higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE (VOCATIONAL)

INSTRUMENTATION TECHNOLOGY
NQF LEVEL 2

10 November 2022

This marking guideline consists of 7 pages.

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QUESTION 1

1.1 1.1.1 The closeness with which a measurement approaches the true value of a variable being measured.

1.1.2 The closeness with which repeated measurements of the same quantity agree with each other.

(2 × 2) (4)

1.2
- Class relates to the type of material that is available for combustion.
- Group is a subsection of class, which determines the specific material involved.
- Division specifies the probability of finding that particular material in a hazardous area. (3 × 2) (6)

1.3
- Pneumatic signal transfer method
- Electronic signal transfer method
- Fibre optics transfer method
- Wireless transfer method
- Fieldbus transfer method (5)

[15]

QUESTION 2

2.1
- Control✓ – Valves are used in three positions: closed, fully open and throttled (partially open) to control the volume of fluid passing through them.✓
- Isolation✓ – Valves are used to cut off or isolate a part of the system from the remainder of the system during maintenance or an emergency. ✓
- Overpressure protection✓ – Valves are used to prevent overpressure in the vessels of a system by opening a vent to relieve pressure and ensure that it stays below the allowable maximum.✓
- Back- or reverse-flow prevention✓ – Valves are used to allow flow in one direction only. Should the fluid attempt to flow in the opposite direction, the valve will close.✓ (4 × 2) (8)

2.2 2.2.1 A throttling control valve is a valve-and-actuator assembly modulating fluid flow at any position between fully open✓ and fully closed in response to signals from a controller.✓

2.2.2 A valve flow characteristic is the relationship between valve flow capacity (in percent) and control valve open travel (in percent)✓, with all other factors that affect flow held constant. ✓

2.2.3 A positioner compares the input signal from the controller to the actual valve position✓ and applies a pneumatic output to the actuator to ensure that the valve moves to the proper position.✓

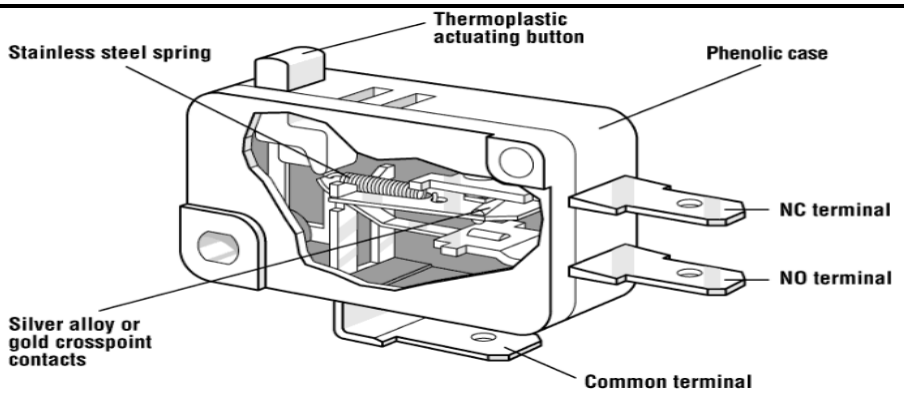
(3 × 2) (6)

2.3
- Mechanical friction
- Flashing
- Cavitation
- Choked flow
- Valve noise
- Erosion
- Chemical attack
- Leaks

(Any 6 × 1) (6)

2.4
- As a fluid flows through a valve restriction, its velocity increases ✓and its pressure decreases.✓ If the pressure within the throat falls below the vapour pressure of the liquid, vapour bubbles form.✓ This phenomenon is known as flashing.
- As a liquid then passes out of the valve, its velocity decreases and its pressure increases.✓ If the pressure rises above the vapour pressure,✓ the vapour bubbles collapse.✓ This phenomenon is known as cavitation. (3 × 2) (6)

2.5



(3 marks for the correctness of drawing)
(5 marks for the labelling) (8)

2.6
- Limit switches have mechanical parts that wear away.
- They cannot be used in all applications, since not all applications use contact sensing.
- They have a shorter contact life than other technologies. (3)

[37]

QUESTION 3

3.1 3.1.1 Pressure measured against atmospheric pressure as a point of reference, but which is always less than atmospheric pressure.

OR

A vacuum pressure (or negative pressure) is a pressure below atmospheric pressure.

3.1.2 A measure of how much force is placed on a unit surface by the weight of air above that surface.

3.1.3 A device that creates known pressures in order to calibrate other pressure-measuring instruments.

(3 × 2) (6)

3.2 3.2.1
- Equal-legged U-tube manometers
- Unequal-legged U-tube manometer
- Well type manometers
- Incline tube manometers
- Raised well type manometers (Any 4 × 1)

3.2.2
- Water
- Mercury
- Paraffin
- Light oil

(2 × 4) (8)

3.3 3.3.1 Bellow pressure gauge (2)

3.3.2
A – Low pressure input
B – Moving end
C – Spring
D – Pressure indicator
E – Bellow element
F – High pressure input (6)

3.3.3 A calibrated spring is used to pre-compress the bellows so that it is never extended past its free length. (1)

3.4 3.4.1
- C-shaped Bourdon tube
- Helical-shaped Bourdon tube
- Spiral Bourdon tube (3)

3.4.2
- Mechanical damage caused by overpressure.
- Glycerine leaks if a glycerine-filled gauge is used.
- Freezing in winter.
- Deformation of the element because of fatigue or overrange.
- Set point shift. (Any 4 × 1) (4)

[30]

QUESTION 4

4.1 4.1.1
- Platinum has a high temperature rating.
- It is very stable.
- It is very repeatable. (3)

4.1.2
- Wire-wound platinum RTDs
- Thin-film platinum RTDs (2)

4.2 Protective barrier✓
- A thermo-well's main purpose is to protect a thermometer from external conditions.✓
- It can handle an assortment of corrosive or abrasive process media and withstand turbulent or high-pressure conditions.✓
- A thermo-well protects a thermometer's sensing element from exposure to extreme heat or cold.✓

Increased serviceability✓
- If a thermometer needs to be removed or replaced, thermo-wells provide easy access to it.✓
- They stay installed in the piping system while a thermometer is being serviced.✓
- As a result, operations continue, which means there is no unnecessary downtime✓
- And the process media continue to flow without worry of escaping the system. ✓

Reduced operational costs✓
- Thermometers last longer and do not need to be serviced often when thermo-wells protect them.✓
- In effect, thermo-wells decrease the total cost of thermometers by minimising the time spent maintaining and servicing them.✓
- Because you don't need to replace thermometers often or maintain a large inventory of them, thermos-wells save you money in the end.✓ (13)

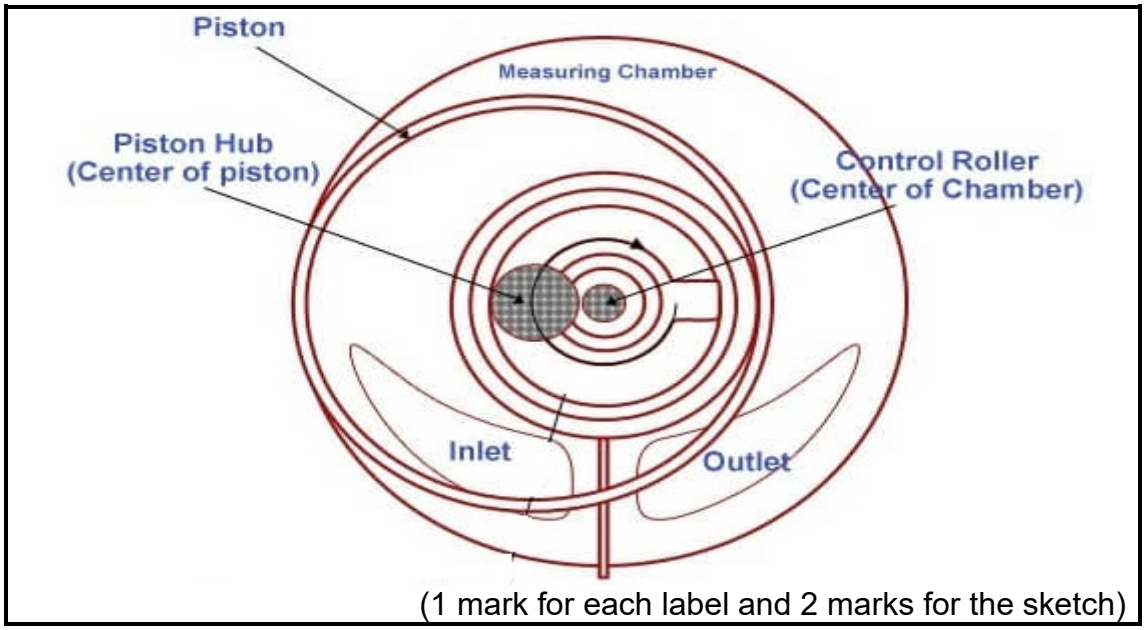
4.3 A resistance thermometer operates on the principle that the resistance of a metallic conductor varies in accordance with temperature variations.✓ The relationship between temperature and resistance is linear.✓ Because a conductor has a positive temperature coefficient,✓ the resistance increases when the temperature increases ✓ and decreases when the temperature decreases.✓ (5)

4.4
4.4.1 True
4.4.2 True
4.4.3 False
4.4.4 True
4.4.5 True
4.4.6 False
4.4.7 True

(7 × 1) (7)
[30]

QUESTION 5

5.1



(1 mark for each label and 2 marks for the sketch) (8)

5.2 $Time = 1hrs = 60 \times 60\,\text{sec} = 3600\ sec$✓

$Volume = 15000\ litres$
$1000\ l = 1\ m^3$✓

$1500\ l = V(m^3)$
$\therefore\ V(m^3) = \frac{15000\ l \times 1\ m^3}{1000\ l} = 15m^3$ ✓

$Q = \frac{\text{Volume}}{\text{Time}} = \frac{15\text{m}^3}{3600\ \text{sec}} = 0{,}0041\ \text{m}^3/\text{sec}$ ✓✓ (5)

5.3 5.3.1 Variable area flow meter or rotameter. (2)

5.3.2 A – Gravity
B – Float
C – Tapered metering tube
D – Flow
E – Scale (5)

5.3.3
- Certain forces act on the float and are at equilibrium when it is at rest.
- A change in flow will affect the pressure drop across the float, upsetting the equilibrium of the forces acting on the float.
- The float will move up or down the tube until the forces are at equilibrium again.
- The position of the float in the tube is then a measure of the flow rate.

OR

- When the flow rate increases, the float does not rise immediately.
- An increased differential pressure will appear across the float, causing the float to rise
- As the float rises, the by-pass area increases, resulting in a decrease in the differential pressure.
- The differential pressure will decrease until the rising and the sinking motions are balanced or reach equilibrium.
- The new float position will be an indication of the increased float rate. (5)

5.3.4
- They can be mounted vertically because they work with gravity.
- They are not suitable to low flow rates.
- They cannot handle dirty liquids or fluids with solids. (3)

5.4
5.4.1 C
5.4.2 C
5.4.3 A
5.4.4 B
5.5.4 B

(5 × 1) (5)

5.5
- Orifice plate
- Venturi tube
- Nozzle
- Segmented wedges
- V-cones (5)

[38]

TOTAL: 150

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