higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T810**(E)**(M27)T

# NATIONAL CERTIFICATE

# INDUSTRIAL INSTRUMENTS N4

(8080194)

**27 March 2018 (X-Paper)**
**09:00–12:00**

**Candidates will require drawing instruments.**
**Calculators may be used.**

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

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# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL INSTRUMENTS N4
TIME: 3 HOURS
MARKS: 100

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**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. Take g as 10m/s
6. Write neatly and legibly.

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## QUESTION 1: PRESSURE

1.1 Calculate the height of the mercury displaced in the narrow leg of an unequal leg manometer if the following are given:

- Differential pressure applied = 25 kPa
- Leg with small diameter = 20 mm
- Leg with large diameter = 160 mm (5)

1.2 Make a neat, labelled sketch of a set of bellows which can be used to determine differential pressure (Barton cell). (4)

1.3 A conductor has a specific resistance of $8 \times 10^{-5}$ Ω/m.

What will the conductor's resistance be if it has a length of 50 m and a diameter of 1 mm? (4)

1.4 State FOUR factors which would influence the movement at the free end of a Bourdon tube. (4)

1.5 Briefly explain the operation of a rare-earth pressure transducer. (3)

1.6 Explain the *piezoelectric effect.* (2)

1.7 A dead-weight tester contains a piston with a cross-sectional area of 0,001 $m^2$.

Calculate the mass that must be placed on the platform to calibrate a pressure gauge of 180 kPa. Ignore the mass of the platform and the piston. (3)

**[25]**

## QUESTION 2: LEVEL

2.1 Calculate, with the aid of a mercury manometer, the height of water in an open tank if the following is given:

The zero mark on a manometer is 1,5 m below the zero level of the tank. The mercury is displaced 25 cm from the zero mark in the manometer. (4)

2.2 Make a neat, labelled sketch of a sight glass which is used to measure the level of the liquid in a boiler. Show the necessary taps. (4)

2.3 How can the quantitative volume of a vessel be verified with a dipstick that measures the level? (2)

**[10]**

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## QUESTION 3: FLOW

3.1 Name THREE types of orifice plates and make a sketch of each of them. (6)

3.2 The pressure difference across the narrowing in a pipe is 100 mm of water at a flow rate of 110 $m^3$/h.

What will the flow rate be at 180 mm of water? (4)

3.3 Explain the principle of a *displacement type flowmeter*. (3)

3.4 Make a sketch that shows the variation of the static pressure curve/profile across an orifice plate. (4)

3.5 State THREE methods that can be used to compensate for the square root effect applicable to all Bernoulli-type primary flow elements. (3)

**[20]**

## QUESTION 4: TEMPERATURE AND TELEMETERING

4.1 State *Stefan Boltzmann's law*. (2)

4.2 Draw a characteristic curve of a thermistor. (2)

4.3 State TWO applications of thermistors. (2)

4.4 What is the purpose of a pneumatic relay? (2)

4.5 Explain the *Peltier effect*. (2)

4.6 Make a neat, fully labelled sketch of a magslip telemetering system. (4)

4.7 Explain how a disappearing filament optical pyrometer functions. (5)

4.8 Make a simple sketch of a basic current telemetering system where a change (input) pressure causes a current. (4)

**[23]**

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## QUESTION 5: AUTOMATIC CONTROL

5.1 What is meant by *proportional action*? (2)

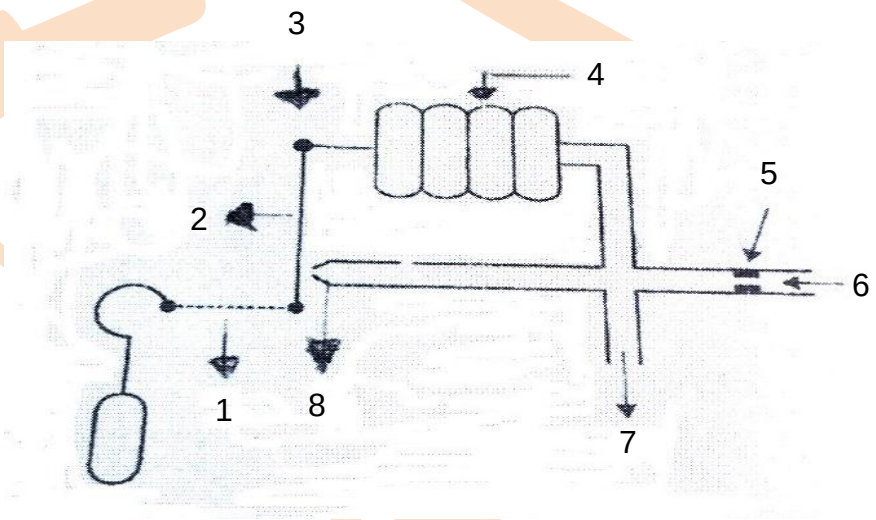
5.2 Make a neat sketch to show how proportional control is achieved in a simple flapper and nozzle system. (4)

5.3 Draw a simple block diagram of a closed-loop control system. Clearly label all the elements. (4)

5.4 Describe a *valve positioner*. (2)

5.5 Explain what is meant by *measured variable*. (2)

5.6 Name the areas indicated on the sketch below. Write only the answer next to the question number (1–8) in the ANSWER BOOK.




(8)
**[22]**

**TOTAL: 100**

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## FORMULA SHEET

## INDUSTRIAL INSTRUMENTS N4

1. $$^{\circ}F = \frac{9}{5}K - 459.67$$

2. $$K = \frac{5}{9}[^{\circ}F + 459.67]$$

3. $$K = ^{\circ}C + 273.15$$

4. $$\text{Volume} = \text{area} \times \text{base}$$

5. $$\Delta P = \rho g h$$

6. $$\text{Percentage} = \frac{\text{Measured variable}}{\text{Total output}} \times 100$$

7. $$A = \frac{\pi d^2}{4}$$

8. $$P = \frac{F}{A}$$

9. $$F = mg$$

10. $$R = Roe^{B(\frac{1}{T} - \frac{1}{T_O})}$$

11. $$R = Ae^{(\frac{B}{T})}$$

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