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THE NATURE OF SCIENCE AND PHYSICS

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Example

- Problem (E1.2):
  A grocery store sells 5 lb bags of apples. You purchase four bags over the course of a month and weight the apples each time. (You obtain the following measurements: Week 1 weight, 4.8 lb ; Week 2 weight 5.3 lb ; Week 3 weight, 4.9 lb ; Week 4 weight, 5.4 lb.) You determine that the weight of the 5 lb has an uncertainty of ± 0.4 lb. What is the percent uncertainty of the bag's weight?

- Solution:
  We have

  A = 5 lb δA = 0.4 lb u_p = ?

  The **percent uncertainty** of the weight

  u_p = (δA / A) x 100 %
  = (0.4 lbs / 5 lbs) x 100 % = 8 %
  = **8 %**

  The weight of the apple is: **5 lb ± 0.4 lb** or **5 lb ± 8%**

Problem 1

- Problem (P1.2):
  A car is traveling at a speed of 33 m/s. What is its speed in kilometers per hour?

- Solution:
  v = 33 m/s **v** (km/h) = ?

  The **speed** of the car in kilometers per hour is
  v = 33 m/s (1 km / 1000 m) (3600 s / 1 h)
  = 118.8 km/h
  = **120 km/h**

Problem 2

- Problem (P1.8):
  The speed of sound is measured to be 342 m/s on a certain day. What is this in km/h?

- Solution:
  v = 342 m/s 1 km = 1000 m 1 h = 3600 s **v** (km/h) = ?

  The **speed** of sound in kilometers per hour is
  v = 342 m/s (1 km / 1000 m) (3600 s / 1 h)
  = 1231.2 km/h
  = **1230 km/h**

Problem 3

- Problem (P1.12):
  A good-quality measuring tape can be off by 0.50 cm over a distance of 20 m. What is its percent uncertainty?

- Solution:
  δL = 0.50 cm L = 20 m u_p = ?

  Converting the **uncertainty** in distance into meters
  δL = 0.50 cm (1 m / 100 cm)
  = 0.0050 m
  = 0.0050 m
  The **percent uncertainty** is given by
  u_p = (δL / L) x 100 %
  = (0.0050 m / 20 m) x 100 %
  = 0.025 %
  = **0.03 %**

Problem 4

- Problem (P1.20):
  A person's blood pressure is measured to be 120 ± 2 mm Hg. Assuming the same percent uncertainty, what is the uncertainty in a blood pressure measurement of 80 mm Hg ?

- Solution:
  δS = 2 mm S = 120 mm D = 80 mm u_p = ? δD = ?

  The **percent uncertainty** for systolic blood pressure
  u_p = (δS / S) x 100 %
  = (2 mm / 120 mm) x 100 % = 1.667 %
  = **2 %**
  Using this percent uncertainty, the **uncertainty** in diastolic blood pressure is
  δD = (u_p / 100 %) D
  = (1.667 % / 100 %) 80 mm = 1.3336 mm of Hg
  = **1 mm of Hg**

Problem 5

- Problem (P1.22):
  What is the area of a circle 3.102 cm in diameter?

- Solution:
  r = 0.5 x 0.03102 m **A** = ?

  The **area** of the circle is
  $A = \pi r^2$
  = (3.14159) [0.5 x 0.03102 m] ^{2} = 7.55741 x 10^{-4} m^2
  = **7.557 x 10^{-4} m^2**

Problem 6

- Problem (P1.28):
  A car engine moves a piston with a circular cross section of 7.500 ± 0.002 cm diameter a distance of 3.250 ± 0.001 cm to compress the gas in the cylinder. By using the amount the gas is decreased in volume in cubic centimeters, find the uncertainty in this volume.

- Solution:
  δd = 0.002 cm d = 7.500 cm **δV** = ?
  δh = 0.001 cm h = 3.250 cm

  The **volume** in cubic centimeters is
  $V = \pi r^2 h$
  = (3.14159) [7.500 cm / 2] ^{2} (3.250 cm) = 143.580 cm^3
  The **percent uncertainty** for diameter, height and volume are
  u_{pd} = (δd / d) x 100 % = (0.002 / 7.500) x 100 % = 0.053 %
  u_{ph} = (δh / h) x 100 % = (0.001 / 3.250) x 100 % = 0.031 %
  u_{pV} = 2 (0.053 %) + (0.031 %) = 0.137 % (Three decimals!)
  The **uncertainty** in the volume of the gas in cubic centimeters is
  δV = (u_{pV} / 100 %) V
  = (0.137 % / 100 %) (143.580 cm^3) = 0.196705 cm^3
  = **0.197 cm^3**

References

1. College Physics
   OpenStax College
   Rice University, 2017.