higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N4

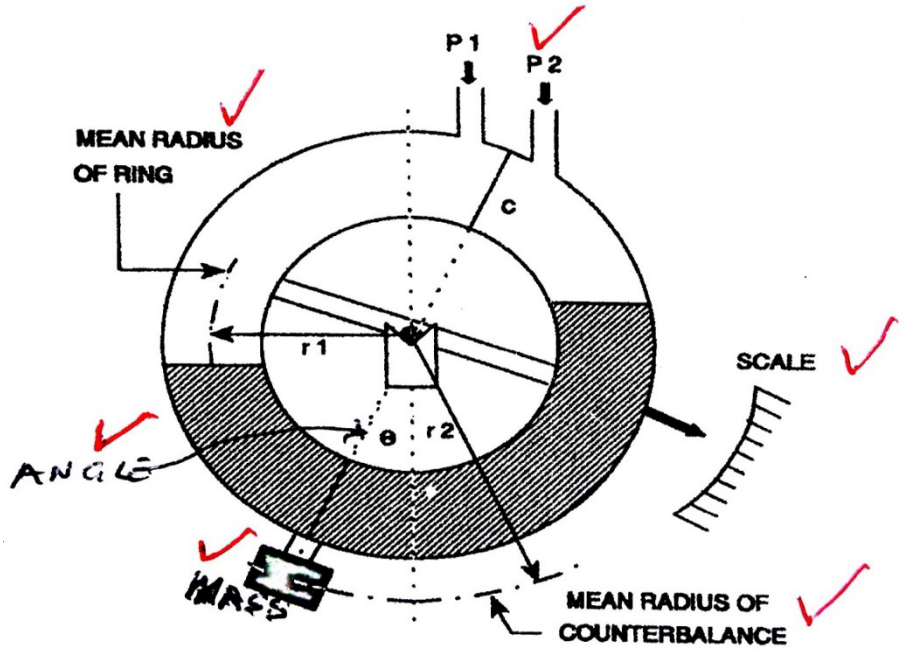
24 JULY 2018

This marking guideline consists of 6 pages.

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QUESTION 1: PRESSURE MEASUREMENT

1.1 1.1.1



(6)

1.1.2 Rotating moment = $(P_1 - P_2)Ar_1$

Restoring moment = $r_2 Mg\sin\theta$

Therefore for balance:

rotating moment = restoring moment:

$$\Rightarrow (P_1 - P_2)Ar_1 = r_2 Mg\sin\theta$$

$$\text{Thus } P_1 - P_2 = \frac{r_2 Mg\sin\theta}{Ar_1}$$

(4)

1.2 $$\Delta P = \frac{r_2 Mg\sin\theta}{Ar_1}$$

$$1\,000 = \frac{0{,}4 \times 0{,}8 \times 10 \times \sin\theta}{0{,}00785 \times 0{,}3}$$

$$\Rightarrow \sin\theta = 0{,}7359$$
$$\theta = \sin^{-1}(0{,}7359)$$
$$= 47{,}386°$$

(5)

1.3 A device that converts one form of energy into another form of energy (2)

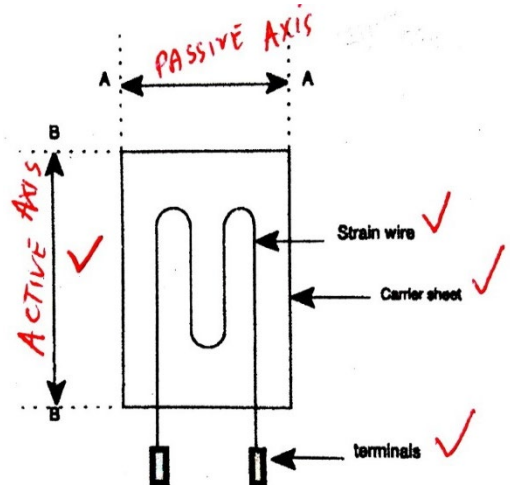
1.4 $$A = \frac{\pi d^2}{4} = \frac{\pi(0{,}001)^2}{4} = 0{,}7857 \times 10^{-6}\ m^2$$

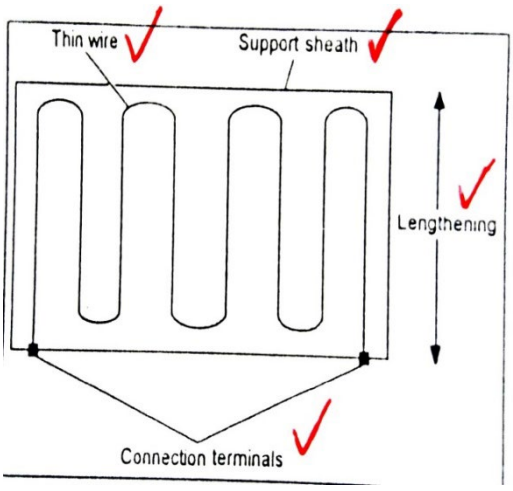
$$R = \frac{\rho L}{A} = \frac{70 \times 10^{-6} \times 20}{0{,}7857 \times 10^{-6}} = 1{,}78\ k\Omega$$

(4)

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1.5

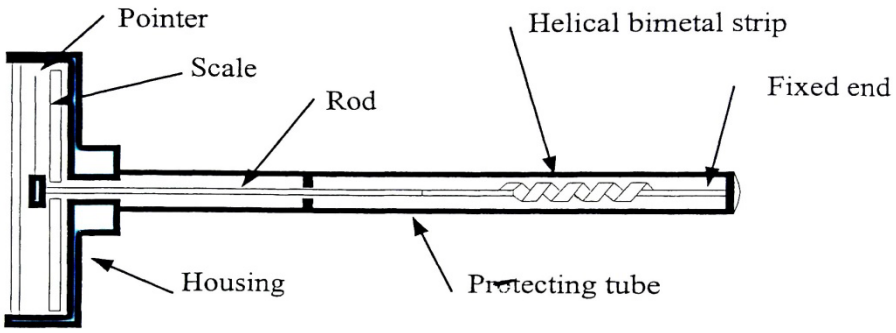




(4)
[25]

QUESTION 2: TEMPERATURE MEASUREMENT

2.1



(7)

2.2 When two dissimilar metal wires, e.g. iron (Fe) wire and copper (Cu) wire, are joined together at one end, a voltage is produced at the other end that is approximately proportional to the temperature difference between the junctions. (4)

2.3 To ensure that the emf generated by the thermocouple is the function of the hot junction only the cold junction must be maintained at a constant temperature, e.g. 0 °C. (2)

2.4 Thermistors are made from semiconductor metal oxides✓ like cobalt oxides,✓ zinc oxides,✓ etc. Several of these oxides are mixed in exact quantities to obtain the desired characteristics.✓ The oxides are then pressed into the desired shapes✓ and baked at high temperatures to crystallise into a homogeneous ceramic material.✓ (6)

2.5 $I_s = \frac{1}{\text{sensitivity}} = \frac{1}{200} = 0{,}005\ A$✓

$\Delta R = \frac{\Delta V}{I_s} = \frac{0{,}65\times10^{-3}}{5\times10^{-3}} = 0{,}13\ \Omega$✓

$\Delta R = \propto R_0 T$

$\Rightarrow R_0 = \frac{\Delta R}{\propto T} = \frac{0{,}13}{0{,}0058\times25}$✓

$= 0{,}8966\ \Omega$✓

$R_{cj} = R_0 + \Delta R$

$= 0{,}8966 + 0{,}13$✓

$= 1{,}0266\ \Omega$✓ (6)

[25]

QUESTION 3: AUTOMATIC CONTROL AND TELEMETERING

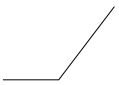
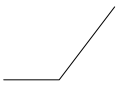
3.1 Transmission of measurements over long distances✓ by electric or electronic means for indicating or recording information✓ (2)

3.2 3.2.1 Current telemetering system (2)

3.2.2 A – Battery/Power supply
B – Slider wire/Rheostat
C – Bourdon tube
D – Telemetering channel
E – Milli-ammeter with scale on kPa (5)

3.2.3 The indication will be influenced by variations in the supply voltage and by variations in the resistance of the lines between the transmitter and receiver due to ambient temperature changes. (2)

3.3

(1)  ✓ (2)  ✓ (3)  ✓ (4)  ✓

(5)  ✓ (6)  ✓ (6)

3.4 A – Input signal
B – Valve motor
C – Diaphragm
D – Spring
E – Valve stem
F – Plug
G – Inlet port
H – Outlet port (8)

[25]

QUESTION 4: FLOW AND LEVEL MEASUREMENT

4.1 They reduce the area of the pipe,✓ thus creating a pressure drop across the restriction.✓ The difference between the static pressure in the pipe and the lowered flow is a function of the flow rate.✓✓ (4)

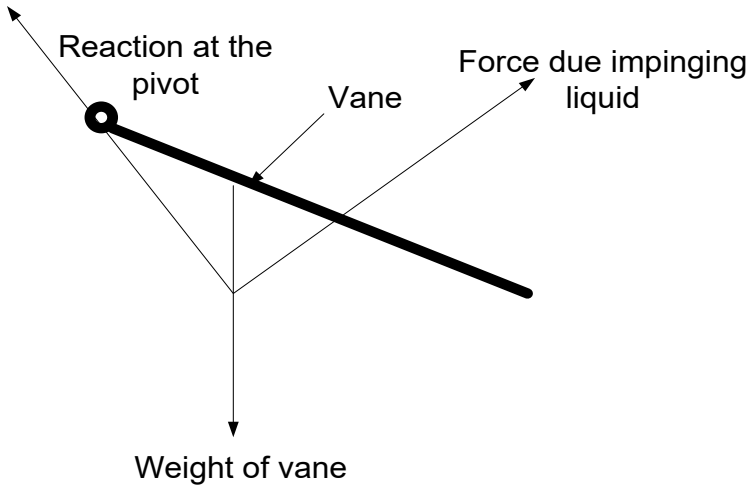
4.2 $\frac{Q_1}{Q_2} = \frac{k\sqrt{h_1}}{k\sqrt{h_2}}$✓

$\Rightarrow \frac{1\,000}{Q_2} = \frac{\sqrt{150}}{\sqrt{200}}$✓

$\Rightarrow Q_2 = \frac{1\,000\sqrt{200}}{\sqrt{150}}$✓

$= 1\,154{,}7\ m^3/h$✓ (4)

4.3



(4)

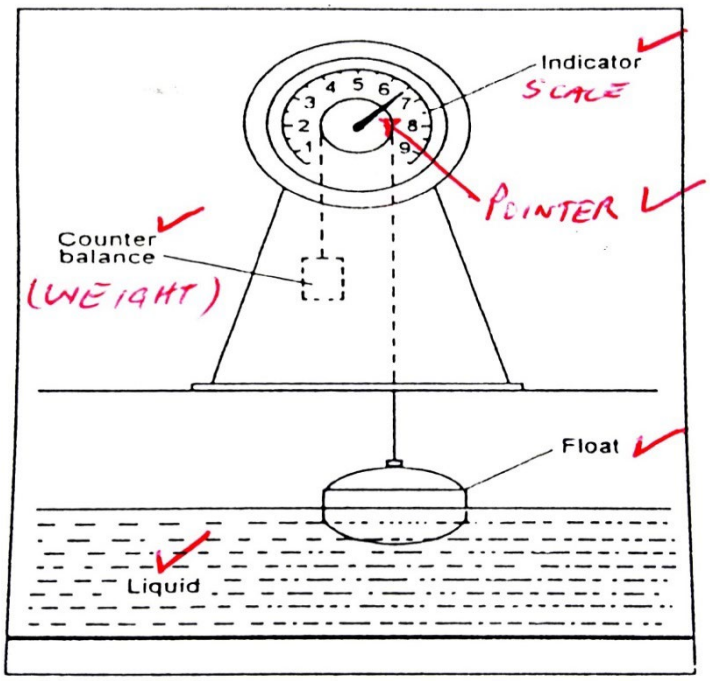
4.4 $\Delta P = \rho gh$✓

$85\ 000 = 3\ 000 \times 10 \times h$✓

$\Rightarrow h = \frac{85\ 000}{30\ 000} = 2{,}833\ m$✓

$h_{total} = 2{,}833 + 0{,}04 = 3{,}233\ m$✓ (4)

4.5



(5)

4.6
- Simple
- Reliable
- Accurate
- Can be used for high temperatures and pressures
- Compatible for measurement over a wide range

(Any 4 × 1) (4)
[25]

TOTAL: 100

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