higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

INSTRUMENTATION TECHNOLOGY
NQF LEVEL 2

(6060452)

8 November 2018 (X-Paper)
09:00–12:00

This question paper consists of 6 pages and 1 formula sheet.

NCV

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. ALL drawings must be neat and in good proportion.
5. Start each section on a NEW page
6. Write neatly and legibly.

NCV

QUESTION 1

1.1 Explain SIL specification as it applies to the instrumentation industry. (3)

1.2 Explain the types of data displays and storage methods available in industrial-instrumentation and process-control systems. (2 + 2) (4)

1.3 Give THREE performance criteria that measuring instruments must comply with to ensure optimal performance. (3)

1.4 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.4.1–1.4.5) in the ANSWER BOOK.

1.4.1 Process instrumentation is used for the design and configuration of automated and manual systems in various process plants.

1.4.2 Fossil fuels are natural fuels, such as coal or gas, formed in the geological past from the remains of living organisms.

1.4.3 Minerals are natural substances, like gold, iron and diamonds, found in the earth.

1.4.4 Synthetic means not natural/made by chemical processes often to imitate a natural product.

1.4.5 Excavation is the process of digging out materials from the ground.

(5 × 1) (5)

[15]

QUESTION 2

2.1 Name FIVE problems commonly associated with control-valve positioners. (5)

2.2 Give FIVE types of control-valve problems and explain how each problem happens or affects the valve. (5 × 3) (15)

2.3 List FIVE steps to follow when replacing stem packing on a control valve. (5)

2.4 A valve plug is a rotational-motion valve used to stop or start fluid flow.

Make a neat labelled diagram of a valve plug. (12)

[37]

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QUESTION 3

3.1 Make drawings of each of the following manometers:

3.1.1 Differential U-tube manometer

3.1.2 Inclined manometer

3.1.3 Raised-well manometer

3.1.4 Well-type manometer

(4 × 6) (24)

3.2 Convert 15 psi to kPa if 1 psi = 6,895. (4)

3.3 Give the mathematical expression of Boyle's law. (2)

[30]

QUESTION 4

4.1 A thermowell is an accessory to temperature-measurement applications.

4.1.1 What is the purpose of a thermowell? (5)

4.1.2 Describe the materials used to construct a thermowell. (4)

4.1.3 Make a neat diagram of a thermowell in use. (7)

4.1.4 Explain how materials for constructing a thermowell are chosen. (2)

4.2 Explain Galileo Galilei's temperature-related invention. (2)

4.3 Explain the term *thermocouple*. (2)

4.4 Why can alcohol thermometers measure temperatures lower than that of mercury? (2)

4.5 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–E) next to the question number (4.5.1–4.5.6) in the ANSWER BOOK.

4.5.1 Thermocouple refers to …

A a thermoelectric temperature sensor.
B a device that changes electrical signal to mechanical.
C a device for measuring unknown potential difference.
D a negative temperature coefficient.
E a thermoelectric device that measures temperature.

4.5.2 The acronym RTD refers to …

A a thermoelectric temperature sensor.
B a device that changes electrical signal to mechanical.
C a device for measuring unknown potential difference.
D a negative temperature coefficient.
E a thermoelectric device that measures temperature.

4.5.3 Discovered that if two wires of different materials are joined, an emf will be generated in the circuit if one junction is heated and the other is kept at a constant temperature:

A Peltier
B Seebeck
C Thompson
D Kruger
E Boyle

4.5.4 The first device to measure temperature was invented in the …

A 1500s.
B 1800s.
C 1900s.
D 1300s.
E 1100s.

4.5.5 Semiconductor equipment, like the integrated circuit sensor, different noncontact sensors, fibre-optic temperature sensors and thermistors were discovered in the …

A 1500s
B 1800s
C 1900s
D 1300s
E 1100s

4.5.6 When did Lord Kelvin hypothesise that an absolute zero exists?

A 1500s
B 1800s
C 1900s
D 1300s
E 1100s

(6 × 1) (6)
[30]

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QUESTION 5

5.1 Make drawings to explain each of the following flow types:

5.1.1 Laminar flow

5.1.2 Turbulent flow

(2 × 3) (6)

5.2 Explain corrected volume in relation to flow measurement. (5)

5.3 Complete the following table by writing the answer next to the question number (5.3.1–5.3.5) in the ANSWER BOOK.

PREFIX	SYMBOL		SCIENTIFIC NOTATION
atto	a	0,000000000000000001	5.3.1
peta	5.3.2	1 000 000 000 000 000	10^{15}
5.3.3	k	1 000	10^{3}
5.3.4	-	1	10^{0}
micro	5.3.5	0,000001	10^{-6}

(5 × 2) (10)

5.4 Explain how to zero check a thermal-mass flowmeter. (3 × 2) (6)

5.5 A nutating-disc flowmeter is a positive-displacement flowmeter with a wobbling disc.

5.5.1 Why is the wobbling disc important in this instrument?

5.5.2 Where is it frequently used?

(2 × 2) (4)

5.6 Calculate the differential pressure if the maximum flow rate is 500 ℓ/h, the differential pressure is 16 kPa and the flow tempo is decreased to half (250 ℓ/h). Use the Bernoulli theorem to prove this.

(7)
[38]

TOTAL: 150

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FORMULA SHEET

$P_G = P_{abs} - P_a$

$P_1 - P_2 = h\rho g$

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

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

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

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

Wet calibration $= \frac{P1-P2}{(\rho 2-\rho 1)g}$

W.C. $= \left(\frac{P1-P2}{(\rho 2-\rho 1)}\right) \times$ D.C.

D.C. $= \left(\frac{P1-P2}{\rho 2}\right) \times$ W.C.

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

$H = h\frac{\rho 2}{\rho 1}$

$t° = 9/5\ t + 32\ °F$

$t\ °C = (t + 273{,}15)$ kelvin

$t\ °F = 5/9(t - 32)\ °C$

$Q = K\sqrt{h}$

Tank volume = base area × height

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