higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE (VOCATIONAL)

INSTRUMENTATION TECHNOLOGY
NQF LEVEL 4

21 November 2023

This marking guideline consists of 7 pages.

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SECTION A

QUESTION 1

1.1 C or D
1.2 B
1.3 A or B
1.4 B
1.5 B
1.6 A
1.7 B
1.8 A
1.9 D
1.10 A

(10 × 1) **[10]**

QUESTION 2

2.1 True
2.2 False
2.3 True
2.4 True
2.5 True

(5 × 1) **[5]**

QUESTION 3

3.1 H
3.2 E
3.3 N
3.4 C
3.5 K
3.6 O
3.7 A
3.8 D
3.9 L
3.10 B

(10 × 1) **[10]**

TOTAL SECTION A: 25

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SECTION B

QUESTION 4

4.1
- A penetration near the bottom of the vessel is needed, where leak paths could be the cause of many problems.
- Measurement errors also occur due to changes in liquid density.
- Vapour builds up above the liquid level. (3)

4.2.1 The time it takes for a transmitted ultrasonic signal to travel from the ultrasonic level transmitter✓ to the surface of the material and back to the receiver✓ (2)

4.2.2 Any changes in the temperature,✓ pressure,✓ humidity✓ and composition of gas above the material✓ affect the speed of the ultrasonic signal. (4)

4.2.3
- A guided wave radar is a level measuring detector consisting of a cable or rod as the wave carrier extending from the emitter down to the bottom of the vessel.✓
- This guiding reduces the effect of dust above granular solids✓ as well as the turbulence in some liquids.✓ (3)

4.3 4.3.1 Radiation methods are used in cases where the liquid is corrosive,✓ very hot✓ or detrimental to installing sensors.✓ (3)

4.3.2 The disadvantages of this system are the cost✓ and the need to handle radioactive material.✓ Special permission must be obtained from government to use these types of radioactive substances.✓ (3)

4.3.3 For point level measurement, a radioactive source is mounted externally on one side of a vessel✓ at the selected level.✓ The source is enclosed in a protective housing✓ with a window allowing the radiation to be directed towards the detector.✓ The nuclear energy detector is mounted externally on the opposite side at the same level.✓ The nuclear energy source produces a beam of radiation✓ of which the frequency is proportional to the strength of the radiation.✓ When the level of the material is high enough to block the beam path,✓ the amount of radioactive energy that reaches the detector is lower than when the level is lower.✓ This causes a controller to send a signal to stop or start a feeder, light a lamp or sound an alarm.✓ (10)

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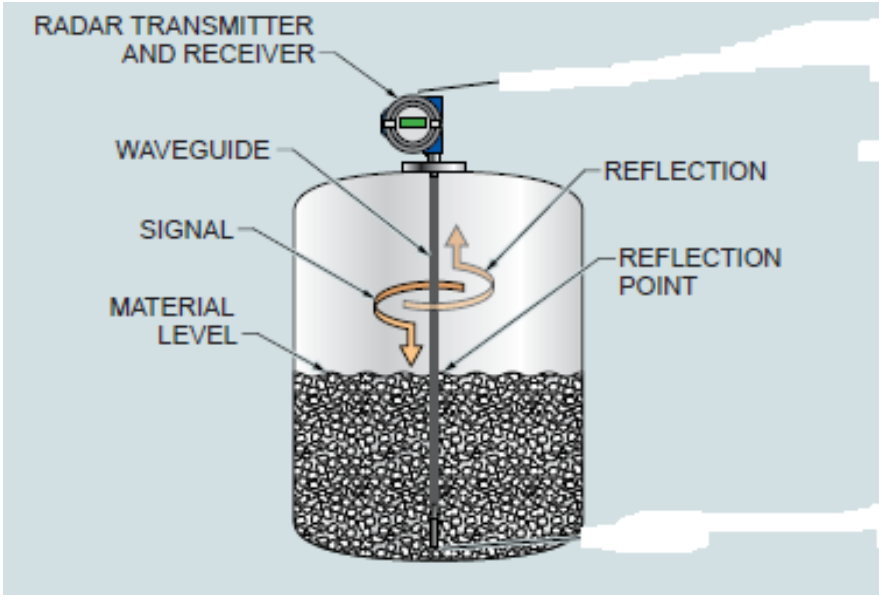
4.4



ONE mark for each correctly labelled part
NOTE: Any other acceptable sketch (6)
(34)

QUESTION 5

5.1 5.1.1 A piston cylinder load cell produces hydraulic output pressure✓ proportional to the applied load,✓ while the strain gauge load cell assemblies provide an electrical output✓ proportional to the applied load.✓ (4)

5.1.2 A strain gauge load cell typically has a beam, column or other stress member✓ with strain gauges bonded to it.✓ When a weight load is impressed against a member, the strain gauge is deformed✓ and its electrical resistance changes.✓ The balance of the bridge provides an output that is proportional to the force acting upon the load cell.✓ (5)

5.2
- A simple calibration method uses physical weights✓ piled onto the vessel a little at a time, checking the indicated weight against the actual applied weight.✓
- Another calibration method uses known amounts of liquid✓ added to the vessel as the calibration weight.✓
- The final method uses a portable load cell calibration system, a readout instrument and hydraulic jacks.✓ The jacks are positioned in line with the calibration load cells to simulate loads on the vessel.✓ (6)

5.3 5.3.1 The weight of an object is the force on a mass due to the pull of gravity,✓✓ which gives rise to the following formula:
Weight (w) = mass (m) × gravity (g) (2)

5.3.2 Density is defined as the mass per unit volume of a material,✓✓
e.g. pound per cubic foot (lb/ft^3) or kilogram per cubic metre (kg/m^3). (2)

5.3.3 1 kg/m^3 = 0,1084 lb/ft^3
500 kg/m^3 = Y lb/ft^3✓

$$Y = \frac{500 \times 0{,}1084}{1} = 54{,}2 \text{ lb/ft}^3$$✓✓ (3)

5.4 The three types of strain gauge load cells are shear,✓ compression✓ and tension.✓ (3)
[25]

QUESTION 6

6.1 6.1.1 A turbidity analyser is an instrument used to measure the cloudiness or haziness of a fluid✓ caused by individual particles or suspended solids✓ that are generally invisible to the naked eye.

6.1.2 A humidity analyser is a device that indirectly measures the amount of moisture✓ by sensing changes in the physical or electrical properties of materials due to their moisture.✓

6.1.3 A pH analyser is used to measure the concentration✓ of hydrogen ions in a solution.✓

OR

A pH analyser is used to measure the acidity or alkalinity✓ of a solution. ✓

6.1.4 A viscosity analyser is used to measure the relative amount of water vapour✓ present in the air or a gas.✓

6.1.5 A dissolved oxygen analyser continuously measures the concentration of oxygen✓ by promoting a desired chemical reaction✓ and then measuring the reaction product.

(5 × 2) (10)

6.2
- Hair hygrometer
- Resistive hygrometer or resistive humidity sensor
- Capacitive hygrometer
- Piezoelectric or sorption hygrometer
- Wet- and dry-bulb hygrometers
- Electrolytic hygrometer
- Dew point hygrometer

(Any 5 × 1) (5)

6.3 6.3.1 This is achieved by cooling the air or gas✓ until water condenses on an object✓ and then measuring the temperature at which condensation takes place.✓ A mirror surface, polished stainless steel or silvered surface✓ is cooled from the back side✓ by cold water, refrigeration or Peltier cooling.✓ As the temperature drops, a point is reached where dew from the air or gas starts to form on the mirror surface.✓ The condensation is detected by the reflection of a beam of light✓ by the mirror to a photocell.✓ The intensity of the reflected light✓ reduces as condensation takes place✓ and the temperature of the mirror at that point can be measured.✓ (12)

6.3.2 Oxidation-reduction potential (3)

6.3.3
- Oxidation means a molecule or element loses electrons.
- Reduction means electrons are added to a molecule. (2)

[32]

QUESTION 7

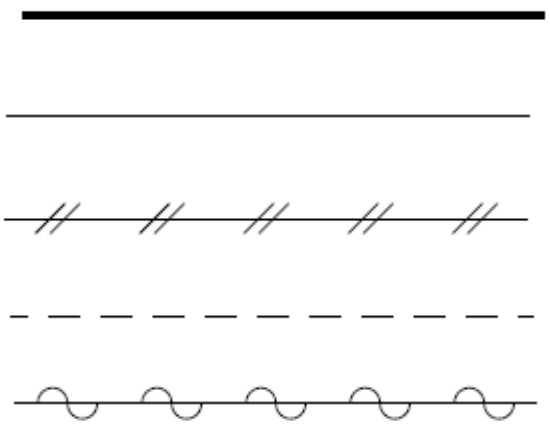
7.1 7.1.1

7.1.2

7.1.3

7.1.4

7.1.5



(5 × 2) (10)

7.2 A safety system is a system that consists of an individual device or an assembly of devices that form a system designed to protect personnel from injury✓ and production equipment from damage.✓ (2)

7.3
- Safety relief valves
- Interlock (burner control systems)
- Trips
- Fuel safety shutoff valves
- Alarm systems
- Hazardous atmosphere detectors (Any 5 × 1) (5)

7.4
- Open to alarm is an alarm that provides a fail-safe alarm signal and should always be used with safety systems.✓✓
- Close to alarm is an alarm that can be used for normal non-safety alarms.✓ This arrangement minimises nuisance alarms,✓ but may fail to provide an alarm signal if there is a broken wire or communications failure.✓ (5)

7.5
- Electrical signals can be used over many kilometres.
- There is negligible time lag in terms of signal travel.
- Information loss is very limited, as the output is linear.
- The electrical systems are not sensitive to vibrations.
- Current transmission is normally not affected by distance and the associated voltage losses.
- Current signal is also virtually immune to noise pickup. (Any 5 × 1) (5)

7.6 7.6.1 An actuator is a device that provides the power and motion to manipulate the moving parts of a valve.✓ An actuator must respond quickly to a change in control signal✓ and have enough power to overcome the process pressure✓ and mechanical friction of the moving parts.✓ (4)

7.6.2 A positioner is a device used to ensure the positive position of a valve.✓ 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)
[34]

TOTAL SECTION B: 125
GRAND TOTAL: 150

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