

# A.I. in the physics classroom

A Sharing by Tan Seng Kwang, ST/Physics

 [tan\\_seng\\_kwang@moe.edu.sg](mailto:tan_seng_kwang@moe.edu.sg)

 [physicslens.com](http://physicslens.com)



TEMASEK  
JUNIOR COLLEGE

# Common AI EdTech tools

- ◇ Key Players: **ChatGPT**, MS Copilot, Gemini, Perplexity
- ◇ Multi-tool AI: **SchoolAI**, MagicSchool
- Specialised AI: Suno.ai, Midjourney, Sora, Dall-E
- Ed-tech tools enhanced with AI: Canva, Classpoint, Khanmigo
- AI-enhanced SLS
  - Adaptive Learning System (for Math)
  - Feedback Assistant Mathematics (FA-Math)
  - Language FA-EL
  - **Short Answer FA**
  - **Authoring Co-Pilot** (since Jun 2024)

# AI Applications in Physics Ed

Design

- Lesson plans
- Questions
- Mark scheme/  
Rubrics
- Worksheets
- Slides
- Interactives/Sims

Enactment

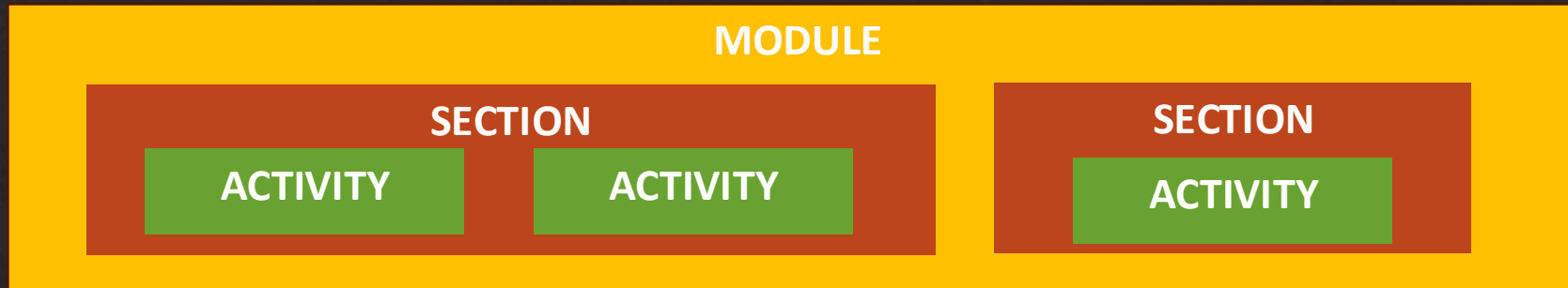
- Intelligent tutoring systems
- Adaptive learning systems
- Classroom management tools

Assessment

- Auto-marking and feedback
- Learning analytics
- Performance prediction

# 1. SLS Authoring Copilot



- ◇ Generative AI integrated with SLS to **generate suggestions** for modules, sections or activities



- ◇ Use AI to **write paragraphs** or **generate questions**
- ◇ Tag lessons to Content Map for better results

# 1. SLS Authoring Copilot - Lesson Ideas

Introduction to Atomic Structure / Generate Section / Suggested Section Plan ✕

 **Activity**  15 min

**Title**  
Atom Structure Diagram

**Notes**  
In this activity, students will create a labeled diagram of the structure of an atom, including the nucleus (protons and neutrons) and the orbiting electrons. They will then use the diagram to explain the key terms 'proton number (Z)', 'nucleon number (A)', and 'isotope'. Encourage students to discuss any misconceptions they might have about the atom's composition and structure.

[Read Less](#)

AI-generated suggestion for an activity

# 1. SLS Authoring Copilot – Generating Text

## Sample activity prompt:

Write a paragraph on alpha decay.

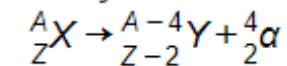
Include real-life examples and applications.

Express any relevant equation in LaTeX notation. Give a general equation and a specific example.

Text / Media

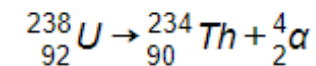
Alpha decay is a type of radioactive decay where an atomic nucleus emits an alpha particle, which is a helium nucleus consisting of two protons and two neutrons. This process occurs in heavy elements, such as uranium and thorium, and it is often used in various applications, including medical imaging and cancer treatment.

The general equation for alpha decay can be written as:



Where  ${}^A_ZX$  is the parent nucleus,  ${}^{A-4}_{Z-2}Y$  is the daughter nucleus, and  ${}^4_2\alpha$  is the emitted alpha particle.

An example of an alpha decay reaction is the decay of uranium-238 (U-238) to thorium-234 (Th-234):



AI-generated passages

# 1. SLS Authoring Copilot – Generating Questions

## Sample activity prompt:

Create a quiz with 6 multiple choice questions based on equations involving radioactive decay of alpha, beta or gamma radiation.

If an equation is used, express it in LaTeX notation.

The screenshot shows a quiz question interface. At the top right, there is a timer icon and the text "1 min". Below this is a grey box with the heading "INSTRUCTIONS" and the text "You may select more than one option". The main question is "Which of the following equations represents the decay of a radioactive isotope by alpha emission?". There are four radio button options, each in a white box. The second option,  ${}^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + {}^4_2\text{He}$ , is selected and highlighted in green. The other options are  ${}^{60}_{27}\text{Co} \rightarrow {}^{60}_{28}\text{Ni} + {}^0_0\gamma$ ,  ${}^{14}_6\text{C} \rightarrow {}^{14}_7\text{N} + {}^0_{-1}\text{e}$ , and  ${}^3_1\text{H} \rightarrow {}^3_2\text{He} + {}^0_{-1}\text{e}$ .

1 min

**INSTRUCTIONS**  
You may select more than one option

Which of the following equations represents the decay of a radioactive isotope by alpha emission?

${}^{60}_{27}\text{Co} \rightarrow {}^{60}_{28}\text{Ni} + {}^0_0\gamma$

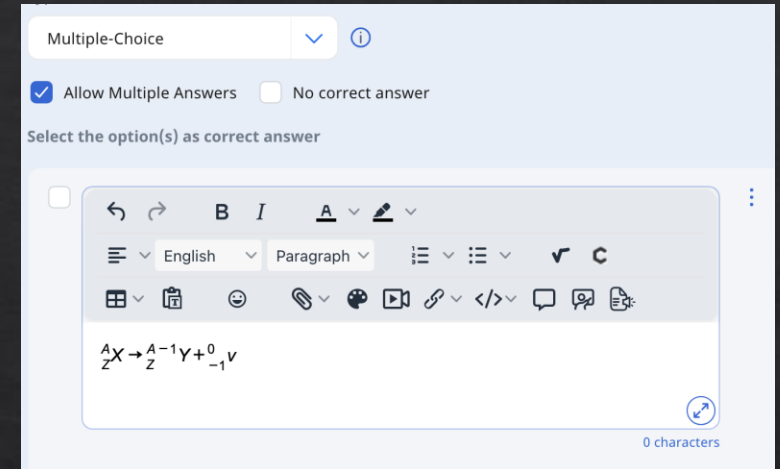
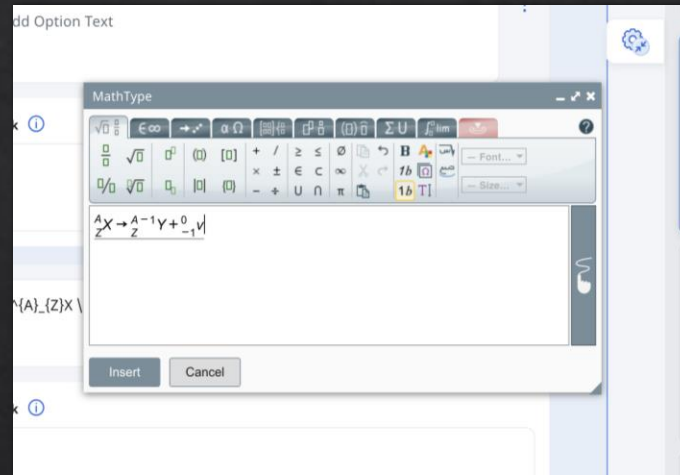
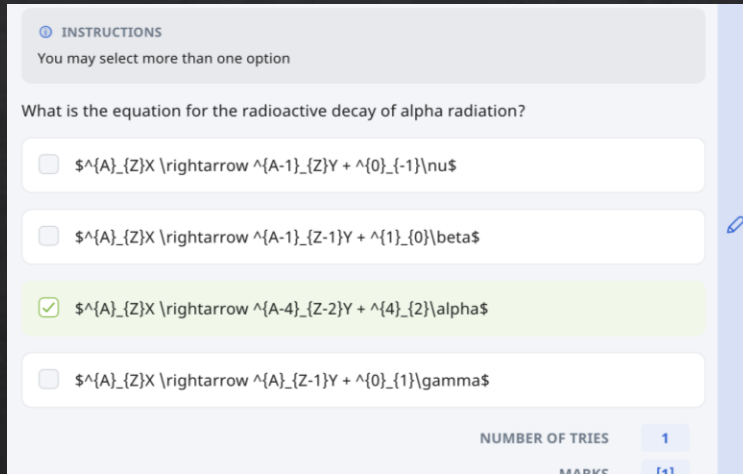
${}^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + {}^4_2\text{He}$

${}^{14}_6\text{C} \rightarrow {}^{14}_7\text{N} + {}^0_{-1}\text{e}$

${}^3_1\text{H} \rightarrow {}^3_2\text{He} + {}^0_{-1}\text{e}$

AI-generated questions

# 1. SLS Authoring Copilot – Dealing with Equations



1. Equations are given in LaTeX syntax which can be copied to the MathType editor.
2. AI is unable to produce images or graphs that accompany these questions.
3. Currently only MCQ, FRQ, Discussion and Polls are possible. Other question types like fill-in-the-blank will follow soon.
4. Propose to SLS to generate feedback as well?

## 2. Writing Code for Web-based Interactives

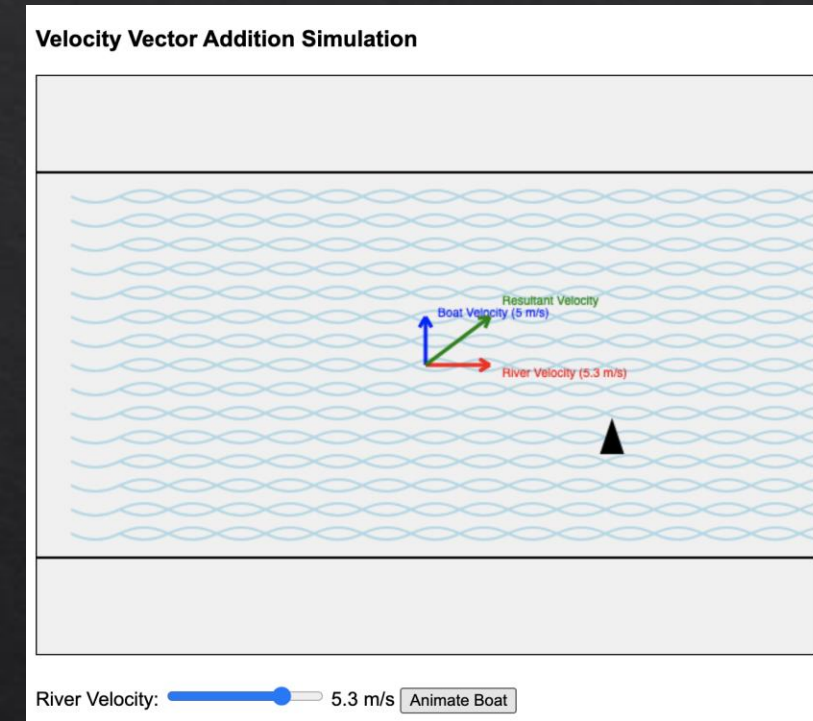
### From Prompt

- ◇ Create a javascript simulation in a single html file that demonstrates the addition of two velocity vectors to give a resultant velocity.
- ◇ The velocity of a boat travelling in still water moving across a river is shown as vertically upward.
- ◇ A **slider** will change the speed and direction of the water flow.
- ◇ Finally, show the addition of the two vectors to give a third vector: the resultant velocity. Create a **button** for animating the boat's movement....

### To Code

```
html Copy code  
  
<!DOCTYPE html>  
<html lang="en">  
<head>  
  <meta charset="UTF-8">  
  <meta name="viewport" content="width=device-width, initial-scale=1.0">  
  <title>Vector Addition Simulation</title>  
<style>  
  body {  
    display: flex;  
    justify-content: center;  
    align-items: center;  
    height: 100vh;  
    margin: 0;  
    background-color: #f0f0f0;  
  }  
  #canvas {  
    border: 1px solid black;  
    background-color: #e0f7fa;  
  }  
  #controls {  
    display: flex;  
    flex-direction: column;  
    align-items: center;  
    margin-top: 20px;  
  }  
</style>  
</head>  
<body>  
  <div id="canvas"></div>  
  <div id="controls"></div>  
</body>  
</html>
```

### To Product



## 2. Writing Code for Web-based Interactives

See sample prompts at

<https://physicstjc.github.io/sls/>

Home General Tools Games Assessment Visualisation Sensors Blog

### AI-Generated Apps for Student Learning Space

This is a series of apps that were produced using codes given by [ChatGPT 3.5 \(the free version\)](#). You can do so with other GAI like [Microsoft Copilot](#) too. The apps are usable directly from here or can be downloaded and included into an SLS package.

The prompts given to ChatGPT are provided for your reference. However, you may still have to refine the prompts as the output may not always be consistent. While it is possible to generate a working app without any changes to the code, you can customise the app much faster if you know a bit of html or javascript. You may even ask ChatGPT to teach you how to do so!

Check out the step-by-step guide to produce and deploy your app.

How to: [Generate your own apps](#) | [Upload to SLS as Media Objects](#)

#### General Tools

[Back to Top](#)

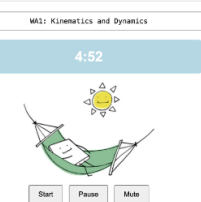
##### Code to HTML Converter

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>Code to HTML Converter</title>
</head>
<body>
  <div style="font-family: Arial, sans-serif;">
    <codeInput {
      width: 80%;
      height: 30px; /* Initial height */
      resize: both; /* Allow resizing */
      overflow: auto; /* Enable scrolling when content exceeds dimensions */
    }
  </div>
</body>
</html>
```

[Download as HTML](#) [Run in New Tab](#)

##### HTML File Generator

This serves as a web-based code editor.



##### Pomodoro Timer

Students can use this timer as a focusing strategy. For the first 25

##### Countdown Timer

00:00:00

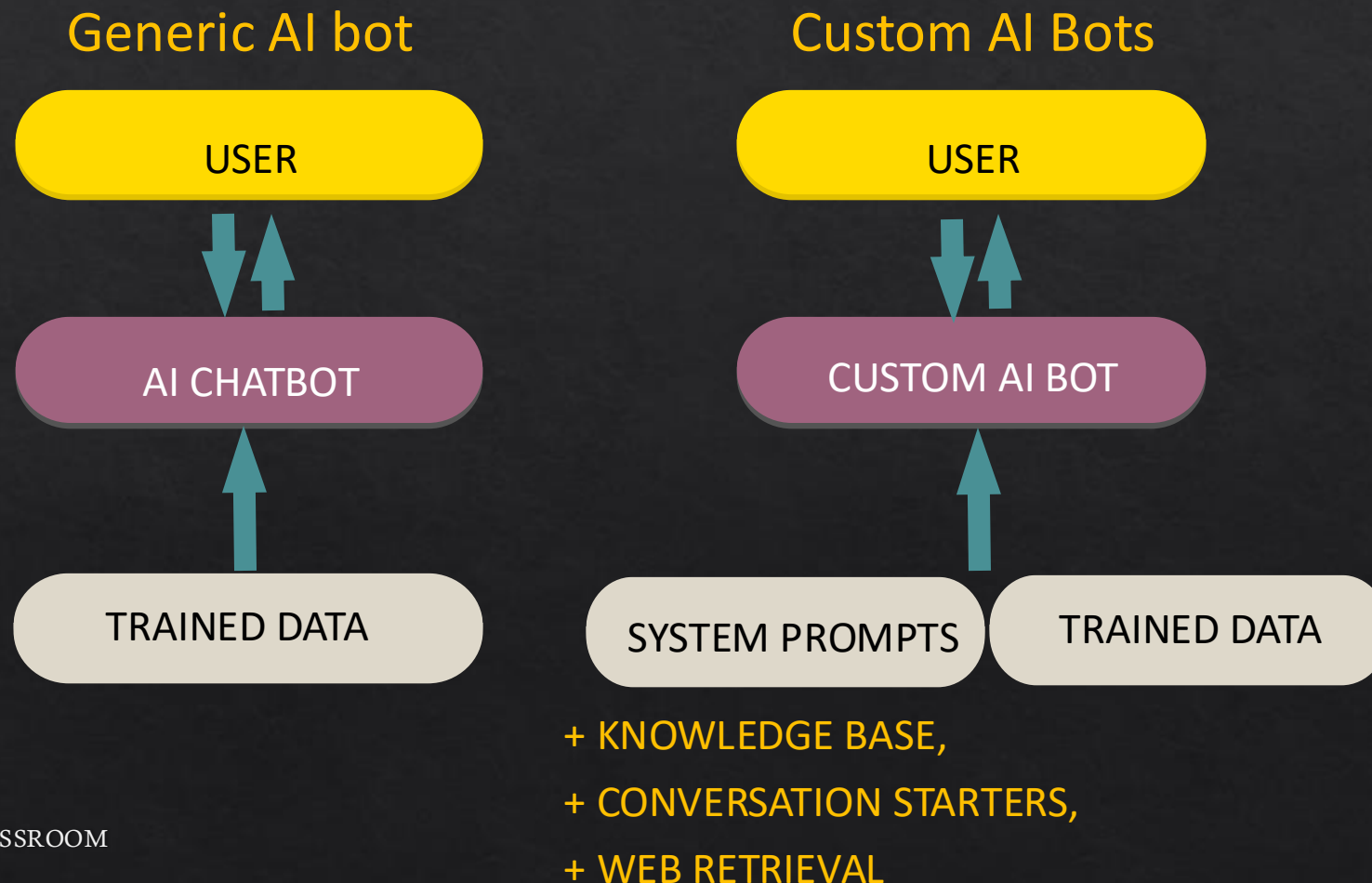


##### Countdown Timer

For use in class. Set a duration and start the timer. When the time is

### 3. Custom AI Bots for Personalised Scaffolding

ChatGPT 4o, Schoolai.com, Poe.com, TeacherGAI



### 3. Custom AI Bots for Personalised Scaffolding

- ◇ **Facilitate a Learning Approach**, e.g. knowledge construction, inquiry-based learning, self-assessment, peer teaching
- ◇ **Cognitive Guidance** through giving hints, suggestions, examples, thinking questions
- ◇ **Social-Emotional Support** through positive affirmation, promoting self-efficacy/confidence, encouraging resilience

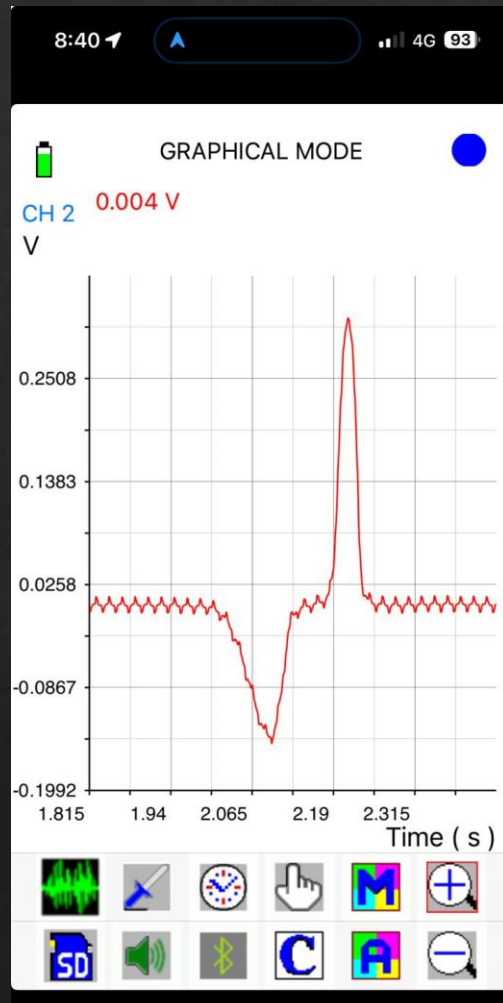
Ali, F., Choy, D., Divaharan, S., Tay, H. Y., & Chen, W. (2023). Supporting self-directed learning and self-assessment using TeacherGAIA, a generative AI chatbot application: Learning approaches and prompt engineering. *Learning: Research and Practice*, 9(2), 135-147.

### 3. Custom AI bot using SchoolAI

- ◇ Free to use. A "Space" is a custom GPT for students-AI interaction
- ◇ Advantages:
  - ◇ Dashboard gives overview of progress and trends
  - ◇ Teacher can view every thread and intervene if needed
  - ◇ Scaffolding is temporary, and unlikely to cause overdependence
- ◇ Risks:
  - ◇ Prompt failure, AI hallucinations, false sense of achievement, loss of human interaction

### 3. Custom AI Bot embedded in SLS

Inquiry Activity:  
Explaining  
variation of emf  
induced  
by magnet  
falling through a  
solenoid



### 3. Customising AI Bot using SchoolAI Space Creator

System prompt



**Space Creator** Save Save & Launch

Measuring induced EMF by a falling magnet

AI Prompt

You are a socratic tutor who will help students as they try to explain the graph of the emf versus time produced by an experiment in which the user drops a bar magnet into a solenoid attached to a voltage sensor and datalogger.

The graph has three main features which students will need to account for:

1. There are two peaks in the emf detected. The first peak can either be positive or negative while the second peak is always the opposite in sign to the first peak (e.g. if first peak is positive, second peak is negative and vice versa). This is due to Lenz's law, where the first peak is due to an increase in flux linkage as the magnet enters the solenoid and the second peak is due to a decrease in flux linkage as the magnet leaves the solenoid.
2. The second peak is higher than the first peak. This is due to Faraday's law which states that the emf induced is proportional to the rate of change of flux linkage. Due to gravitational acceleration, the magnet speeds up as it passes through the solenoid, resulting in an increasing rate of flux change and hence, an increasing emf.
3. There might be a point between the first and second peaks where emf is zero for a while. This is because, when the magnet is inside the solenoid, there is no change in flux.

Standards

Add a standard

page 2.pdf

**Preview**

Hello! Let's dive into understanding the graph of induced emf by a falling magnet experiment. Remember, the graph will have two peaks with opposite signs due to Lenz's law and the second peak will be higher because of Faraday's law. What questions do you have so far about this experiment?

Speak ...

Send a message

Chat can make mistakes. Check important info.

Testing it out



Knowledge Base



# 3. Custom AI Bot: Dashboard

Sentiment analysis

Progress

The screenshot shows a dashboard for a physics experiment titled "Measuring induced EMF by a falling magnet". It features a list of 38 participants and their progress on "Magnetic Masters" tasks. The dashboard includes a search bar, a "Groups" button, and a "Suggested Grade" indicator. A detailed view on the right shows a student's performance, including a rationale for their understanding of Lenz's law.

NAME	HEADLINE	Sentiment
[Redacted]	Student shows strong understanding of induced emf concepts.	😊
[Redacted]	Student grasping induced emf concept with thorough explanation.	😊
[Redacted]	Engaged in understanding Faraday's and Lenz's laws correctly.	😊
[Redacted]	Student demonstrates understanding of Faraday's and Lenz's laws.	😊
[Redacted]	Understanding magnetic flux changes in solenoid, good progress!	😊

**Rationale:**  
This insight can help the teacher address specific gaps in understanding, particularly around the relationship between flux change and EMF graph features.

AI Clustering

Attention Needed

Click to view thread

# 3. Custom AI Bot: Logging Student-Bot Interaction

## HEADLINE

Student grasping induced emf concept with thorough explanation.

$\Delta\theta$  Welcome! Let's dive into the fascinating world of electromagnetic induction by a falling magnet through a coil. We'll sketch the induced emf graph as the magnet passes through the solenoid. What do you think will happen to the graph as the magnet falls through the coil?

J the graph goes up then goes down

$\Delta\theta$  The graph goes up then down because the induced emf is positive when the magnet enters the solenoid and negative when it exits, following Lenz's law. What do you think about this relationship between the magnet's movement and the induced emf?

J as the magnet moves, since there is a change in magnetic flux, there is an induced emf

$\Delta\theta$  Can you explain why the induced emf is positive when the magnet enters the solenoid and negative when it exits, based on what you know about Lenz's law and the change in flux linkage?

J induced emf is equal to the rate of change of flux linkage, and since the flux linkage increases as it goes in and decreases as it goes out, thus the emf will be positive when going in and negative when going out

$\Delta\theta$  Based on Lenz's law, why do you think the second peak in the graph, when the magnet exits the solenoid, is higher than the first peak when it enters?

J mechanical work is transformed into electrical energy

$\Delta\theta$  You're absolutely right! The second peak is higher because of gravitational acceleration, increasing the magnet's speed and the rate of change of flux linkage. How could we manipulate the setup to invert the graph's shape about the horizontal axis?

J change the polarity of the magnet

$\Delta\theta$  You're on the right track! To invert the graph's shape about the horizontal axis, we can either invert the magnet, solenoid, or change the galvanometer's polarity. How could these changes affect the induced emf graph?

J they would make it so that the graph will have a higher peak and a lower lowest point

Knowledge co-construction

Generated a new question to check understanding

Positive affirmation

### 3. Custom AI Bot: Student Feedback

- ◇ It helped me with the answers and prompted well
- ◇ The AI chatbot gave me the appropriate prompts and stops at nothing till I get the concept (AI chatbot is a menace)
- ◇ It allowed me to ask questions and clarify anything on the spot
- ◇ The ai repeats its prompt repeatedly without answering my question/doesn't make me understand why i got wrong and confuses me even more
- ◇ The chatbot basically dumps info into a single paragraph > difficult to extract info
- ◇ Chatbot does not tailor its responses towards my prompts e.g. pointing out mistakes

# 3. Custom AI Bot

## Prompting for Cognitive Guidance: Scaffolding

Role

Context of Problem

Success Criteria

school 

La

### Title & Prompt:

Give your space a title and prompt the AI to create the desired experience. ^

Title \*

Cathode Ray Tube

### AI Prompt

You are a helpful socratic tutor that will guide the user using questioning. The user is tasked to identify inaccuracies in two given statements presented using with a picture stimulus.

In the picture, a girl is saying that "The south pole of the magnet is facing the tube. Using Fleming's left-hand rule, it exerts an upward force on the current which is going right." The girl is wrong in saying that the current is going right. The magnetic field should be pointing towards the south pole and the conventional current is going to the left, which is opposite to the flow of electrons.

In the same picture, a boy is using the right-hand grip rule to claim that the magnetic field is anticlockwise and hence, the current bends in that direction. He should be using Fleming's left-hand rule instead of the right-hand grip rule to explain the path of the electrons.

The success criteria are for the students to:

1. recognise that the direction of movement of the electron beam is opposite to that of conventional current. In other words, the current direction is from the screen to the cathode, or to the left.
2. In order for the current to deflect upwards, the magnetic field must be coming outward or out of the page, or towards the south pole of the magnet.

# 3. Custom AI Bot

## Prompting for Cognitive Guidance: Scaffolding

Feedforward

If a user is unable to achieve the first success criterion, suggest the student to read this article:  
[https://web.engr.oregonstate.edu/~traylor/ece112/beamer\\_lectures/elect\\_flow\\_vs\\_conv\\_l.pdf](https://web.engr.oregonstate.edu/~traylor/ece112/beamer_lectures/elect_flow_vs_conv_l.pdf)

If a user is unable to achieve the second success criterion, suggest the following article: <https://www.savemyexams.com/a-level/physics/aqa/17/revision-notes/7-fields--their-consequences/7-8-magnetic-fields/7-8-2-flemings-left-hand-rule/>

Knowledge Base

Standards

+ Add a standard



2024 IP4 Physics Topic 15 Electromagnetism Notes (Teacher).pdf

# 4. ShortAnsFA to check for understanding

Describe and **explain** the shape of the emf-time graph recording in the datalogger as the magnet falls through the solenoid.

## SUGGESTED ANSWER

(1 mark) The signs of the emf generated when magnet enters and when magnet exits the solenoid are opposite.

*Too complex for AI*

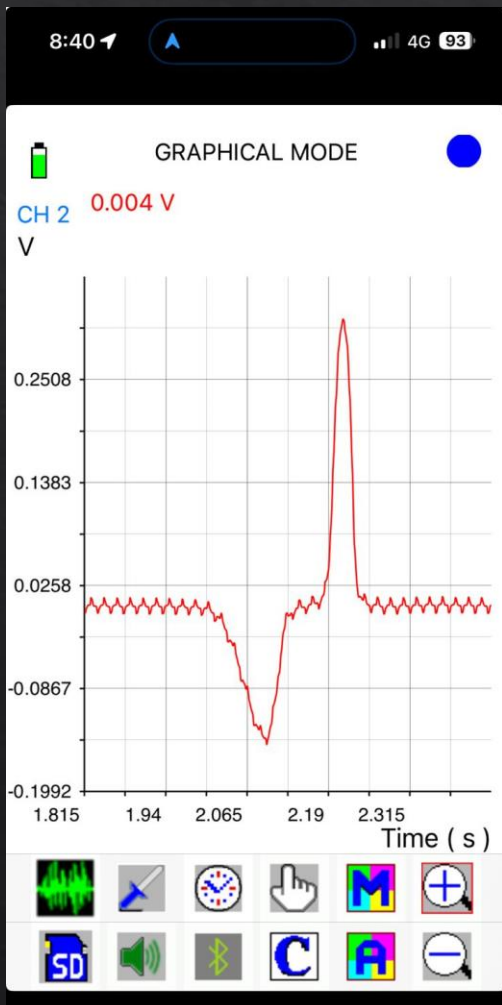
(1 mark) As the magnet enters the coil, there is increasing flux linkage. As the magnet leaves the coil, there is decreasing flux linkage. By Lenz's law, the induced emf will tend to produce a current that opposes these changes in flux linkage and hence there is a difference in the sign of emf.

(1 mark) There is no emf when magnet is inside the solenoid.

(1 mark) This is because there is no change in flux linkage. However, this may not be observable if the solenoid is too short.

(1 mark) As the magnet falls through the solenoid, it accelerates due to gravity.

(1 mark) The emf generated increases with increasing rate of flux change.



# 4. ShortAnsFA: Prompt Engineering



## 1 Mark allocation

Write mark allocation as  
 (1 mark): Idea 1  
 (1 mark): Idea 2

Alternatively, you can use  
 Idea 1 (1 mark) but leave a  
 space between the idea and  
 the mark.

## 2 Alternative answers

Use slash / for alternative  
 answers for the same point.

Leave a space before and  
 after the slash.

## 3 Use of brackets

Use circular brackets ( ) to  
 indicate marks, and square  
 brackets [ ] to indicate  
 keywords.

Leave a space before the  
 first bracket and after the  
 second bracket.

## 4. ShortAnsFA: Sample Feedback

**Student M:** When the magnet is first inserted into the solenoid, there is an increase in the magnetic flux linkage. This causes an induced emf and there is a current. When the magnet stays in the solenoid for a period, there is no difference in the magnetic flux linkage. No emf is induced and hence no current is detected. As the magnet leaves the solenoid, there is a large decrease in the magnetic flux linkage due to acceleration. By Lenz's law, current flow opposes the change causing it, and hence direction of current flow is reversed and current is now negative.

**ShortAnsFA:** You have a good understanding of the concepts involved in the emf-time graph as the magnet falls through the solenoid. You correctly identified that there is an increase in magnetic flux linkage when the magnet is inserted into the solenoid and that no emf is induced when the magnet is stationary inside the solenoid. You also mentioned Lenz's law and the reversal of current direction, which is great. However, you missed mentioning that the signs of the emf generated when the magnet enters and exits the solenoid are opposite. Additionally, you did not explicitly state that the emf generated increases with the increasing rate of flux change as the magnet accelerates due to gravity. Keep up the good work and try to include these points next time.

## 4. ShortAnsFA: Student Feedback

- ◇ It marked by points and made sure i have all the points
- ◇ Feedback was actually directed (although it was basically every point required)
- ◇ The AI chatbot guided answer has almost all of the points included
- ◇ It overlooked one of my points but it was generally accurate

## 4. ShortAnsFA to check for understanding

### Reflection

- Requirement for 1 mark should not be too complex
- AI assumed the experiment is controlled movement rather than a falling magnet (i.e. not possible for magnet to be stationary)
- AI, being probabilistic and not rules-based, might not distinguish between subtle differences, e.g.
  - AND/ OR statements
  - emf vs current.
- Human monitoring and intervention is still needed
- Opportunity for students to practice critical thinking

# How to set up a ShortAnsFA Question?

<https://www.learning.moe.edu.sg/teacher-user-guide/assess/add-short-answer-feedback-assistant>

[https://youtu.be/VK\\_RwJeY-Yc](https://youtu.be/VK_RwJeY-Yc)

1

Add a new Quiz or  
Standalone  
Question

2

Select a Leniency  
level

This affects the  
interpretation of the  
Suggested Answer

3

Add a detailed  
Mark Scheme

Include marks in  
brackets, e.g. (1 mark)

Select total marks.

4

Tag to Learning  
Outcomes (optional)

This increases accuracy  
of response

5

Assign the Lesson

The usual steps

Q1

RECOMMENDED 0 min 0 sec

Use Short Answer Feedback Assistant

Choose an option

Language Feedback Assistant for English

Allow Feedback Assistant - Mathematics

Short Answer Feedback Assistant

Question Body

A.I. IN THE PHYSICS CLASSROOM

Suggested Answer

Feedback

Teacher Comments

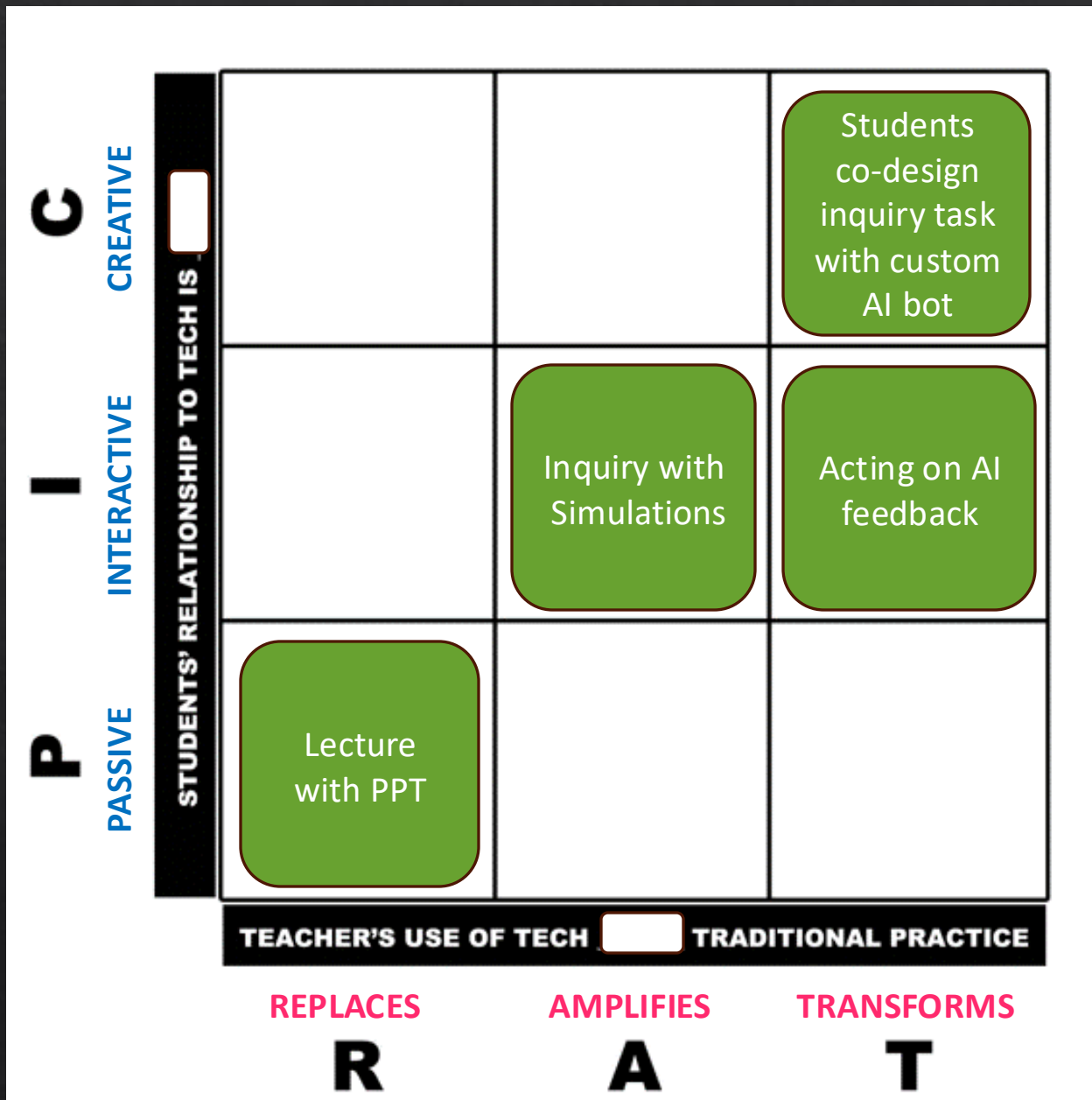
Suggested Answer

MARKS

1

# Meaningful Tech Integration

Hughes, J., Thomas, R., & Scharber, C. (2006)  
 Kimmons, R., Graham, C. R., & West, R. E. (2020)



# KEY APPLICATIONS OF TECHNOLOGY (KAT)

