1.2 Uncertainties & Errors

Question Paper

Course	DP IB Physics
Section	1. Measurement & Uncertainties
Topic	1.2 Uncertainties & Errors
Difficulty	Medium

To be used by all students preparing for DP IB Physics SL
Students of other boards may also find this useful

Question 1

Systematic and random errors can be compared.

What are the properties that apply to random errors?

1 The error is consistently too high or too low and by different amounts

2 The error is constantly too high or low and by the same amount each time

3 The error can be fully eliminated

4 The error cannot be fully eliminated

5 The error can be reduced by averaging repeated measurements

6 The error cannot be reduced by averaging repeated measurements

A. 1, 3 and 6

B. 2, 4 and 6

C. 2, 3 and 6

D. 1, 4 and 5

[1 mark]

Question 2

The measurement of a physical quantity may be subject to random errors and systematic errors.

Which statement is correct?

A. random errors can be reduced by taking the average of several measurements

B. random errors are always caused by the person taking the measurement

C. a systematic error cannot be reduced by adjusting the apparatus

D. a systematic error results in a different reading each time the measurement is taken

[1 mark]

Question 3

A stone falls from rest to the bottom of a water well of depth d. The time t taken to fall is 3.0 ± 0.3 s. The depth of the well is calculated to be 30 m using $d = \frac{1}{2}at^2$. The uncertainty in a is negligible.

What is the absolute uncertainty in d?

A. ± 0.6 m

B. ± 3 m

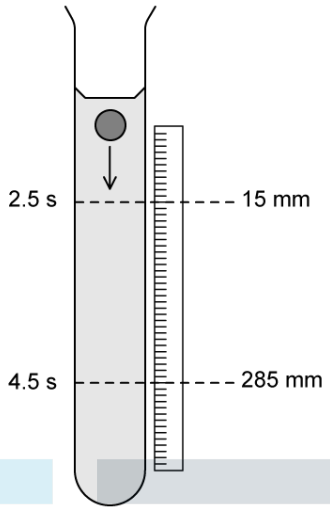
C. ± 24 m

D. ± 6 m

[1 mark]

Question 4

The diagram shows an experiment to measure the speed of a small ball falling at constant speed through a clear liquid in a glass tube.



There are two marks on the tube. The top mark is positioned at 15 ± 1 mm on the adjacent rule and the lower mark at 285 ± 1 mm. The ball passes the top mark at 2.50 ± 0.02 s and passes the lower mark at 4.50 ± 0.02 s.

The constant speed of the ball is calculated to be 135 mm s^{-1}.

Which expression calculates the fractional uncertainty in the value of this speed?

A. $\frac{2}{270} + \frac{0.04}{2.00}$

B. $\frac{1}{270} + \frac{0.02}{2.00}$

C. $\frac{1}{15} + \frac{0.02}{2.50}$

D. $\frac{1}{285} + \frac{0.02}{4.50}$

[1 mark]

Question 5

The strain energy W of a spring is determined from its spring constant k and extension x. The spring obeys Hooke's law and the value of W is calculated using the equation shown.

$$W = \frac{1}{2}kx^2$$

The spring constant k is $200 \pm 1\ \text{N m}^{-1}$ and the extension x is 0.040 ± 0.004 m.

What is the percentage uncertainty in the calculated value of W?

A. 20%

B. 20.5%

C. 10%

D. 10.5%

[1 mark]

Question 6

In an experiment investigating the electrolysis of copper, a student sets out to find the electrochemical equivalent, Z.

The electrochemical equivalent of a substance is the amount of substance deposited on a cathode per Coulomb of charge.

This can be determined using the equation:

$$Z = \frac{m_1 - m_2}{It}$$

Where:

- Mass of cathode before passing current, $m_1 = (54.39 \pm 0.01) \times 10^{-3}$ kg
- Mass of cathode after passing current, $m_2 = (52.06 \pm 0.01) \times 10^{-3}$ kg
- Current, $I = 3.00 \pm 1$ A
- Time, $t = 4800 \pm 100$ s

What is the largest possible value of Z from these readings?

A. $\frac{233}{940} \times 10^{-6}\ \text{kg C}^{-1}$

B. $\frac{231}{940} \times 10^{-6}\ \text{kg C}^{-1}$

C. $\frac{235}{940} \times 10^{-6}\ \text{kg C}^{-1}$

D. $\frac{253}{720} \times 10^{-6}\ \text{kg C}^{-1}$

[1 mark]

Question 7

The sides of a square are measured to be 8.0 ± 0.2 cm.

Which of the following gives the area of the square and its uncertainty?

A. $64.0 \pm 0.2\ \text{cm}^2$

B. $64.0 \pm 0.4\ \text{cm}^2$

C. $64.0 \pm 3.2\ \text{cm}^2$

D. $64.0 \pm 1.6\ \text{cm}^2$

[1 mark]

Question 8

In an experiment, a radio-controlled car takes 1.50 ± 0.05 s to travel 30.0 ± 0.1 m.

What is the car's average speed and the uncertainty in this value?

A. $20.0 \pm 0.732\ \text{m s}^{-1}$

B. $20.0 \pm 0.0366\ \text{m s}^{-1}$

C. $20.0 \pm 0.066\ \text{m s}^{-1}$

D. $20.0 \pm 9.91\ \text{m s}^{-1}$

[1 mark]

Question 9

The diagram shows a thermometer reading of a liquid's temperature, before and after heating.

What is the best estimate for the temperature increase of the liquid?

A. (54.0 ± 0.5) degrees

B. (54 ± 1.0) degrees

C. (54 ± 1) degrees

D. (54.0 ± 2.0) degrees

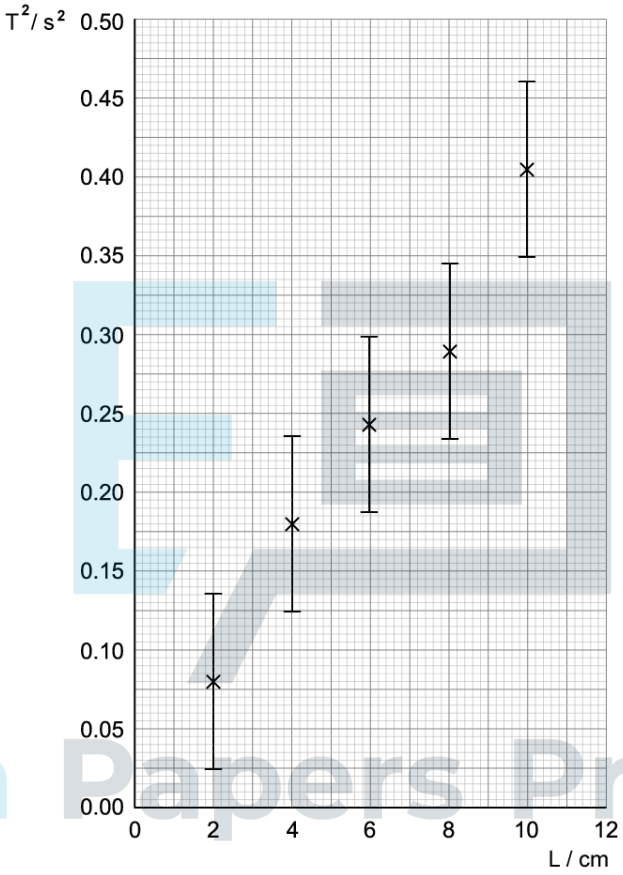
[1 mark]

Question 10

A student collects values of the time period, T, of a pendulum at different lengths of string, L. They want to investigate the relationship:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

They plot the values on a graph along with the error bars associated with each point, as shown in the diagram.



What is the percentage uncertainty in the experimental value of g?

A. $\frac{43}{32}\%$

B. $\frac{43}{1600}\%$

C. $\frac{43}{800}\%$

D. $\frac{215}{8000}\%$

[1 mark]