DEVIL PHYSICS

THE BADDEST CLASS ON CAMPUS

AP PHYSICS

GIANCOLI LESSON 1-7 TO 1-8

ORDER OF MAGNITUDE: RAPID ESTIMATING

DIMENSIONS AND DIMENSIONAL ANALYSIS

Introductory Video

Powers of 10 – Scales of the Universe

Objectives

- Quickly estimate the answer to a complicated problem to within a factor of 10.
- Use dimensional analysis to convert units and to check solutions.
- Find important facts in your textbook.

Order of Magnitude

- Order of magnitude often refers to a number's power of 10
- Avagadro's number is 6.02×10^{23}, it's order of magnitude would be 10^{23}

Order of Magnitude Estimating

- Round all numbers to one significant digit before performing operations.
- Find an order of magnitude estimate for

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$$(8\div2)\times10^{-9-5}=4\times10^{-14}$$

$$Actual=5.499\times10^{-14}$$

Dimensional Analysis

- Two main uses
  - Converting units
    - Meters to feet
    - m/s to mi/hr
  - Cancelling units in an equation
    - Drive 60 mi/hr for 3 hours
    - 60 mi/hr x 3 hr/1 = 180 mi

Dimensional Analysis

- Simplify

$$\frac{6}{15}$$

Dimensional Analysis

- Simplify

$$\frac{6}{15} = \frac{3*2}{3*5} = \frac{3}{3} * \frac{2}{5} = 1 * \frac{2}{5} = \frac{2}{5}$$

or

$$\frac{6}{15} = \frac{\cancel{3}*2}{\cancel{3}*5} = \frac{2}{5}$$

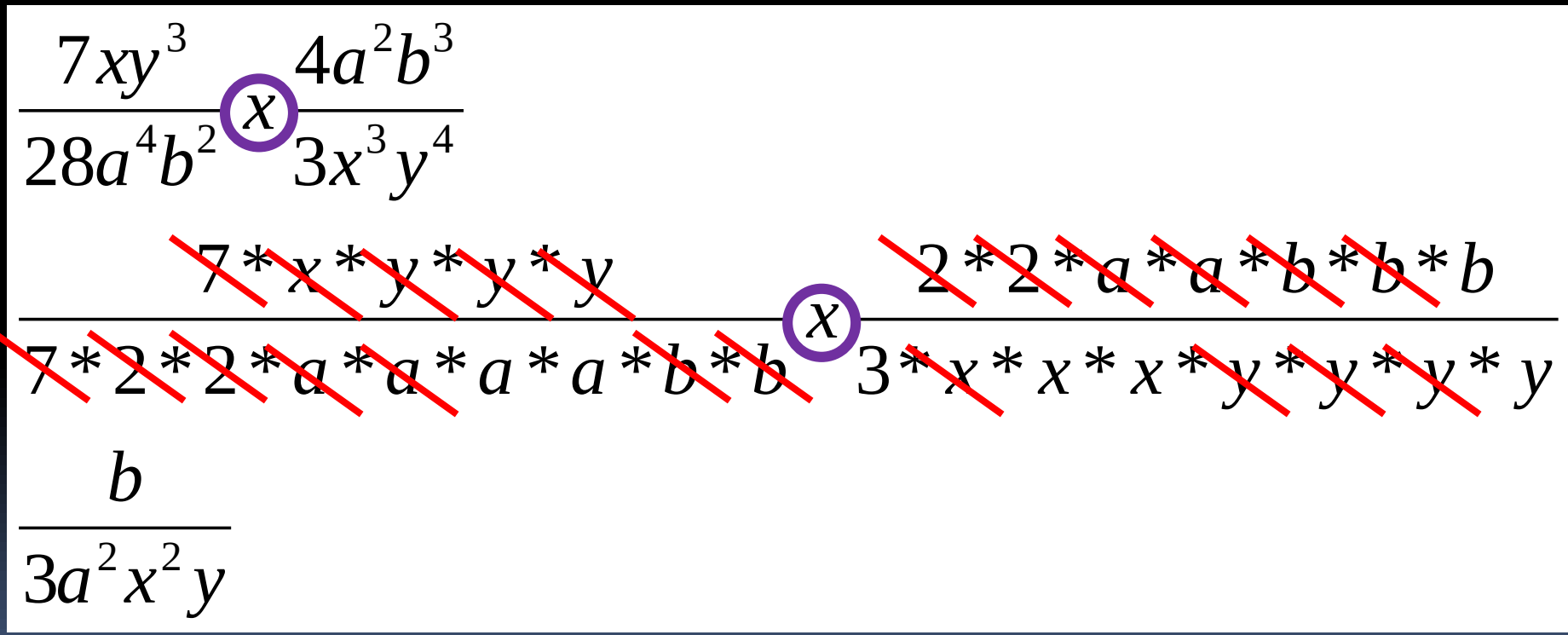
Dimensional Analysis

- Simplify

$$\frac{7xy^3}{28a^4b^2} \; x \; \frac{4a^2b^3}{3x^3y^4}$$

Dimensional Analysis

- Simplify



Dimensional Analysis

- Conversion factors – *inside front cover, pg. 2*

$$3\,ft = 1yd$$

$$1m = 3.281\,ft$$

$$1.01325x10^5\ N/m^2 = 14.7\,lb/in^2$$

Dimensional Analysis

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$$\frac{3\,ft}{1\,yd} = \frac{1\,yd}{3\,f} = 1$$

$$\frac{1m}{3.281\,ft} = \frac{3.281\,ft}{1m} = 1$$

$$\frac{1.01325x10^5\ N/m^2}{14.7\,lb/in^2} = \frac{14.7\,lb/in^2}{1.01325x10^5\ N/m^2} = 1$$

Dimensional Analysis

- Identity Property of Equality says we can multiply any value by 1 and get the same value
  - *117 ft x 1yd/3ft = 39yds*
  - *17yds x 3ft/1yd =*

$$\frac{3\,ft}{1yd} = \frac{1yd}{3\,f} = 1$$

$$\frac{1m}{3.281\,ft} = \frac{3.281\,ft}{1m} = 1$$

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$$\frac{25mm}{1s} x \frac{1cm}{10mm} x \frac{60s}{1\min} = \frac{150cm}{1\min} = 150\,cm/\min$$

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$$\frac{150cm}{1\min} = \frac{1\min}{150cm} = \frac{1}{150}\min/cm = 6.67x10^{-3}\min/cm$$

or

$$(150\,cm/\min)^{-1} = 6.67x10^{-3}\min/cm$$

Dimensional Analysis

- Solving problems
- *Atmospheric pressure is 14.7 psi (lb/in^2). How much force in lbs is exerted on a 3 sq yd area?*

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$$1yd = 36in$$

$$1yd^2 = 36^2 in^2 = 1296in^2$$

$$\frac{14.7lbs}{in^2} x \frac{1296in^2}{1yd^2} x \frac{3yd^2}{1} = 5.72x10^4 lbs$$

INFORMATION IN THE TEXTBOOK

Math in Physics
Textbook Scavenger Hunt

- You are going to be shown a series of questions
- First person to raise their hand and answer correctly gets a shot at a Homework Pass

Math in Physics
Textbook Scavenger Hunt

- **What is the resting mass of an electron in kg?**

Math in Physics
Textbook Scavenger Hunt

- **What is the resting mass of an electron in kg?**
- **9.11×10^{-31} kg (inside front cover)**

Math in Physics
Textbook Scavenger Hunt

$$\frac{d}{dx} x^n = ?$$

New Book Only

Math in Physics
Textbook Scavenger Hunt

$$\frac{d}{dx}x^n = ?$$

$$\frac{d}{dx}x^n = nx^{n-1}$$

Inside back cover

Math in Physics
Textbook Scavenger Hunt

- **What is the value of one henry in terms of its base units?**

Math in Physics
Textbook Scavenger Hunt

- **What is the value of one henry in terms of its base units?**
- **$1 kg \cdot m^2/(s^2 \cdot A^2)$ (inside front cover, pg 2)**

Math in Physics
Textbook Scavenger Hunt

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- **What does the variable "A" stand for in this derived unit?**

Math in Physics
Textbook Scavenger Hunt

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- $1kg \cdot m^2/(s^2 \cdot A^2)$ (inside front cover, pg 2)
- What does the variable "A" stand for in this derived unit?
- Ampere (electric current), (footnote)

Math in Physics
Textbook Scavenger Hunt

- **What is the outer shell electron configuration for Ra?**

Math in Physics
Textbook Scavenger Hunt

- **What is the outer shell electron configuration for Ra?**
- **$7s^2$ (inside back cover)**

Math in Physics
Textbook Scavenger Hunt

- **What is the answer to problem #15 in chapter 4?**

Math in Physics
Textbook Scavenger Hunt

- **What is the answer to problem #15 in chapter 4?**
  - **New Book - 2.5 m/s^2 , down (page A-28)**
  - **Old Book – a $\geq$ 2.2 m/s^2**

Math in Physics
Textbook Scavenger Hunt

- **What is the formula for the surface area of a right circular cone?**

Math in Physics
Textbook Scavenger Hunt

- **What is the formula for the surface area of a right circular cone?**

$$\pi r^2 + \pi r\sqrt{r^2 + h^2}$$

- **(New Book - inside back cover)**
- **(Old Book – Pg. 1044)**

Math in Physics
Textbook Scavenger Hunt

- **Without using a calculator, find the tangent of 19°.**

Math in Physics
Textbook Scavenger Hunt

- **Without using a calculator, find the tangent of 19°.**
- **0.344**
  - **New book (pg. A-9)**
  - **Old book (inside back cover)**

Math in Physics Textbook Scavenger Hunt

- **What is the half-life of Einsteinium?**

Math in Physics
Textbook Scavenger Hunt

- **What is the half-life of Einsteinium?**
  - **New Book - 471.7 days (pg. A-15)**
  - **Old Book – 275.7 days (pg. 1067)**
  - **Why the difference?**

Math in Physics
Textbook Scavenger Hunt

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  - **Old Book – 275.7 days (pg. 1067)**
  - **Why the difference?**
    - **New Book – Einsteinium 252**
    - **Old Book – Einsteinium 254**

Math in Physics Textbook Scavenger Hunt

- **What is the Law of Sines?**

Math in Physics
Textbook Scavenger Hunt

- **What is the Law of Sines?**

$$\frac{\sin\alpha}{a} = \frac{\sin\beta}{b} = \frac{\sin\gamma}{c}$$

  - **Old Book - (page 1045)**
  - **New Book – (page A-8)**

Math in Physics
Textbook Scavenger Hunt

- **25-point bonus question: Determine the thickness of one page of your book in micrometers using a ruler.**

Math in Physics
Textbook Scavenger Hunt

- **25-point bonus question: Determine the thickness of one page of your book in micrometers.**

$$\frac{33mm}{(946+58+26)\,pgs/2} = 6.4\times10^{-2}\,mm$$

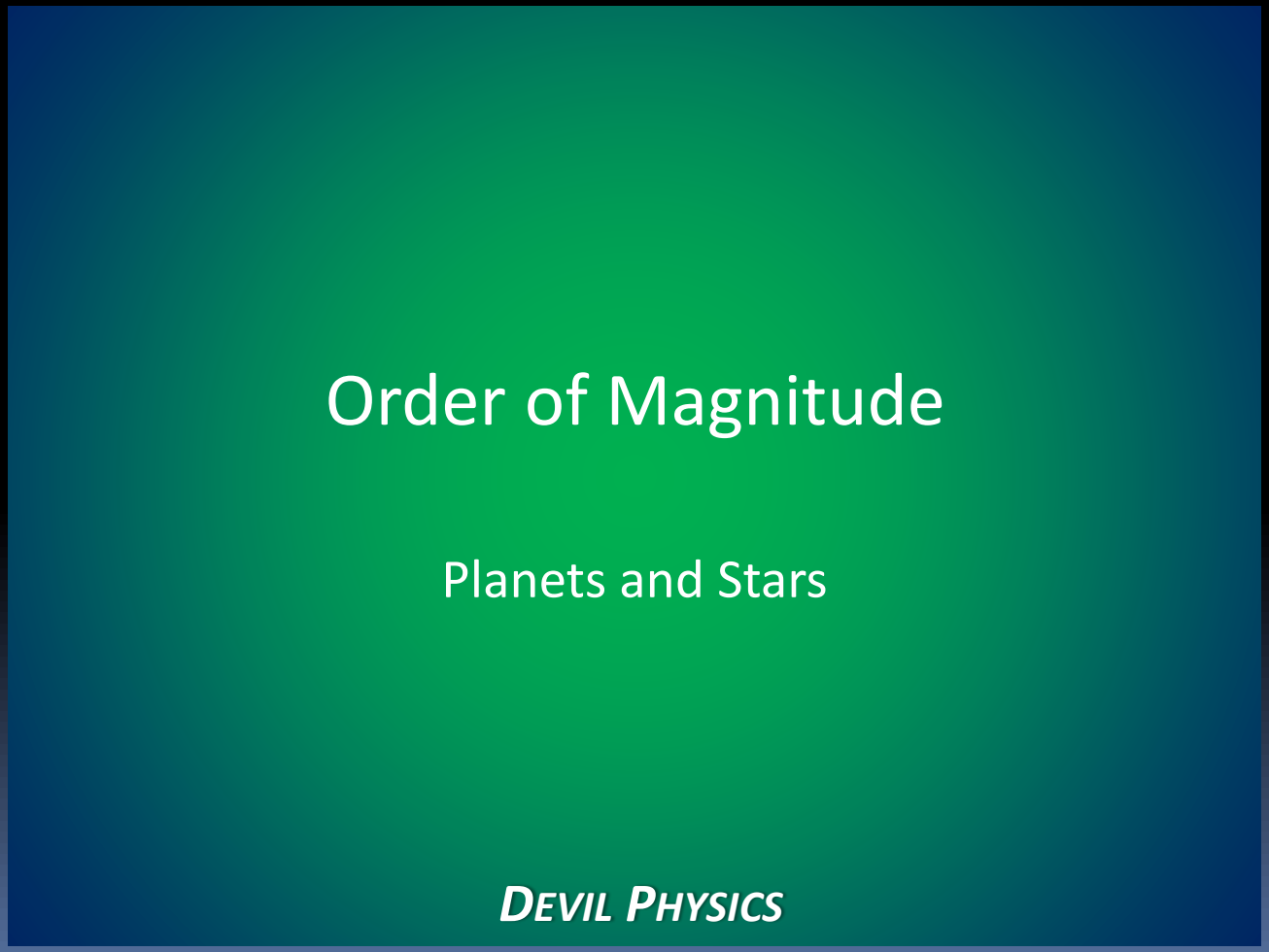
$$= 6.4\times10^{-5}\,m$$

$$= 64\,\mu m$$

Review: Can You

- Quickly estimate the answer to a complicated problem to within a factor of 10?
- Can you use dimensional analysis to convert units and to check solutions?
- Find important facts in your textbook?

Orders of Magnitude Perspective on Life



QUESTIONS?

Homework

- #24-30, 32-33
  - *Be sure to state the assumptions you make for each problem*