# **Unit 3: Estimation and Approximation**

# **Lesson 1: Estimation and Approximation**

# **Essential Understanding**

- Numbers are used to represent quantities in real life.
- There are more types of number other than the natural counting numbers
- Numbers can be operated on and there is an order to which operations can be carried out.

#### **Essential Questions**

- •How can arithmetic be performed in quick and simplified manner to obtain estimated values instead of exact ones?
- •How do we approximate to a given degree of accuracy?
- What is the difference between estimation and approximation?

### **Key Points (Learning Outcomes)**

- What is estimation? What is approximation?
- Why do we estimate?
- How do we estimate?

#### **Difficult Point**

• To use different techniques of estimating based on the needs of situations

#### **Critical Point**

- Approximation is estimation to a given degree of accuracy.
- Understand that there is need to have a system to ascertain the relative degree of accuracy of an estimation, hence the need to modify estimation by rounding to a given decimal place

### **Definition to Estimation**

#### **Estimation**

esti mei(e)n/

noun

noun: estimation; plural noun: estimations

1. a rough calculation of the value, number, quantity, or extent of something.

"estimations of protein concentrations"

### So why do we estimate?

- -Estimation is often enough to solve a problem, so why the need for an exact answer? If a hamburger costs \$4.25, fries cost \$0.99 and you've got a five dollar note, a two-dollar note and some coins, you don't need to count the notes and coins to know if you can afford it.
- -Sometimes all you need to know is "about how much" f you're painting the living room, you want to know about how much paint you need. No need to figure it out to the teaspoon.
- -Sometimes you don't have any paper or pencil or a calculator with you, or it's too hard to calculate an exact answer mentally.
- -Sometimes it's not even possible to get an exact answer.

You've promised to pick up a friend at the airport. The vagaries of traffic prevent you from knowing precisely how long it will take to get there. But you must still decide when to leave home.

-You can check whether an answer is reasonable.

You've started a new exercise programme and you want to know how many extra calories you've burned this week. Because your interest is so keen, you gather calories-per-minute figures and add them. The sum seems low. Did you add correctly?

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# **Significant Figures**

### **Essential Understanding**

- Numbers are used to represent quantities in real life.
- There are more types of number other than the natural counting numbers
- Numbers can be operated on and there is an order to which operations can be carried out.

### **Essential Questions**

- How can we evolve the natural number systems to model real-life situations?
- How do we denote and perform operations on real numbers?

### **Key Points (Learning Outcomes)**

- Definition of Significant figures Difficult Point
- Rules for counting significant figures

#### **Critical Point**

• Why is rounding to a given significant figure necessary when we can already round to a given decimal point?

The exact thickness of a piece of glass is 0.004 503 m.

The thickness of the piece of glass in metre correct to 2 decimal places is 0.01cm.

- Is this figure going to be useful to him?
- How else can you describe the length to him?

#### **RULES FOR WRITING SIGNIFICANT FIGURES**

Rules	Example	Number of Significant Figures
All non-zero figures are significant.	846.381 5	7
Zeros at the <b>end</b> of a decimal are significant.	182.00	5
	3.660	4
Zeros that come before the first non-zero figure are <b>not</b> significant.	0.000 256 0	4
Zeros that lie between significant figures are significant.	310.008	6
	45000.0	6
The final zeros in a whole number may or may not be significant depending on how the estimation is made.	94 000	<ul> <li>2 (if the estimation is made correct to the nearest 1 000)</li> <li>3 (if the estimation is made correct to the nearest 100)</li> <li>4 (if the estimation is made correct to the nearest 10)</li> </ul>
		5 (if the estimation is made correct to the nearest 1)

Remember not to confuse the number of significant figures with the number of decimal places!

#### **Round and Truncation Errors**

### **Essential Understanding**

- Numbers are used to represent quantities in real life.
- There are more types of number other than the natural counting numbers
- Numbers can be operated on and there is an order to which operations can be carried out.

### **Essential Questions**

- How can we evolve the natural number systems to model real-life situations?
- What are rounding errors and how to avoid them in multi-steps workings

### **Key Points (Learning Outcomes)**

• understand the concepts of rounding and truncation errors for multi-steps workings

- know the meta-language such as
- evaluate
- estimate
- round .. to x decimal places
- round .. to x significant figures

#### **Difficult Point**

How to avoid rounding errors

#### **Critical Point**

• Premature rounding of figures in workings will lead to rounding errors

When trying to **evaluate**, **calculate** or **solve** a question, **DO NOT** round off before the end of the calculation even if you are asked to round off the answer.

E.g. **Evaluate** 2.44 + 6.93 to 2 significant figures.

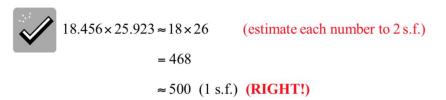
$$2.44 + 6.93 \approx 2.4 + 6.9 = 9.3$$
 (WRONG!)

$$2.44 + 6.93 = 9.37 \approx 9.4$$
 (2 s.f.) (RIGHT!)



- 2. When asked to **estimate** the calculation, always work to one <u>more</u> significant figure than you are required to give.
  - E.g. **Estimate** 18.456×25.923 to 1 significant figure.





When numbers in an expression is rounded off too early, we may not get an accurate numerical value for the expression.

In Practice... If a problem requires an answer correct to 3 significant figures, we should store the intermediate working values in the calculators or round them off to at least 4 significant figures. Storing and using stored calculator values is the preferred method though.

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