higher education
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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N6

(8080216)

28 March 2019 (X-Paper)
09:00–12:00

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

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. Sketches must be large, neat and fully labelled.

5. Write neatly and legibly.

SECTION A

QUESTION 1: ANALYSERS

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   A limitation of a/an … analyser is that it can only measure binary mixtures accurately.

        A   thermal conductivity
        B   magnetic wind-type
        C   ultraviolet absorption
        D   infrared absorption

    1.1.2   A … is NOT an infrared radiation source.

        A   globar source
        B   Nernst glower
        C   tungsten filament lamp
        D   glow wire

    1.1.3   The resetting of the set point of a secondary controller by the output of a primary controller:

        A   Inherent regulation
        B   Automatic control loop
        C   Cascade control
        D   Open-loop control

    1.1.4   Until an unfired furnace has been air-cleansed, no fuel may be admitted to the furnace:

        A   Fuel interlock
        B   Fan interlock
        C   Air-purging interlock
        D   Low-water interlock

    1.1.5   It specifies the probability of finding a particular material in a hazardous area:

        A   Class
        B   Division
        C   Group
        D   Class III

                (5 × 1)   (5)

1.2 Choose a/an item/word from COLUMN B that matches a description in COLUMN A. Write only the letter (A–K) next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

COLUMN A	COLUMN B
1.2.1 The filter cell is filled with the overlapping gas to prevent interfering absorption by other components in the sample	A range ability
	B Class I
	C interlock
1.2.2 The ratio of the maximum to the minimum flows measured at constant pressure drop across the valve, through which a control valve maintains an equal percentage characteristic	D valve coefficient
	E purge interlock
	F cascade control
1.2.3 A device that prevents a machine from harming its operator or damaging itself by stopping the machine by tripping	G positive filter type
	H division
	I Class III
1.2.4 Locations in which flammable gases or vapours may or may not be in sufficient quantities to produce explosive or ignitable mixtures	J deviation
	K boiler
1.2.5 The quantity of water that will pass through a specific valve size at maximum valve lift and one psi pressure drop	

(5 × 1) (5)

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 Turndown is the ratio of the maximum to the minimum flows measured at constant pressure drop across the valve, through which a control valve maintains an equal percentage characteristic.

1.3.2 A paramagnetic gas has a negative volume susceptibility (k) value.

1.3.3 Division 2 indicates that the hazardous material has a high probability of producing an explosive or ignitable mixture.

1.3.4 Split range is when one common controller signal commands two or more control valves.

1.3.5   The flash point of a flammable liquid is the lowest temperature at which a sufficient quantity of vapour will arise to permit ignition under laboratory conditions.

(5 × 1)   (5)
[15]

TOTAL SECTION A: 15

SECTION B

QUESTION 2: ANALYSERS

2.1   Name TWO general recording methods which can be used in emission spectrometers.   (2)

2.2   Explain the function of each of the following elements of basic gas chromatography:

2.2.1   A carrier gas supply

2.2.2   A chromatographic column

2.2.3   A detector

2.2.4   A programmer

(4 × 2)   (8)

2.3   Describe the action a non-linear magnetic field has on a paramagnetic gas and a diamagnetic gas.   (4)

2.4   Make a neat, labelled sketch of a dual beam/dual detector UV analyser.   (6)

2.5   Make a neat, labelled sketch of a crystal monochromator for X-rays.   (5)
[25]

QUESTION 3: AUTOMATIC CONTROL AND VALVES

3.1   Describe the general procedure in the reaction curve method of controller adjustment for a small step change in the correcting elements.   (6)

3.2   Define the term *flashing*.   (3)

3.3   Draw a block diagram of a cascade control system.   (6)

3.4 A control valve with the following characteristics, is required to control water pressure:

A CV = 60
B Range ability = 40
C Turndown = 35

The working conditions are:

A Steam pressure = 4 Bar
B Controlled downstream pressure = 2,5 Bar

Calculate the following:

3.4.1 The maximum flow through the valve (2)

3.4.2 The minimum controlled flow (4)

3.4.3 The normal working flow (4)

[25]

QUESTION 4: DISTILLATION COLUMN AND BOILERS

4.1 The pressure control in a distillation column can be complicated by the presence of inert gases.

How do these gases influence the column pressure? (3)

4.2 Make a sketch of the control system of a vacuum distillation process. (6)

4.3 What precautions must be taken to ensure the correct operation of a pressure transmitter for a pressure control system of a vacuum distillation process? (3)

4.4 Name FIVE factors which will influence the operation of a reflux condenser. (5)

4.5 Name THREE types of drum-level control designs. (3)

4.6 Drum-level control is a method often applied for a boiler system where the drum water level is considered to be important.

Explain the importance of maintaining the water level in the drum within a certain band. (5)

[25]

QUESTION 5: INTRINSIC SAFETY

5.1 Describe the burn-out test for a transformer. (4)

5.2 Which SIX steps of analysis are essential when designing for intrinsic safety? (6)

[10]

TOTAL SECTION B: 85
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.
$$C_v = \frac{72,4\, W}{\sqrt{\Delta P(P_1 + P_2)}}$$