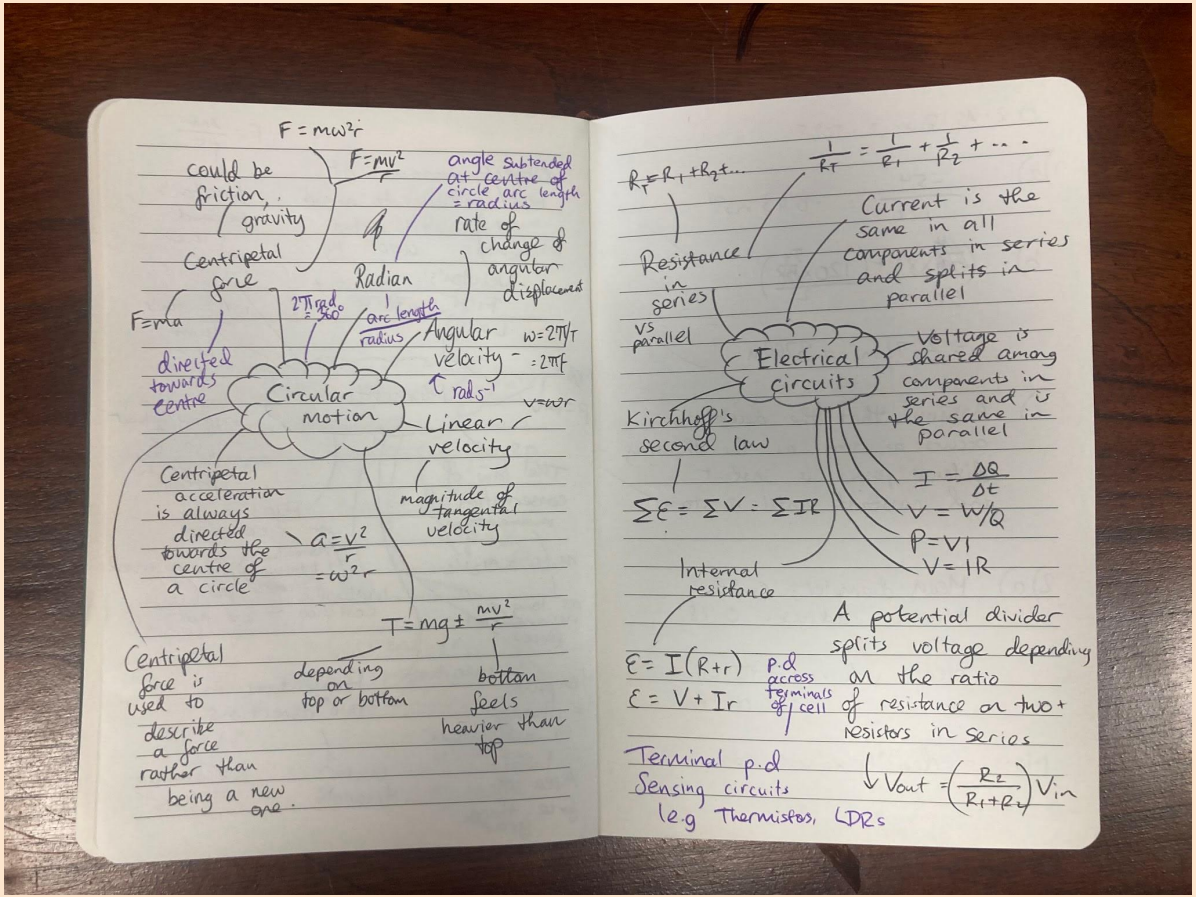
Examples of excellent independent study in Physics

Courtesy of Y13 students (2026-2027)



I find that mindmapping every topic helps me to organise the concepts in my head.

I do these before answering simple questions and then add to them with details from a range of sources.

Link to drive folder:

https://drive.google.com/drive/folders/1ULskDyAtaMEXlLTqiWGN1kWh2q5Gxcz3?usp=drive_link

Keeping track of incorrect concepts/questions and gradually amending them

https://docs.google.com/document/d/1rMvTtt0qpgDoVs3djvq3NtI5ebYrcF2cMmbMLxGZicw/edit?usp=sharing

This term I have mostly been focusing on COMPOS and university entrance exams but it is all related to Physics.

COMPOS - Comprehensive Oxford Maths and Physics Online School

Evidence - https://drive.google.com/drive/folders/1cnNaBdeboOzvFX_TafY9xs_53JaSIo5H?usp=drive_link

- Assignment 01 on coordinate geometry completed early-mid September
- Assignment 02 on trigonometry completed 03/11/25-05/11/25
- Assignment 03 on differentiation completed late november 03/12/25
- Assignment 04 on integration:
  - Problems 1-3 30/12/25
  - Problems 3-16 Early January
- Assignment 05 on exponentials and logarithms:
  - Problems 1-11 Late January
  - Problems 12-20 01/02/26
- Assignment 06 on Functions and Graphical Analysis:
  - Problems 1-3 01/03/26
  - Problems 4-5 02/03/26
  - Problem 6 03/03/26
  - Problems 7-10 04/03/26
  - Problems 11-12 05/03/26
  - Problems 13-16 15/03/26
- Assignment 07 on Equations and inequalities 1:
  - Problems 1-4 13/04/26
  - Problems 5-9 14/04/26
  - Problems 10-11 15/04/26
  - Problems 12-16 16/04/26
- Assignment 08 on Sequences and Series:
  - Problems 1-8 14/05/26
  - Problems 9-14 16/05/26
  - Problems 15-20 17/05/26
- Assignment 10 on Differential Equations:
  - Problems 1-7 06/07/26
  - Problems 8-11b 08/07/26
  - Problem 11c 09/07/26
  - Problems 12-17 12/07/26
- Assignment 01 on Matrices:
  - Problems 1-4 01/09/26
  - Problems 5-8 02/09/26
  - Problems 9-12 03/09/26
  - Problems 13-15 04/09/26

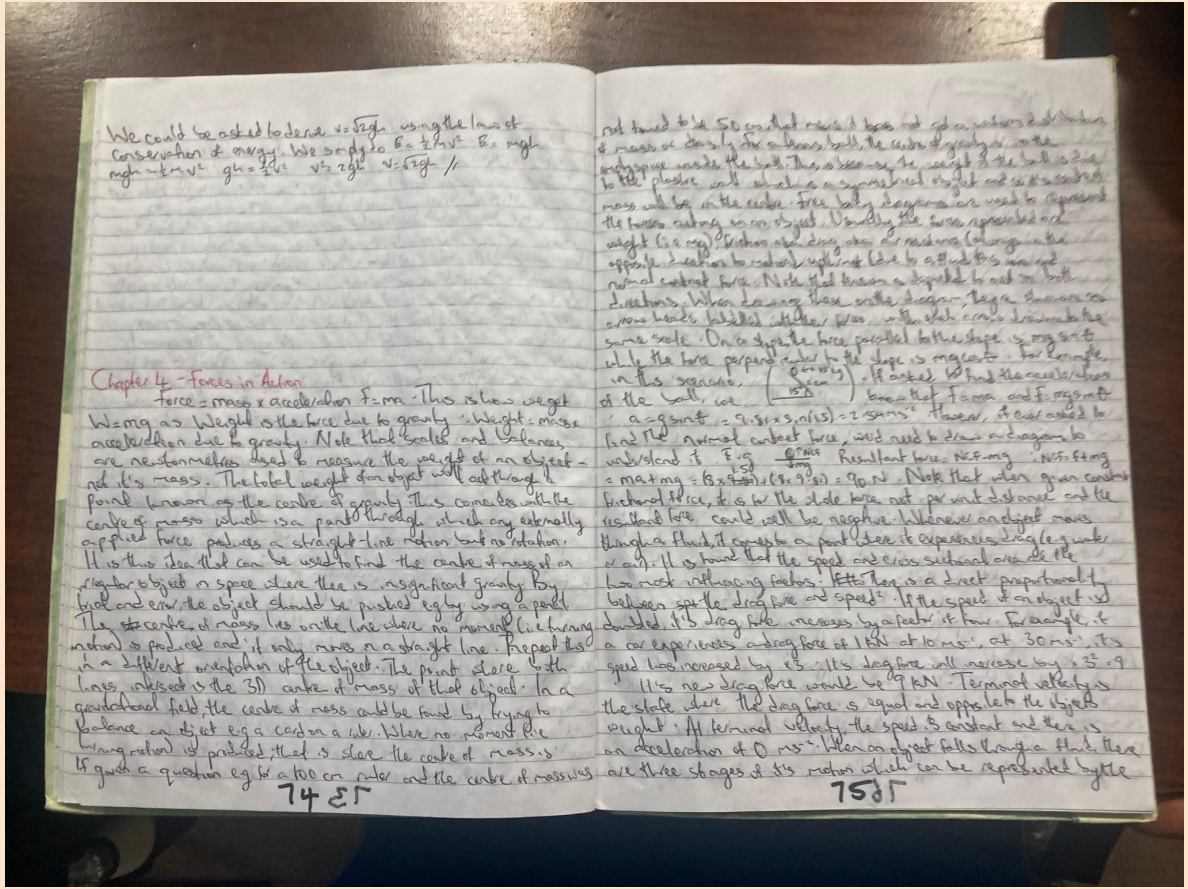
Challenges

- Gold in the SMC

University Admissions

- PAT 2006 Mathematics for Physics section completed 25/02/26
- PAT 2007 completed 11/05/26

- 17/18 on Blue Education ESAT Maths COMPOS Test 1
- 18/18 on Blue Education COMPOS ESAT Test 2: Maths 1
- 24/27 on Blue Education COMPOS Test 3: ESAT Maths 1
- 22/27 on Blue Education COMPOS Test 3: ESAT Maths 2
- 18/18 on Blue Education ESAT Maths 1: w/c 22 June
- 15/18 on Blue Education ESAT Maths 2: w/c 22 June 27/07/26
- 18/18 on Blue Education ESAT Maths 1: w/c 29 June 28/07/26
- 15/18 on Blue Education ESAT Maths 2: w/c 29 June 05/08/26
- 16/18 on Blue Education ESAT Maths 1: w/c 9 July 06/08/26



We could be asked to derive $v = \sqrt{2gh}$ using the law of conservation of energy. We say $E_p = E_k$ $E_k = \frac{1}{2}mv^2$ $E_p = mgh$ $mgh = \frac{1}{2}mv^2$ $gh = \frac{1}{2}v^2$ $v^2 = 2gh$ $v = \sqrt{2gh}$ //

Chapter 4 - Forces in Action

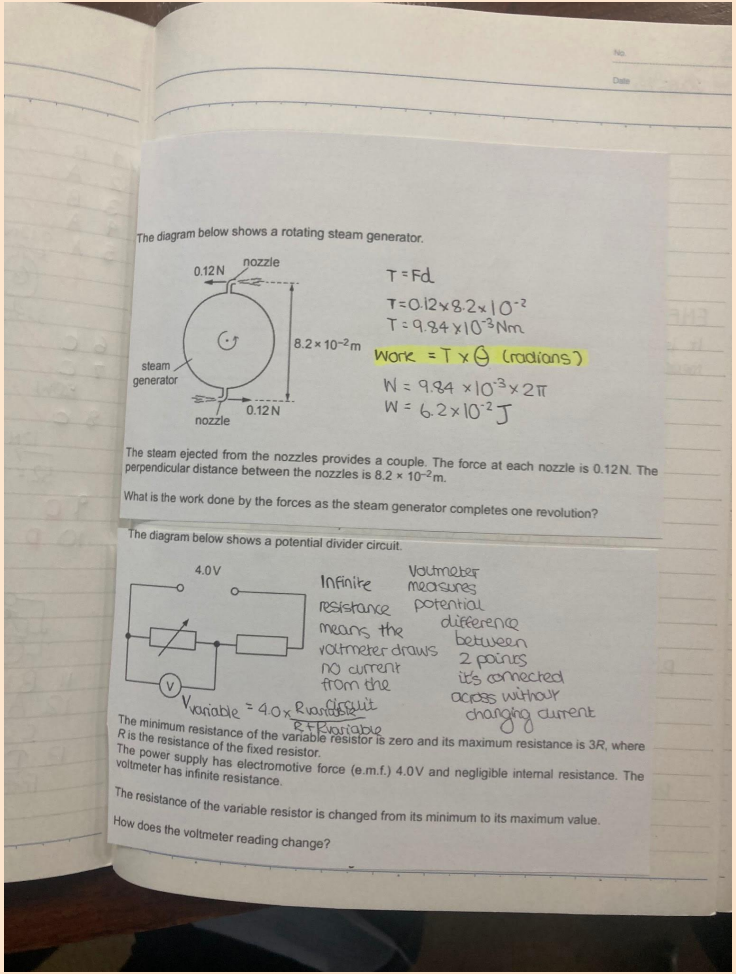
force = mass x acceleration $F = ma$. This is how we get $W = mg$ as Weight is the force due to gravity : Weight : mass acceleration due to gravity. Note that scales and balances are not newtonmeters used to measure the weight of an object - not it's mass. The total weight for an object will act through a point known as the centre of gravity. This coincides with the centre of mass which is a point through which any externally applied force produces a straight line motion but no rotation. It is this idea that can be used to find the centre of mass of an irregular object in space where there is insignificant gravity. By trial and error, the object should be pushed eg by using a pencil. The centre of mass lies on the line where no moment (turning motion) is produced and it only moves in a straight line. Repeat this in a different orientation of the object. The point where both lines intersect is the 3D centre of mass of that object. In a gravitational field, the centre of mass can be found by trying to balance an object eg a card on a ruler. Where no moment (turning motion) is produced, that is where the centre of mass is. If given a question eg for a toy car, ruler and the centre of mass is not found to be 50 cm but more it does not act as a uniform distribution of mass or density like a beam, ball, the centre of gravity is where the engineer made the ball. This is because the weight of the ball is due to the plastic and wheels + a screw/rod object and so it's centre of mass will be on the rocket. Free body diagrams are used to represent the forces acting on an object. Usually the force represented are weight (i.e. mg), friction, drag, air resistance (always in the opposite direction to motion), upthrust (due to a fluid) + any applied or normal contact force. Note that known + unknown forces are both directions. When drawing these on the diagram, they are known as cross hairs, labelled whether they are the ones drawn to the same scale. On a slope, the force parallel to the slope is $mg\sin\theta$ while the force perpendicular to the slope is $mg\cos\theta$. For example, in this scenario, (5kg, 15°) If asked to find the acceleration of the ball, we know that $F = ma$ and $F = mg\sin\theta$ $a = g\sin\theta = 9.81 \times \sin(15) = 2.5\,ms^{-2}$ However, if we were asked to find the normal contact force, we'd need to draw a diagram to understand it. F.B.D. Resultant force: $N = F - mg$ $N = F + mg$ $= ma + mg = (5 \times 9.81 \times \sin(15)) + (5 \times 9.81) = 62\,N$. Note that when given contact forces, it is for the slope force not perpendicular and the resultant force could well be negative. Whenever an object moves through a fluid, it experiences drag e.g. a wake or air. It is found that the speed and cross sectional area of the two most influencing factors. The drag is directly proportional to between the drag force and speed^2. If the speed of an object is doubled, it's drag force increases by a factor of four. For example, a car experiences a drag force of 1kN at 10 ms^{-1}, at 30 ms^{-1}, it's speed has increased by x3 : it's drag force will increase by $3^2 = 9$: it's new drag force would be 9 kN. Terminal velocity is the state where the drag force is equal and opposite to the objects weight. At terminal velocity, the speed is constant and there is an acceleration of 0 ms^{-2}. When an object falls through a fluid, there are three stages of it's motion which can be represented by the

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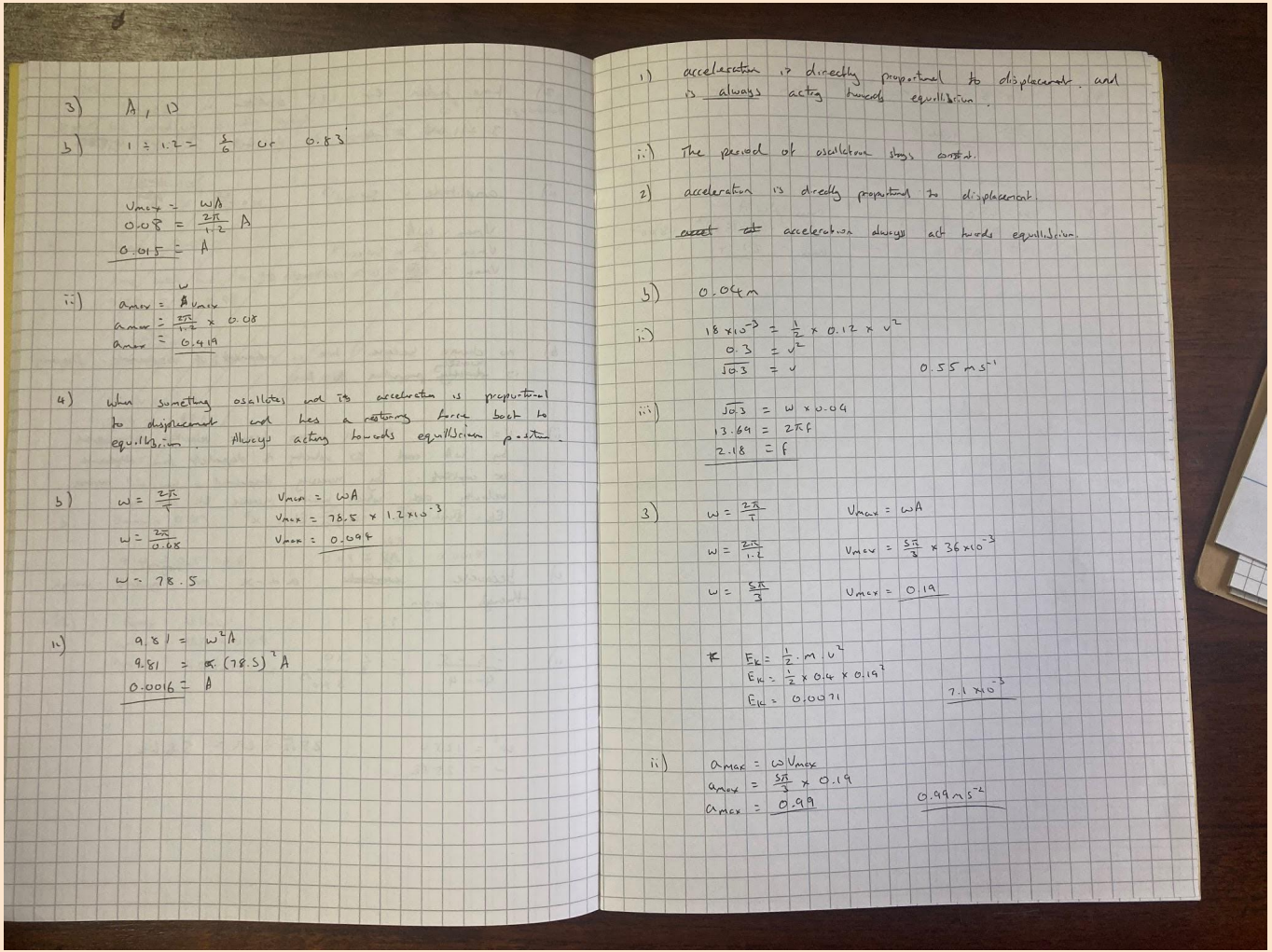
Blurt.

I write down everything I think I know about the topic



I was finding these questions difficult last year, so I have revisited the hardest ones, printed them out and am finding them much easier now.

I made a list of the difficult questions/topics.



3) A, D

3) $1 \div 1.2 = \frac{5}{6}$ or 0.83

$v_{max} = \omega A$
$0.08 = \frac{2\pi}{1.2} A$
$0.015 = A$

ii) $a_{max} = \omega v_{max}$
$a_{max} = \frac{2\pi}{1.2} \times 0.08$
$a_{max} = 0.419$

4) When something oscillates and its acceleration is proportional to displacement and has a restoring force back to equilibrium. Always acting towards equilibrium position.

5) $\omega = \frac{2\pi}{T}$
$\omega = \frac{2\pi}{0.08}$
$\omega = 78.5$

$v_{max} = \omega A$
$v_{max} = 78.5 \times 1.2 \times 10^{-3}$
$v_{max} = 0.094$

ii) $9.81 = \omega^2 A$
$9.81 = (78.5)^2 A$
$0.0016 = A$

1) acceleration is directly proportional to displacement and is always acting towards equilibrium.

ii) The period of oscillation stays constant.

2) acceleration is directly proportional to displacement.
~~exact~~ acceleration always act towards equilibrium.

5) 0.04m

i) $18 \times 10^{-3} = \frac{1}{2} \times 0.12 \times v^2$
$0.3 = v^2$
$\sqrt{0.3} = v$ $0.55 \, ms^{-1}$

iii) $\sqrt{0.3} = \omega \times 0.04$
$13.69 = 2\pi f$
$2.18 = f$

3) $\omega = \frac{2\pi}{T}$
$\omega = \frac{2\pi}{1.2}$
$\omega = \frac{5\pi}{3}$

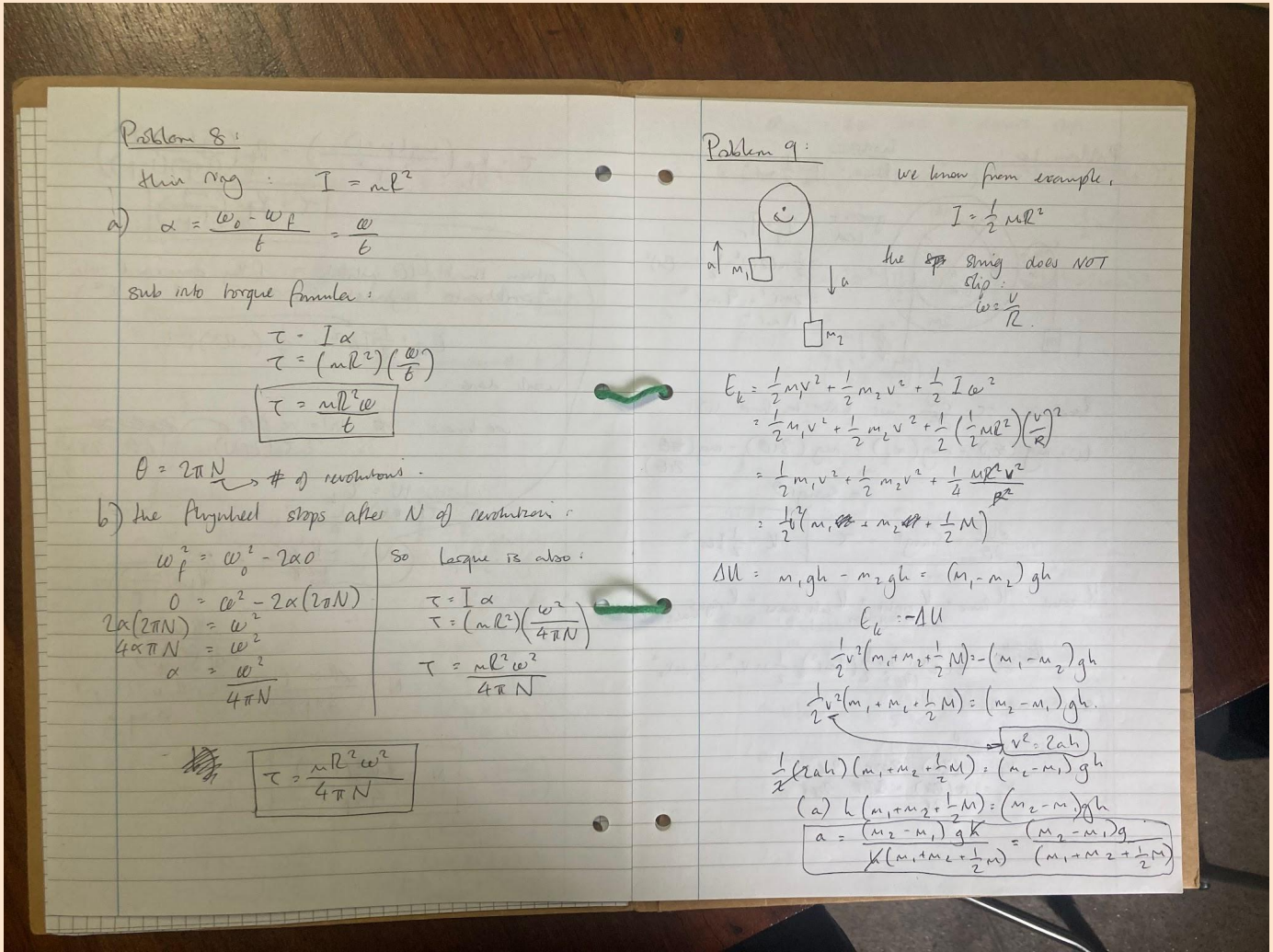
$v_{max} = \omega A$
$v_{max} = \frac{5\pi}{3} \times 36 \times 10^{-3}$
$v_{max} = 0.19$

$E_K = \frac{1}{2} \cdot m v^2$
$E_K = \frac{1}{2} \times 0.4 \times 0.19^2$
$E_K = 0.0071$ 7.1×10^{-3}

ii) $a_{max} = \omega v_{max}$
$a_{max} = \frac{5\pi}{3} \times 0.19$
$a_{max} = 0.99$ $0.99 \, ms^{-2}$

Lots of past paper question practice.

I don't worry about using lots of pages as it helps me to make my thinking clear.



Problem 8:

thin ring: $I = mR^2$

a) $\alpha = \frac{\omega_0 - \omega_f}{t} = \frac{\omega}{t}$

sub into torque formula:

$\tau = I\alpha$

$\tau = (mR^2)\left(\frac{\omega}{t}\right)$

$\boxed{\tau = \frac{mR^2\omega}{t}}$

$\theta = 2\pi N$ → # of revolutions.

b) the flywheel stops after N of revolutions:

$\omega_f^2 = \omega_0^2 - 2\alpha\theta$

$0 = \omega^2 - 2\alpha(2\pi N)$

$2\alpha(2\pi N) = \omega^2$

$4\alpha\pi N = \omega^2$

$\alpha = \frac{\omega^2}{4\pi N}$

So torque is also:

$\tau = I\alpha$

$\tau = (mR^2)\left(\frac{\omega^2}{4\pi N}\right)$

$\tau = \frac{mR^2\omega^2}{4\pi N}$

$\boxed{\tau = \frac{mR^2\omega^2}{4\pi N}}$

Problem 9:

we know from example,

$I = \frac{1}{2}MR^2$

the string does NOT slip:

$\omega = \frac{v}{R}$.

$E_k = \frac{1}{2}m_1v^2 + \frac{1}{2}m_2v^2 + \frac{1}{2}I\omega^2$

$= \frac{1}{2}m_1v^2 + \frac{1}{2}m_2v^2 + \frac{1}{2}\left(\frac{1}{2}MR^2\right)\left(\frac{v}{R}\right)^2$

$= \frac{1}{2}m_1v^2 + \frac{1}{2}m_2v^2 + \frac{1}{4}\frac{MR^2v^2}{R^2}$

$= \frac{1}{2}v^2\left(m_1 + m_2 + \frac{1}{2}M\right)$

$\Delta U = m_1gh - m_2gh = (m_1 - m_2)gh$

$E_k = -\Delta U$

$\frac{1}{2}v^2\left(m_1 + m_2 + \frac{1}{2}M\right) = -(m_1 - m_2)gh$

$\frac{1}{2}v^2\left(m_1 + m_2 + \frac{1}{2}M\right) = (m_2 - m_1)gh$.

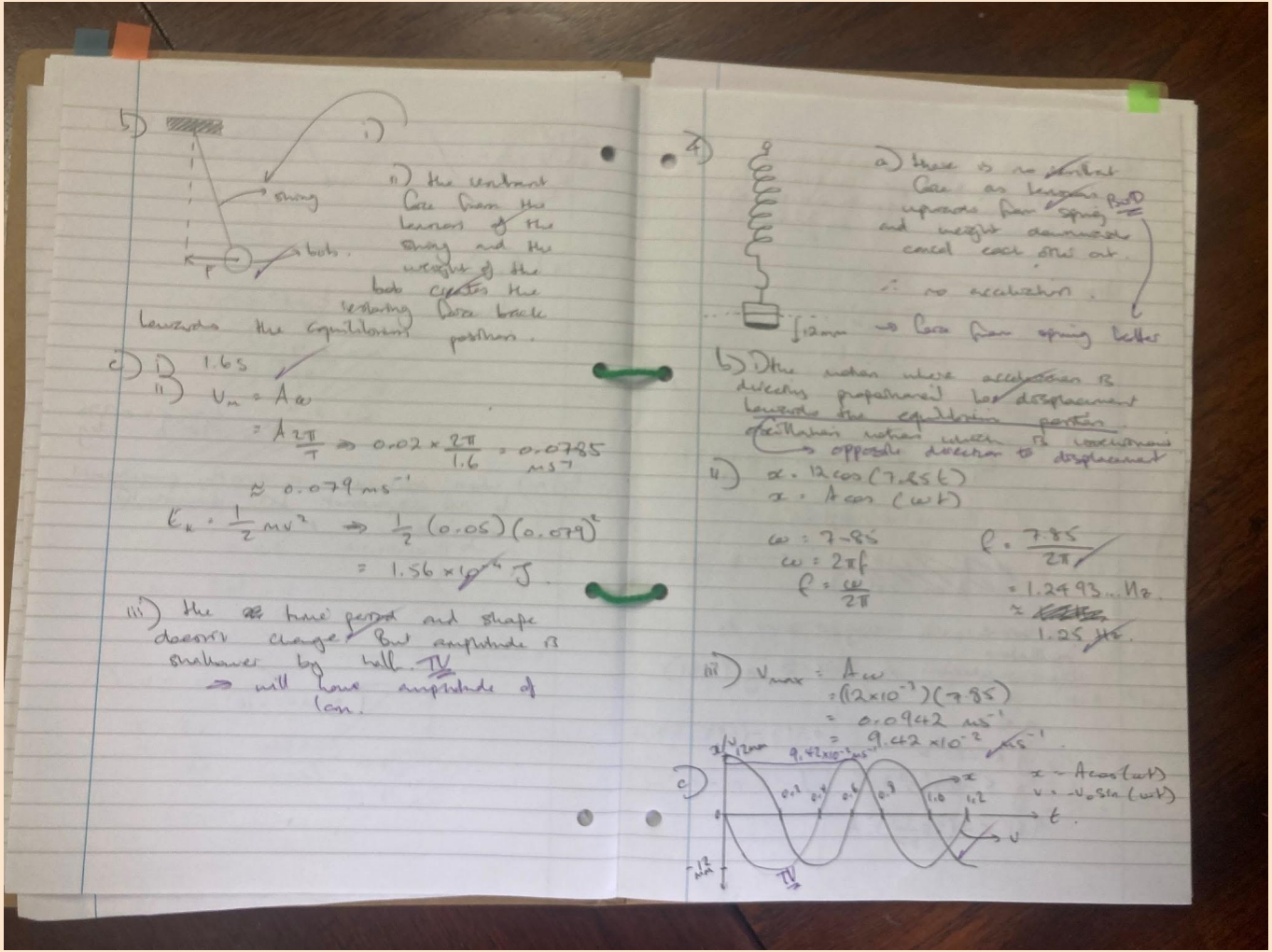
$v^2 = 2ah$

$\frac{1}{2}(2ah)\left(m_1 + m_2 + \frac{1}{2}M\right) = (m_2 - m_1)gh$

$(a)\,h\left(m_1 + m_2 + \frac{1}{2}M\right) = (m_2 - m_1)gh$

$a = \frac{(m_2 - m_1)gh}{h\left(m_1 + m_2 + \frac{1}{2}M\right)} = \frac{(m_2 - m_1)g}{\left(m_1 + m_2 + \frac{1}{2}M\right)}$

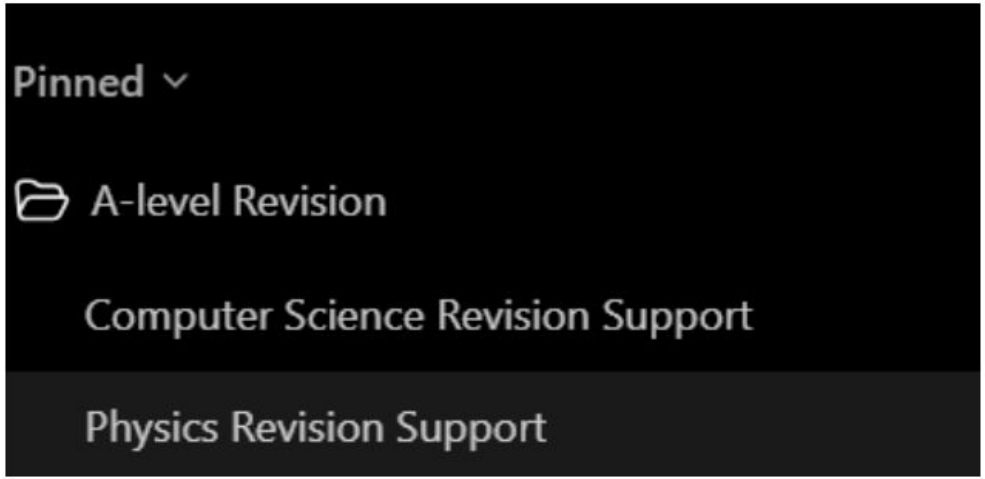
I've been doing the COMPOS assignments and also lots of problem solving type questions including from other exam boards.



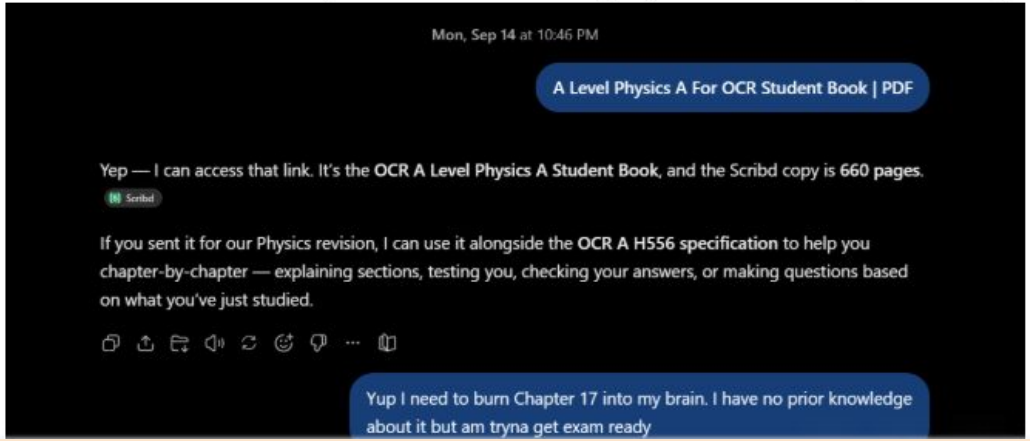
The purple pen is my annotations after reviewing my work.

I find this helps me to avoid repeating the same mistakes.

Here are the independent study screenshots from ChatGPT.



I created a folder for Physics so that it's always pinned to the top and easily accessible.



I am using ChatGPT as a teacher to review each topic.

Retrieval Test 1 — no scrolling back 👀

Answer these **from memory.** Don't worry if some are wrong — that's useful because I'll know exactly what needs reinforcing.

1. What is an oscillation?

2. Define **amplitude.**

3. A mass oscillates between $x = -8\,cm$ and $x = +8\,cm$. What is its amplitude?

4. Define **period** and **frequency.**

5. An oscillator has a period of $0.25s$. Calculate its frequency.

6. Calculate its angular frequency ω.

7. State the defining equation for SHM.

8. Complete these:

At equilibrium:

$$x = ?, \qquad a = ?, \qquad v = ?$$

At maximum positive displacement:

$$x = ?, \qquad v = ?, \qquad |a| = ?$$

9. In the equation

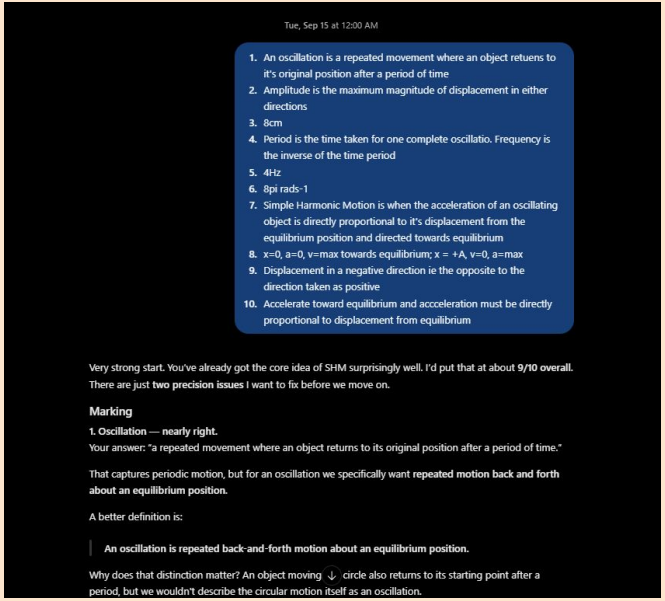
$$a = -\omega^2 x$$

what is the **physical meaning of the minus sign?**

10. OCR-style [2 marks]:
State the two conditions that must be satisfied for the acceleration of an object to be described as simple harmonic motion.

Send me **1–10.** I'll mark them properly, fix anything sh[illegible], and then we go into **17.2 where the proper SHM maths and graphs begin.**

+ Ask ChatGPT 5.6 High



Tue, Sep 15 at 12:00 AM

1. An oscillation is a repeated movement where an object retuens to it's original position after a period of time
2. Amplitude is the maximum magnitude of displacement in either directions
3. 8cm
4. Period is the time taken for one complete oscillatio. Frequency is the inverse of the time period
5. 4Hz
6. 8pi rads-1
7. Simple Harmonic Motion is when the acceleration of an oscillating object is directly proportional to it's displacement from the equilibrium position and directed towards equilibrium
8. x=0, a=0, v=max towards equilibrium; x = +A, v=0, a=max
9. Displacement in a negative direction ie the opposite to the direction taken as positive
10. Accelerate toward equilibrium and accceleration must be directly proportional to displacement from equilibrium

Very strong start. You've already got the core idea of SHM surprisingly well. I'd put that at about **9/10 overall.** There are just **two precision issues** I want to fix before we move on.

Marking

1. Oscillation — nearly right.
Your answer: "a repeated movement where an object returns to its original position after a period of time."

That captures periodic motion, but for an oscillation we specifically want **repeated motion back and forth about an equilibrium position.**

A better definition is:

> **An oscillation is repeated back-and-forth motion about an equilibrium position.**

Why does that distinction matter? An object moving [illegible] circle also returns to its starting point after a period, but we wouldn't describe the circular motion itself as an oscillation.

I told the chat my exam board and subject (OCR Physics A) and told it my time limit

After teaching a specific chunk of a chapter, it gives retrieval tests with 10 questions

You type out your answers and it marks them and gives improvement models for each one immediately.