higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

INSTRUMENTATION TECHNOLOGY
NQF LEVEL 3

(6060463)

26 February 2018 (X-Paper)
09:00–12:00

This question paper consists of 9 pages and 1 formula sheet.

NOT

Copyright reserved

TIME: 3 HOURS
MARKS: 150

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Write neatly and legibly.

NCV

QUESTION 1

1.1 The McLeod gauge is mainly used to measure very low absolute pressures and compressibility of gases.

1.1.1 Make a neat, labelled diagram of a McLeod gauge. (7)

1.1.2 The McLeod gauge works according to Boyle's law.

State Boyle's law. (3)

1.1.3 Give TWO disadvantages of the McLeod gauge. (2)

1.2 Resistance strain gauges can be used as a secondary element in pressure measurements. They are joined together with bellows and diaphragms to effectively measure pressure.

1.2.1 Draw a diagram to show how low differential pressure can be measured. (6)

1.2.2 Explain the operation of the instrument in QUESTION 1.2.1. (5)
[23]

NCV

QUESTION 2

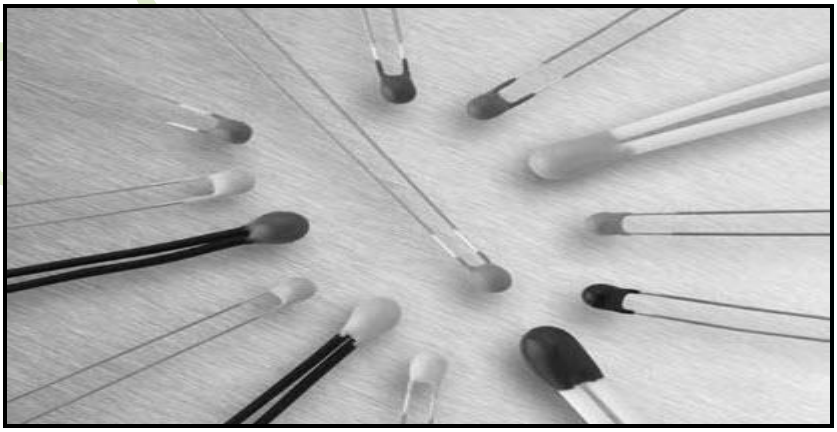
2.1 There are many types of thermometers available on the market. Before you make your purchase, it is vital that you are aware of the range of available products. You should also understand and consider the suitability of each type of thermometer for a number of different uses.

Complete the table below to show an understanding of thermometers.

DESCRIPTION	NAME OF THERMOMETER	BENEFITS/ ADVANTAGES
This thermometer is one of the cheapest and most popular types of thermometer. It is ideal for use in the home or in nonspecialist environments where traceable accuracy is not required. The visual display is often a dial, pointer or scale.	2.1.1 (2)	2.1.2 (5)
This is one of the more specialised and niche types of thermometer. It deals with extreme temperatures and is most common in laboratories and industries. This type of device caters for applications that require high precision. Its most notable feature is the ability to facilitate a range of interchangeable plug-in probes.	2.1.3 (2)	2.1.4 (5)

(14)

2.2 The image below shows examples of thermistors.



2.2.1 Define the term *thermistor*.

2.2.2 Give TWO applications of a thermistor.

2.2.3 Explain the working principle of a thermistor.

(3 × 2) (6)

Copyright reserved

2.4 Expansion thermometers indicate temperature by means of the change in volume or pressure of the liquid or gas inside it.

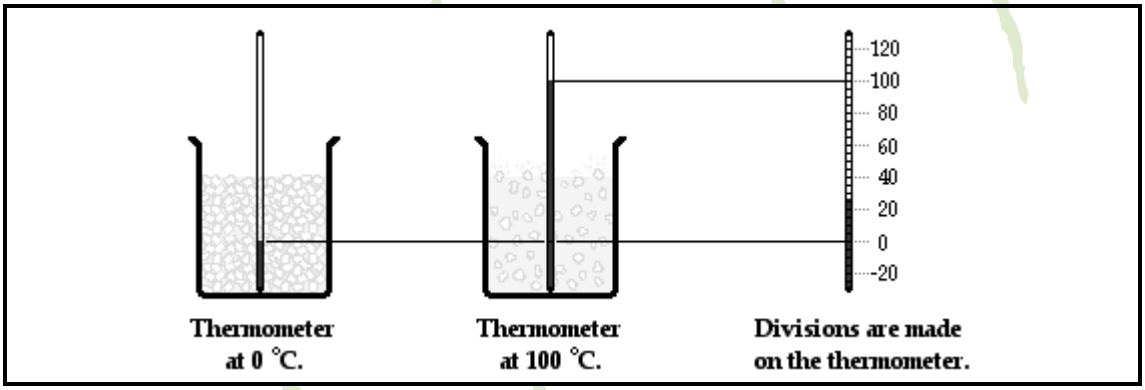
2.4.1 Make a neat, labelled drawing of a liquid-filled expansion thermometer. (6)

2.4.2 Give TWO types of liquid that can be used in the thermometer drawn in QUESTION 2.4.1. (2)

2.4.3 Explain the term *calibration*. (2)

2.4.4 Explain how to calibrate the instrument drawn in QUESTION 2.4.1. (5)

2.5 Explain what is happening in the image below.



(2)
[37]

QUESTION 3

3.1 Within a couple of years, a number of companies that previously only had single-variable vortex flowmeters, entered the multivariable vortex flowmeter market. In addition to this, a number of new companies that did not previously offer vortex flowmeters, have entered the vortex flowmeter market.

Explain the reasons why companies prefer vortex flowmeters by giving FIVE advantages of a vortex flowmeter. (5)

3.2 The Coriolis flowmeter is the perfect flowmeter, George Mattingly (Ph.D.) of the National Institute of Standards and Technology (now retired) said because it never drifts or wears. It never needs zeroing and measures in mass units. It is immune to the effects of changing fluid properties and fluid dynamics, density, viscosity, Reynolds number, the speed of sound, swirl and an irregular flow profile. It virtually has no pressure drops.

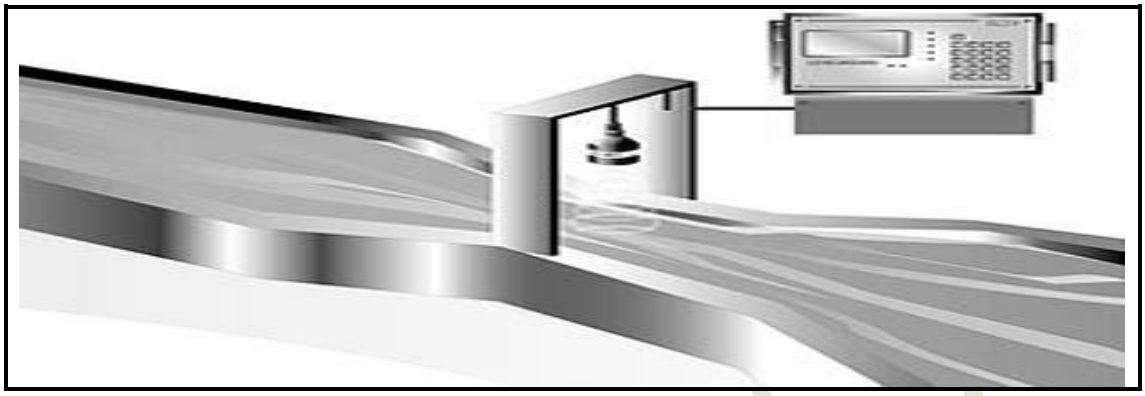
3.2.1 Why is it important to zero-check the meter? (3)

3.2.2 Despite the statement above, how would one zero-check the instrument (Coriolis) on site? (4)

Copyright reserved

3.2.3 Make a neat, labelled drawing of a Coriolis flowmeter. (6)

3.3 The figure below represents an open-flow channel.



3.3.1 What is an open-flow channel? (2)

3.3.2 Give TWO examples of open-flow channels? (2)

3.3.3 Name THREE methods used to measure open-channel flows. (3)

3.3.4 Give TWO disadvantages of an open-flow channel meter. (2)

3.4 Ultrasonic flowmeters will generally not work with distilled water or drinking water.

3.4.1 What is the popular industry application of the ultrasonic flowmeter? (4)

3.4.2 What does an ultrasonic flowmeter require in its flow and what kind of liquid is it ideal for? (4)

3.4.3 Make a drawing of a volumetric meter for gases and show the in-and-out direction of gas flow. (6)

3.4.4 Give FOUR methods for commissioning the ultrasonic flowmeter. (4)

[45]

Copyright reserved

QUESTION 4

4.1 *Level* is defined as the filling height of a liquid or bulk material, for example, in a tank or reservoir.

4.1.1 Give THREE principles that level devices operate under. (3)

4.1.2 Name TWO methods used to measure the level of liquids. (2)

4.2 Explain how petrol would be measured from its tank to inform the owner how much is left. (5)

4.3 An instrument is suitable to determine the liquid level in a tank or container where the liquid serves as the dielectric.

4.3.1 What is the name of the instrument mentioned above? (2)

4.3.2 Make a neat, labelled sketch to represent the instrument mentioned in QUESTION 4.3.1 above. (8)

4.3.3 What should be taken into consideration when installing this instrument? (5)

4.3.4 Explain the instrument's theory of operation. (3)

Copyright reserved

4.4 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–K) next to the question number (4.4.1–4.4.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
4.4.1	Method that is the same as the method using manometers	A	conductivity type level
4.4.2	Can be applied for both high-/low-level alarm indication, as well as pump valve control, and can also be employed in cases of run-dry protection and overfilled tanks	B	measurement instrument
4.4.3	Instrument with two dual-tip probes to detect the maximum and minimum levels in a tank	C	electromechanical level measurement
4.4.4		D	capacitance level sensors
4.4.5		E	ultrasonic level meter
4.4.6	Level sensors that measure the level within a specified range and determine the exact amount of substance in a certain place	F	static pressure measurements
4.4.7	Instruments that excel in sensing the presence of a wide variety of solids, aqueous and organic liquids and slurries	G	gas purging system
4.4.8	Air is the most common gas to be used	H	pointlevel sensor
4.4.9	Level sensors that only indicate whether the substance is above or below the sensing point	I	suitable for point level measurements
4.4.10	The time it takes for the pulse to move from the transmitter and be reflected back to the receiver, which indicates the level in a tank	J	continuous level sensor
		K	application of conductivity level measurement

(10 × 1) (10)

Copyright reserved

4.5 A mercury U-tube manometer is mounted 3 m below the zero level of an oil storage tank.

Determine the level of the liquid if the manometer shows a reading of 80 cm. The density of the oil is 900 kg/m^3. (7)

[45]

TOTAL: 150

NCV

Copyright reserved

FORMULA SHEET

$P_G = P_{abs} – Pa$

$P_1 – P_2 = h\rho\ g$

$P_1 – P_2 = d\rho\ g\ (\frac{A1}{A2} + 1)$ or $P_1 – P_2 = d\rho\ g\ (\frac{A2}{A1} + 1)$

$P = \frac{Mg}{A}$

$\beta_L g H_L + \beta_L g \frac{h}{2} = \beta_m\ g\ h$

$H_L = (p_m/p_L \times h) – H_1 – h/2$

$\frac{Q1}{Q2} = \frac{k\sqrt{h1}}{k\sqrt{h2}}$

Dry calibration = $\frac{P1-P2}{\rho g}$

Wet calibration = $\frac{P1-P2}{(\rho2-\rho1)g}$

W.C. = $(\frac{P1-P2}{(\rho2-\rho1)}) \times$ D.C

D.C. = $(\frac{P1-P2}{\rho2}) \times$ W.C.

$H = \frac{\Delta P}{\rho g}$

$H = h\frac{\rho2}{\rho1}$

$t^{\circ} = 9/5\ t + 32\ ^{\circ}F$

t °C = (t + 273,15) kelvin

t °F = 5/9 (t – 32) °C

Copyright reserved