higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N2

(11040452)

1 December 2023 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 5 pages and 1 formula sheet.

203Q1G2301

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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NATIONAL CERTIFICATE
INSTRUMENT TRADE THEORY N2
TIME: 3 HOURS
MARKS: 100

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. Take 'g' = 10m/s^2
5. Start each section on a new page.
6. Use only a blue or black pen.
7. Write neatly and legibly.

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QUESTION 1: PRESSURE MEASUREMENTS

1.1 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–L) next to the question number (1.1.1–1.1.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.1.1	Force per unit area	A	dry calibration
1.1.2	The difference between the pressures of the fluid	B	bourdon tube
1.1.3	Specific gravity is 1000kg.m^2	C	density
1.1.4	It is the most common pneumatic instrument used for positive and negative ranges	D	gauge pressure
1.1.5	The high pressure is applied to the outside of the bell and the low pressure to the inside	E	applied pressure
1.1.6	The instrument works according to Boyle's law	F	absolute pressure
1.1.7	It consists of flexible metal diaphragms, which is stacked upon each other	G	single bell
1.1.8	When a manometer-type instrument is calibrated with air.	H	water
1.1.9	The mass of a unit volume of a substance	I	diaphragm stack
1.1.10	The pressure measured with atmospheric pressure as its reference point	J	mercury
		K	helical type
		L	Mcleod gauge

(10 × 1) (10)

1.2 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

1.2.1 The helical bourdon tube type is used for high pressures only.

1.2.2 The disadvantage of the equal leg manometer is that it can only be used for small differential pressures.

1.2.3 The pressure exerted by a column of liquid depends on its density, height, pressure and gravitational force.

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1.2.4 The relative density of water is 13.6×10^3 Kg/m^3

1.2.5 Absolute pressure is the pressure measured with atmospheric pressure as its reference point.

(5 × 1) (5)

1.3 Make a neat, labelled sketch of an inclined tube manometer. (5)

1.4 An inclined tube manometer uses mercury as a sealing liquid. Calculate the applied differential pressure if the following are known:

Angle of tube with the horizontal = 45^0
Area of cistern = 0.05 m^2
Area of tube = 0.0009 m^2
Scale reading = 29 cm (5)

[25]

QUESTION 2: TEMPERATURE MEASUREMENTS

2.1 Make a neat sketch of mercury-filled liquid expansion thermometer. (6)

2.2 State FOUR advantages of using resistance thermometers. (4)

2.3 Name FOUR filling materials used for expansion thermometers. (4)

2.4 Draw a neat, labelled sketch of a self-balancing Wheatstone bridge resistance thermometer. (7)

2.5 State the law of intermediate metals. (4)

[25]

QUESTION 3: FLOW

3.1 The Dall tube is a short version of a Venturi tube with a very narrow throat area.

3.1.1 Make a labelled sketch of the Dall tube differential pressure instrument. (6)

3.1.2 Briefly explain the basic operation of a differential pressure instrument in QUESTION 3.1.1 (5)

3.2 Name any THREE displacement-type flow meters. (3)

3.3 Draw a neat labelled sketch of a shaped chamber flow meter. (5)

3.4 Define *Vena-contracta.* (3)

3.5 State THREE advantages of a magnetic flow meter. (3)

[25]

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QUESTION 4: LEVEL

4.1 Draw a diagram of the conduction method of level measurement and explain its operation. (10)

4.2 Make a neat, labelled sketch of a torque tube-displacer detector. (5)

4.3 Make a neat labelled sketch of a ultrasonic level detector and briefly explain its working principle. (10)

[25]

TOTAL: 100

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INSTRUMENT TRADE THEORY N2

FORMULA SHEET

$P_G = Pabs - Pa$

$P_1 - P_2 = h\,\rho\,g$

$P_1 - P_2 = d\rho g\left(\frac{A_1}{A_2}+1\right)$ ***OR*** $P_1 - P_2 = d\rho g\left(\frac{A_2}{A_1}+1\right)$

$P_1 - P_2 = \rho g L\left(\sin\theta + \frac{A_2}{A_1}\right)$

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

$$\frac{Q_1}{Q_2} = \frac{k\sqrt{h_1}}{k\sqrt{h_2}}$$

$$Dry\ calibration = \frac{P_1 - P_2}{\rho g}$$

$$Wet\ calibration = \frac{P_1 - P_2}{(\rho_2 - \rho_1)g}$$

$$W.C. = \left(\frac{\rho_2}{\rho_2 - \rho_1}\right) \times D.C.$$

$$D.C. = \left(\frac{\rho_2 - \rho_1}{\rho_2}\right) \times W.C.$$

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

$$H = h\left(\frac{\rho_2}{\rho_1} - \frac{1}{2}\right)$$

$$H = \frac{\rho_2}{\rho_1}h - \frac{h}{2} - H = \left(\frac{\rho_2}{\rho_1} - \frac{1}{2}\right)h - H_1$$

$$t°C = \frac{9}{5}t + 32°F$$

$$t°C = (t + 273{,}15)\ kelvin$$

$$t°F = \frac{5}{9}(t - 32)\ °C$$

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