higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T900**(E)**(A6)T

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N2

(11040452)

6 April 2018 (X-Paper)
09:00–12:00

This question paper consists of 7 pages and 2 formula sheets.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

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. Sketches must be large, neat and fully labelled.
5. Write neatly and legibly.

SECTION A

QUESTION 1: GENERAL

1.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 Which term is defined as mass per unit volume of a substance?

A Pressure
B Specific gravity
C Density
D Viscosity

1.1.2 Pressure that is below atmospheric pressure:

A Gauge pressure
B Vacuum pressure
C Absolute pressure
D Differential pressure

1.1.3 Which ONE of the following meters is NOT an example of an inferential flowmeter?

A Turbine flowmeter
B Vortex flowmeter
C Nutating disc flowmeter
D Deflecting-type flowmeter

1.1.4 The linear flow of liquids, where the central line of the fluid moves faster than the outer lines:

A Turbulent flow
B Laminar flow
C Ideal flow
D Transitional flow

1.1.5 Which ONE of the following is the Bernoulli primary flow element which measures the velocity of the stream at a point:

A Pitot tube
B Flow nozzle
C Dall tube
D Orifice plate

(5 × 1) (5)

1.2 Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A–M) next to the question number (1.2.1–1.2.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.2.1	A pressure-measuring device consisting of a transparent tube bent into a U-shape and filled with a liquid	A	Bourdon tube
1.2.2	This error is caused by insensitivity in the low range	B	lower fixed point
1.2.3	This tube is actually a round tube that has been flattened to form an oval shape and is sealed off on one end	C	resistance thermometer
1.2.4	Error in indication over the full range of the instrument	D	viscosity
1.2.5	The temperature of pure ice melting at one standard atmosphere	E	zero error
1.2.6	An instrument which measures resistance but is calibrated in temperature units	F	thermocouple
1.2.7	When two dissimilar metal wires are joined together at one end, a voltage is produced at the other end proportional to the temperature difference between the junctions	G	distance between plates
1.2.8	This meter uses the principle of operation of Faraday's law for magnetic inductance	H	angularity error
1.2.9	The resistance of a liquid to flow	I	magnetic flowmeter
1.2.10	The principle of operation upon which the capacitive level transducer is based	J	turbine flowmeter
		K	range error
		L	manometer
		M	size of the plates

(10 × 1) (10)

1.3 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (1.3.1–1.3.5) in the ANSWER BOOK.

1.3.1 Volume-type flowmeters measure flow by closing off liquids into compartments.

1.3.2 Inferential flowmeters are also known as rate-of-flow meters.

1.3.3 The two-lead method is used to compensate for ambient temperature changes in the Wheatstone bridge circuit.

1.3.4 The four-lead method is used to compensate for the sensitivity of the meter in the Wheatstone bridge circuit.

1.3.5 The disadvantage of the equal-leg manometer is that it can be used to measure small differential pressures only.

(5 × 1) (5)
[20]

TOTAL SECTION A: 20

SECTION B

QUESTION 2: PRESSURE MEASUREMENT

2.1 Name TWO types of manometers that you have studied. (2)

2.2 Calculate the height of mercury displaced in the wide leg of an unequal-leg manometer if the following information is known:

- Area of wide leg = 60 mm^2
- Area of narrow leg = 25 mm^2
- Differential pressure applied = 85 KPa (6)

2.3 What is the primary difference between a *diaphragm stack* and a *bellows*? (4)

2.4 There are TWO equations that are used in the calculation of pressure.

Write down these two equations and, using a dimensional analysis (using the units), prove that they are in fact the same. (4)

2.5 Make a neat, labelled sketch of a spiral-type Bourdon tube. (4)
[20]

QUESTION 3: TEMPERATURE MEASUREMENT

3.1 Explain what you understand by the term *temperature*. (1)

3.2 3.2.1 What is a bimetal strip? (3)

3.2.2 How can a bimetal strip be used as a thermometer? (3)

3.3 Make a neat, labelled sketch of a liquid expansion thermometer. (5)

3.4 The resistances of a platinum resistance thermometer for different temperatures are given below:

Temperatures (°C)	Resistances (Ω)
0	20 Ω
100	27,6 Ω
444,6	48, 9Ω

3.4.1 Calculate the temperature coefficient of resistance. (3)

3.4.2 What will the resistance of the bulb be when heated to 50 °C? (2)

3.4.3 What is the temperature of the bulb, if the bulb resistance is 25,7 Ω? (3)

[20]

QUESTION 4: FLOW MEASUREMENT

4.1 Explain the working principle of positive-displacement-type flowmeters. (4)

4.2 Make a neat, labelled sketch of a reciprocating-piston-type flowmeter. (5)

4.3 Name THREE forces acting on the vane of a deflecting-vane-type flowmeter. (3)

4.4 4.4.1 Make a sketch to show the operating principle of a pitot tube. (4)

4.4.2 Describe the operating principle of a pitot tube. (4)

[20]

QUESTION 5: LEVEL MEASUREMENT

5.1 Pressure can be used to measure the level of liquid in a tank.

Comment on this statement (2)

5.2 5.2.1 Sketch a sight glass installation as used in boilers. (5)

5.2.2 Explain the purpose of all the components of the sight glass. (3)

5.3 5.3.1 Make a neat, labelled sketch of a capacitive level meter. (5)

5.3.2 Explain the working principle of a capacitive level meter. (5)
[20]

TOTAL SECTION B: 80
GRAND TOTAL: 100

INSTRUMENT TRADE THEORY N2

FORMULA SHEET

(1) $\Delta P = \rho gh$

(2) $\Delta P = \rho gh\left[\frac{A_2}{A_1} + 1\right]$

(3) $\Delta P = \rho gL\left[\sin\theta + \frac{A_2}{A_1}\right]$

(4) $P_1 - P_2 = \frac{r_2 Mg\sin\theta}{Ar_1}$

(5) $P_1 - P_2 = \frac{Mgr\sin\theta}{AL}$

(6) $F = ma$

(7) $P = \frac{F}{A}$

(8) $A = \frac{\pi d^2}{4}$

(9) $°F = \frac{9}{5}°C + 32$

(10) $R_T = R_0(1+\propto T)$

(11) $R_T = R_0(1+\propto T + \beta T^2)$

(12) $Q = k\sqrt{h}$

(13) $H_L = \left[\frac{\rho_m}{\rho_L}\right] \times h - \frac{h}{2}$

(14) $H_L = \left[\frac{\rho_m}{\rho_L}\right] \times h - H_1 - \frac{h}{2}$

INSTRUMENT TRADE THEORY N2
FORMULA SHEET

$P_G = Pabs - Pa$

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

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

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

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

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

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

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

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

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

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

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

$t°C = \frac{9}{5}t + 32°F$

$t°C = (t + 273{,}15)\ kelvin$

$t°F = \frac{5}{9}(t - 32)\,°C$