

Lecture Outline

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PHY 100 Introduction to Physics

- Preparation for PHY 101 or PHY 107 – smaller class – slower pace – introductory topics – no final exam
- Weekly online problem assignments – approximately 6 problems – instant feedback – multiple attempts allowed – credit for attempting problems
- In-class tests – approximately every other week – approximately 10-15 minutes each – practice for PHY 101, 107 exams
- Credit for class participation – minute papers
- Complete assigned reading before lecture – study worked examples in each section
- Work as many extra problems as you can – answers to odd-numbered problems are given in the Appendix

What is Physics?

Curiosity

- How does the physical universe (matter and energy) work? – science
- How do things work? – engineering

Concepts

- Space – Time – Velocity – Acceleration – Mass – Force – Energy

Measurements

- The stuff of physics can be measured – observation – experiment

Laws

- Measurements obey laws like Newton's second law: $\sum \mathbf{F} = m\mathbf{a}$
Use boldface (\mathbf{F}) for vectors, italic (m) for scalars.

Predictions

- Laws can be used to make predictions – understand how Nature works – design useful things – problem solving!

Units and Dimensions

Quantity	Type	SI Units	BE Units	Dimensions
Length	(fundamental)	m	1 ft = 0.3048 m	[L]
Mass	(fundamental)	kg	1 sl = 14.59 kg	[M]
Time	(fundamental)	s	s	[T]
Acceleration	(derived)	m/s ²	ft/s ²	[L][T] ⁻²
Force	(derived)	N = kg·m/s ²	1 lb = 4.448 N	[M][L][T] ⁻²

- Equations: each term must have the same dimensions

$$\sum \mathbf{F} = m \cdot \mathbf{a}$$

$$[\mathbf{M}][\mathbf{L}][\mathbf{T}]^{-2} = [\mathbf{M}] \cdot [\mathbf{L}][\mathbf{T}]^{-2}$$

- Unit conversions: multiply by dimensionless unity so units cancel

$$1 = \frac{0.3048 \text{ m}}{1 \text{ ft}} \quad \text{and} \quad 1 = \frac{14.59 \text{ kg}}{1 \text{ sl}}$$

$$1 \text{ lb} = 1 \frac{\text{sl} \cdot \text{ft}}{\text{s}^2} \times 1 \times 1 = 1 \frac{\text{sl} \cdot \text{ft}}{\text{s}^2} \times \frac{0.3048 \text{ m}}{1 \text{ ft}} \times \frac{14.59 \text{ kg}}{1 \text{ sl}} = 4.447 \frac{\text{kg} \cdot \text{m}}{\text{s}^2} \simeq 4.448 \text{ N}$$

- Last step correct to 4 *significant figures* – review Appendix B

Online Homework Demo

- Go to the eGrade webpage <http://edugen.wiley.com/edugen/class/cls13736/>
- Register using your student access card. Note: if you purchased a used access card it may not work. Return your used package to the bookstore for a new textbook package!
- Work the problem on paper – you can't do these problems in your head – you then have a record of your solution steps to check if the answer is not correct
- Read and understand the problem – draw a figure – what are the know (given) quantities? – what are the unknowns to be found?
- Devise a solution strategy – find equations relating unknowns to known quantities – see “reasoning” in the worked examples
- Solve for the unknowns – check dimensions – check units
- Check your answer – is it reasonable? – is there an alternative solution strategy?
- Save your work and don't forget to hit the submit button when you are done! Note: eGrade will log you off for inactivity.

Trigonometry

- Greek: trigonon = three-cornered, triangle; metria = measurement
- Review Appendix E2
- Sum of three interior angles = $180^\circ = \pi$ rad. (Calculators have degree/radian switch!)
- Right triangle: one angle = 90° , if second angle is θ , then the third is $90^\circ - \theta$.
- Pythagoras' Theorem for right triangles:

$$h^2 = h_a^2 + h_o^2$$

h = hypotenuse (side opposite 90°), h_a = side between θ and 90° , h_o = side opposite θ .

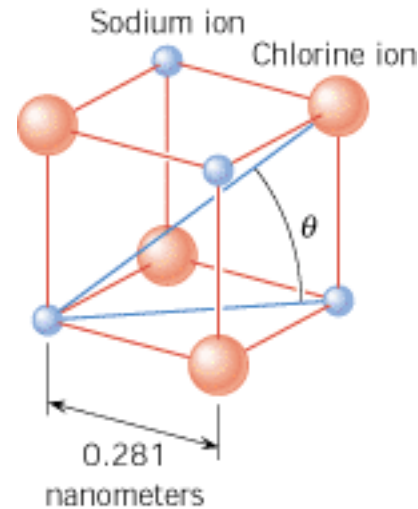
- Trigonometric functions for right triangle:

$$\sin \theta = \frac{h_o}{h}, \quad \cos \theta = \frac{h_a}{h}, \quad \tan \theta = \frac{\sin \theta}{\cos \theta} = \frac{h_o}{h_a}$$

- Inverse trigonometric functions:

$$\theta = \tan^{-1} \left(\frac{h_o}{h_a} \right) = \arctan \left(\frac{h_o}{h_a} \right) = \sin^{-1} \left(\frac{h_o}{h} \right), \quad \text{etc.}$$

Problem 16: Find diagonal length of NaCl crystal cube



- Understand the problem – re-draw the figure – given quantity is length of cube edge $d = 0.281$ nm – unknown to be found is the body diagonal $x = ?$
- Solution strategy: use right triangles and trigonometry. Are d and x the sides of a right triangle?
- There is a second unknown, the face diagonal $\ell = ?$ which forms two different right triangles with d and x – this is a two-step problem!
- Step 1: find ℓ in terms of d using Pythagoras' theorem on the base triangle:

$$\ell^2 = d^2 + d^2 = 2d^2$$

- Step 2: find x using Pythagoras' theorem again on the diagonal triangle:

$$x^2 = \ell^2 + d^2 = 3d^2$$

- Plug in the numbers:

$$x = \sqrt{3d^2} = \sqrt{3} \times d = 0.4867062769 \text{ nm}$$

- Round the answer to 3 significant figures: $x = 0.487 \text{ nm}$.
- Right triangles will also be very useful in vector problems!

Minute Paper

1. What do you hope to learn from this course?
2. What do you hope to do with this new knowledge?
3. What do you expect the lectures to do for you?
4. What do you expect the textbook to do for you?
5. How many hours do you think it will take to learn all you need to know from this course? Include everything: lectures, homework, etc.

_____ hours/week