higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N4

23 July 2021

This marking guideline consists of 6 pages.

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QUESTION 1: ELECTRICAL AND NON-ELECTRICAL PRESSURE MEASUREMENT

1.1 Pressure at point X = Pressure at point Y✓
$\Longrightarrow P_g = pressure\ due\ to\ h\ + P_{atm}$✓
$P_g - P_{atm} = \rho gh$✓
That is, the differential pressure
$\Delta P = Pg - Patm = \rho gh$ (3)

1.2 $\Delta P = \rho gh$
$\Delta P = 13600 \times 10 \times 0{,}3$✓
$\Delta P = 40{,}8\ kpa$✓ (2)

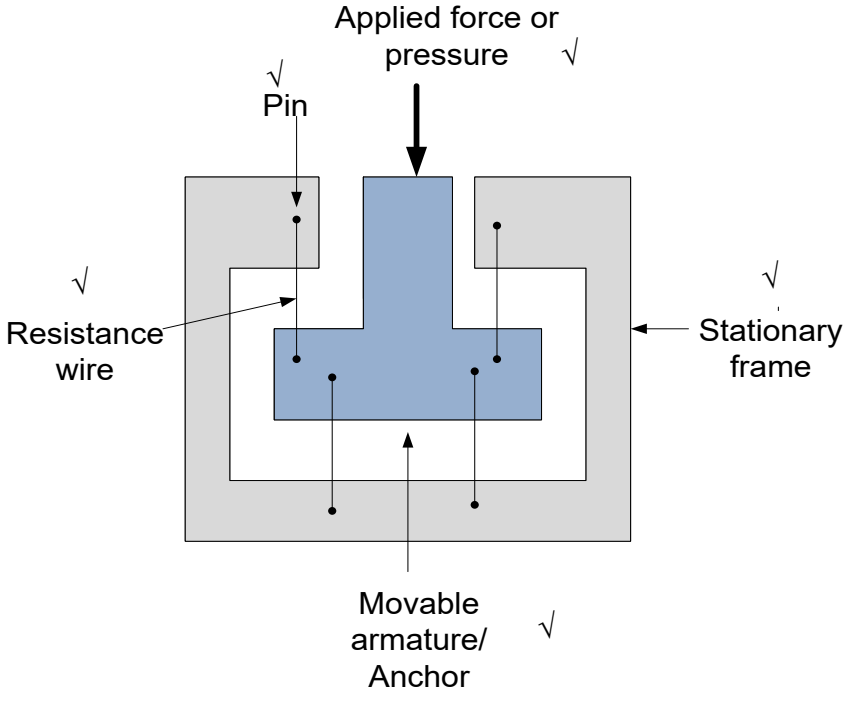
1.3 $\Delta P = \rho gL\left[\sin\theta + \frac{A_2}{A_1}\right]$
$L = \frac{\Delta P}{\rho g\left[sin\theta + \frac{A_2}{A_1}\right]}$✓

$L = \frac{150}{1000 \times 10 \times \left[sin45 + \frac{10}{100}\right]}$✓✓

$L = 0{,}0186\ m$✓ (4)

1.4
- Must have a maximum gauge factor
- Maximum melting point
- Minimum temperature coefficient, i.e. the influence of temperature must be as small as possible
- Minimum coefficient of linear expansion
- Minimum thermo-electrical effect at the connections to the material of optimum distort ability (Any 4 × 1) (4)

1.5



(5)

1.6
- Area of the plates
- Dielectric between the plates
- Distance between the plates (3)

1.7
- It is suitable to determine the liquid level in a tank where the liquid serves as the dielectric.
- As the level rises and falls, the dielectric between the plates changes,
- causing the capacitance to change.
- The change in capacitance is directly proportional to the level. (4)

[25]

QUESTION 2: ELECTRICAL AND NONELECTRICAL TEMPERATURE MEASUREMENT

2.1 2.1.1

$R_T = R_0(1+\propto T + \beta T^2)$

$R_T = 38[1 + 3{,}92 \times 10^{-3} \times 500 - 5{,}88 \times 10^{-7} \times (500)^2]$ ✓✓

$R_T = 120{,}959\ \Omega$✓ (3)

2.1.2

$R_T = R_0[1 + \alpha T]$

$\Rightarrow R_0 = \frac{R_T}{[1+\alpha T]}$✓

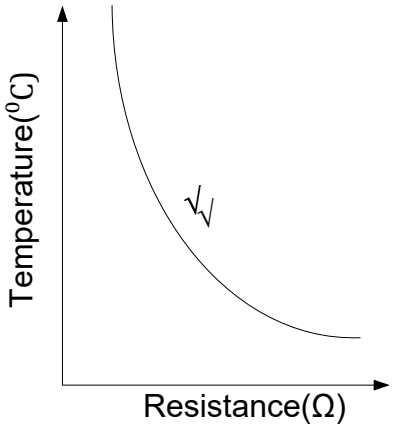
$= \frac{150}{[1+0{,}00392\times 25]}$✓

$= 136{,}61\Omega$✓ (3)

2.2 2.2.1 Cold junction resistor
- The emf produced by the temperature of the cold junction subtract from the emf of the hot junction resulting in an error
- This must be account for by adding a voltage equal to the emf at the cold junction.
- The value of this resistor must change with temperature since the room temperature changes all the time (4)

2.2.2
- The standard cell is periodically connected to the sensitivity resistance and the current through this resistor is adjusted by the variable resistor until the galvanometer is balanced.✓✓
- The voltage applied to the potentiometer is then correct.✓ (3)

2.3



(2)

2.4
- It can be used to measure temperature
- It can be used as a current suppressor or current limiter (2)

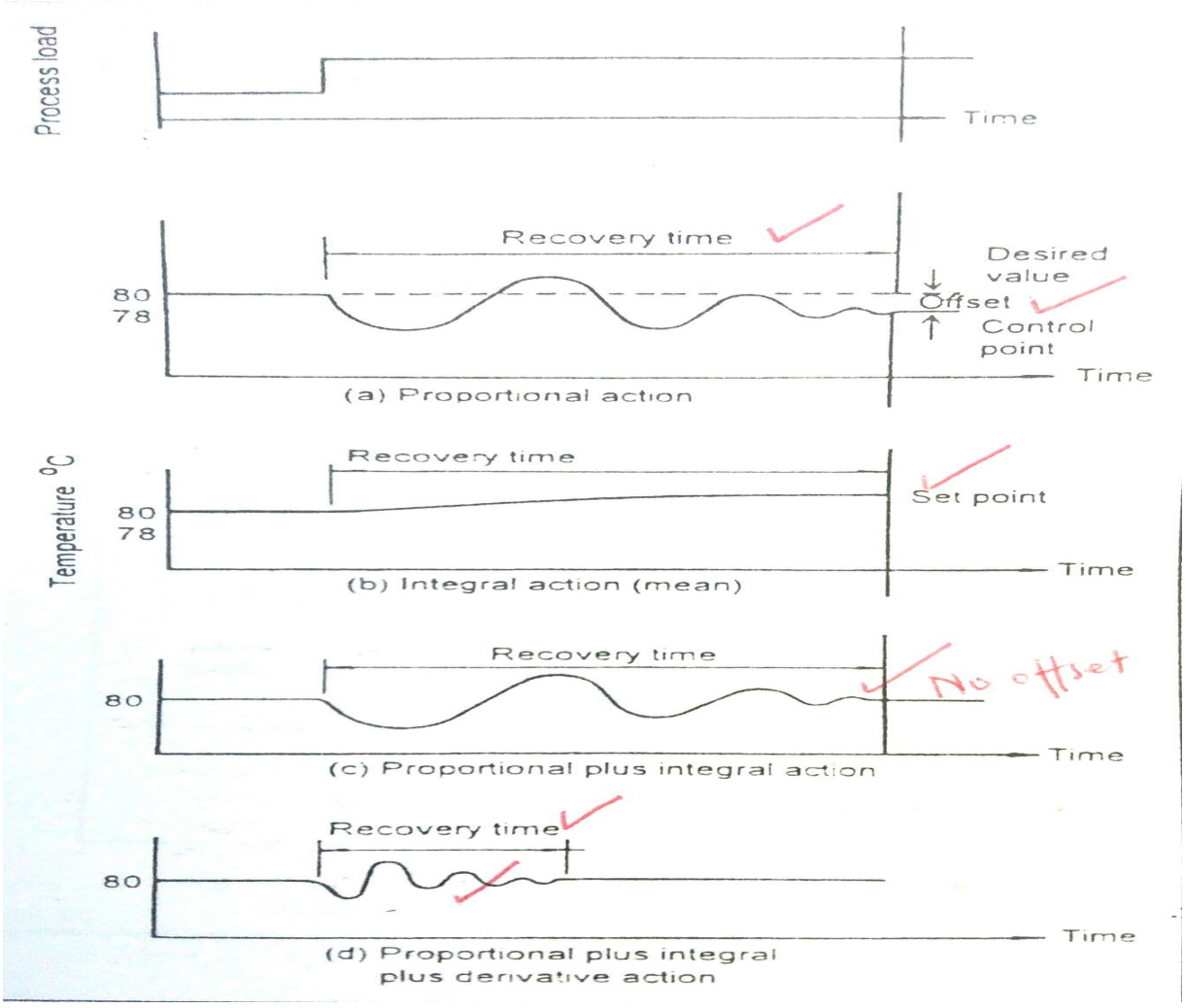
2.5
- If two bodies of different temperatures are placed opposite each other
- there is a transfer of heat energy from the hot body to the colder body,
- and the amount of radiated energy per time unit is roughly proportional to the fourth power
- of the absolute temperature difference between the two bodies. (4)

2.6
- Total radiation pyrometers cover the whole spectrum of heat radiation.
- Optical pyrometers measure the radiant flux given off
- in a narrow band of wavelengths
- in the visible spectrum. (4)

[25]

QUESTION 3: AUTOMATIC CONTROL AND TELEMETERING

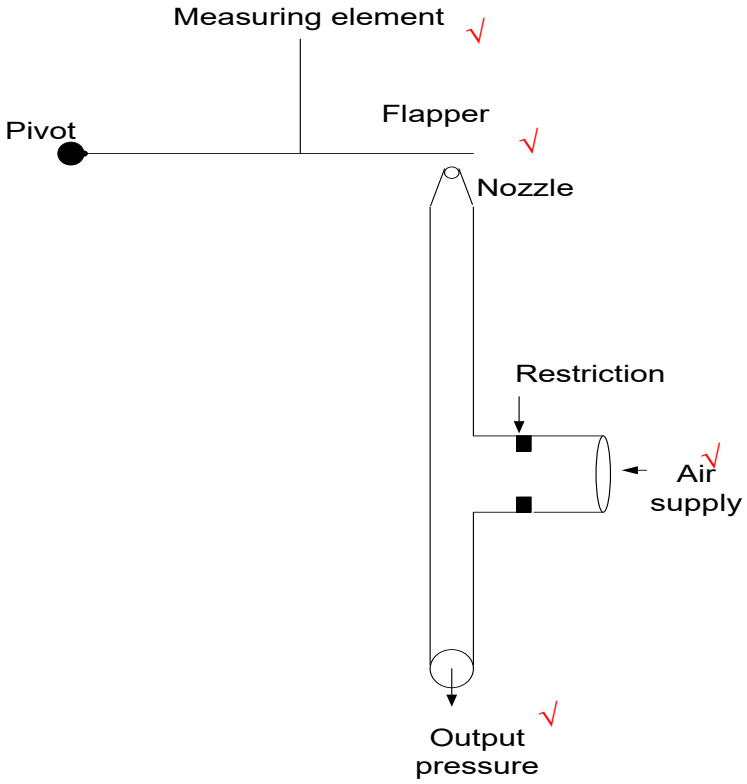
3.1



(6)

3.2
- The measuring unit consists of a detecting and a measuring element.✓
- Detecting element is part of the measuring unit which is in direct contact with the process✓
- and responds directly to the value of the measured variable.✓
- The measuring element is defined as that part of the measuring unit which responds to the signal from the detecting element✓
- and gives the measured value of the controlled condition✓ (5)

3.3



(6)

- When the flapper is completely away from the nozzle,√ there is a high flow out of the nozzle creating a low pressure at the output receiver.√
- When the flapper seals the nozzle,√ the output pressure builds up to the supply pressure ,creating a high pressure to the output receiver.√ (2)

3.4 3.4.1
- Accurate calibration
- Linear relationship between the measured variable and the output
- Reduces vibration

3.4.2
- Provides a greater volume of air
- Increased response time
- Amplifies the pressure/Increase the power or energy gain

(2 × 3) (6)
[25]

QUESTION 4: FLOW AND LEVEL MEASUREMENT

4.1
- Potential energy
  A body of a mass 'm' at a height 'h' above the ground possesses a potential energy of $E_p = mgh$
- Kinetic energy
  This is energy arising from motion.
  For a particle of mass 'm' moving with a velocity 'v' it is $E_k = \frac{1}{2}mv^2$
- Pressure energy
  This is energy arising from pressure 'p' and a specific volume
  It is E_p = PV

(6)

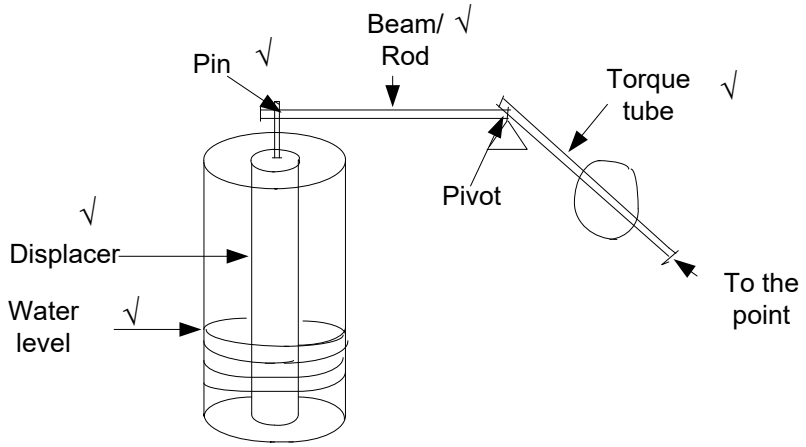
4.2
- Q = k$\sqrt{h}$
- Where Q = the rate of liquid flow
- K = flow constant (this is particular constant for a flow measuring device)
- h = P1 –P2, i.e. the differential pressure developed across the device

(4)

4.3
- The diameter of the hole in relation to the pipe diameter must be such that it will produce a maximum flow rate.
- The sharp edge of the orifice plate must face upstream.
- The plate must be strong enough to withstand the pressure difference.
- The orifice plate may not corrode in the liquid of which the flow rate is to be measured.

(4)

4.4



(5)

4.5 $\Delta P = \rho gh$✓

$h = \frac{\Delta P}{\rho g} = \frac{37000}{800 \times 10}$✓ $= 4{,}625\ m$✓

(3)

4.6
- Conductivity level switch
- Capacitance level measurement
- Ultrasonic level measurement
- Nuclear level measurement

(Any 3 × 1) (3)

[25]

TOTAL: 100

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