

# 1.2 Uncertainties & Errors

# **Question Paper**

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

Time allowed: 20

Score: /10

Percentage: /100



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#### 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?

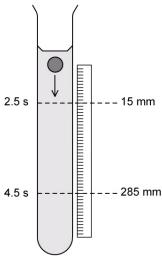
- A. random errors can be reduced by taking the average of several measurements
- B. random errors are always caused by the person taking the measurement
- C. a systematic error cannot be reduced by adjusting the apparatus
- D. a systematic error results in a different reading each time the measurement is taken

A stone falls from rest to the bottom of a water well of depth d. The time t taken to fall is  $3.0 \pm 0.3$  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?

- $A. \pm 0.6 \, m$
- $B.\pm3m$
- $C.\pm 24\,m$
- $D.\pm6m$

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  $15 \pm 1$  mm on the adjacent rule and the lower mark at  $285 \pm 1$  mm. The ball passes the top mark at  $2.50 \pm 0.02$  s and passes the lower mark at  $4.50 \pm 0.02$  s.

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

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

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

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

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

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

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  $200 \pm 1 \,\mathrm{N}\,\mathrm{m}^{-1}$  and the extension x is  $0.040 \pm 0.004 \,\mathrm{m}$ .

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 ± 1 A
- Time,  $t = 4800 \pm 100 \text{ s}$

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

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

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

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

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

[1 mark]

#### Question 7

The sides of a square are measured to be  $8.0 \pm 0.2$  cm.

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

- $A.64.0 \pm 0.2 \, cm^2$
- $B.64.0 \pm 0.4 \, cm^2$
- $C.64.0 \pm 3.2 \, cm^2$
- $D.64.0 \pm 1.6 \, cm^2$

[1 mark]

#### **Question 8**

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

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

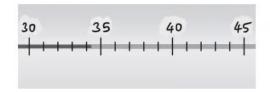
- $A.20.0 \pm 0.732 \, m \, s^{-1}$
- $B.20.0 \pm 0.0366 \,\mathrm{m\,s^{-1}}$
- $C.20.0 \pm 0.066 \, \text{m s}^{-1}$
- $D.20.0 \pm 9.91 \,\mathrm{m \, s^{-1}}$



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## 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.  $(54.0 \pm 0.5)$  degrees

B.  $(54 \pm 1.0)$  degrees

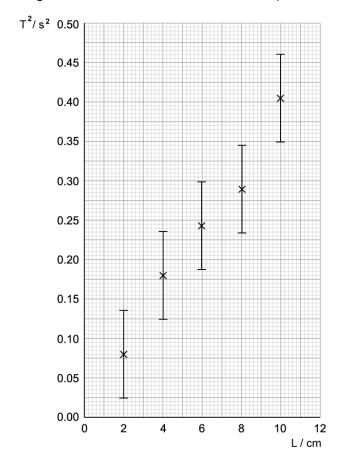
C.  $(54 \pm 1)$  degrees

D.  $(54.0 \pm 2.0)$  degrees

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



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