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Error Analysis Questions

1. Perform the following calculation. Express your answer to the proper number of significant figures.

$$\frac{4.000-3.009}{10.000 * 0.01000}$$

4.000 - 3.009 = 0.991, 3 significant figures

10.000 * 0.01000 = 0.1000, 4 significant figures

0.991 / 0.1000 = 9.91, 3 significant figures

2. Present the following measurement of q = 8.565309 ± 0.03310, in its most appropriate form.

8.57 ± 0.03

3. Suppose you are subtracting the following values: $p = p_1 - p_2$. With $p_1 = 6.5 \pm 0.2$ kg m/s and $p_2 = 6.0 \pm 0.4$ kg m/s. What is the measure of p and uncertainty?

p = 6.5 - 6.0 = 0.5

Uncertainty = 0.4 + 0.2 = 0.6

Final answer = 0.5 ± 0.6 kg m/s

4. Suppose and individual measures the distance an object travels as 11.5 ± 0.5 m in a time of 4.8 ± 0.1 s. What is the measure of the speed of an object and uncertainty in this speed?

V = distance / time

$V_{best} = 2.4$ m/s

$$\frac{\delta V}{V_{best}} = \frac{\delta d}{d_{best}} + \frac{\delta t}{t_{best}}$$

$$\delta V = (\frac{0.5}{11.5} + \frac{0.1}{4.8}) * 2.4 = 0.15$$

Final answer: 2.4 ± 0.15 m/s

5. Suppose you measure the diameter of a circle as d = 8.7 ± 0.7 cm. What is the measure of the circumference and uncertainty?

$$\frac{\delta C}{C_{best}} = \frac{\delta d}{d_{best}}$$

$C_{best} = \pi * d = 27$ cm

Rearrange to find δC:

$$\delta C = \frac{\delta d}{d_{best}} * C_{best} = \frac{0.7cm}{8.7cm} * 27cm = 2cm$$

Final answer: 27 ± 2 cm

6. Find the acceleration of an object moving down a slope with velocities $v_1 = 0.21 \pm 0.05$ m/s and $v_2 = 0.85 \pm 0.04$ m/s in time $t = 4.0 \pm 0.1$s. What is the acceleration of the object and corresponding uncertainty? Recall $a = (v_2-v_1)/t$.

$$V = v_2-v_1 = 0.64 \pm 0.09 \text{ m/s}$$

$$V / t = 0.64 \pm 0.09 \text{ m/s} / 4.0 \pm 0.1 \text{ s}$$

$$a_{best} = 0.16 \text{ m/s}^2$$

$$\frac{\delta a}{a_{best}} = \frac{\delta V}{V_{best}} + \frac{\delta t}{t_{best}}$$

$$\delta a = \left(\frac{\delta V}{V_{best}} + \frac{\delta t}{t_{best}}\right) * a_{best} = \left(\frac{0.09}{0.64} + \frac{0.1}{4.0}\right) * 0.16 = 0.03$$

Final answer: 0.16 ± 0.03 m/s^2

7. Suppose you are measuring the kinetic energy of an object $E = ½ m*v^2$. What is the measure of kinetic energy and uncertainty? The measure of mass is 6.3 ± 0.1 kg and the measure of the velocity is 8.2 ± 0.4 m/s. Show all work.

$$\frac{\delta KE}{KE_{best}} = \frac{\delta m}{m_{best}} + \frac{\delta v}{v_{best}} + \frac{\delta v}{v_{best}}$$

$$KE_{best} = 0.5 * 6.3\text{kg} * (8.2 \text{ m/s})^2 = 210 \text{ J/s}^2$$

$$\delta KE = 0.5\left(\frac{0.1}{6.3} + \frac{0.4}{8.2} + \frac{0.4}{8.2}\right) * 210 = 12$$

Final answer: 210 ± 12 J/s^2