higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## INDUSTRIAL INSTRUMENTS N6

**21 November 2023**

**This marking guideline consists of 6 pages.**

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## SECTION A

## QUESTION 1

| | | |
|---|---|---|
| 1.1 | 1.1.1 | E |
| | 1.1.2 | H |
| | 1.1.3 | J |
| | 1.1.4 | A |
| | 1.1.5 | I |
| | 1.1.6 | B |
| | 1.1.7 | G |
| | 1.1.8 | D |
| | 1.1.9 | C |
| | 1.1.10 | F |

(10 × 1) (10)

| | | |
|---|---|---|
| 1.2 | 1.2.1 | True |
| | 1.2.2 | True |
| | 1.2.3 | False |
| | 1.2.4 | False |
| | 1.2.5 | True |

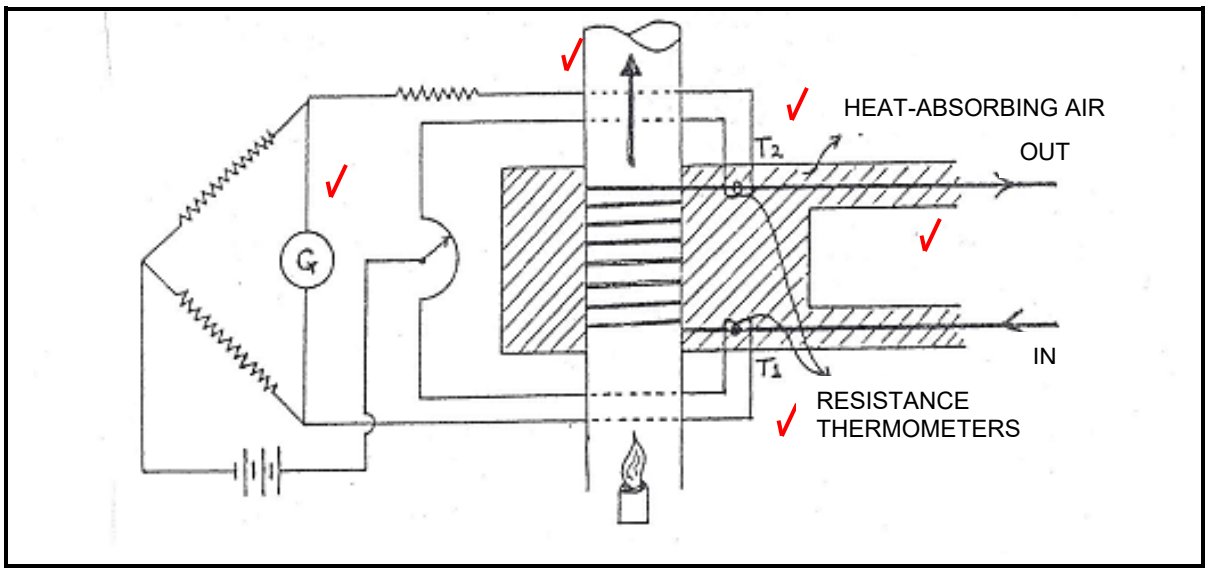
(5 × 1) (5)
**[15]**

**TOTAL SECTION A: 15**

## SECTION B

## QUESTION 2: ANALYSERS

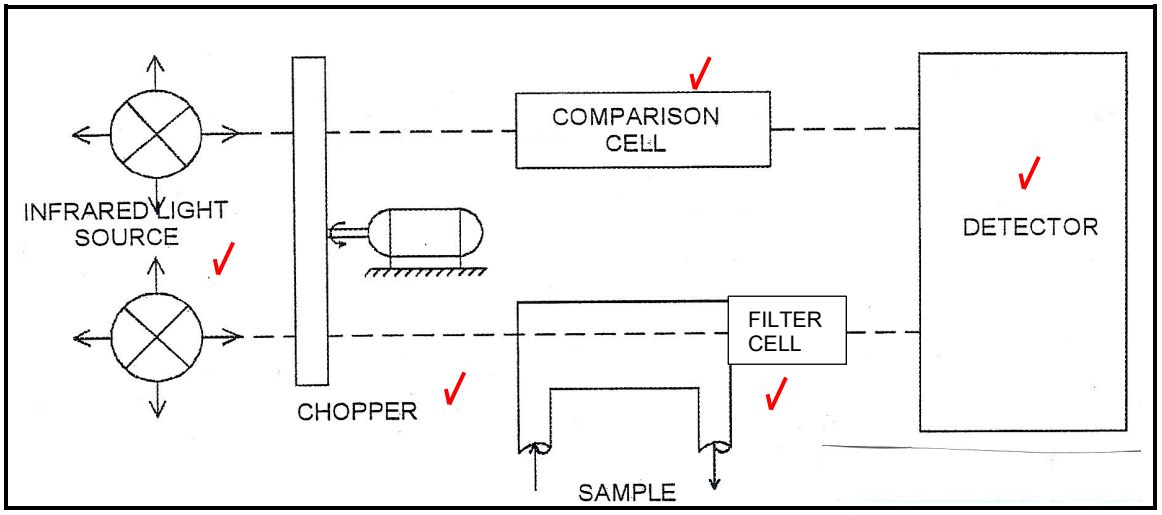
2.1




(5)

- Metered quantities of gas and air are introduced to a burner.✓
- The tank is heated and when air is introduced to the air chamber, it absorbs the heat from the tank.✓
- The air temperature rise is measured by resistance thermometers to provide a measure of the heating value.✓
- Both thermometers sense the same temperature, thus the bridge is in balance.✓
- A cooling medium is introduced through capillary tubing.✓
- $T_1$ will be cooled and $T_2$ heated up as a result of the heat exchange between the tank and tube.✓
- The bridge goes out of balance and the unbalance is proportional to the heat exchange and the heat developed by the burning gas.✓ (7)

2.2




(5)

2.3

- When the energy of a given frequency passes through a sample with molecules that have the same vibrating frequency,✓
- the energy may be absorbed by the molecules causing its natural vibration to increase✓
- thus radiation energy is absorbed and converted to kinetic energy.✓ (3)

2.4 They isolate the wave bounds in which only the component of interest will be isolated for analysis. (2)

2.5

- Photographic radiation detection
- Photoelectric radiation detection (2)

**[24]**

## QUESTION 3: AUTOMATIC CONTROL AND VALVES

3.1 $P_1$ = 22 + 1,0135 = 23,0135 bar✓
$P_2$ = 8 + 1,0135 = 9,0135 bar✓
T = 80 °C + 273 = 353 °K✓

$$Cv = \frac{Q}{295}\sqrt{\frac{GT}{\Delta P(P_1 + P_2)}}$$ ✓

$$2{,}2 = \frac{Q}{295}\sqrt{\frac{0{,}8\ X\ 353}{14(23{,}0135 + 9{,}0135)}}$$ ✓✓

Q = 817,895 $m^3/h$✓✓ (8)

3.2
- Set the derivative time to zero.✓
- Start with a wide band and narrow it gradually step by step while observing the behaviour following the set point changes✓
- until the desired stability is obtained, i.e. 0,25 wave damping.✓
- Allowing the P.B. to remain at its setting, increase the derivative time in small steps while creating set-point load changes until the cycling behaviour begins to increase.✓
- Then slightly reduce the derivative time.✓
- The P.B. can now be narrowed a little without decreasing the stability.✓ (6)

3.3 3.3.1
- Danger exists where ATO (air-to-open) valves are used.✓
- If the supply air fails, the valve must stay open, controlling the air to the furnace.✓

3.3.2
- Used in the supply line to the furnace (GAS).✓
- If the air fails, the valve must close thus preventing a runaway temperature or explosion.✓

(2 × 2) (4)

3.4
- Mechanical strength of the valve body
- Material of the valve construction
- Nature of the connection to the plant
- Valve size
- Valve characteristics
- Type of plunger or plug of the valve (Any 5 × 1) (5)

3.5 The turndown of a control valve is based not upon the actual maximum flow of the valve but upon the normal operating maximum flow. (2)
**[25]**

## QUESTION 4: DISTILLATION COLUMN AND BOILERS

4.1
- As automatic control technology developed, it became more difficult to determine the composite effect of several controllers,✓
- making simultaneous changes.✓
- To offset this growing complexity of control systems, methods were developed for studying the dynamics of processes✓
- and to model control systems by the use of mathematical equations.✓
- Electronic computers are used to make control computation✓
- and control plants by automatically setting the control settings.✓
- Feed-forward control is used to handle the many disturbances, that can occur during a distillation operation.✓
- Feed-forward control is usually implemented by using computers.✓ (8)

4.2 It has a low degree of efficiency. (2)

4.3
- A decrease in the water level in the steam drum may uncover the boiler tubes, allowing them to become overheated.
- An increase in the water level in the steam drum may interfere with the operation of the internal devices in the drum which separate the moisture from the steam. (2 × 2) (4)

4.4
- Single-element feedwater control/Single-element drum-level control
- Two-element feedwater control/Two-element drum-level control.
- Three-element feedwater control/Three-element drum-level control. (3)

4.5
- The inert gases, e.g. nitrogen, blanket off the condensing surface of the accumulator
- reducing the exposed tube area.
- This will reduce the condensing rate and the tower pressure will also decrease. (3)

**[20]**

## QUESTION 5: INTRINSIC SAFETY

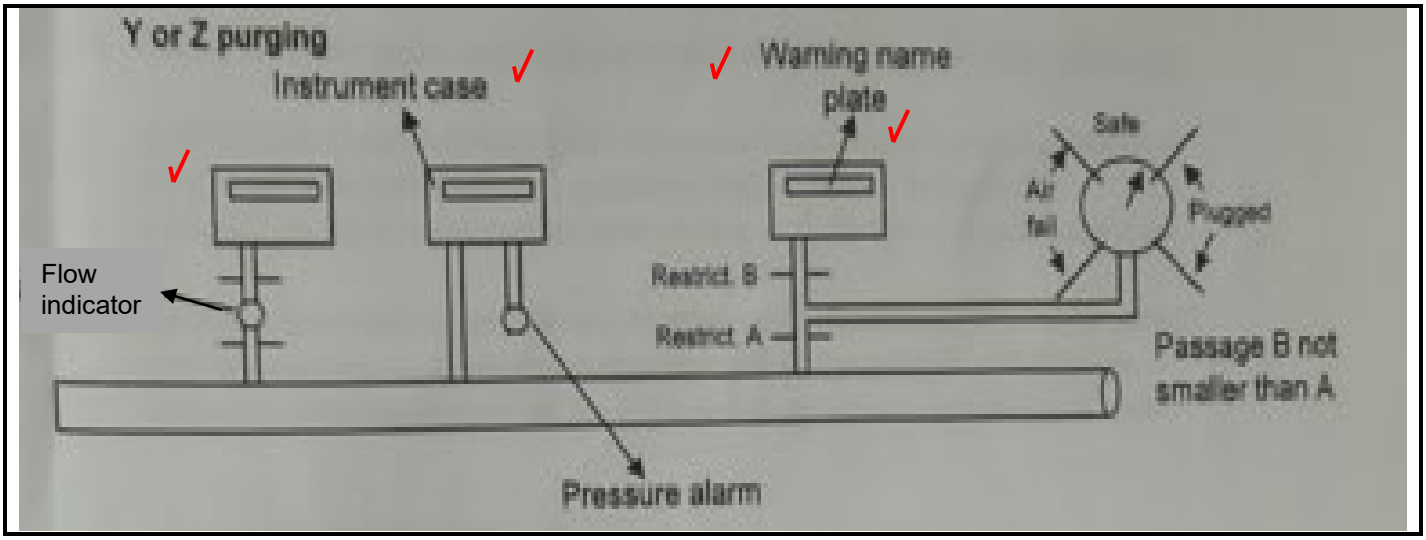
5.1 It is a location where both fuel and an ignition source are present under normal and abnormal conditions. (2)

5.2 A barrier circuit prevents high-voltage currents from flowing through a hazardous area. (2)

5.3
- X – to reduce the classification within an enclosure from division 1 to non-hazardous.
- Y – to reduce the classification within an enclosure from division 1 to division 2.
- Z – to reduce the classification within an enclosure from division 2 to non-hazardous. (3 × 2) (6)

5.4 The amount of energy required to ignite the most easily ignitable concentration under ideal conditions. (2)

5.5




(4)
**[16]**

**TOTAL SECTION B: 85**
**GRAND TOTAL: 100**

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