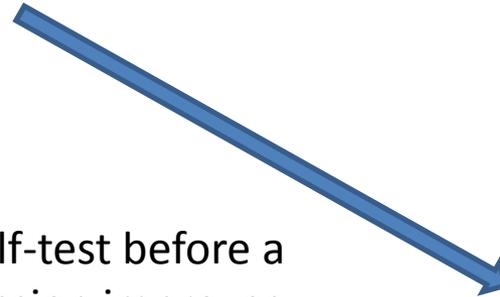
Mace 1968



Students who self-tested one week after learning, remembered **80%** in subsequent assessment, as opposed to **35%** for those who did not test. *Karpicke 2003*



Taking a self-test before a revision session improves learning. *Karpicke 2010*



Free recall is better than MCQ.

Duchastel 1982

Agarwal 2008

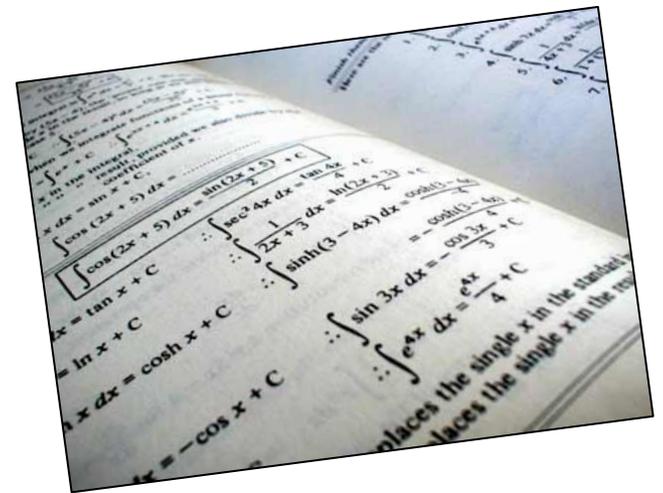
Explained asthe process of retrieval forms additional memory pathways in the brain, making information more accessible in the future. *Dunlosky 2013*

More than just recall

In a study of Mathematics, it has been found that 'interleaving' promotes more than just recall. It enhances **inductive thought**, **generalisation** and **abstract thinking**. *Rohrer and Taylor 2007*

For massed practice students repeat the same procedure many times and then move on to the next topic.

In spaced practice students revisit topics, in a cumulative manner. This has the added benefit of **requiring them to decide on the most appropriate method to solve the problem**.

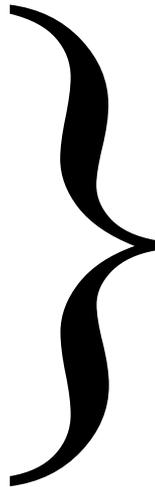


What about Physics?



Benchmark Statement for Physics:

- ❑ Identify and use relevant principles and laws in problem solving.
- ❑ Use appropriate mathematical and physical techniques.
- ❑ Interpret and contextualise mathematical descriptions of physical phenomena



All of this requires students to know (**recall**) a wide body of 'information' in order to select the **relevant 'tools for the job'**.

- Laws + equations
- Algorithms, standard procedures
- Data, to allow estimation

How do students study?

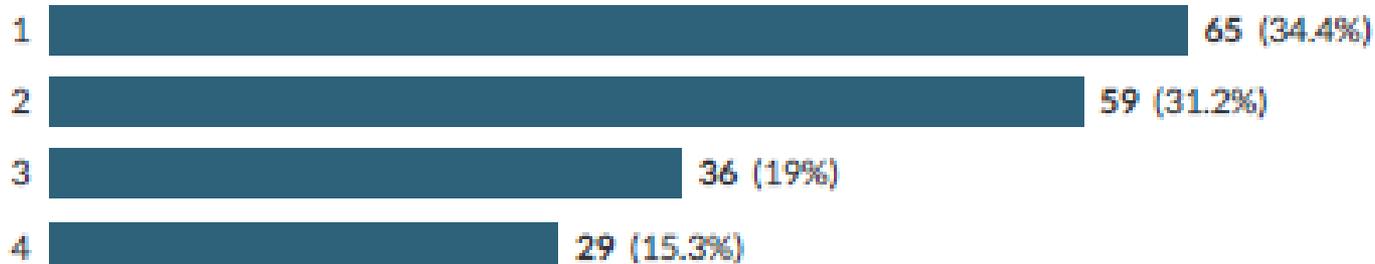
BSc project students undertook survey of student study habits

J Curtis and A Lowe 2018

Open to all our UG students (~ 450)

Responses 196

Y1 = 65 Y2 = 59 Y3 = 36 Y4 = 29



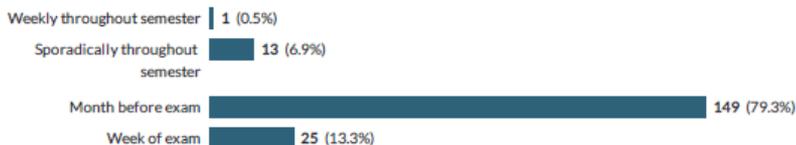
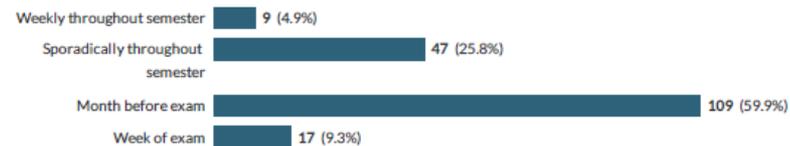
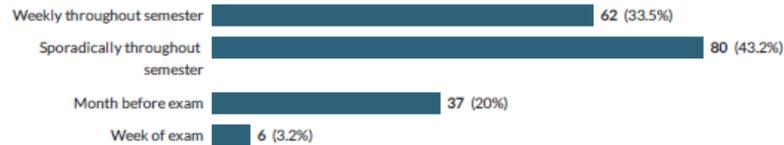
How/when do students study?

Read Notes

Write Notes

Test yourself

Try Past Exam Papers



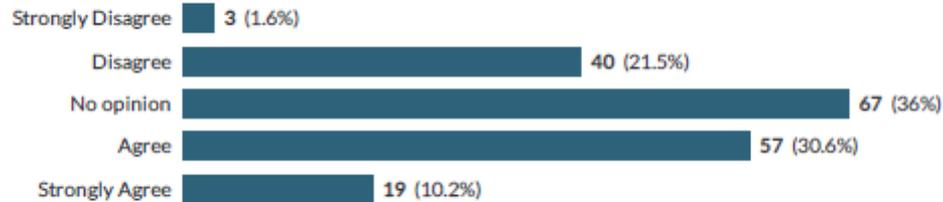
Result: students don't test themselves much during the semester

When do students test themselves?

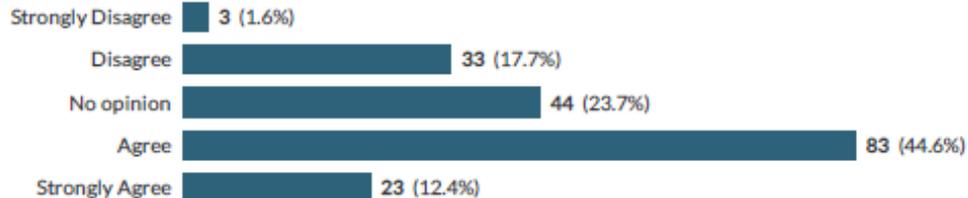
	Year of Study			
	1	2	3	4
Weekly throughout semester	5%	8%	3%	0%
Sporadically throughout semester	23%	31%	19%	24%
Month before exam	52%	56%	56%	72%
Week of exam	14%	2%	17%	3%

Result: No real change of pattern with year group

Forgetting



Performance in exams hindered by forgetting things



Forget soon after the exam

Result: Many students cram for short-term memory

What can we do?

What have we learned?

- Spaced practice is good for long-term memory
- Spacing intervals align to assessment time
- Sustained repetition needed to counteract forgetting
- Active recall is better than passive reading or MCQ

Some ideas

- Regular coursework sheets, tutorials, workshops, to be cumulative
- Short tests at start of some classes on anything studied in module
- 'Quiz' at start of new module, to test recall of previous related module
- Mid-term test. Self or peer marked (It's the recall that is most important)
- Help students to think about and understand how they learn



Personalised Spacing

- Computers allow personalisation of spacing
- Commercial: SuperMemo, ANKI
- Custom built (Arran Stirton, Derek Raine)

Question

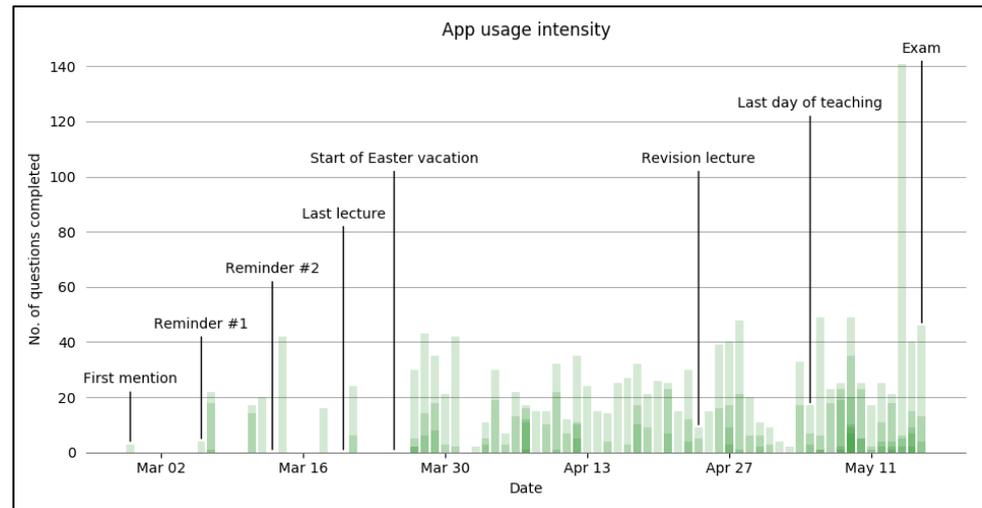
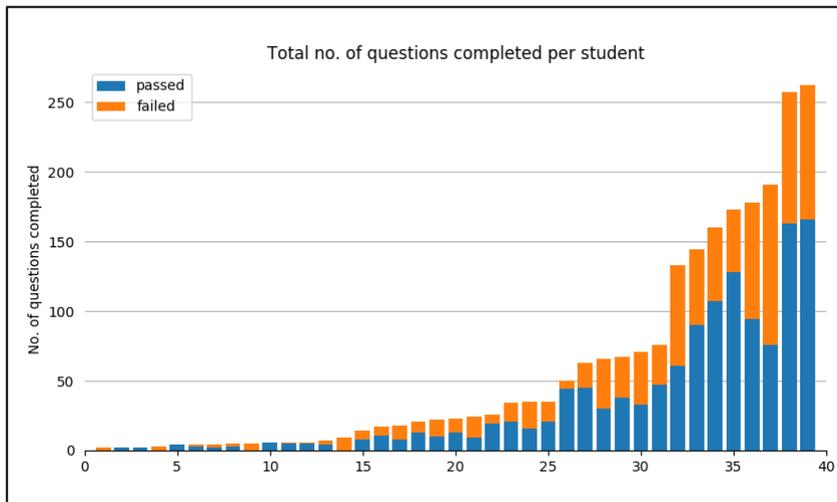
How is the mean free path of gas molecules in a rigid container affected by increase in temperature?

SHOW ANSWER

Answer

No change, since mean free path only depends on geometric factors (molecular size and particle density)

SHOW ME AGAIN GOT IT!



Conclusions

To be a good physicist students need to:

- Identify and use relevant principles and laws in problem solving.
- Use appropriate mathematical and physical techniques.

This requires good long-term memory of core material which is developed by:

Spaced repetition to aid learning, and save from forgetting

Acknowledgements



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'Ask the Audience'

Let's be honest, we probably all do a lot of massed practice !

Do you have examples of spaced repetition?

Are you interested in creating some?