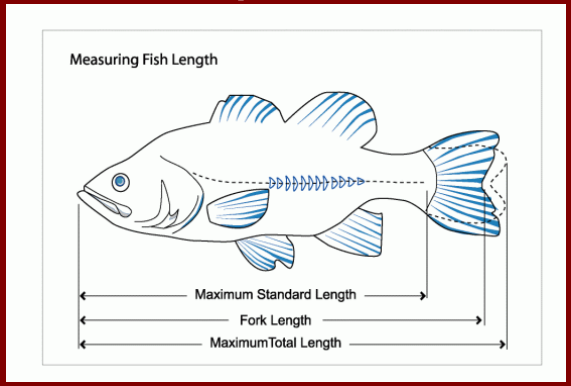
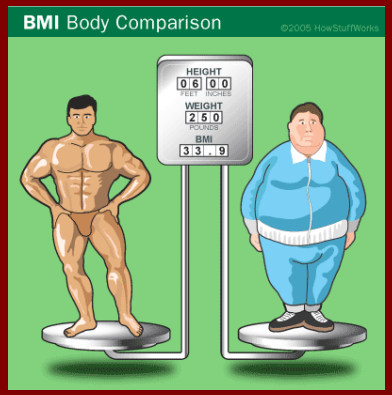
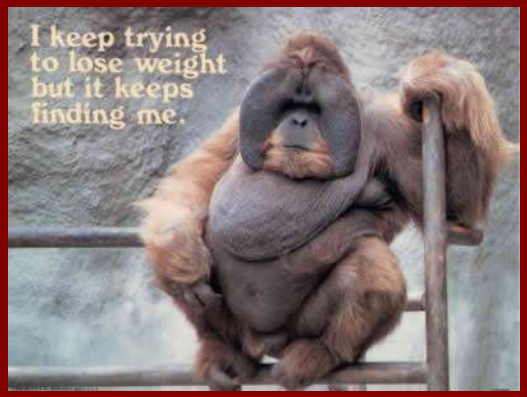
Starter S-11

What is the SI (metric) unit for each of the following?

1. Length
2. Mass
3. Weight
4. Energy
5. Time
6. Volume







Chapter 3

Scientific Measurement

Section 3.1

Measurements and Their Uncertainty

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

d. Express appropriate numbers of significant figures for calculated data, using scientific notation where appropriate.

Standard

Measurements and Their Uncertainty 3.1

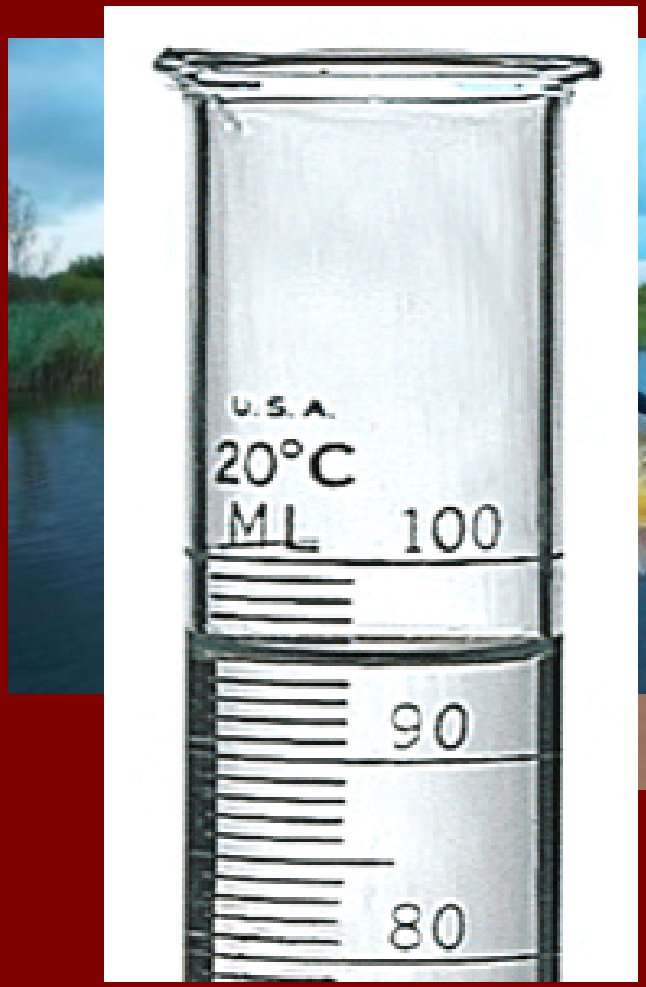
Express appropriate numbers of significant figures for calculated data

Measurement – quantity (magnitude) and a unit

100 m

15 kg

95 mL

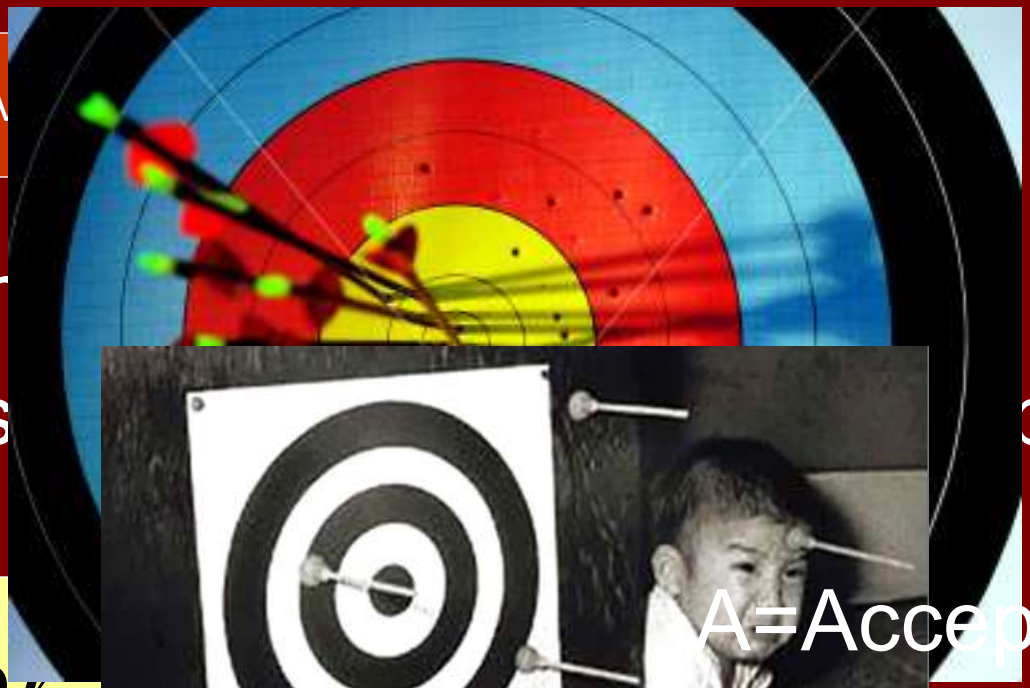


Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

Accuracy – how close a measurement come to the actual value

Accuracy V



Error – m

How clos pted value

Error

A=Accepted Value

O=Observed value

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

Percent Error (Relative Error) – better measurement of how much error there was

$$\%Error = \frac{error}{A} x100\%$$

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

For example

If you measured the mass of a beaker to be 12.5g, but the box said it had an actual mass of 12.0 g, then

$$Error = 0.5$$

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

We use that value to calculate percent error

$$Error = 0.5$$

$$\%Error = 4\%$$

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

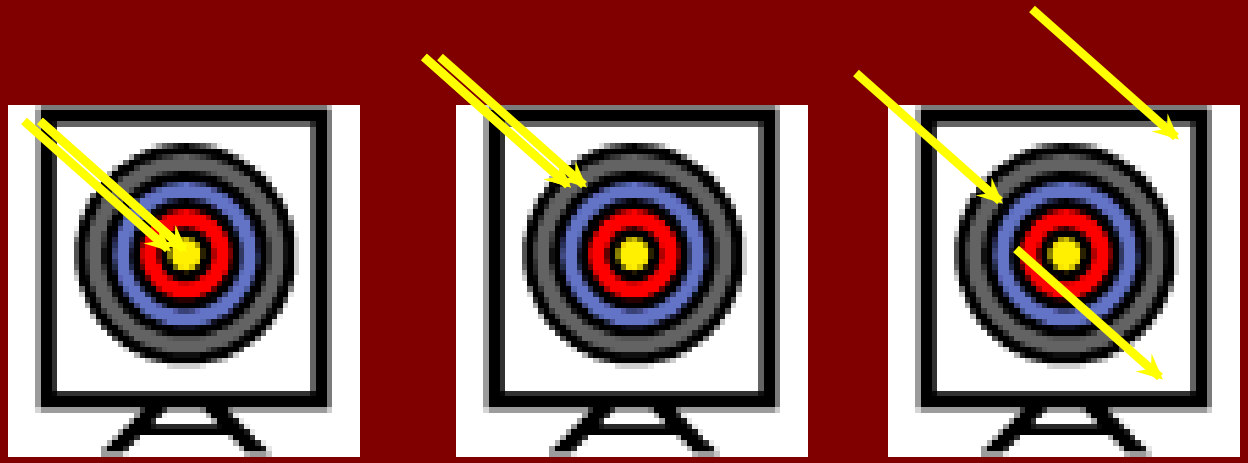
Precision – how close are measurements to each other

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

Can you hit the bull's-eye?

Three shooters with three arrows each to shoot.



How do they compare?

Both accurate and precise	Precise but not accurate	Neither accurate nor precise

Can you define accuracy and precision?

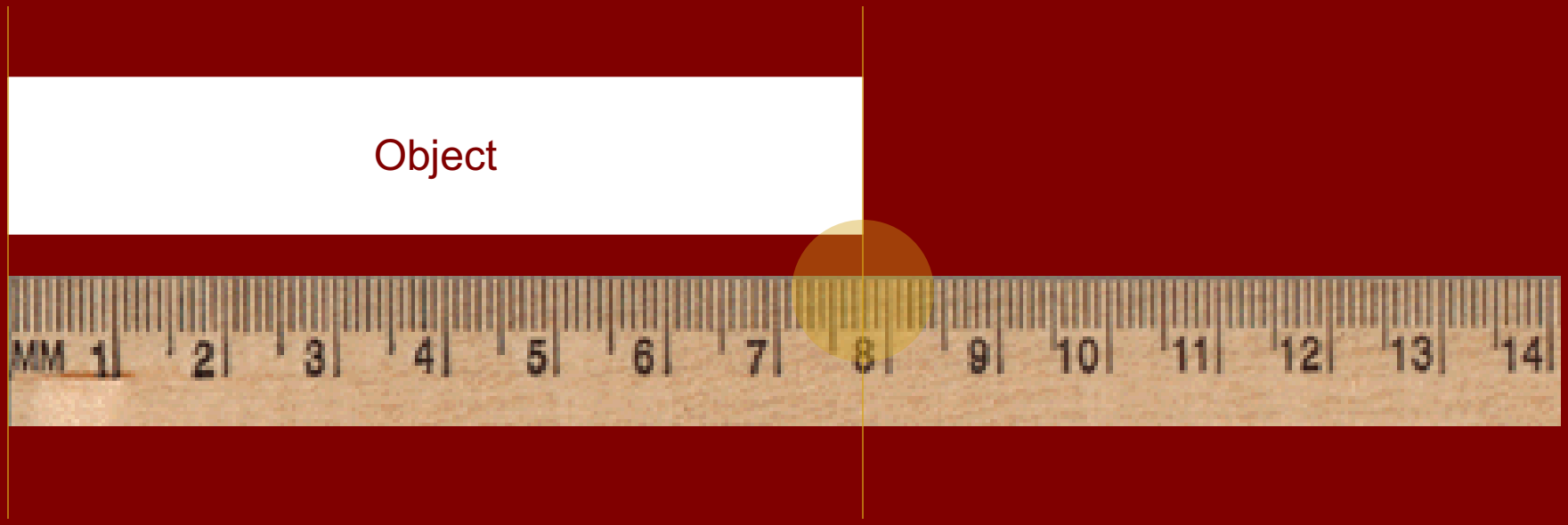
Practice Accuracy and Precision

Express appropriate numbers of significant figures for calculated data

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

Significant Figures – all the digits that are known, plus one digit that is estimated



Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

Significant Figures – all the digits that are known, plus one digit that is estimated

Object

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

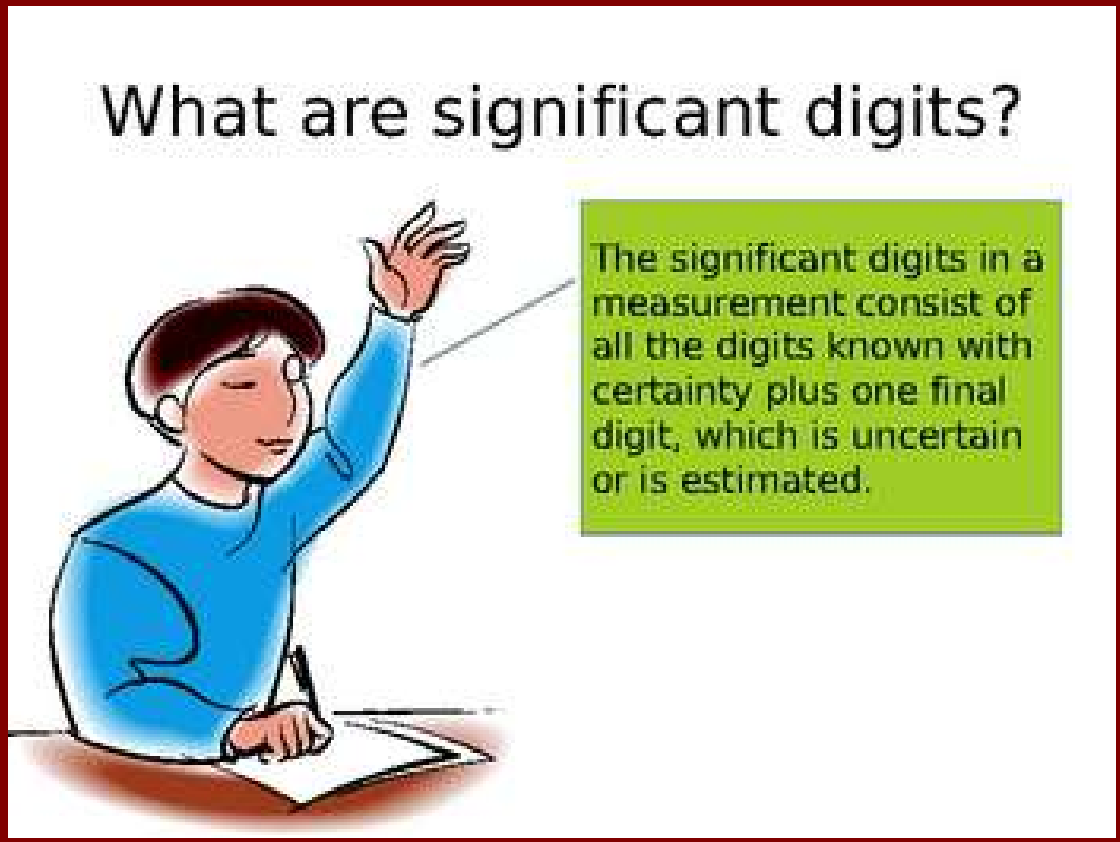
Which written digits are significant

1. All nonzero digits are significant

a. 24.7 m

b. 0.743 m

c. 714 m



Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

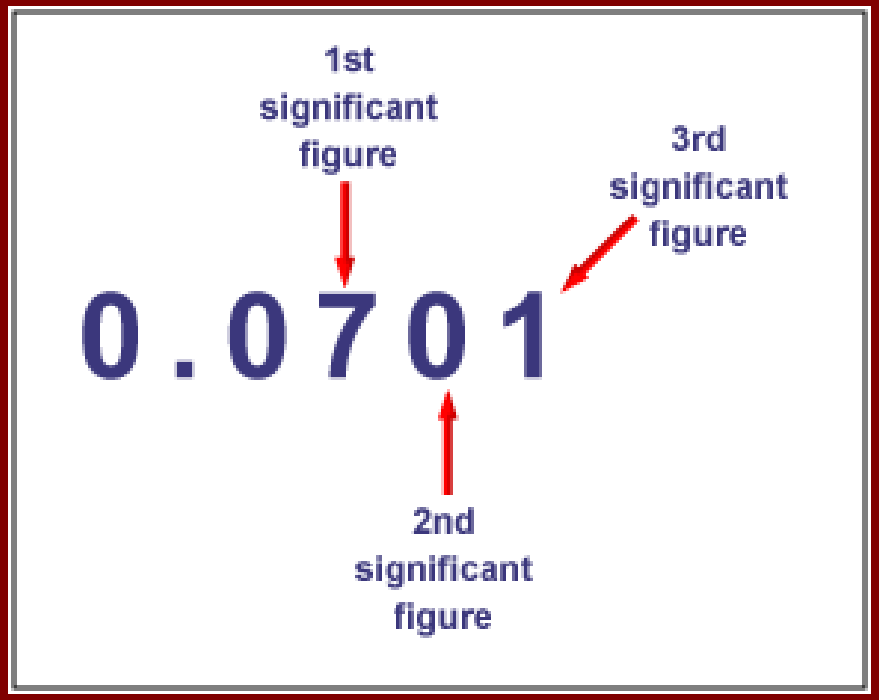
Which written digits are significant

2. Zeros between nonzeros are significant

a. 7003 m

b. 40.79 m

c. 1.503 m



Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

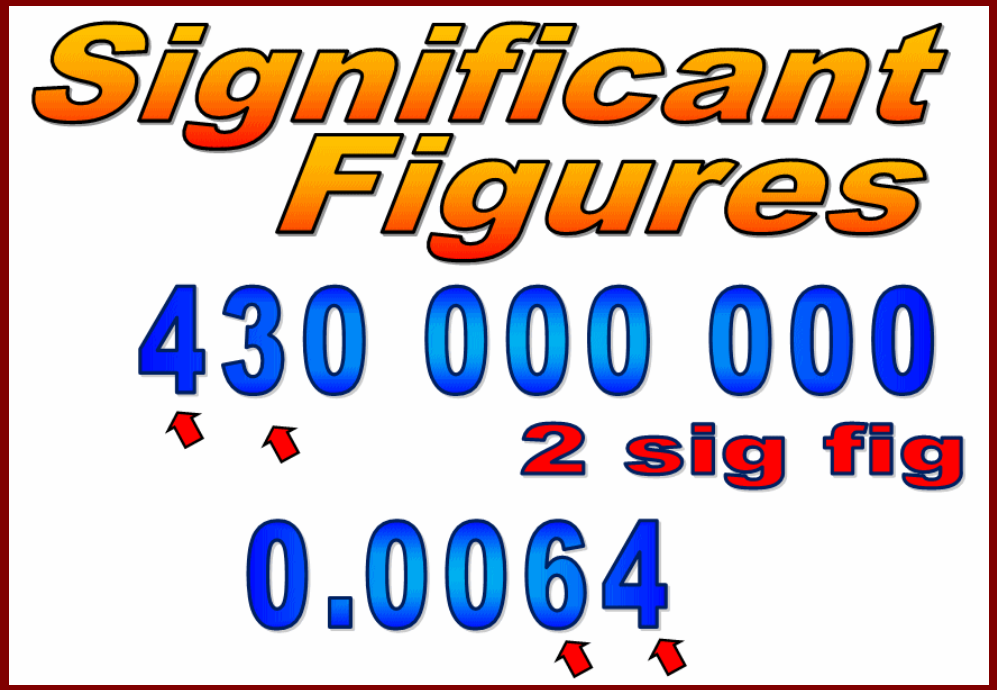
Which written digits are significant

3. Left zeros in front of nonzeros are not significant

a. 0.0071 m

b. 0.42 m

c. 0.000099 m



Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

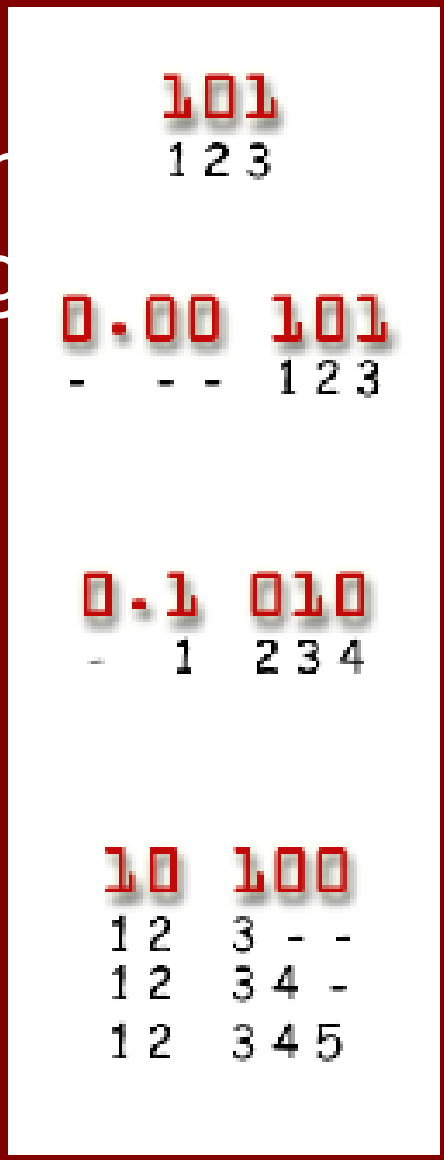
Which written digits are significant

4. Zeros at the end of a number ar
   right of a decimal are always sig

a. 43.00 m

b. 1.010 m

c. 9.000 m



Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

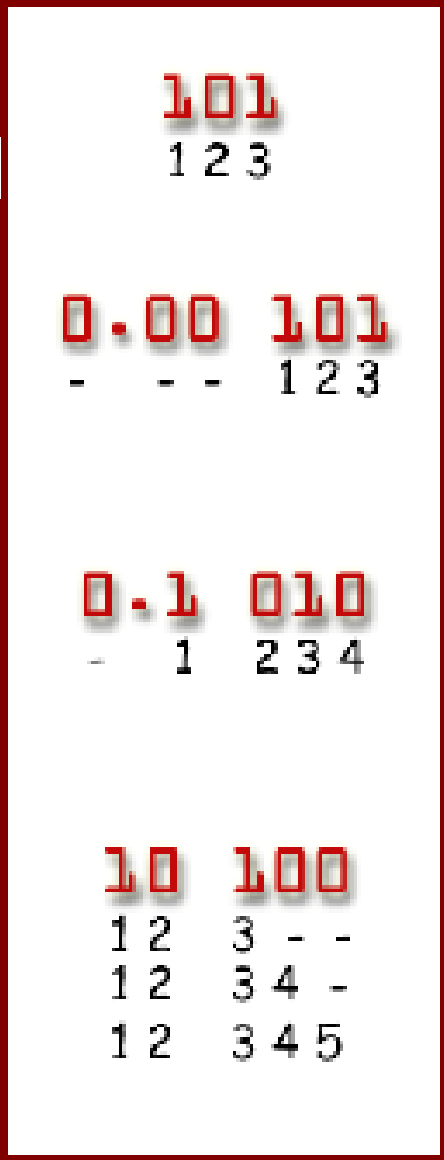
Which written digits are significant

5. Zeros at the right of a digit as pl
   holders are not significant

a. 300 m

b. 7000 m

c. 27210 m



Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

Which written digits are significant

6. Two types of numbers have unlimited significant digits

a. When counting the number of something

b. Defined quantities

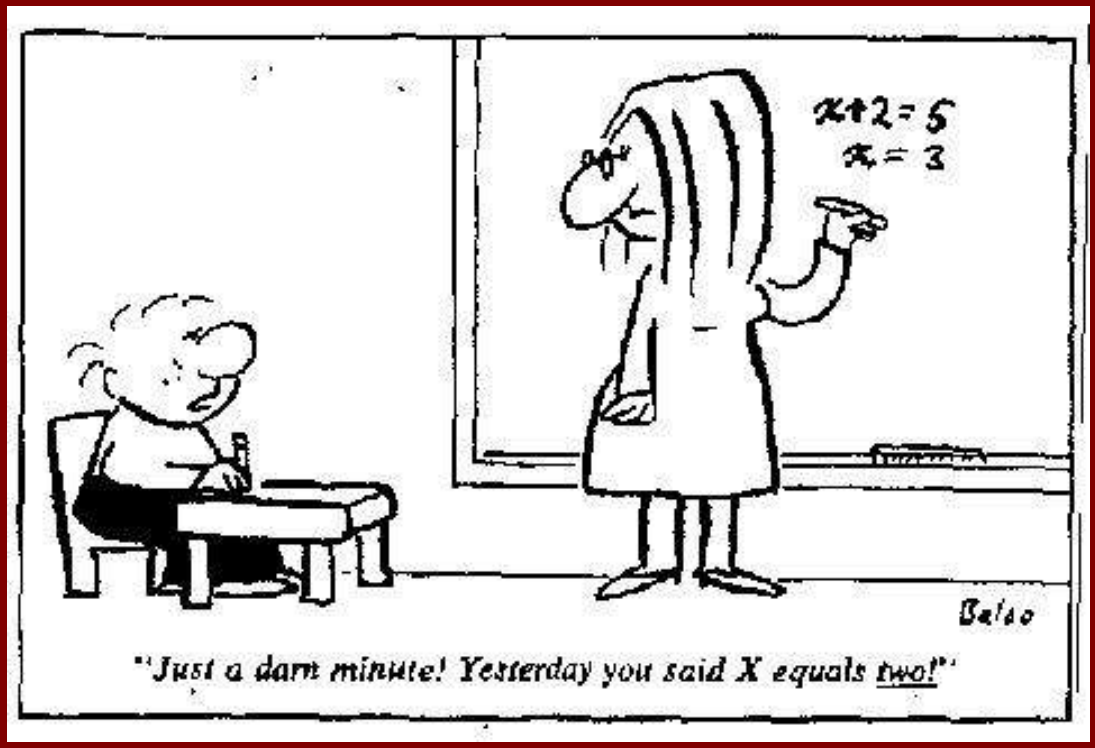
$$d = v_o t + \frac{1}{2} a t^2$$

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

Examples of digits

1. 400
2. 0.065
3. 35.05
4. 1003
5. 0.00500
6. 10200
7. 0.010200
8. 10.5

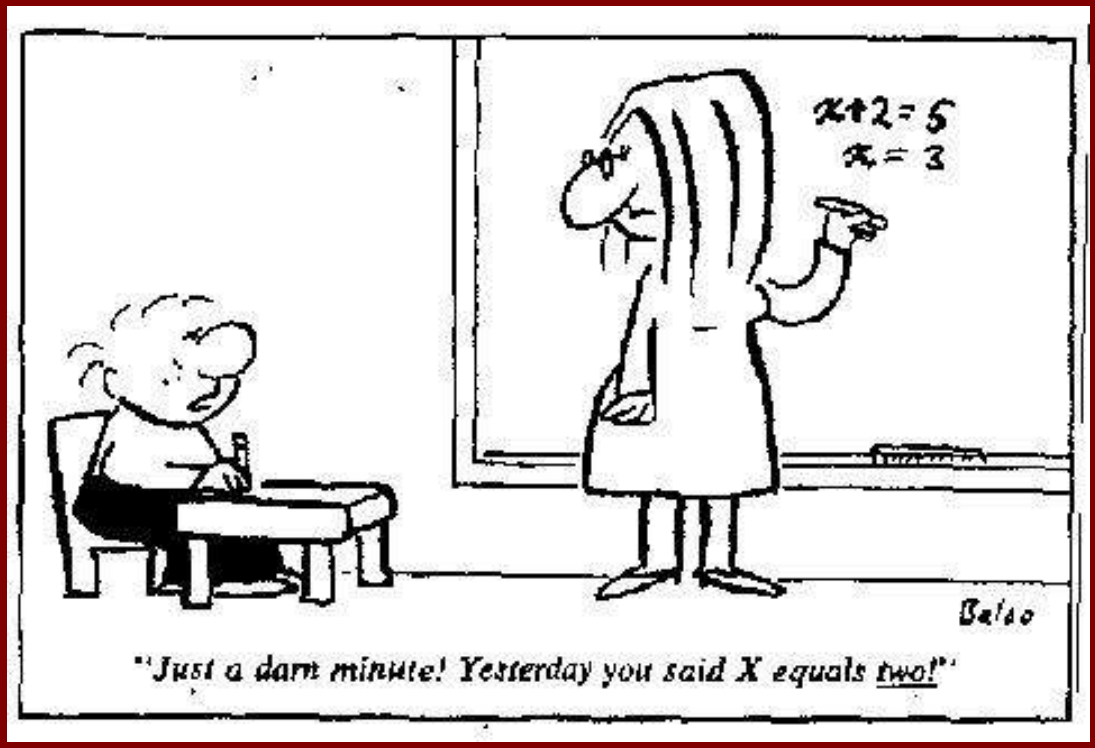


Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

Examples of digits

1. 4001
2. 0.0652
3. 35.054
4. 10034
5. 0.005003
6. 102003
7. 0.0102005
8. 10.53



Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

Calculations – Addition and Subtraction

1. Line up numbers by their decimal point

56.4

+11.688

68.088

Round the number to match the number with the least number of decimal places

So the answer is 68.1

Measurements and Their Uncertainty 3.1

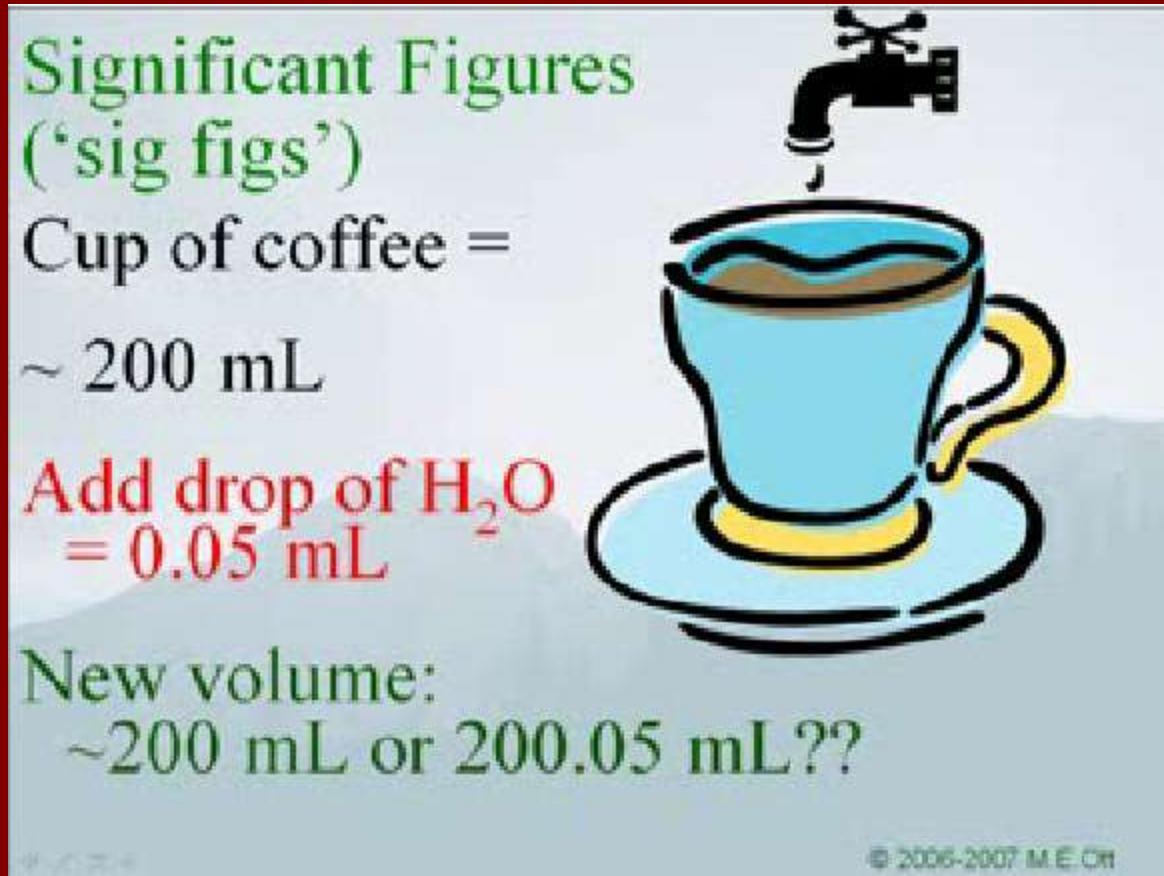
Express appropriate numbers of significant figures for calculated data

62.1

9.35

+8.6

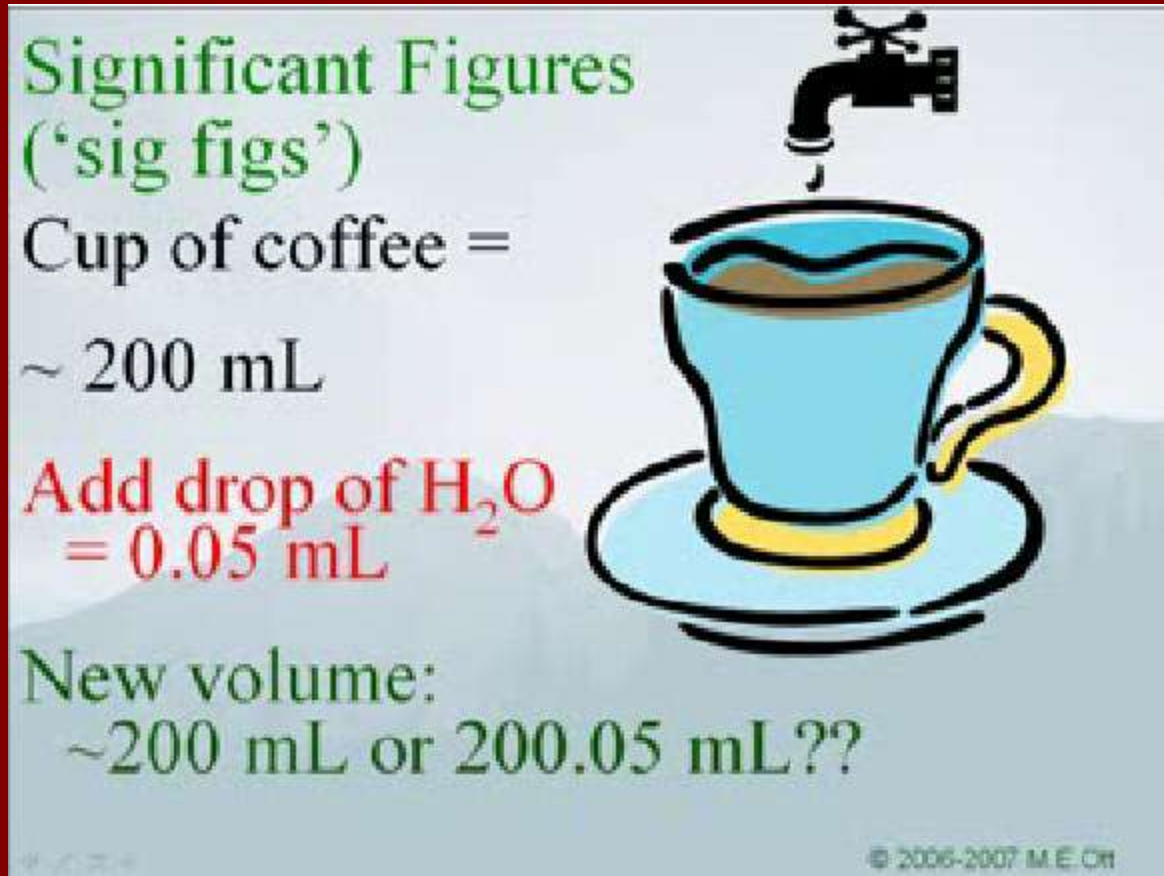
80.05



Measurements and Their Uncertainty 3.1

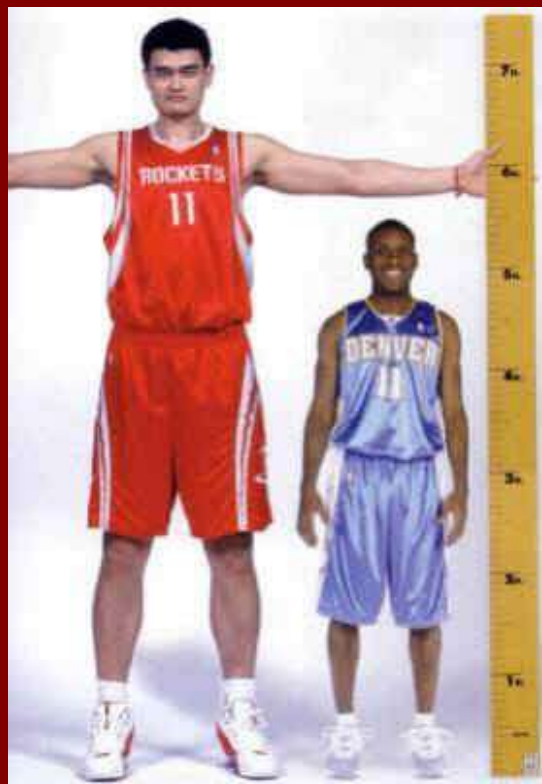
Express appropriate numbers of significant figures for calculated data

62.1
9.35
+8.6
80.0



Starter S-14

What is the error and percent error if a lab measure the length of a person to be 1.99 m, but the actual length of that person is 1.85 m?



Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

$$\begin{array}{r} 1.36 \\ +10.2 \\ \hline 11.56 \end{array}$$

$$\begin{array}{r} 2,456.2314 \\ +\quad 24.23 \\ \hline = 2,480.46 \end{array}$$

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

$$\begin{array}{r} 1.36 \\ +10.2 \\ \hline 11.6 \end{array}$$

$$\begin{array}{r} 2{,}456.2314 \\ +\quad 24.23 \\ \hline = 2{,}480.46 \\ \hline \end{array}$$

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

Calculations – Multiplication and Division

Perform the math operation

7.55

x 0.34

2.567

Choose the number with the fewest significant digits

Keep that many digits in your answer

2.6

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

2.10

X 0.70 ←

1.47

12.3 (3 sig. fig)
x 6.7 (2 sig. fig)

82.41 → 82 (2 sig. fig)

12.3 (3 sig. fig)
6.7 (2 sig. fig)

= 1.835820896
= 1.8 (2 sig.fig)

Measurements and Their Uncertainty 3.1

Express appropriate numbers of significant figures for calculated data

2.4526

÷ 8.4 ←

0.291976

Section 3.2

The International System of Unit

The International System of Units 3.2

The International System of Units – metric system

Length – meter (m)

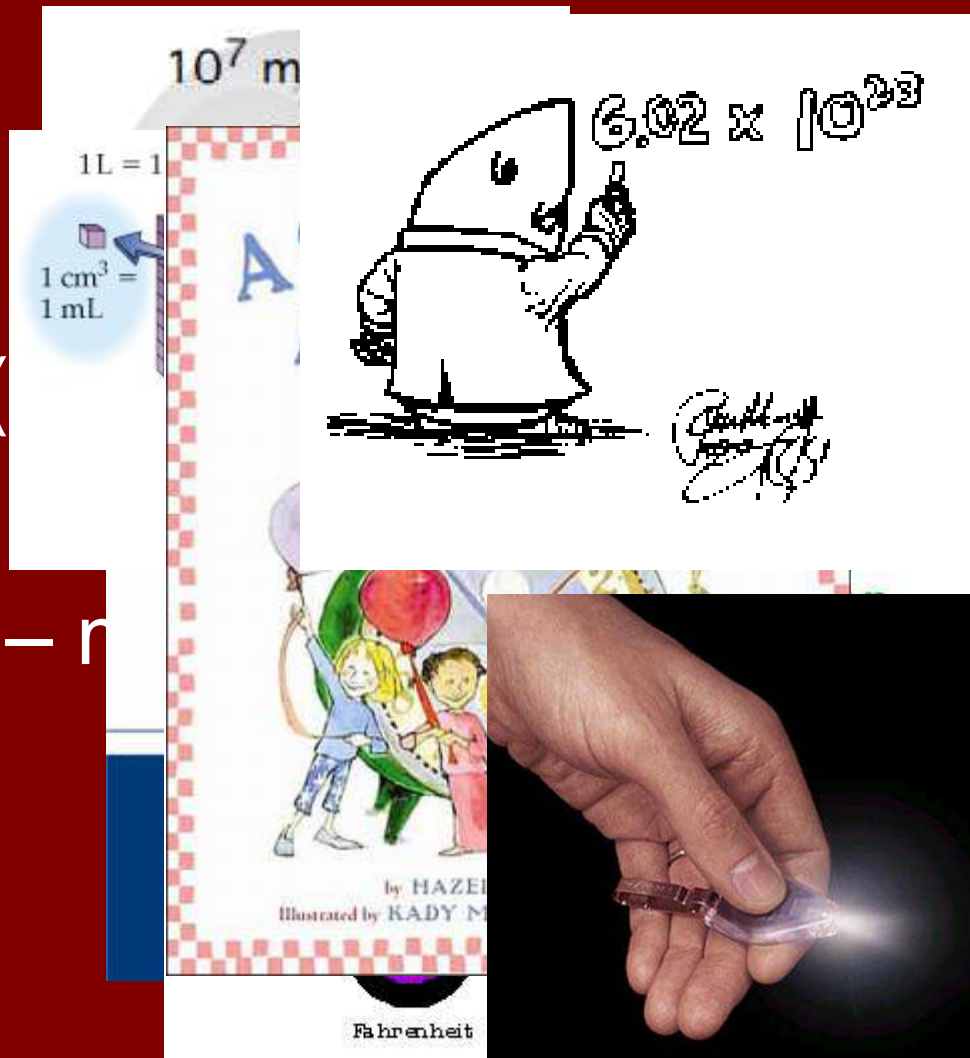
Mas kg)

Tem vin (

Time

Amo nce – r

Energy – joule (J)



The International System of Units 3.2

Metric Prefixes

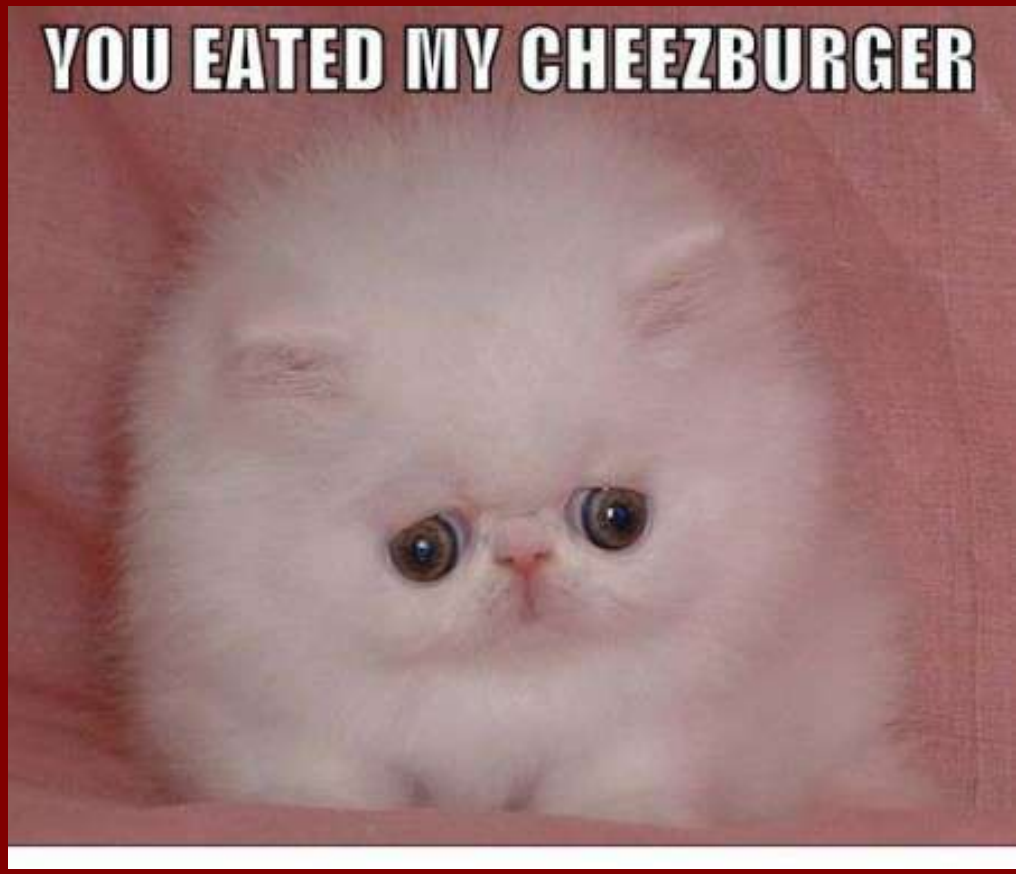
- Kilo – 1000 x
- Centi – 1/100
- Milli – 1/1000

Know these three

Starter S-15

Write the correct answer using significant digits.

1. 85.2 x 3
2. 512÷315.00500
3. 0.00400 x .050
4. 600÷.08700



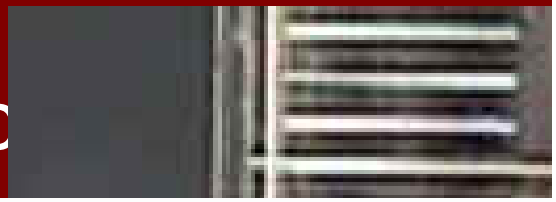
The International System of Units 3.2

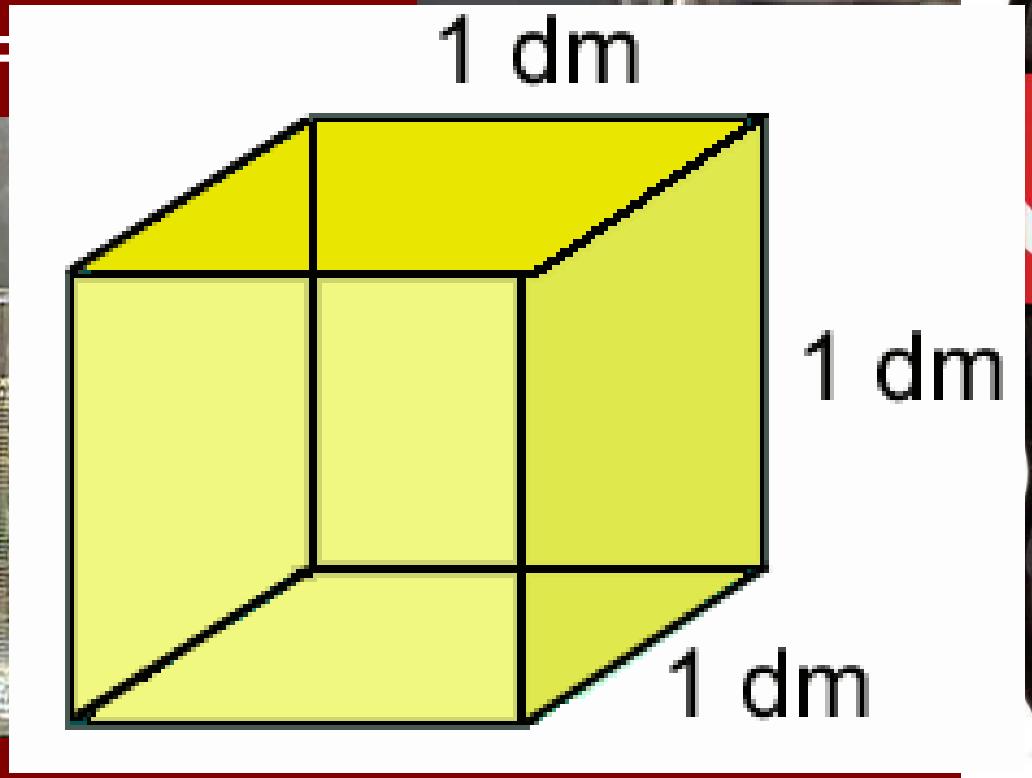
Derived units

Volume – liter

10 cm x 10 cm x 10 c

1/1000 L =





The International System of Units 3.2

Temperature Conversion

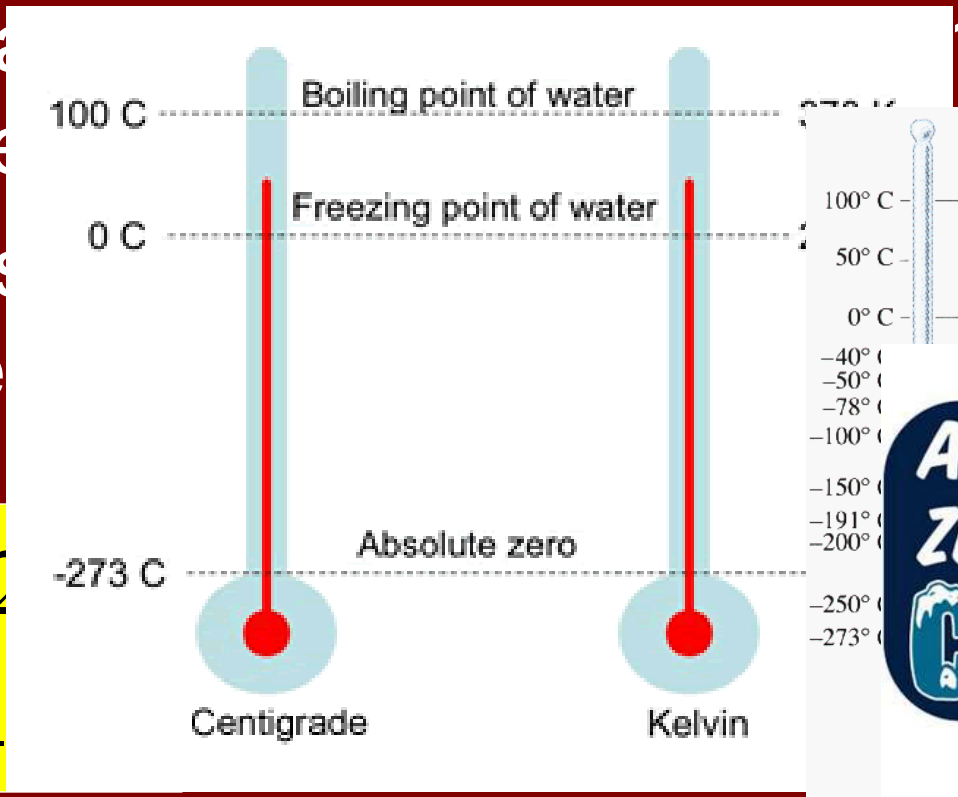
Need to switch between Celsius and Kelvin

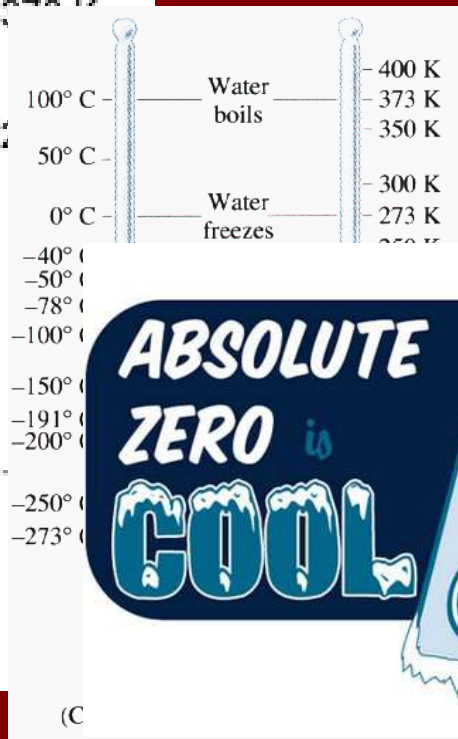
Celsius ba… …100°C)
and fre…

Kelvin bas…
tempe…

$$K = {}^{o}C + 2$$

$$^{o}C = K -$$





Practice Converting Temperature

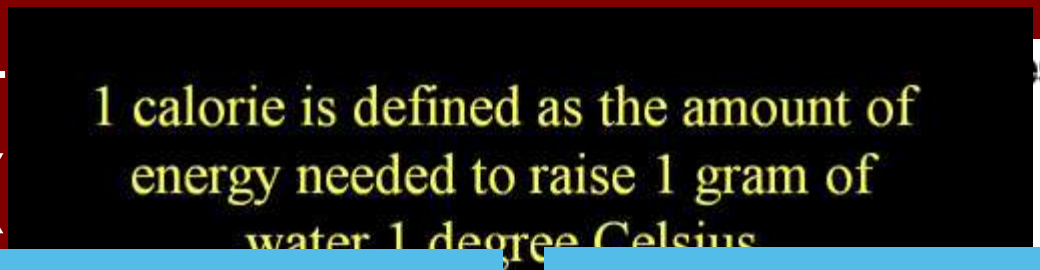
The International System of Units 3.2

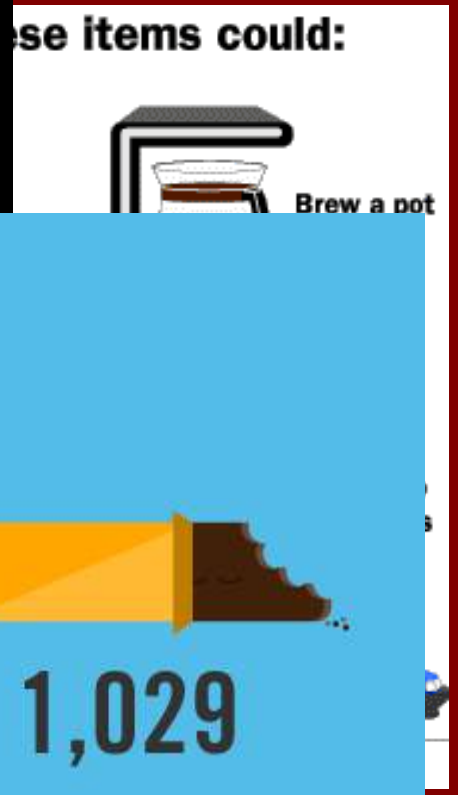
Energy Units

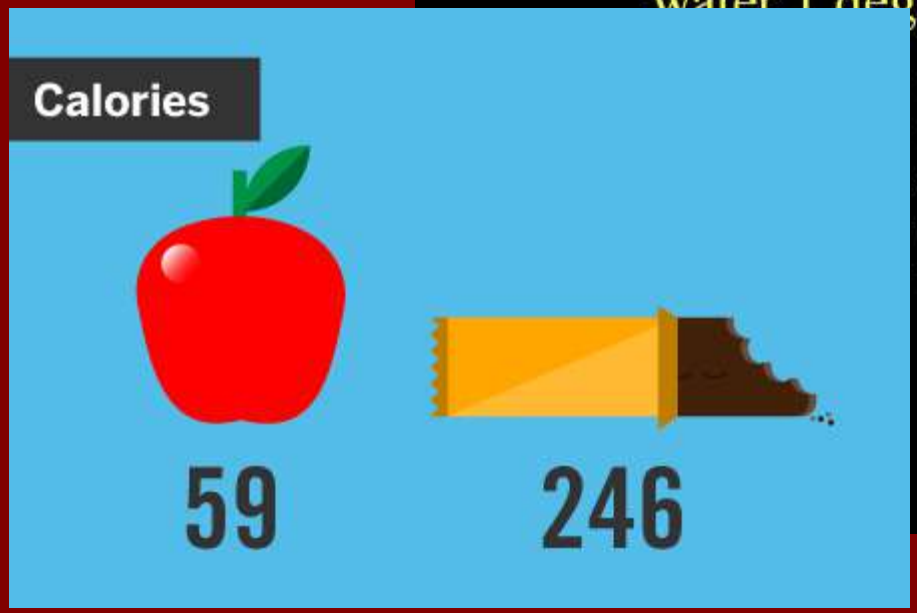
calorie – energy needed to raise one gram of water one ^{o}C

1 cal = 4

Calorie (







Section 3.3

Conversion Problems

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

e. Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas as appropriate.

Standard

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

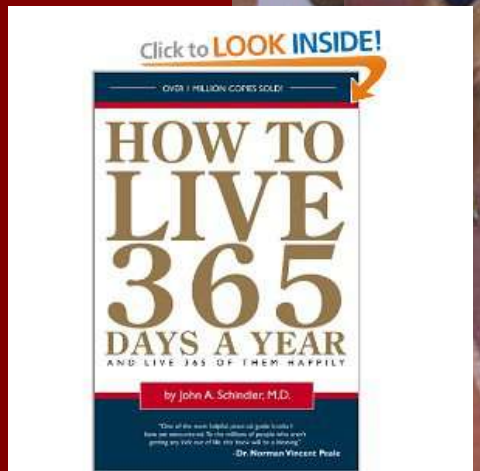
Equality – numbers that are in different units, but have the same value

$1.00 = 100¢

1000 m =

1 minute

1 year = 3



Conversion Problems 3.3

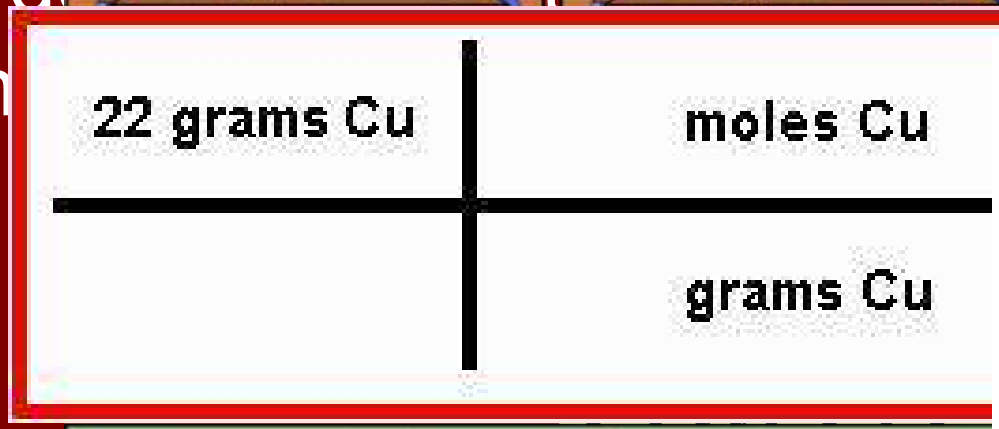
Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

We now use a math trick to create conversion factors

Conversio ge from one ur

You will d this. So learn

In math,



Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

If we want to convert to kilometers, we remember 1000m=1km

If we divide 1km/1000m, what does it equal?

$$\frac{1km}{1000m} = 1$$

$$(1m)x(1) = 1m$$

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

Now the math trick

Since we can multiply by 1, we can multiply by 1km/1000m

$$(1m)x(\frac{1km}{1000m}) = 0.001km$$

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

Your turn

How many second are in 3.5 minutes?

First – what

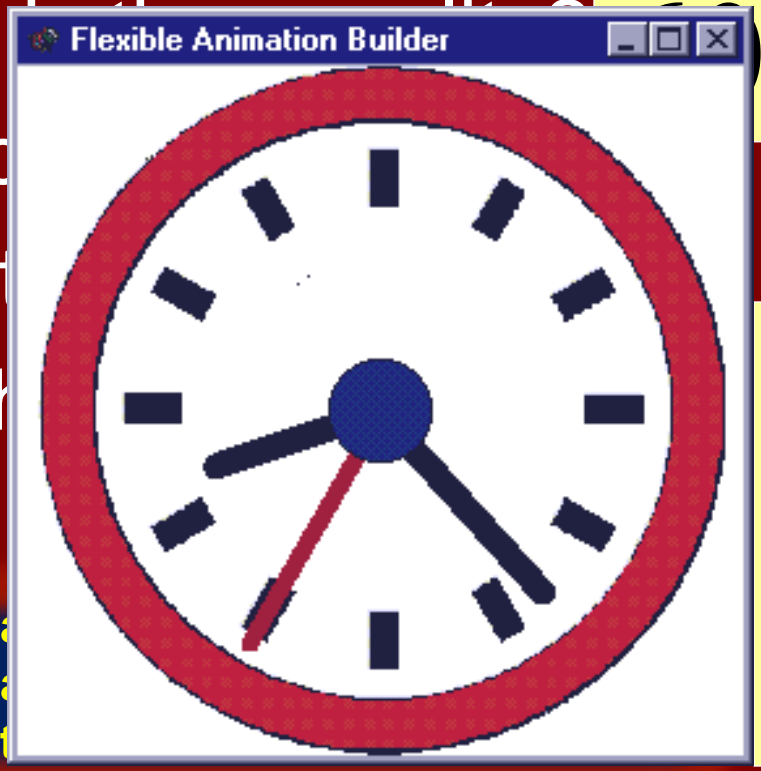
If you are co

minutes

what is th

factor?

$s = 1\,\text{min}$



$$\frac{60s}{1\,\text{min}}$$

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

The rule for the conversion factor is that what you have is on the bottom (unit)

What you are trying to convert to is on top

So

$$60s = 1\,\text{min}$$

$$3.5\,\text{min}\left(\frac{60s}{1\,\text{min}}\right) = 210s$$

$$\frac{60s}{1\,\text{min}}$$

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

Sample Problems

1. Convert
2. Convert
3. Convert
4. 5.6 doze
   many do

0.701 yr

0.095 kg

4.52 m

67 d

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

You should have the following equalities memorized

1 kilo = 1000
100 centi = 1
1000 milli = 1
1 min = 60 s

Others equalities will be given in later chapters

Starter S-16

As of yesterday $1.00 will buy you 0.6946 Euro. The symbol for a Euro is €. If you have €67.5 and want to convert to US dollars

A. What is the equality?

B. What is the conversion factor?

C. How many dollars can you get?

Starter S-16

As of yesterday $1.00 will buy you 0.6978 Euro. The symbol for a Euro is €. If you have €67.5 and want to convert to US dollars

A. What is the equality?

$1.00 = €0.6978

B. What is the conversion factor?

($1.00/€0.6978)

C. How many dollars can you get? $96.73

Section 3.4

Density

Conversion Problems 3.3

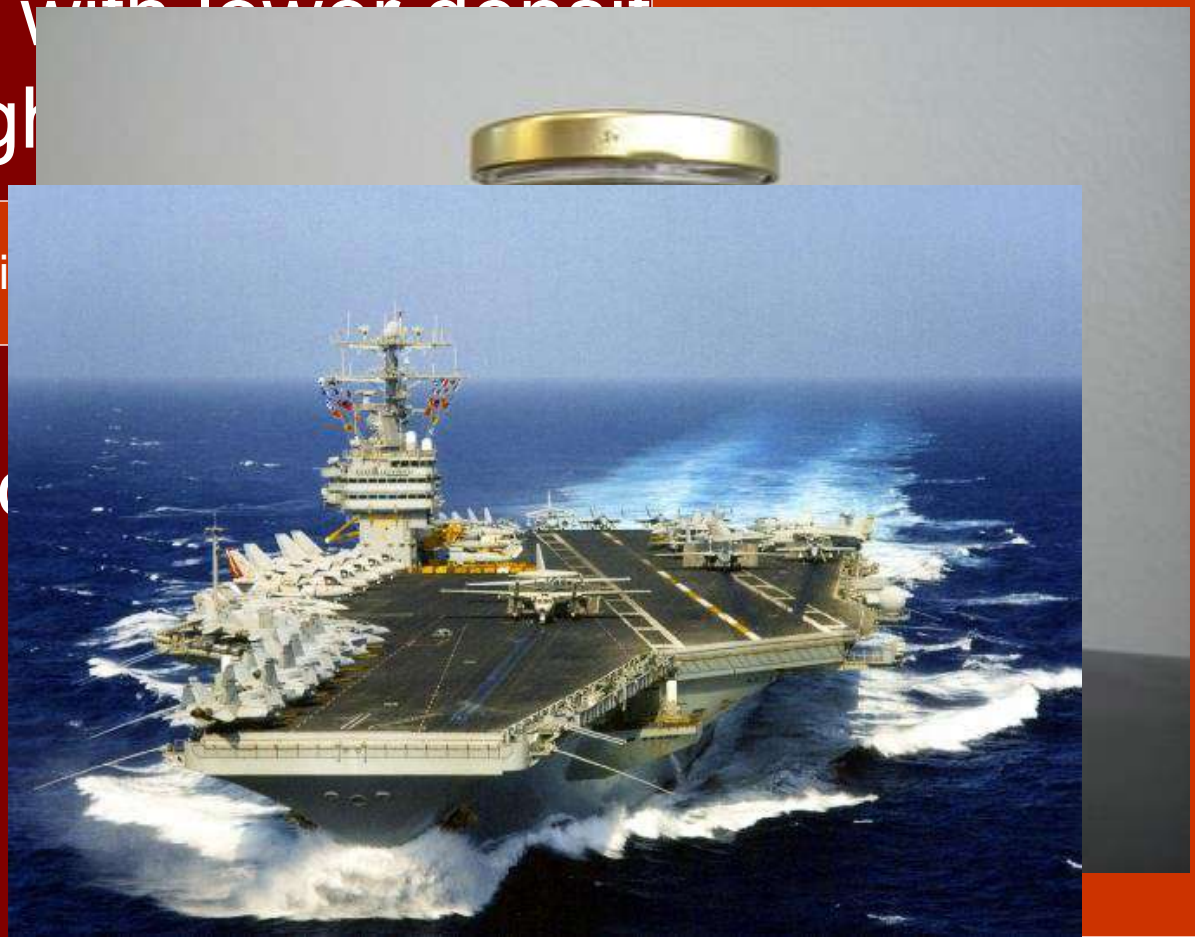
Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

Density – ratio of mass to

Objects with lower densit
a high

Density Gi

Some c



Material	Density (kg/m^3)
Air (1 atm, 20 degrees C	1.20
Aluminum	2,700
Benzene	900
Blood	1,600
	8,600
	2,000
	8,900
	810
	1,260
	19,300
	920
	7,800
	11,300
	13,600
	10^{18}
	21,400
	1,030
	10,500
	7,800
	1,000
	10^{10}

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

Density equation

ρ=density (g/cm^3)

m=mass (g)

V=volume (cm^3=mL)

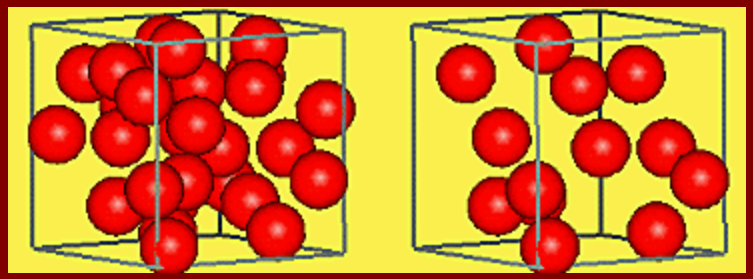
$$\rho = \frac{m}{V}$$

An intensive property

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

Depends on composition of matter, not on the size of the sample



So lead

Has a very different density from styrofoam

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

The density of a substance usually decreases as temperature increases

1. Oil heats up – density decrease
2. Oil rises – less density
3. Oil cools – density increases
4. Oil sinks

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

Density problems

1. What is the density of a copper penny, if it has a mass of 3.1g and a volume of $0.35cm^3$?

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

Density problems

2. What is the volume of a pure silver coin that has a mass of 14g? The density of silver is 10.5g/cm^3.

ρ

V

V cm^3

$10.5g / cm$

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

Density problems

3. What is the mass of a metal that has a density of 2.50g/cm^3, and a volume of 245 cm^3?

$$\rho = \frac{m}{V}$$

$$m = \rho V$$

$$m = (2.50 g / cm^3)(245 cm^3)$$

$$m = 612 g$$

Conversion Problems 3.3

Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas

Your turn

1. What is the density of an object that has a mass of 12.0 g and a volume of 35 cm^3?

   $0.34 g/cm^3$

2. What if the mass of an object with a volume of 23.1 cm^3 and a density of $7.9 g/cm^3$?

   180g

Starter S-19

Add the following

A) 15.2 + 90 + 5.778

B) 150.0 + 20.0 + 8.000

Multiply

C) 325.455688 x 5 x 0.8920

Starter S-20

Twinkle, twinkle little test
Time to go and do your best
If you studied all the day
You may earn yourself an A
Twinkle, twinkle little test
Time to go and do your best