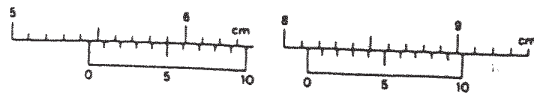


2. Measurement Techniques.

- 1) The diagrams show the scale readings of a travelling microscope focused in turn on each of the ends of a short metal rod.



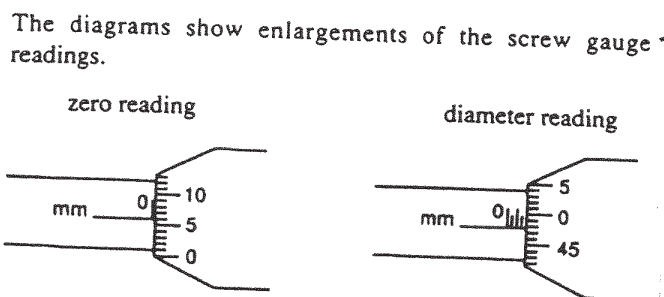
On reading the vernier, an error of one division either way may be made.

What is the length of the rod and the associated error in the measurement?

- A 2.66 ± 0.01 cm
- B 2.68 ± 0.01 cm
- C 2.68 ± 0.02 cm
- D 2.70 ± 0.01 cm
- E 2.70 ± 0.02 cm

J91/Q2

- 2) The diameter of a steel ball is measured using a micrometer screw gauge. A student takes an initial zero reading and then a reading of the diameter.

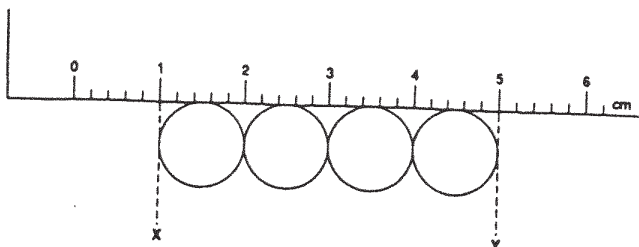


What is the diameter of the ball?

- A 3.48mm
- B 2.04mm
- C 1.98mm
- D 1.92mm
- E 1.42mm

J93/Q1

- 3) A student attempts to measure the diameter of a steel ball by using a metre rule to measure four similar balls in a row.



The positions on the scale are estimated to be

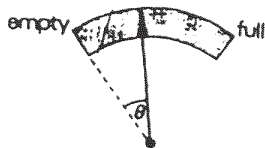
- X (1.0 ± 0.2) cm
- Y (5.0 ± 0.2) cm

What is the diameter of a steel ball together with its associated uncertainty?

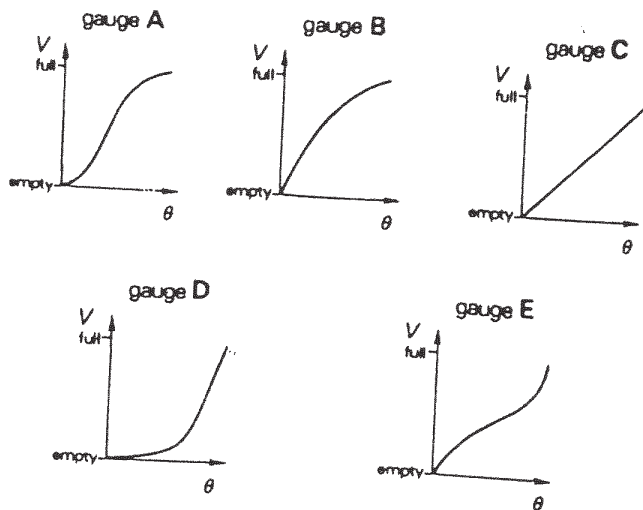
- A (1.0 ± 0.05) cm
- B (1.0 ± 0.1) cm
- C (1.0 ± 0.2) cm
- D (1.0 ± 0.24) cm

A petrol gauge in a car indicates the volume V of fuel in the tank. V is given by the angular deflection θ of the pointer on a dial.

4)



Below are the calibration curves for five different gauges.



For low fuel levels in the tank, which gauge would be most sensitive?

D93 / Q30

5) In a simple electrical circuit, the current in a resistor is measured as (2.50 ± 0.05) mA. The resistor is marked as having a value of $4.7 \Omega \pm 2\%$.

If these values were used to calculate the power dissipated in the resistor, what would be the percentage uncertainty in the value obtained?

- A 2% B 4% C 6% D 8%

D94 / Q2

6) When comparing systematic and random errors, the following pairs of properties of errors in an experimental measurement may be contrasted:

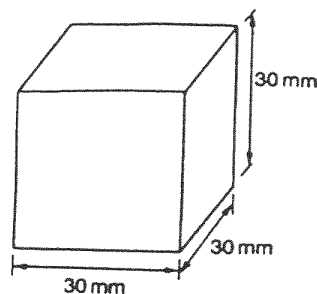
- P_1 : error can possibly be eliminated
 P_2 : error cannot possibly be eliminated
 Q_1 : error is of constant sign and magnitude
 Q_2 : error is of varying sign and magnitude
 R_1 : error will be reduced by averaging repeated measurements
 R_2 : error will not be reduced by averaging repeated measurements

Which properties apply to random errors?

- A P_1, Q_1, R_2 C P_2, Q_2, R_1
 B P_1, Q_2, R_2 D P_2, Q_1, R_1

J95 / Q2

7) The dimensions of a cube are measured with vernier calliper



The measured length of each side is 30 mm. If the vernier callipers can be read with an uncertainty of ± 0.1 mm, what does this give for the approximate uncertainty in the value of its volume?

- A $\frac{1}{27}\%$
 B $\frac{3}{10}\%$
 C $\frac{1}{3}\%$
 D 1%

J96 / Q2

8) Four students each made a series of measurements of the acceleration of free fall g . The table shows the results obtained.

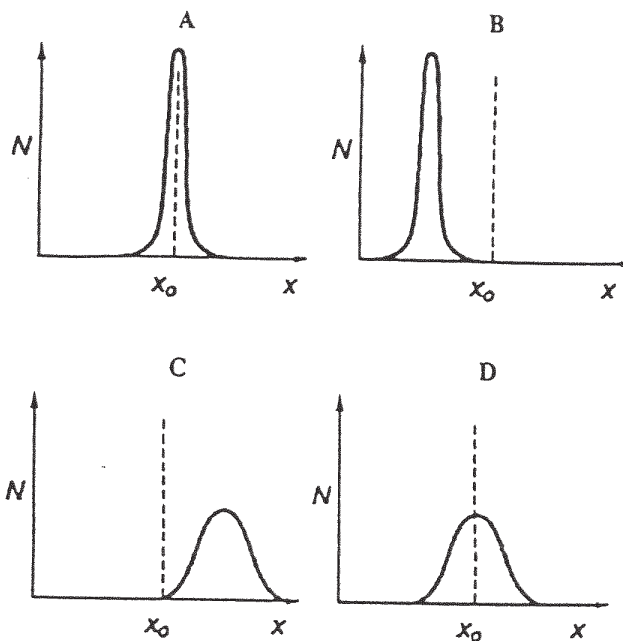
Which student obtained a set of results that could be described as precise but not accurate?

student	results, g/ms^{-2}			
A	9.81	9.79	9.84	9.83
B	9.81	10.12	9.89	8.94
C	9.45	9.21	8.99	8.76
D	8.45	8.46	8.50	8.41

D96 / Q3

- 9) A quantity x is measured many times and the number N of measurements giving a value x is plotted against x . The true value of the quantity is x_0 .

Which graph best represents precise measurements with poor accuracy?



D97 / Q2

10)

The density of the material of a rectangular block was determined by measuring the mass and linear dimensions of the block. The table shows the results obtained, together with their uncertainties.

mass	$= (25.0 \pm 0.1) \text{ g}$
length	$= (5.00 \pm 0.01) \text{ cm}$
breadth	$= (2.00 \pm 0.01) \text{ cm}$
height	$= (1.00 \pm 0.01) \text{ cm}$

The density was calculated to be 2.50 g cm^{-3} .

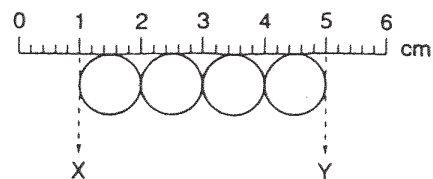
What was the uncertainty in this result?

- A $\pm 0.01 \text{ g cm}^{-3}$
- B $\pm 0.02 \text{ g cm}^{-3}$
- C $\pm 0.05 \text{ g cm}^{-3}$
- D $\pm 0.13 \text{ g cm}^{-3}$

D98 / Q2

11)

A student attempts to measure the diameter of a steel ball by using a metre rule to measure four similar balls in a row.



The student estimates the positions on the scale to be as follows.

X $(1.0 \pm 0.2) \text{ cm}$

Y $(5.0 \pm 0.2) \text{ cm}$

What is the diameter of a steel ball together with its associated uncertainty?

A $(1.0 \pm 0.05) \text{ cm}$

B $(1.0 \pm 0.1) \text{ cm}$

C $(1.0 \pm 0.2) \text{ cm}$

D $(1.0 \pm 0.24) \text{ cm}$

J99 / Q2

12)

A micrometer, reading to $\pm 0.01 \text{ mm}$, gives the following results when used to measure the diameter d of a uniform wire:

1.02 mm 1.02 mm 1.01 mm 1.02 mm 1.02 mm

When the wire is removed and the jaws are closed, a reading of -0.02 mm is obtained.

Which of the following gives the value of d with a precision appropriate to the micrometer?

A 1.0 mm

C 1.038 mm

B 1.00 mm

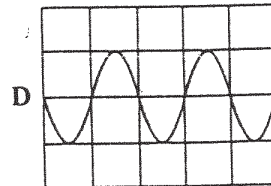
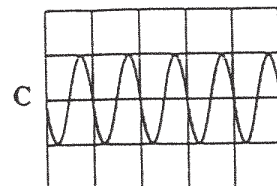
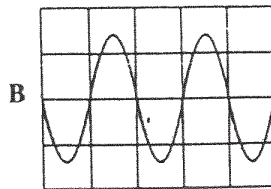
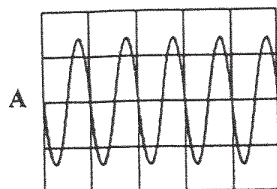
D 1.04 mm

J00 / Q2

13)

The Y-input terminals of an oscilloscope are connected to a supply of peak value 5.0 V and of frequency 50 Hz. The time-base is set at 10 ms per division and the Y-gain at 5 V per division.

Which trace could be obtained?



D00 / Q2

14)

In an experiment to determine the acceleration of free fall g , the period of oscillation T and length l of a simple pendulum were measured. The uncertainty in the measurement of l was estimated to be 4%, and that of T , 1%.

The value of g was determined using the formula

$$g = \frac{4\pi^2 l}{T^2}$$

What is the uncertainty in the calculated value for g ?

- A 2% B 3% C 5% D 6%

D01 / Q2