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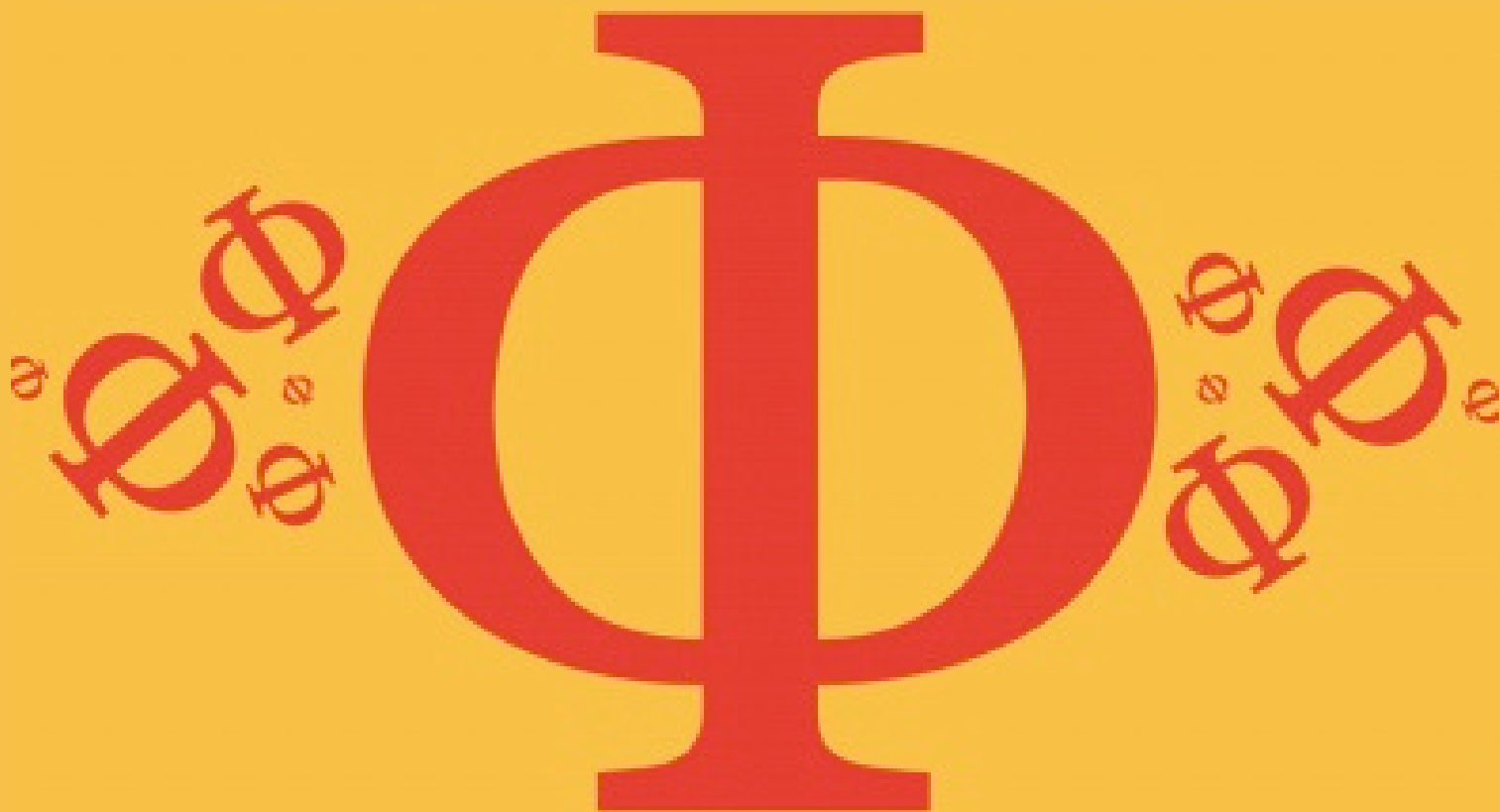
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1.2 Uncertainties & Errors

Medium



PHYSICS

IB HL

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

Question 1

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 2

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 3

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

Which statement is correct?

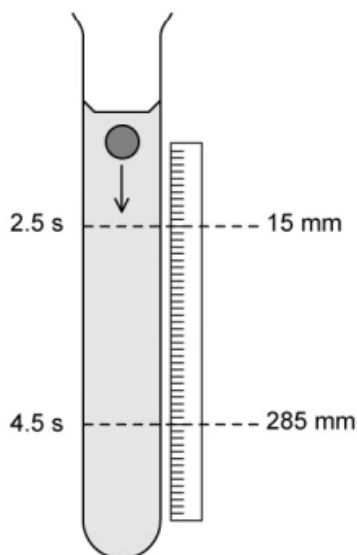
- A. random errors can be reduced by taking the average of several measurements
- B. random errors are always caused by the person taking the measurement
- C. a systematic error cannot be reduced by adjusting the apparatus
- D. a systematic error results in a different reading each time the measurement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

[1 mark]



Question 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 $0.040 \pm 0.004 \text{ m}$.

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:

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

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Where:

- Mass of cathode before passing current, $m_1 = (54.39 \pm 0.01) \times 10^{-3} \text{ kg}$
- Mass of cathode after passing current, $m_2 = (52.06 \pm 0.01) \times 10^{-3} \text{ kg}$
- Current, $I = 3.00 \pm 1 \text{ A}$
- 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. $\frac{235}{940} \times 10^{-6} \text{ kg C}^{-1}$
- D. $\frac{253}{720} \times 10^{-6} \text{ kg C}^{-1}$

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 ± 0.2 cm²
- B. 64.0 ± 0.4 cm²
- C. 64.0 ± 3.2 cm²
- D. 64.0 ± 1.6 cm²

[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?

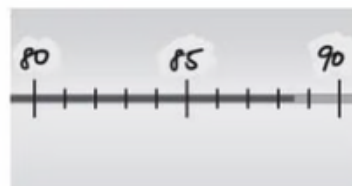
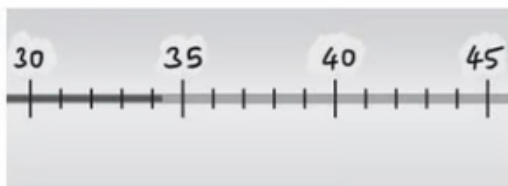
- A. 20.0 ± 0.732 m s⁻¹
- B. 20.0 ± 0.0366 m s⁻¹
- C. 20.0 ± 0.066 m s⁻¹
- D. 20.0 ± 9.91 m s⁻¹

[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]



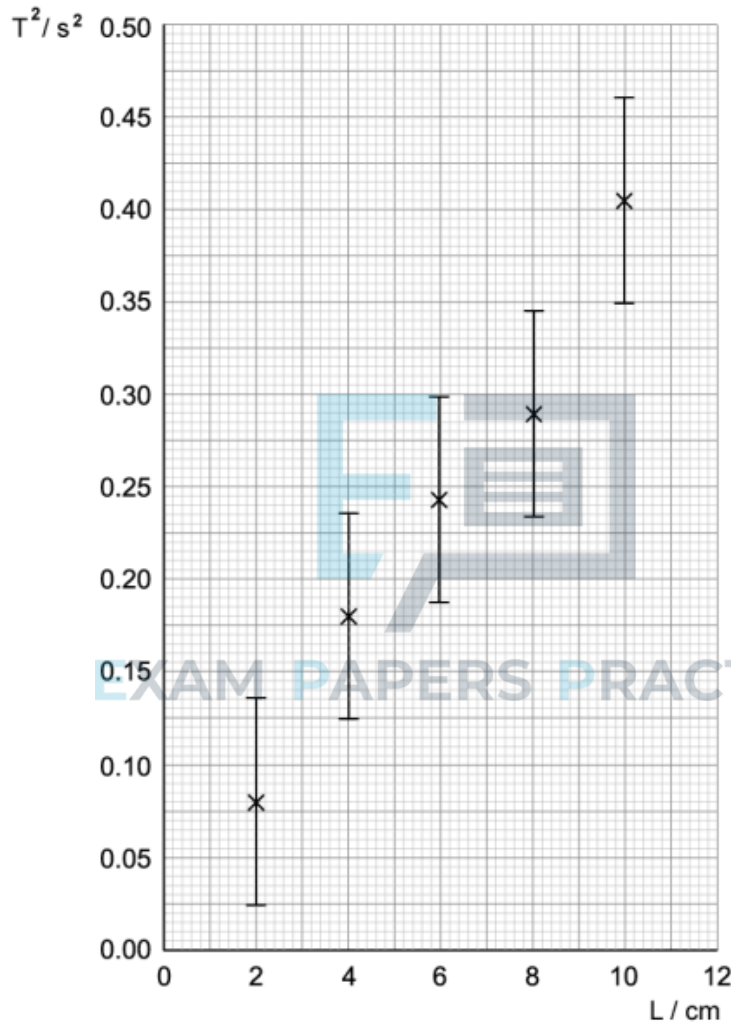


Question 10

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]