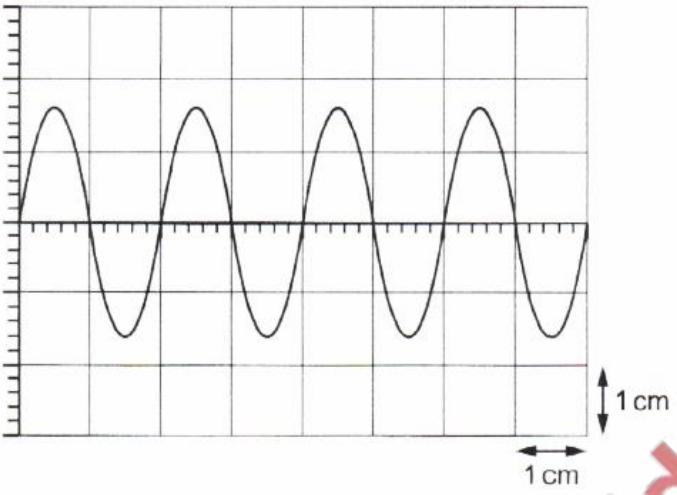
Measurement Techniques – 2021 AS Physics

1. June/2021/Paper_11/No.4

A signal of frequency 25 Hz is displayed on the screen of a cathode-ray oscilloscope.



$f = \frac{1}{T} \Rightarrow T = \frac{1}{f} = \frac{1}{25}$

$= 0.04\,s$

$\simeq 40\,ms$

If 2 cm = 40 ms

1 cm = 20 ms/cm

$\Rightarrow 20\,ms\,cm^{-1}$

What is the time-base setting?

A $10\,ms\,cm^{-1}$ B $20\,ms\,cm^{-1}$ C $25\,ms\,cm^{-1}$ D $40\,ms\,cm^{-1}$

2. June/2021/Paper_11/No.5

A micrometer screw gauge is used to measure the diameter of a wire.

The reading on the micrometer with the jaws closed is (–0.05 ± 0.02) mm.

The reading with the wire in position between the two jaws is (+1.03 ± 0.02) mm.

What is the diameter of the wire?

A (0.98 ± 0.02) mm

B (1.08 ± 0.02) mm

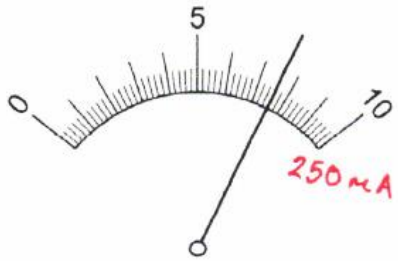
C (0.98 ± 0.04) mm

D (1.08 ± 0.04) mm

$1.03 + 0.05 = 1.08 \pm 0.02 + 0.02 = 0.04$

3. June/2021/Paper_12/No.4

An analogue ammeter with a range of 0–250 mA is connected into an electrical circuit. The diagram shows the ammeter's display.



7.6

Scale
25 = 1.0 mA
?? = 7.6
7.6 x 25 = 190 mA

What is the reading on the ammeter?

A 76 mA **B** 165 mA **C** 183 mA **D** 190 mA

4. June/2021/Paper_12/No.5

Students take readings of the volume of a liquid using three different pieces of measuring equipment X, Y and Z.

The true value of the volume of the liquid is *V*.

The students' results are shown.

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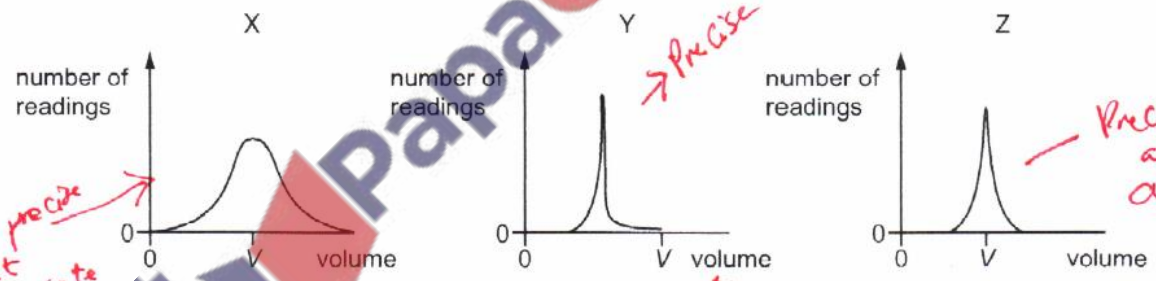


not precise but accurate

precise

Precise and accurate

How many pieces of equipment are precise and how many are accurate?

	number of precise pieces of equipment	number of accurate pieces of equipment
A	1	1
B	1	2
C	2	1
D	2	2

Not accurate since V is not at the true value

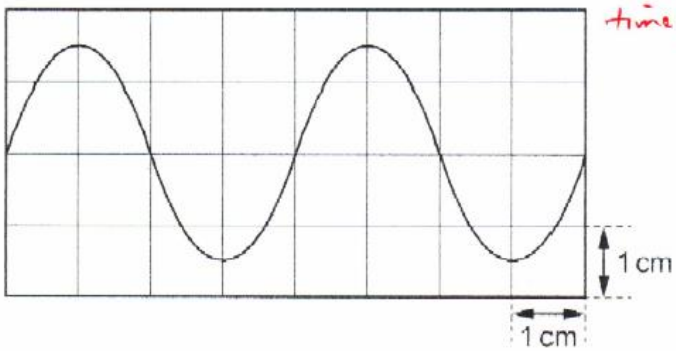
Precise - Value close together.
Accurate - Near to the true value.

5. Nov/2021/Paper_11/No.4

A cathode-ray oscilloscope (CRO) is used to display a sound wave of frequency 2000 Hz.

The display of the CRO is shown.

T = period
f = frequency
$T = \frac{1}{f}$
$= \frac{1}{2000}$
$= 0.0005$



T = time base × divisions
$\text{time base} = \frac{T}{\text{divisions}}$
$= \frac{0.0005\ s}{4\ cm}$
$= 0.000125\ s\,cm^{-1}$
$= 125\ \mu s\,cm^{-1}$
$= 125 \times 10^{-6}\ s\,cm^{-1}$

What is the time-base setting on the CRO?

A ✓ $125\ \mu s\,cm^{-1}$ **B** $250\ \mu s\,cm^{-1}$ **C** $500\ \mu s\,cm^{-1}$ **D** $1000\ \mu s\,cm^{-1}$

6. Nov/2021/Paper_11/No.5

Four possible sources of error in a series of measurements are listed.

1 an analogue meter whose scale is read from different angles ← random
2 a meter which always measures 5% too high ← systematic
3 a meter with a needle that is not frictionless, so the needle sometimes sticks slightly ← random
4 a meter with a zero error ← systematic

Which errors are random and which are systematic?

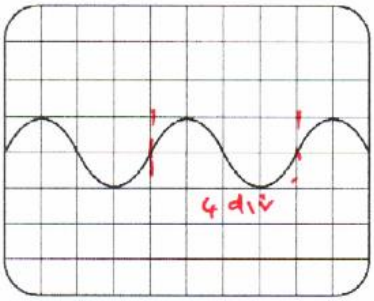
	random error	systematic error
A	1 and 2	3 and 4
B ✓	1 and 3	2 and 4
C	2 and 4	1 and 3
D	3 and 4	1 and 2

7. Nov/2021/Paper_12/No.4

Four cathode-ray oscilloscope (CRO) screens each display a waveform. The screen and the time-base setting of each CRO is shown.

$f = \frac{1}{T}$

1



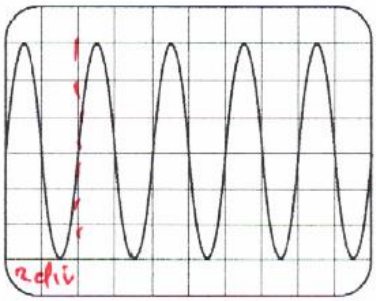
time-base setting: 0.02 s / div

$T = 0.02 \frac{s}{div} \times 4\ div$

$= 0.08\ s$

$f = \frac{1}{0.08} = 12.5\ Hz$

2



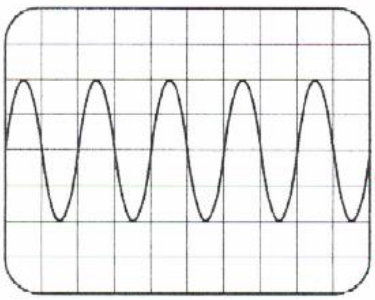
time-base setting: 0.04 s / div

$T = 0.04 \frac{s}{div} \times 2\ div$

$= 0.08\ s$

$f = \frac{1}{0.08} = 12.5\ Hz$

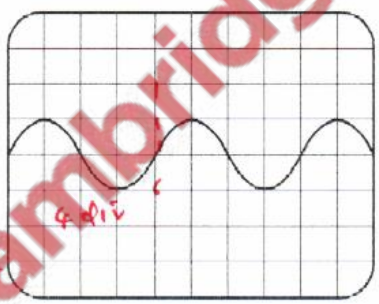
3



time-base setting: 0.01 s / div

$f = 50\ Hz$

4



time-base setting: 0.08 s / div

$T = 0.08 \frac{s}{div} \times 4\ div$

$= 0.32$

$f = \frac{1}{0.32}$

$= 3.125\ Hz$

Which screens show waveforms of the same frequency?

A 1 and 2 **B** 1 and 3 **C** 1 and 4 **D** 2 and 3

8. Nov/2021/Paper_12/No.5

A student measures the time T for one complete oscillation of a pendulum of length l.

Her results are shown in the table.

l/m	T/s
0.420 ± 0.001	1.3 ± 0.1

She uses the formula

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

to calculate the acceleration of free fall g.

What is the best estimate of the percentage uncertainty in the value of g?

A 0.02% **B** 4% **C** 8% **D** 16%

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

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

$= \frac{4\pi^2 \times 0.420}{1.3^2}$

$= 9.81 \text{ m/s}^2$

$\frac{\Delta g}{g} = \frac{\Delta l}{l} + 2\frac{\Delta T}{T}$

$= \frac{0.001}{0.42} + \frac{2 \times 0.1}{1.3}$

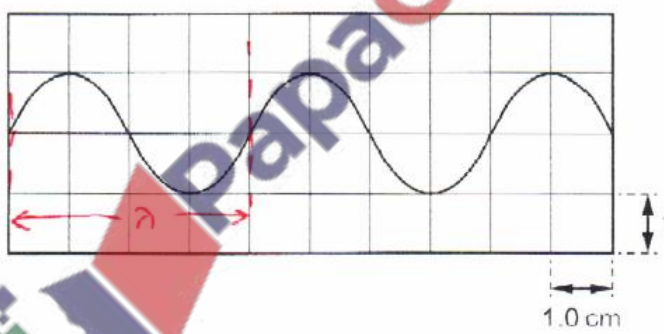
$= 0.156 \times 100$

$= 15.6\%$

$= 16\%$

9. Nov/2021/Paper_13/No.4

The output of a signal generator is connected to a cathode-ray oscilloscope (CRO). A trace is shown on the screen.



The time-base of the CRO is set at 2.00 ms cm^{-1}.

What is the frequency of the signal?

A 50 Hz **B** 125 Hz **C** 250 Hz **D** 500 Hz

$T = L \times x$

where

T = period

L = length of 1

x = time-base setting

$T = 4 \times 2.00 \text{ ms}$

$= 8 \text{ ms}$

$= 8 \times 10^{-3} \text{ s}$

$f = \frac{1}{T}$

$= \frac{1}{8 \times 10^{-3}} = 125 \text{ Hz}$

10. Nov/2021/Paper_13/No.5

After measuring the width of a shelf to be 305 mm, it is found that the graduations on the ruler used are 1.0% further apart than they should be.

Which type of measurement error is this and what is the true width of the shelf?

	type of error	true width / mm
A	random	302
B	random	308 ✓
C ✓	systematic	302
(D)	systematic	308 ✓

305 mm is under measured due to graduation be far apart.

So

305 mm — 99%

? — 100%

$$\frac{305\text{ mm} \times 100}{99}$$

$$= 308\text{ mm}$$

Sytematic errors are predicatable errors due to the measuring system.