higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## INDUSTRIAL INSTRUMENTS N5

## 17 April 2020

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

## SECTION A: FLOW MEASUREMENTS

### QUESTION 1

1.1
- The large pipe carries a greater volumetric rate of water flow than the small pipe.✓
- Since the vortex-shedding frequency is proportional to the fluid velocity, the flow velocities in both cases must be the same (given identical bluff body geometries).✓✓
- However, since the larger pipe has a greater cross-sectional area, an identical velocity equates to a greater volume rate of water moving past the bluff body and sensor.✓✓✓ (6)

1.2
- Primary device or measuring unit
- Secondary device or recording unit (2)

1.3
- Gravity
- Pump (2)

**[10]**

### QUESTION 2

2.1 $Q = V_1A_1 = V_2A_2$✓✓

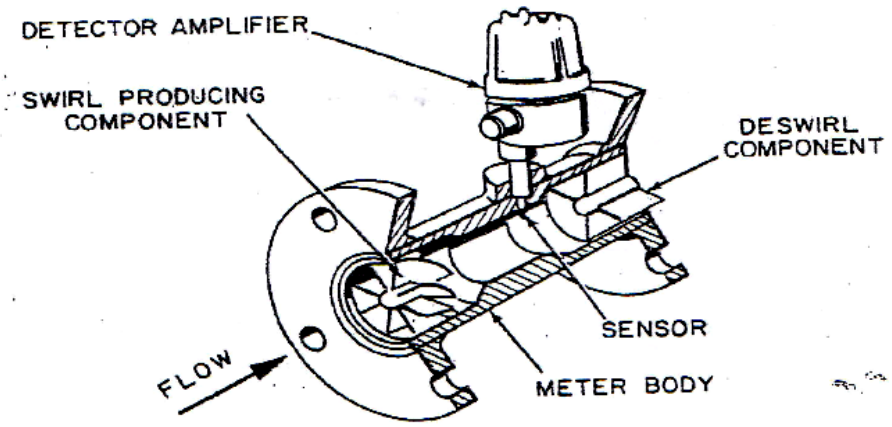
$2{,}21(\frac{\pi D2}{4}) = V_2(\frac{\pi D2}{4})$✓

$2{,}21(\frac{\pi(0{,}09)2}{4}) = V_2(\frac{\pi(0{,}06)2}{4})$✓

$0{,}0141 = 2{,}827 \times 10^{-3}\ V_2$✓

$V_2 = 4{,}988$ m/s✓ (6)

2.2 2.2.1




(6)

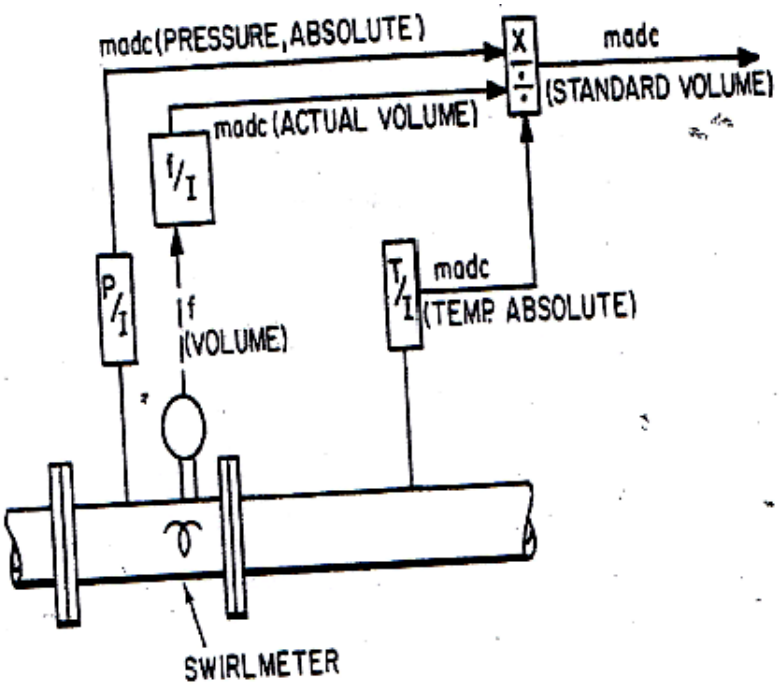
2.2.2 **Advantages:**

- No moving parts
- Low-pressure losses
- High accuracy

**Disadvantages:**

- Expensive
- In-mounting requirement
- Not accurate in slurry application (3 + 3) (6)

2.2.3




(6)
**[24]**

**TOTAL SECTION A: 34**

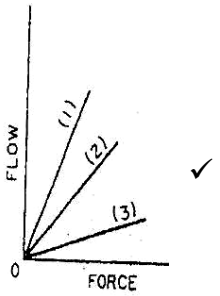
## SECTION B: DENSITY, HUMIDITY AND VISCOSITY

## QUESTION 3

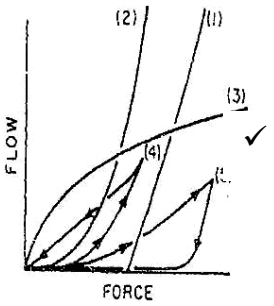
3.1
- In the displacement meter liquid flows continuously through the displacer chamber.
- An upward force acts on the balance beam because of the volume of liquid displaced by the float.
- A pneumatic system balances this upward force and transmits a signal proportional to the density of the liquid.
- Liquids with specific gravities of 0,5 and higher can be measured with this equipment as long as suitable materials are used to prevent damage from corrosion.
- If the temperature of the flowing liquid changes, a thermostat heater may be used to hold it constant. (5)

3.2 Newtonian fluids: When fluids are deformed by strain the ratio between shear rate and shear stress will be a constant value.✓✓

Non-Newtonian fluids: When fluids are deformed by strain the ratio between shear rate and shear stress will not be a constant value.✓✓



✓

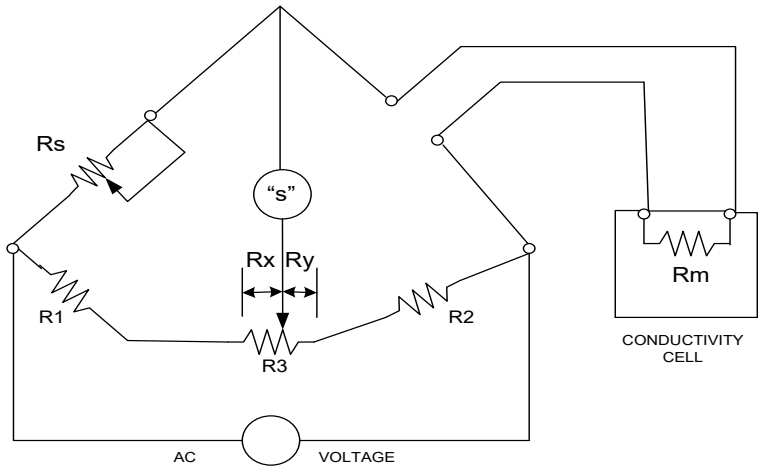


✓

(3 + 3) (6)

3.3
- The instrument should not be mounted near doors or other openings where it will be exposed to artificial drafts.✓ Flush mounting on the panel should be avoided✓ because the atmosphere in the back of the panel is motionless.✓
- The hair element can be mounted on top or on the back of the instrument case depending on the installation.✓
- The element can also be mounted on an extension in the back of the instrument✓ so that the sensing portion is in the room or compartment where relative humidity is to be measured while the readout device is surface mounted on the wall outside.✓✓
- Recorders are generally available as two-pen instruments with the second pen recording temperature.✓ (8)

3.4 3.4.1




(6)

3.4.2 Reference conductivity-cell sampling which is a solution of typical composition✓ and subject the same temperature as the measuring cell.✓ Bring a thermistor in contact with the process fluid and resistor network.✓ (3)

**[28]**

**TOTAL SECTION B: 28**

## SECTION C: pH MEASUREMENT

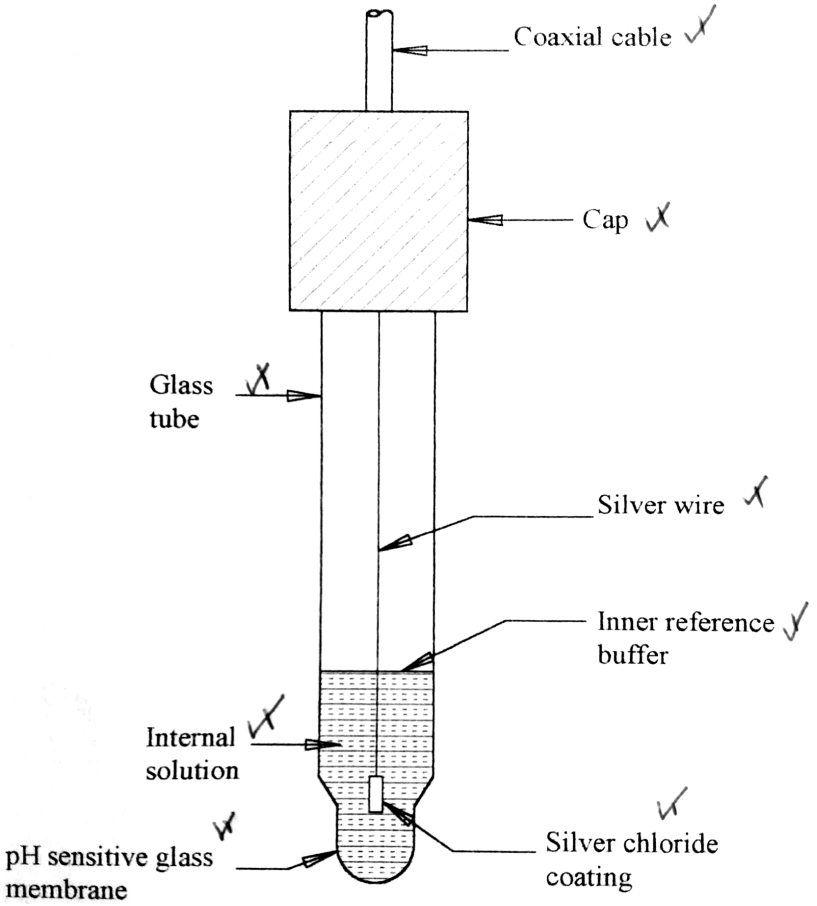
### QUESTION 4

4.1 A screened glass electrode can be used✓ and the electrode assembly✓ must be located at a point where the residual field is smallest.✓ (3)

4.2 The main purpose is to complete the electrical circuit with the glass-membrane electrode.✓ It must provide a stable potential that is relatively invariable,✓ despite changes in either the chemical composition or physical properties of the process stream.✓ (3)

4.3 Hydroxyl ions (2)

4.4




For a glass-membrane electrode to function, both surfaces of the membrane must be hydrated.✓ Hydration occurs by absorption of water by the membrane interface in contact with the solution.✓ There is also an exchange of univalent cations of the glass for hydrogen ions from the solution.✓ At both surfaces of the membrane there will be a boundary potential that will be a function of the hydronium ion activity in the solution at the interface.✓ Because the hydronium ion activity for the internal filling solution is constant,✓ the potential will be a function of the hydronium ion activity of the external solution.✓

(4 for diagram + 6 for discussion) (10)

**[18]**

**TOTAL SECTION C: 18**

## SECTION D: AUTOMATIC CONTROL

## QUESTION 5

5.1
- All four bellows will have the same pressure.
- The motion pin will be on its true centreline.
- There will be no control actions generated. (3)

5.2
- The output will increase by 10 kPa if the gain is direct.
- Should the gain be indirect the output will decrease by 10 kPa.
- This would be due to the pressure increasing in the process bellows while the pressures in the other bellows stay constant.
- The motion pin will move off its centreline causing the flapper to move either towards or away from the nozzle.
- This should cause the nozzle feedback pressure to either increase or decrease thus causing the output to change accordingly. (5)

5.3 100% Pb = 100/gain (1)

5.4 By swivelling the gain adjustment dial directly to reverse (1)

5.5
- When the integral action is marked in repeats per minute it indicates that the integral will repeat per minute✓
- When marked in minutes per repeat it indicates the time to repeat the proportional band✓✓ (3)

5.6
- The derivative action time taken for proportional action to repeat the derivative action for a ramp change✓
- Most controllers do not produce the true theoretical output due to interactions between the control actions✓ and are therefore called interactions controllers✓ (3)

5.7 **Advantages of a live zero-based signal:**

- Difference between power on and power off
- See movement from zero in both directions
- Two-wire system (no high voltage in hazardous area)

**Advantage of a zero-based signal controller:**

- Mathematical functions are easy, as they do not have to be biased (4)

**[20]**

**TOTAL SECTION D: 20**
**GRAND TOTAL: 100**