higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE (VOCATIONAL)

INSTRUMENTATION TECHNOLOGY
NQF LEVEL 4

27 February 2020

This marking guideline consists of 7 pages.

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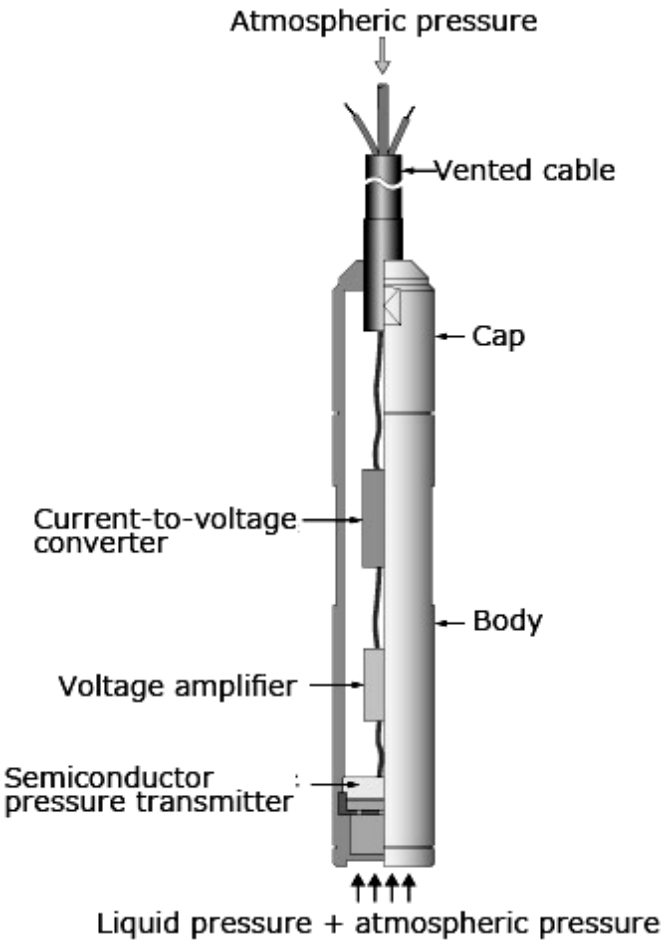
QUESTION 1

1.1 1.1.1

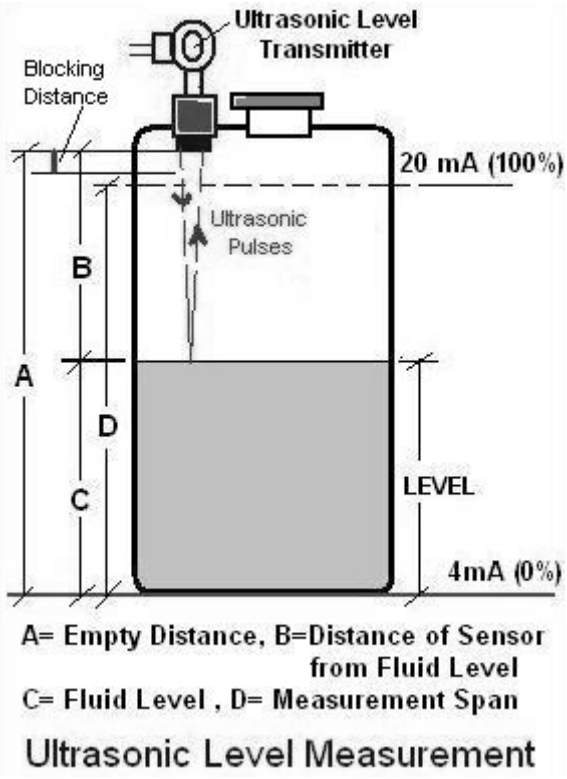


(4 for sketch + 4 for labelling) (8)

1.1.2 The diaphragm at the end of the sensor receives liquid pressure,✓ which changes proportionally to the liquid level.✓ An incorporated semiconductor pressure transmitter✓ continuously converts the liquid pressure to electric signals,✓ thus continuously indicating a liquid level. With the incorporated vented cable,✓ any detection error due to change in atmospheric pressure is automatically corrected.✓ (6)

1.2 1.2.1 Ultrasonic waves detect an object in the same way as radar.✓ Ultrasonic uses sound waves✓ and radar uses radio waves.✓ When an ultrasonic pulse signal is targeted towards an object, it is reflected by the object and an echo returns to the sender.✓ The time travelled by the ultrasonic pulse is calculated and the distance of the object is determined.✓ (5)

1.2.2



Ultrasonic Level Measurement

(9)

1.2.3
- Velocity of sound changes due to the variation of air temperature. An integrated temperature sensor is used to compensate for changes in the velocity of sound due to temperature variations.
- There are some interference echoes developed by the edges, welded joints, etc. This is taken care of by the software of the transmitter and called interference echo suppression.
- Calibration of the transmitter is crucial. Accuracy of measurement depends on the accuracy of calibration. The empty distance A and measurement span D is to be ascertained correctly for inclusion in calibration of the transmitter.
- The transient characteristics of the sensor will develop a blocking distance as shown in the sketch. Span D should never extend to the blocking distance. (4)

1.3
1.3.1 True
1.3.2 True
1.3.3 True
1.3.4 True
1.3.5 False

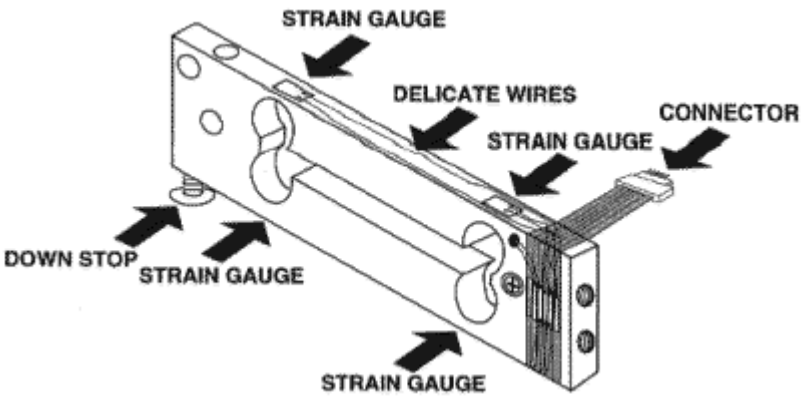
(5 × 1) (5)
[37]

QUESTION 2

2.1 Load cells are also known as load transducers,✓ because they convert a load (force) into electrical signals.✓ A load cell is defined as a weight-measurement device✓ necessary for electronic scales that display weights in digits.✓ (4)

2.2
- One can check if a load cell is working or not by verifying two aspects of the load cell, namely load-cell resistance✓ and load-cell voltage.✓
- Load-cell output resistance is measured between the positive and negative wires. The load-cell input resistance is measured between the positive excitation wire and the negative excitation wire. In both cases, the value between the wires must be equal or similar to the datasheet provided with the load cell.✓✓
- To measure the load-cell voltage, connect the two wires to the amplifier. Now measure the response signal between the positive and negative signal wires while incrementing the load to see the corresponding signal increment.✓✓ (6)

2.3



(3 for sketch + 3 for labelling) (6)

2.4 Given:

R = 157 Ω
K = 1,65
Stress = 52 MPa
ΔR = ?
E = 140 GPa

$E = \frac{\sigma}{\epsilon}$

$E = \frac{\sigma}{\epsilon}$

$E = \frac{52x\ 10^{6}\ Pa}{140\ x\ 10^{9}\ Pa}$ ✓✓

$= 3{,}714 \times 10^{-4}$ ✓✓

$K = \frac{\frac{\Delta R}{R}}{\epsilon}$ ✓✓

$\frac{\Delta R}{R} = K\ x \in$

$\Delta R = K \times \epsilon \times R$

$= 1{,}65 \times 3{,}7 \times 10^{-4} \times 157\ \Omega$ ✓✓

$\Delta R = 0{,}0958\ \Omega$ ✓✓ (10)

2.5 When taking scientific measurements, it is important to be both accurate and precise.✓ Accuracy represents how close a measurement comes to its true value.✓ This is important because bad equipment, poor data processing or human error can lead to inaccurate✓ results that are not very close to the truth.✓ (4)

[30]

QUESTION 3

3.1 Steam-and-water analysis system (2)

3.2 Effective acidity or alkalinity of a liquid (2)

3.3 Standardises equipment (2)

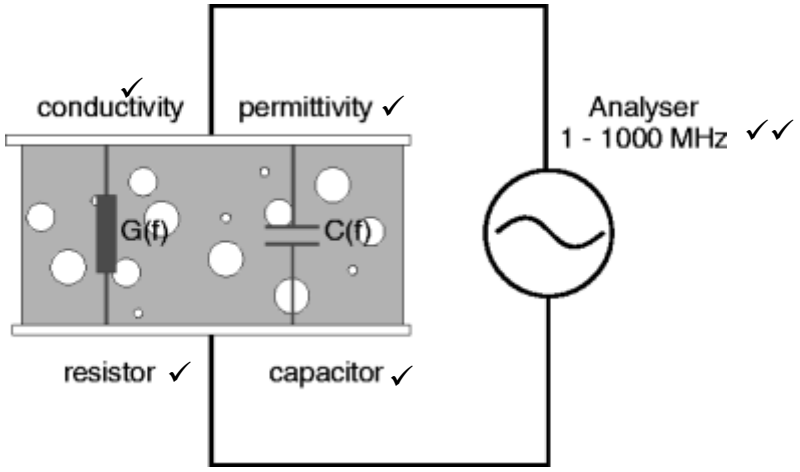
3.4 Helium (2)

3.5 Strong absorption of IR✓ radiation by water✓✓ (3)

3.6
- Concentration
- Material in solution
- Temperature (3)

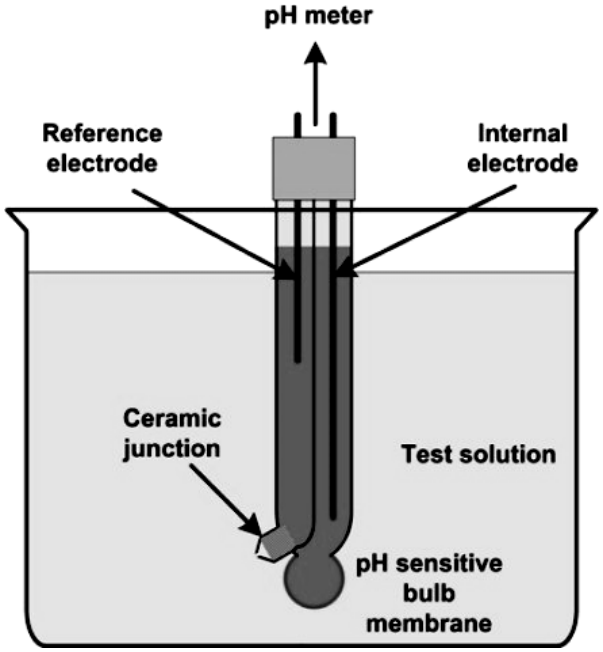
3.7 Chemical analysis is a significant test to verify that the material supplied meets the design or product requirements or to identify the machinability, durability and weldability of the material.✓✓ Chemical analysis is one of the most important methods to support failure-analysis investigations. Nowadays, the technologies in steel industries are more competitive and innovative. Manufacturers develop new varieties of specific modern steels to satisfy technological needs.✓✓ These technologies may add, increase or reduce some critical elements in the making of modern steel to develop steel that is lighter, stronger and more resistant to heat, chemicals or the environment. The quality of the material is developed and controlled to ensure the composition meets the requirements.✓✓ (6)

3.8



(4 for drawing + 6 for labelling) (10)

3.9



(4 for sketch + 3 for labelling) (7)

3.10
- Verification of conformance to a standard or specification
- Evaluation of raw materials
- Detection of impurities
- Identification of alloys (4 × 2) (8)

[45]

QUESTION 4

4.1 When there exists two or more controllers in a control loop✓ and the one controller is providing a set✓ point for the other controller✓ (3)

4.2 Controlling process (2)

4.3
- Feed-water flow
- Doom level
- Steam flow (3 × 2) (6)

4.4 To reduce the effect of load variation on the process variable (2)

4.5 Controlled variable (2)

4.6

SCADA	DCS
• Event driven • Covers large geographical areas • Software used for monitoring process	• State driven • Usually used in factories • High-speed communications

(3 + 3) (6)

4.7
- No time lag
- Linear output
- Not sensitive to vibration
- No pressure drop
- No time lag
- Electrical signal used over many kilometres (6)

4.8
- Independent monitoring of the process
- Bringing the plant into a safe state as or when control is lost (2 × 2) (4)

4.9 Failing safe is a practice that, in the event of a specific type of failure,✓ inherently responds in a way that will cause no or minimal harm✓ to other equipment, the environment or people.✓ (3)

4.10
- Fully closed
- Fully open
- Last position
- Continue throttling (4)

[38]

TOTAL: 150

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