
HEE2025

Engineering Electromagnetics

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Light

Light, my light, the world-filling light,
the eye-kissing light,
heart-sweetening light!

Ah, the light dances, my darling, at the center of my life;
the light strikes, my darling, the chords of my love;
the sky opens, the wind runs wild, laughter passes over the earth.

The butterflies spread their sails on the sea of light.
Lilies and jasmines surge up on the crest of the waves of light.

The light is shattered into gold on every cloud, my darling,
and it scatters gems in profusion.

Mirth spreads from leaf to leaf, my darling,
and gladness without measure.
The heaven's river has drowned its banks
and the flood of joy is abroad.

[Rabindranath Tagore](#)



Question

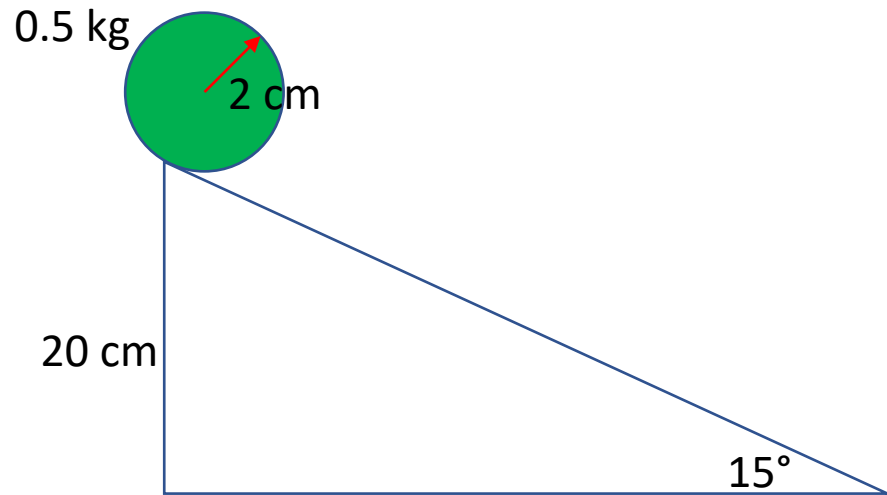
Can I control the spread of light?

And

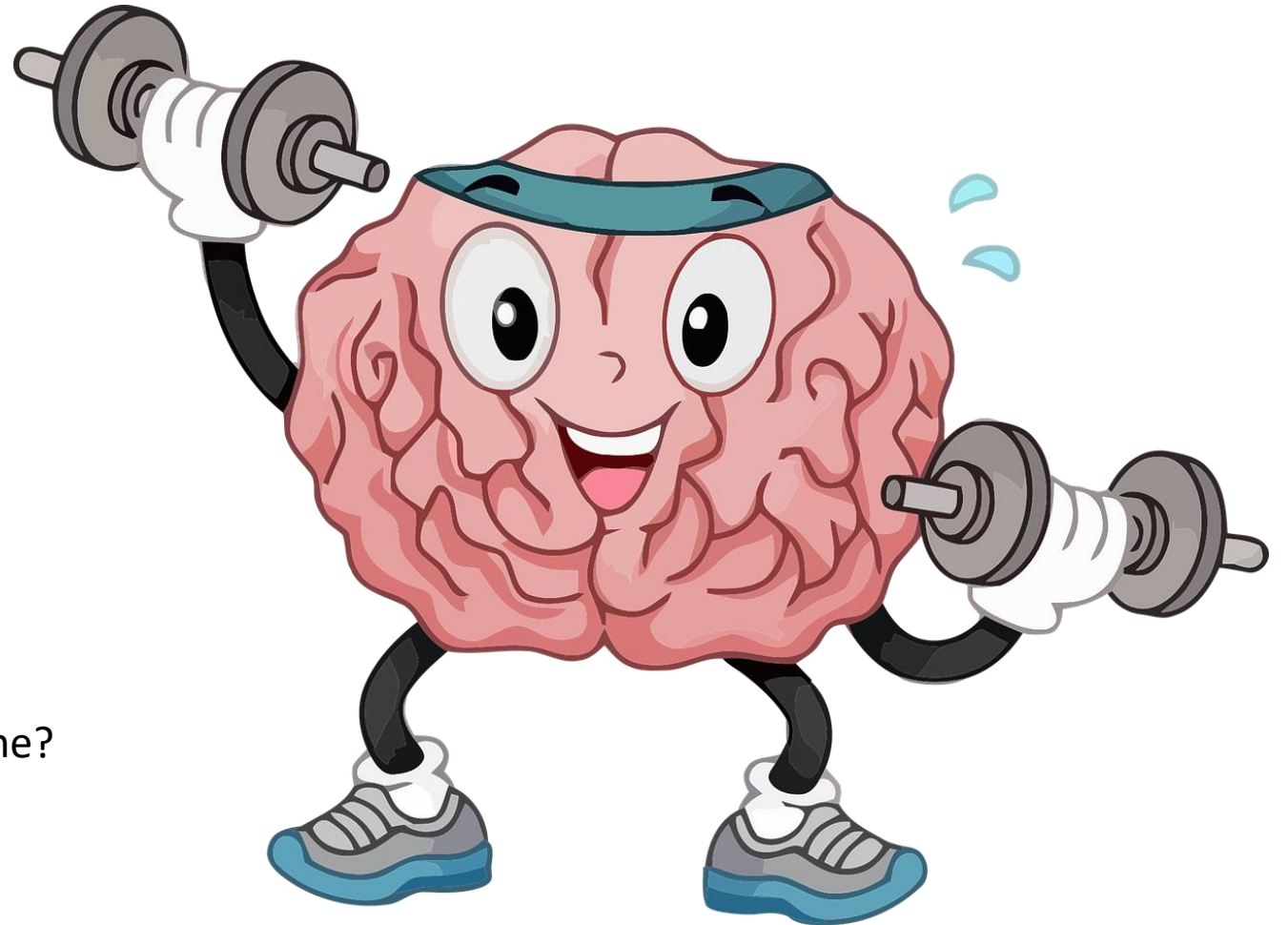
How does light spread?



Time to flex



What is the time to reach the bottom of the incline?

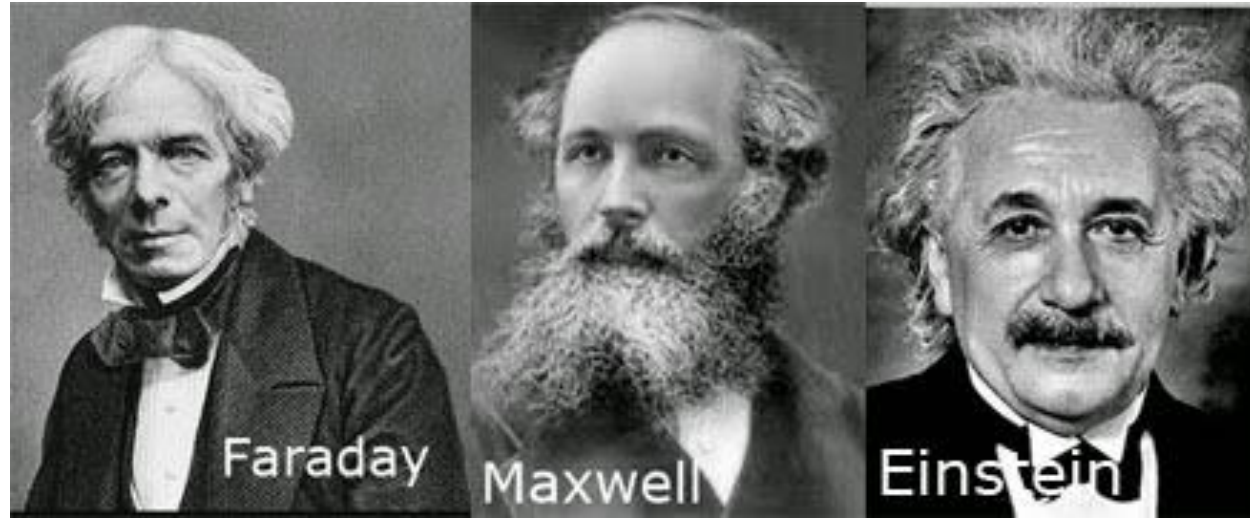


Reality is described by laws that are mathematical

- Physics is a model.
- To a lot of modern-day physicists asking what is real, isn't really an important question. They see it as a mathematical tool that makes calculations (predictions) easier.



Standing on the shoulders of giants



50 points

He loved poetry and has written his own. He had an excellent memory.

30 points

He is credited as the founder of the theory of additive color.



10 points

He demonstrated that Saturn's ring must be composed of numerous small particles.

Pre- and Post- Maxwell

We may say that, before Maxwell, Physical Reality, in so far as it was to represent the process of nature, was thought of as consisting in material particles, whose variations consist only in movements governed by partial differential equations. Since Maxwell's time, Physical Reality has been thought of as represented by ***continuous fields***, governed by partial differential equations, and not capable of any mechanical interpretation. This change in the conception of Reality is the most profound and the most fruitful that physics has experienced since the time of Newton.

-Einstein

Maxwell's theory becomes simple and intelligible only when you give up thinking in terms of mechanical models. Instead of thinking of mechanical objects as primary and electromagnetic stresses as secondary consequences, you must think of the electromagnetic field as primary and mechanical forces as secondary. The idea that the primary constituents of the universe are ***fields*** did not come easily to the physicists of Maxwell's generation. Fields are an abstract concept, far removed from the familiar world of things and forces. The field equations of Maxwell are partial differential equations. They cannot be expressed in simple words like Newton's law of motion, force equals mass times acceleration. Maxwell's theory had to wait for the next generation of physicists, Hertz and Lorentz and Einstein, to reveal its power and clarify its concepts. The next generation grew up with Maxwell's equations and was at home in a universe built out of fields. The primacy of fields was as natural to Einstein as the primacy of mechanical structures had been to Maxwell.

-Freeman Dyson



Fields



Shocktopus

https://testtubegames.com/shocktopus_web.html



Schocktopus physics

- Does the electric field and the voltage, from the Voltmeter in the game, corroborate with each other?
- Based on the Voltmeter in the game, what is the strength of the charges in Coulombs?
- Based on how the Shocktopus moves, how strong is gravity?
- Based on how the Shocktopus moves, what is the strength of *his* charge?
- How about the strength of the magnetic fields?



ODEs vs PDEs

| | ODE | PDE |
|---------------------|--------------------|-----------------------------|
| Number of variables | One | Many |
| Domain | Line segment | Region |
| Given | Initial conditions | Boundary/Initial conditions |
| General Solution | Possible | Impossible |
| Solving Method | Treasure hunt | Not easy |



Great trio of PDEs

$$u_{xx} + u_{yy} = 0 \quad \text{Laplace equation (elliptic)}$$

$$u_t = u_{xx} \quad \text{Heat equation (parabolic)}$$

$$u_{tt} = c^2 u_{xx} \quad \text{Wave equation (hyperbolic)}$$



Graduation day oath

We the graduates of the Indian Institute of technology Madras hereby pledge that we shall in thought word and deed, ever endeavor to be scrupulously honest in the discharge of our duties, that in all circumstances we shall uphold the dignity and integrity of our profession, and the honor of our institute and the nation and we shall devote all our energies to promoting the unity and secular ideal of our country and utilize our knowledge in the service of our nation and society.



Writing scientific arguments



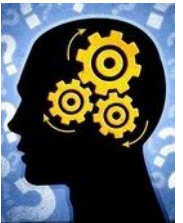
CLAIM

A statement that answers the question



EVIDENCE

The scientific data and details that support your claim



REASONING

Explain “how” or “why” the evidence supports the claim.
A.K.A. the scientific rule.

Course details and preparation for next class

- **Know your TAs**

- Assessment format: 2 Quizzes (20% each) and a Final (40%). Tutorial tests (10%) and Poster (10%).
- Slides and assignments will be posted on my website.
- Relevant NPTEL courses by R. K. Shevgaonkar (IITB), Sheel Aditya (IITD), Pradeep Kumar (IITK)
- Textbooks: **R.K. Shevgaonkar**
- References: N.N. Rao, F. T. Ulaby, D. J. Griffiths, M. N. O. Sadiku

- Hypothes.is – Browser annotation tool. You can also ask questions.

Join the group using the following link:

<https://hypothes.is/groups/E2dz7Awa/engg-electromagnetics>

- Watch this video in preparation for tomorrow's activity

https://www.youtube.com/watch?v=oD9amPhBi8k&ab_channel=PhysicsBurns

