

**SURNAME:**

Von K

12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

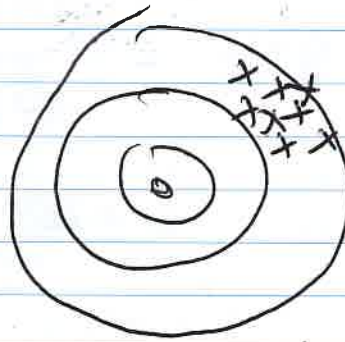
69.6

69%

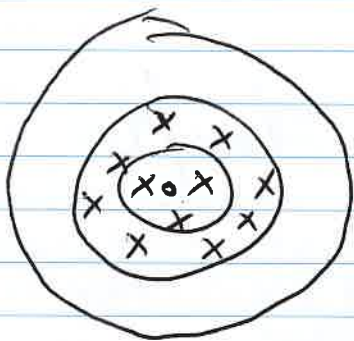
- ① Accuracy = how close the readings are to the actual measurements. ✓
 Precision = high precision would be all measurements recorded ~~would~~ (for the same test) would be similar. ✓



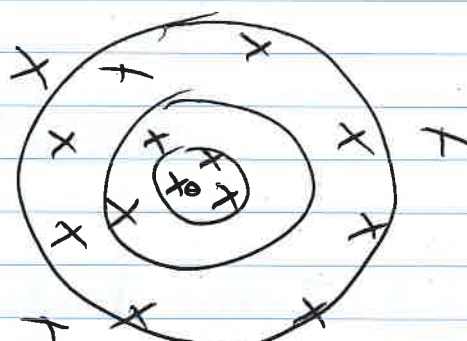
High Accuracy
High Precision ✓



High Precision
Low Accuracy ✓



High Accuracy
Low Precision ✓



Low Precision
Low Accuracy ✓

Well calibrated instruments have high accuracy and precision.

5

5

2

(a) Graph plotted

3

3

x + y WRONG WAY AROUND

(b) Sensitivity;

$$21^{\circ}\text{C} = \frac{100 - 0}{4 - 0}$$

↓

Shame

$$= + \frac{1}{25} \text{ kg/mm/}^{\circ}\text{C}$$

x WRONG UNITS
mm/kg.

$$35^{\circ}\text{C} = \frac{100 - 0}{4.6 - 0.2}$$

↓

1

1

$$= +22.7 \text{ kg/mm/}^{\circ}\text{C}$$

WRONG UNITS.
mm/kg.

$$\begin{aligned} \text{Zero drift} &= 0.2 - 0 \\ &= 0.2 \text{ mm/}^{\circ}\text{C} \end{aligned}$$

x

$$\begin{aligned} \text{Sensitivity drift} &= 25 - 22.7 \\ &= 2.3 \text{ kg/mm/}^{\circ}\text{C} \end{aligned}$$

1

1

RIGHT METHOD, WRONG NUMBERS.

WRONG UNITS. SHOULD BE mm/kg/}^{\circ}\text{C}

③

Calibrated reading = 4.276 m

~~4.298~~

①

Average of readings

$$\frac{4.299 + 4.295 + 4.296 + 4.293 + 4.292 + 4.294 + 4.293 + 4.290 + 4.294 + 4.291}{10}$$

$$\text{Average} = 4.293 \text{ m}$$

$$\text{Max deviation from Average} = 4.296 \text{ m}$$

$$\text{Min deviation from Average} = 4.290 \text{ m}$$

$$\begin{aligned} \text{Precision} &= \text{Max} - \text{Min} \\ &= 4.296 - 4.290 \\ &= 0.006 \text{ m} \\ &= \pm 6 \text{ mm} \end{aligned}$$

①

②

$$\begin{aligned} \text{Maximum in accuracy} &= 4.296 - 4.276 \\ &= 0.02 \text{ m} \\ &= \pm 2 \text{ cm} \end{aligned}$$

②

$$100 \text{ cm} = 1 \text{ m}$$

$$10 \text{ mm} = 1 \text{ cm}$$

(c) ~~#~~ Temperature at 30°C
 $= 4.43 - 4.276$
 $= 0.154 \text{ m}$
 $= 15.4 \text{ cm}$

(d) The instrument could have an inbuilt temperature sensor so the PIC can take readings of the temperature and predict how the density of the air would have changed. Based on this the ultrasonic tape measure can auto calibrate ~~the~~ its self to produce more accurate readings.

(4) Random error. This is a type of error that is not preplanned and happens with out being expected. This could occur (lets use ~~the~~ ultrasonic sensors for example) if the ~~the~~ device works in normal air environments and then it is used somewhere with more CO_2 in the air then the reading ~~is~~ may be wrong as CO_2 is denser than oxygen.

Systematic errors. These are errors that are preplanned and caused by a person. These are normally used for testing how something will cope under difference ~~and~~ conditions. As before the readings were wrong due to CO_2 . With systematic readings the CO_2 would deliberately be put in the air to see how it effected to readings.

⑤ a) See graph with ⑤ on it. - ④ -

b) Maximum non-linearity of transducer.

line of best fit at $O = -1.8$

$$Y = -2.71$$

$$\begin{aligned} -2.71 - (-1.8) \\ = -0.91 \text{ V} \end{aligned}$$

$$\begin{aligned} \text{full scale} &= 12.41 + 2.71 \\ Y &= 15.12 \end{aligned}$$

$$\begin{aligned} \text{Max non-linearity} &= \frac{2.71}{15.12} \times 100 \\ &= 17.9\% \end{aligned}$$

$$\frac{0.91}{15.12} \times 100$$

$$\begin{aligned} \text{Max non-linearity} &= 6.0\% \\ &= 6\% \end{aligned}$$

c) Sensitivity

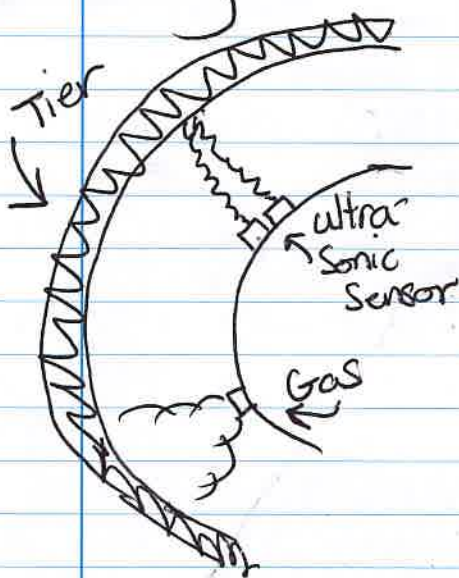
$$\frac{\Delta y}{\Delta x} = \frac{9.9 - 5}{80 - 60}$$

$$\frac{\Delta y}{\Delta x} = 0.245 \text{ V/measurand}$$

⑥ Requirements for pressure sensors.

(a) Automatic tyre inflator the inflates to a pre-set pressure.

You would need a transducer that could measure the density of air pressure.
 You know what gas is going into the tyre so from this you can work out ~~what~~ how fast sound can travel through the air. (ultra sonic sensor.)
 when the ~~air~~ sound travels at a set speed to air pressure will be a set density i.e. they correlate and are constant. A PIC would be needed for the user to input the ~~the~~ density they wanted.



The ultra sonic sensor sends its readings to the pic for the pic to compare them to the specified density.

SOUNDS COMPLICATED.

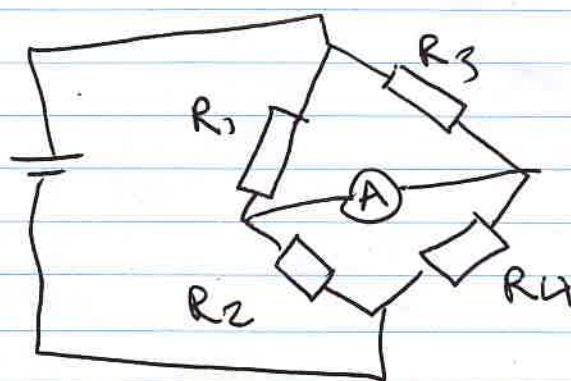
WHAT ABOUT SPECIFICATION?

Agree

~~Tension Gadge~~

(b) Altitude control in an auto-pilot system of an aeroplane.

~~Ultrasonic sound could be used for this one again for air pressure readings~~



Wheatstone Bridge

If this above circuit was inside the plane and the R_4 resistor was made out of a flexible material that ~~we~~ have air inside (like a balloon but conductive) this would change size with air pressure and therefore change resistance.

As long as ~~all~~ the ~~other~~ resistors are kept constant you can use the formulae.

$$\cancel{R_1} \frac{R_2}{\cancel{R_1}} R_4 = R_3 \frac{R_2}{R_1}$$

To work out R_4 .

Agree

WHAT ABOUT SPECIFICATIONS?
 PRESSURE RANGES?
 TEMPERATURE RANGES?
 ENVIRONMENTAL FACTORS.

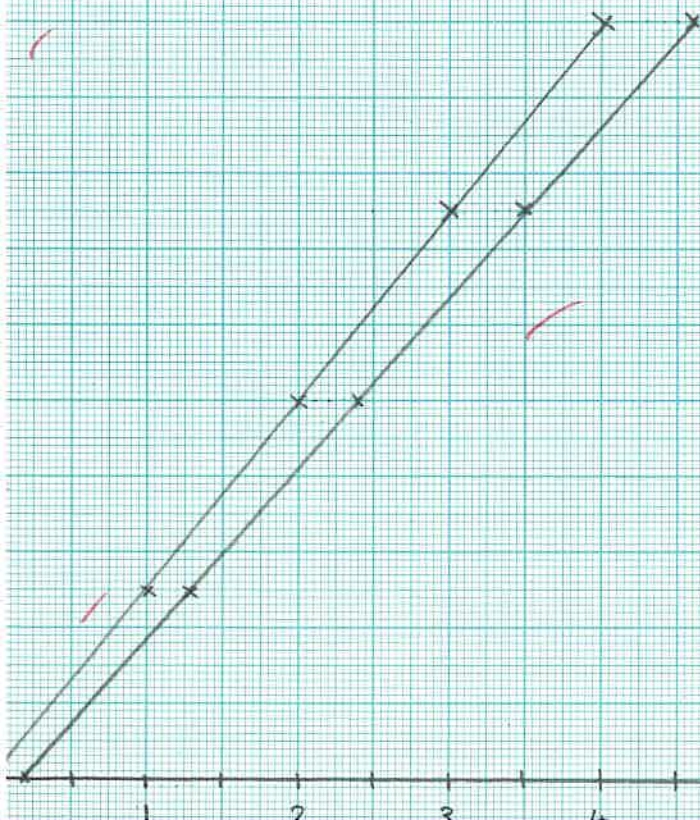
1704018

Axis wrong way around

Yes!!

③

③



1704018

