



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL INSTRUMENTS N6

(8080216)

31 March 2020 (X-paper)
09:00–12:00

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

024Q1A2031


DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NATIONAL CERTIFICATE
INDUSTRIAL INSTRUMENTS N6
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 black or blue pen.
 6. Write neatly and legibly.
-

SECTION A**QUESTION 1**

Choose the correct word or words from those given in brackets. Write only the answer next to the question number (1.1–1.5) in the ANSWER BOOK.



- 1.1 A (paramagnetic/diamagnetic) gas is magnetised in the direction of the applied field and tends to go to the strongest part of the magnetising field.
- 1.2 In (an automatic/a cascade) control loop, the set point of a secondary controller is determined by the output of the primary controller. 
- 1.3 The term (group/division) specifies the probability of finding that particular material in the hazardous area.
- 1.4 The phenomenon (X-ray spectral line/continuous spectrum) happens when an incident electron knocks orbital electrons out of an atom and an electron from an outer shell will fall to the inner orbit to fill the vacancy.
- 1.5 (Single-element/Two-element) feed water control uses both drum level and steam flow to regulate the feedwater flow into the drum.

(5 × 1)

[5]**QUESTION 2**

Choose a suitable term from the following list for each description below. Write only the answer next to the question number (2.1–2.5) in the ANSWER BOOK.

spectrum; X-ray spectral line; continuous spectrum; flashing; cavitation;
Class I; Class III; valve characteristic

- 2.1 A mathematical relationship between the valve stroke and the effective port area 
- 2.2 A drop in pressure below the vapour pressure of the fluid when the flow passes across the seat of a valve
- 2.3 The rainbow series of colours produced when visible (white) light is split into its different components, that is, violet through indigo, blue, green, yellow, orange and red
- 2.4 When an individual high-speed electron is abruptly decelerated when passing through matter, the electron will lose energy, emitting X-ray photons of different energy and wavelength 
- 2.5 Locations in which ignitable fibres may or may not be in sufficient quantities to produce explosive or ignitable mixtures

(5 × 1)

[5]


QUESTION 3

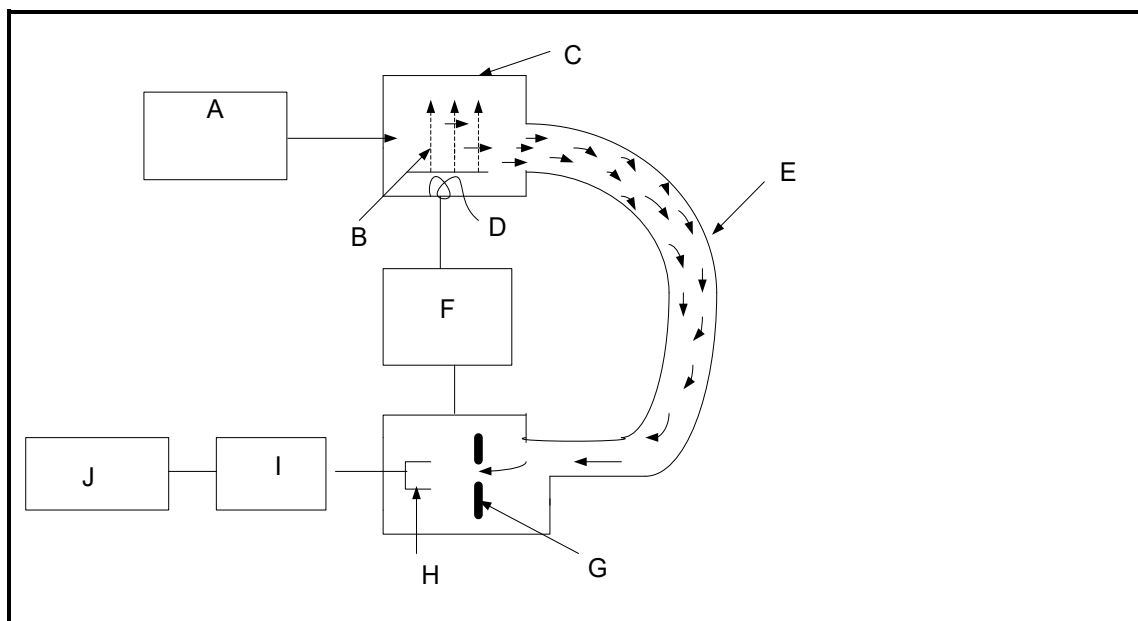
Define the following terms as applicable to instrumentation:

- 3.1 Intrinsic safety (3)
- 3.2 Distillation (3)
- 3.3 Analyser  (2)
- 3.4 Boiler (2)
- [10]**

TOTAL SECTION A: 20

SECTION B**QUESTION 4: ANALYSERS**

- 4.1 X-rays are very high-frequency electromagnetic waves generated by a high-vacuum Coolidge-type tube for analysis of certain materials or substances.
- 4.1.1 Make a neat, labelled sketch of a high-vacuum Coolidge-type tube. (9)
- 4.1.2 Explain the principle of operation of the X-ray tube mentioned in QUESTION 4.1.1. (4)
- 
- 4.2 The schematic diagram below shows an analyser.



- 4.2.1 Name the type of analyser indicated in the diagram. (2)

- 4.2.2 Name the components indicated in the diagram by writing only the answer next to the letter (A–J) in the ANSWER BOOK.

(10)
[25]



QUESTION 5: AUTOMATIC CONTROL AND VALVES

- 5.1 A control valve is required for water pressure control. The characteristics of the valve are as follows:

Cv = 75

Rangeability = 46

Turndown = 42

Upstream pressure = 4 bar

Controlled downstream pressure = 2,5 bar

Calculate:

- 5.1.1 The maximum flow that the valve can allow

- 5.1.2 The minimum controlled flow

- 5.1.3 The normal operating flow



(3 × 3) (9)

- 5.2 Make a neat, labelled sketch of a cascade control. Clearly show all the elements of the controller. (7)

- 5.3 Describe the systematic experimental method of adjusting the control settings of a proportional plus derivative controller on the plant. (6)

[22]

QUESTION 6: DISTILLATION COLUMN AND BOILERS

- 6.1 What is the purpose of the feedwater control system in the boiler? (2)

- 6.2 What precautions must be taken to ensure the correct operation of the pressure transmitter for a pressure control system in a vacuum distillation column? (4)

- 6.3 State EIGHT variables that can be manipulated when controlling a distillation column. (8)

- 6.4 Make a neat, labelled sketch of a distillation column consisting of the following components:



feed pump, preheater, reboiler, condenser, reflux, accumulator, reflux pump

(9)
[23]

QUESTION 7: INTRINSIC SAFETY

- 7.1 Give THREE important questions to be asked when evaluating a system for intrinsic safety. (3)
- 7.2 What is the purpose of a barrier circuit? (3)
- 7.3 Name FOUR methods that can be used to prevent electrical equipment from placing ignition capable currents and voltages into an explosive atmosphere. (4)
- [10]**

TOTAL SECTION B: 80
GRAND TOTAL: 100

INDUSTRIAL INSTRUMENTS N6

FORMULA SHEET

1.

$$C_v = 1.16 Q \sqrt{\frac{G_f}{\Delta P}}$$

2.

$$C_v = \frac{1.16 W}{\sqrt{G_f \Delta P}}$$

3.

$$C_v = \frac{Q}{295} \sqrt{\frac{G.T}{\Delta P(P_1 + P_2)}}$$

4.

$$C_v = \frac{47,2 W}{\sqrt{\Delta P(P_1 + P_2)}}$$

5.

$$C_v = \frac{72,4 W}{\sqrt{\Delta P(P_1 + P_2)}}$$