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Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N2

(11040452)

9 April 2020 (X-paper)
09:00–12:00

This question paper consists of 6 pages and a formula sheet of 2 pages.

203Q1A2009

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. Start each section on a new page.
5. Use only a blue or black pen.
6. Write neatly and legibly.

SECTION A

QUESTION 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 (1.1–1.5) in the ANSWER BOOK.

1.1 The relative density of water is …

A 1 000 kg/m^3.
B 13 600 kg/m^3.
C 1 kg/m^3.
D 13,6 kg/m^3.

1.2 A … error results when a reading of the water level is taken from an incorrect position.

A capillary
B hysteresis
C parallax
D zero

1.3 Which ONE of the following metals is not used in the manufacturing of resistance thermometers?

A Nickel
B Iron
C Platinum
D Copper

1.4 The tappings that are taken at one pipe diameter(D) upstream from the face of the orifice and one half pipe diameter downstream from the orifice is called …

A radius taps
B Vena contracta taps
C pipe taps
D corner taps

1.5 Which of the following represent the output of a pneumatic D/P at 0%?

A 4 mA
B 20 mA
C 20 kPa
D 100 kPa

(5 × 1) **[5]**

QUESTION 2

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (2.1–2.5) in the ANSWER BOOK.

2.1 A bimetallic strip can be used as thermostat for temperature control.

2.2 In a three-lead Wheatstone bridge circuit, the third lead resistance added to the meter resistance, makes it more sensitive.

2.3 A pitot tube can only measure fluid velocity at one position in the cross section of the pipe.

2.4 The measurement of pressure can give information of the liquid level or volume content of the liquid in a tank.

2.5 A McLeod gauge works according to Boyle's law.

(5 × 1) **[5]**

QUESTION 3

Give ONE word/term for each of the following descriptions. Write only the answer next to the question number (3.1–3.5) in the ANSWER BOOK

3.1 The volume of any given mass of gas is inversely proportional to the absolute pressure, provided that the temperature remains constant.

3.2 This pressure is measured with atmospheric pressure as its reference point.

3.3 Liquids are closed off into compartments and the number of times the compartments are filled and emptied is an indication of the flow

3.4 The sum of pressure and the kinetic energy and the potential energy of a fluid per unit volume flowing through a tube is constant. A greater energy associated with pressure in the fluid corresponds to lower kinetic and potential energy.

3.5 Mass per unit volume of a substance

(5 × 2) **[10]**

TOTAL SECTION A: 20

SECTION B

QUESTION 4: PRESSURE MEASUREMENT

4.1 Make a neat, labelled sketch of a cistern manometer. (4)

4.2 Calculate the height that mercury is displaced in the narrow leg of an unequal legged manometer if the following information is known:

Area of wide leg = 0,008 m²
Area of narrow leg = 0,002 m²
Differential pressure applied = 100 kPa (4)

4.3 The Pirani gauge works on the principle that if a gas is in contact with a heated wire, it will conduct some of the heat away from the wire.

4.3.1 Make a sketch of the circuit diagram of the Pirani gauge. (5)

4.3.2 Explain the working principle of the gauge mentioned in QUESTION 4.3.1. (7)

[20]

QUESTION 5: TEMPERATURE MEASUREMENT

5.1 Name the TWO SI scales of temperature. (2)

5.2 What is the difference between a *thermostat* and a *thermometer*? (4)

5.3 Make thermocouple sketches to show the law of intermediate temperatures. (3)

5.4 Explain the operating principle of a resistance thermometer. Make use of a formula to support your explanation. Explain every constant in the formula. (6)

5.5 Calculate the temperature of a platinum resistance thermometer if its resistance is 15 Ω. The resistance is 12 Ω at 0 °C and α = 0,004 Ω/Ω°C. (5)

[20]

QUESTION 6: FLOW MEASUREMENT

6.1 State Bernoulli's principle on the conservation of energy for a steady liquid flow in a system. (4)

6.2 Make a neat, labelled sketch of a Venturi tube and briefly explain its working principle. (8)

6.3 Make a neat, labelled sketch of a liquid-sealed drum-type gas meter. (5)

6.4 Name THREE advantages of a Pitot tube. (3)

[20]

QUESTION 7: LEVEL MEASUREMENT

7.1 A gas purge level measurement system gives a reading of 54,3 kPa.

Determine the volume of water in the tank if its base dimensions are 5 m by 7 m. (6)

7.2 A mercury U-tube manometer is mounted 2 m below the datum level of a petroleum storage tank. The full reading on the manometer is 60 cm. The density of petroleum is 890 kg/m³.

Calculate the level in the storage tank. (4)

7.3 Make a neat, labelled sketch of a bellows-type level meter. (6)

7.4 Explain the working principle of the level meter mentioned in QUESTION 7.3. (4)

[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) $°F = \frac{9}{5}℃ + 32$

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

(15) $$\Delta P = \rho g h$$

(16) $$\Delta P = \rho g h \left[\frac{A_2}{A_1} + 1\right]$$

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

(18) $$P_1 - P_2 = \frac{r_2 M g \sin\theta}{A r_1}$$

(19) $$P_1 - P_2 = \frac{M g r \sin\theta}{A L}$$

(20) $$F = ma$$

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

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

(23) $$°F = \frac{9}{5}°C + 32$$

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

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

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

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

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