

TSOKOS READING ACTIVITY

Section 1-2

1. Read:
 - a. IB Assessment Statements below.
 - b. Section 1-2 in your textbook.
 - c. Article on Significant Figures on the website.
2. Essential Idea
 - a. Scientists aim towards designing experiments that can give a “true value” from their measurements, but due to the limited precision in measuring devices, they often quote their results with some form of uncertainty.
3. Nature Of Science
 - a. Uncertainties: “All scientific knowledge is uncertain... if you have made up your mind already, you might not solve it. When the scientist tells you he does not know the answer, he is an ignorant man. When he tells you he has a hunch about how it is going to work, he is uncertain about it. When he is pretty sure of how it is going to work, and he tells you, ‘This is the way it’s going to work, I’ll bet,’ he still is in some doubt. And it is of paramount importance, in order to make progress, that we recognize this ignorance and this doubt. Because we have the doubt, we then propose looking in new directions for new ideas.” (3.4) *Feynman, Richard P. 1998. The Meaning of It All: Thoughts of a Citizen-Scientist. Reading, Massachusetts, USA. Perseus. P 13.*
4. Theory Of Knowledge
 - a. “One aim of the physical sciences has been to give an exact picture of the material world. One achievement of physics in the twentieth century has been to prove that this aim is unattainable.” – Jacob Bronowski.
 - b. Can scientists ever be truly certain of their discoveries?
5. Understandings
 - a. Random and systematic errors
 - b. Absolute, fractional and percentage uncertainties
 - c. Error bars
 - d. Uncertainty of gradient and intercepts
6. Applications And Skills
 - a. Explaining how random and systematic errors can be identified and reduced
 - b. Collecting data that include absolute and/or fractional uncertainties and stating these as an uncertainty range (expressed as: best estimate \pm uncertainty range)

- c. Propagating uncertainties through calculations involving addition, subtraction, multiplication, division and raising to a power
- d. Determining the uncertainty in gradients and intercepts

7. Guidance

- a. Analysis of uncertainties will not be expected for trigonometric or logarithmic functions in examinations

8. Data Booklet Reference

- a. If $y = a \pm b$, then $\Delta y = \Delta a + \Delta b$
- b. If $y = \frac{ab}{c}$, then $\frac{\Delta y}{y} = \frac{\Delta a}{a} + \frac{\Delta b}{b} + \frac{\Delta c}{c}$
- c. If $y = a^n$, then $\frac{\Delta y}{y} = \left| n \frac{\Delta a}{a} \right|$

9. Utilization

- a. Students studying more than one group 4 subject will be able to use these skills across all subjects

10. Aims

- a. **Aim 4:** it is important that students see scientific errors and uncertainties not only as the range of possible answers but as an integral part of the scientific process
- b. **Aim 9:** the process of using uncertainties in classical physics can be compared to the view of uncertainties in modern (and particularly quantum) physics

11. Write a question regarding some aspect or characteristic of each of the terms listed below. The questions must start with either the word “How” or “Why”. *Provide an answer to your question.*

a. systematic error: _____

b. random uncertainty: _____

c. reading uncertainty: _____

d. accurate: _____

- e. precise: _____

- f. average: _____

- g. standard deviation: _____

- h. level of confidence: _____

- i. absolute uncertainty: _____

- j. fractional uncertainty: _____

- k. percentage uncertainty: _____

- l. best-fit line: _____

m. error bars _____

n. uncertainties in gradient: _____

o. uncertainties in intercept: _____

12. List the rules for propagating uncertainties.

addition and subtraction:

multiplication and division:

powers and roots:

13. Answers may be typed or neatly printed. Drawings may be freehand, but try to make use of the 'Shapes' or 'Insert Clipart' functions of MS Word.