higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N6

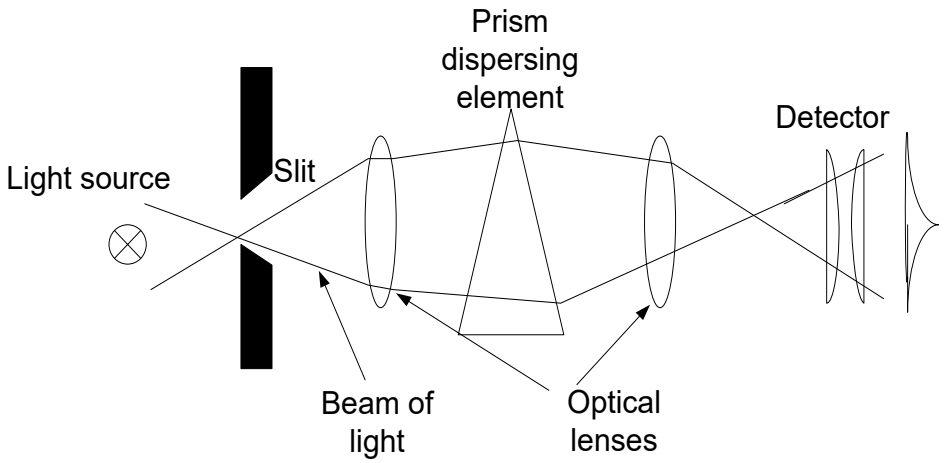
19 November 2024

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QUESTION 1: ANALYSERS

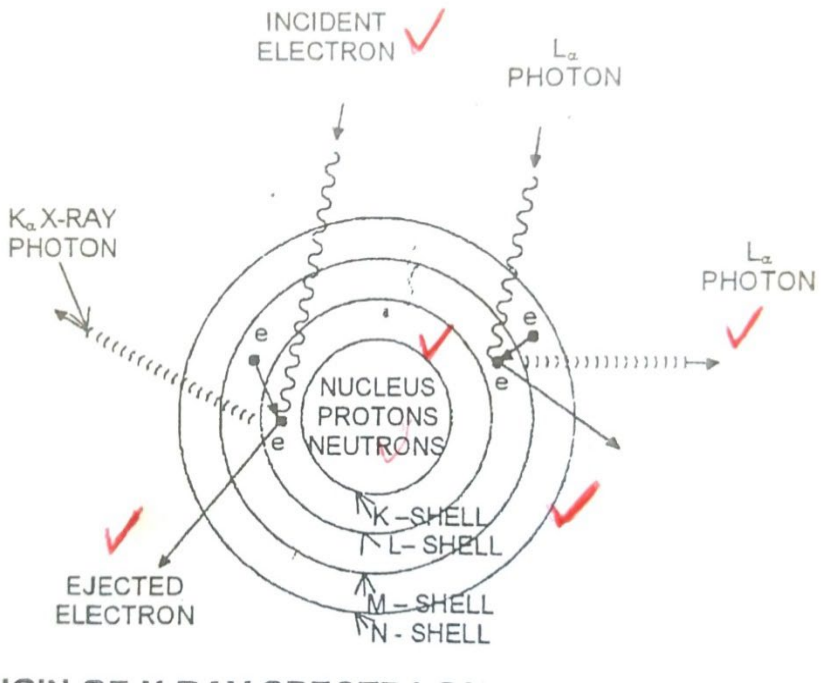
1.1 1.1.1



(6)

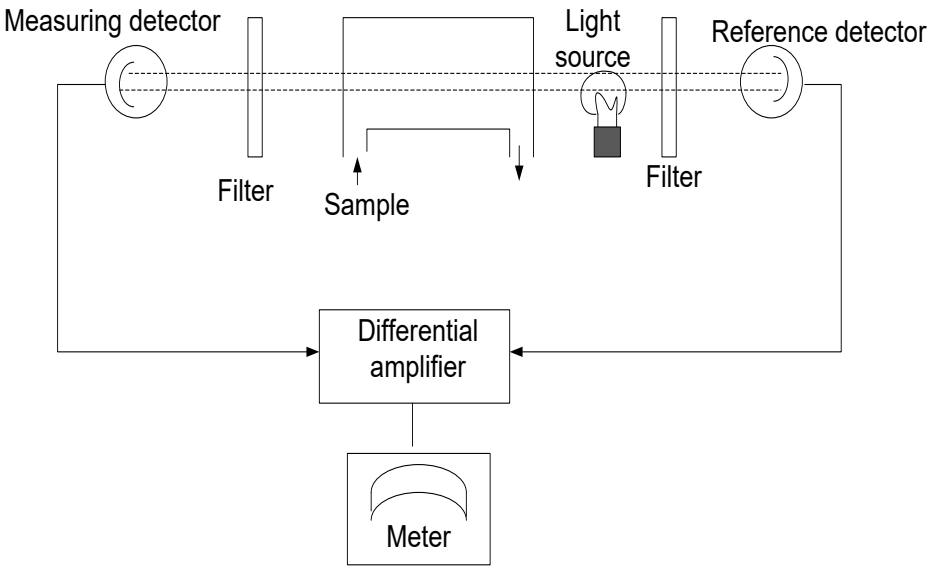
1.1.2 Measurement of the chemical elements in samples of matter is obtained by thermally exciting (heating) the sample to produce emitted radiation✓ which is passed through the narrow slit.✓ This radiation is collimated and dispersed by the prism to produce a spectrum of slit images✓ according to wavelength in the focal plane of the spectrograph.✓ The image densities are then measured with a densitometer and compared with the density recordings from known samples.✓ (5)

1.2



(5)

1.3 1.3.1



(6)

1.3.2
- Radiation from the source is partially absorbed in passing through the sample.
- The filter is elected to isolate the wavelengths in which only the component of interest will be absorbed.
- Radiation at the analytical wavelength striking the measuring detector is absorbed strongly by the component whose concentration is being measured.
- Radiation at the reference wavelength is directed to the reference detector and absorbed weakly or not at all by the component.
- An amplifier compares the outputs of the two detectors and the difference in their outputs is related to the ultraviolet energy absorbed by the sample. (5)

1.4
- Fluctuation and drift of the light source
- Dirt or bubbles in the sample cell
- Drift in the detector circuit (3)

QUESTION 2: AUTOMATIC CONTROL AND VALVES

2.1 2.1.1 Offset is the difference between the process variable and the point of process equilibrium (set point).

2.1.2 A property of the plant when, in the absence of a controller, equilibrium is reached after a disturbance for any fixed set of conditions.

2.1.3 Split range is when one common controller signal commands two or more control valves.

(3 × 2) (6)

2.2 $$Q = \frac{6000l}{hr} = 6\ m^3/h$$✓

$$\Delta P = 6 - 3{,}6 = 2{,}4\ bar$$✓

$$G_f = \frac{G \times 273}{T} = \frac{1 \times 273}{273+6} = 0{,}9785$$✓

$$C_v = 1.16Q\sqrt{\frac{G_f}{\Delta P}}$$✓

$$C_v = 1.16 \times 6\sqrt{\frac{0{,}9785}{2{,}4}} = 4{,}444$$✓✓ (6)

2.3 Due to the Bernoulli, there is a sharp reduction in pressure when the flow passes across the seat of a valve.✓ If this reduced pressure drops below the vapour pressure of the fluid, sudden evaporation may occur, i.e. fluid flashes.✓✓ (3)

2.4
- The ultimate gain✓ K_u and the ultimate period✓ P_u of the system are determined.
- The ultimate gain is the maximum allowable gain of the controller in proportional mode for which the system is stable.
- The ultimate period is the period of the oscillations that occurs when the controller is controlling at this ultimate gain. (3 × 2) (6)

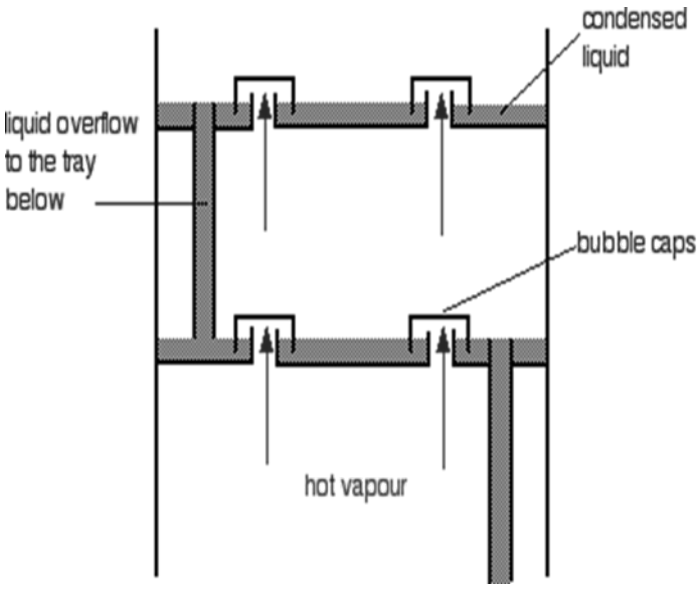
2.5
- Not all processes are the same, therefore not all processes can tolerate cycle conditions.
- Some control systems have characteristics making these equations inapplicable.
- The curves should be taken under the most unstable load and set point conditions of the process.
- A continuous process cannot stay stable long enough to obtain representative curves resulting from a step change only. (4)

[25]

QUESTION 3: DISTILLATION COLUMN AND BOILERS

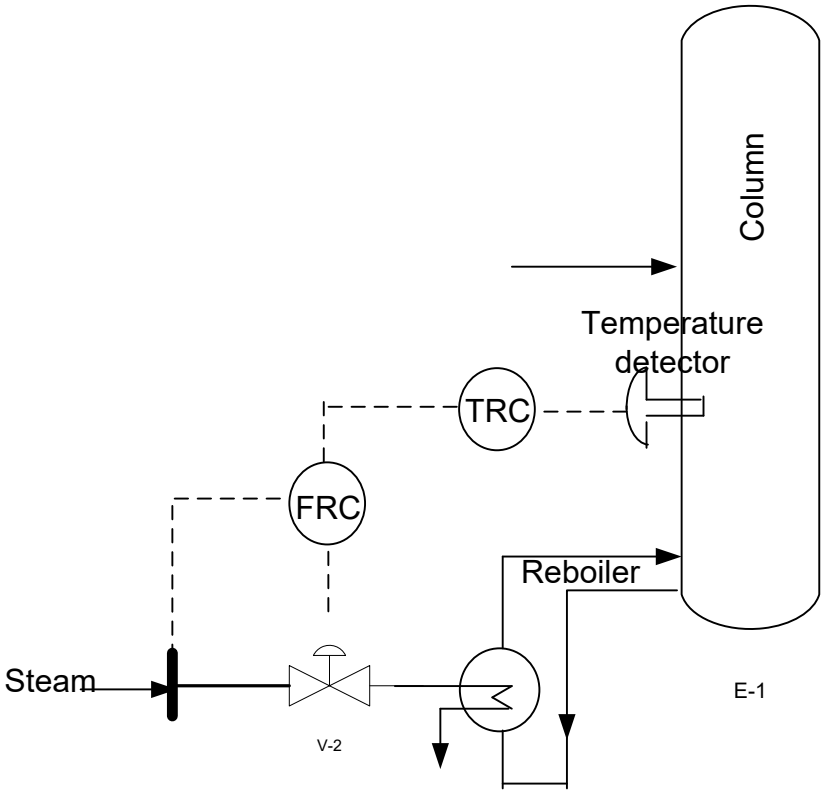
3.1 The main purpose of distillation is to separate a mixture of several components into their individual components✓ by heating the mixture until its more volatile constituents pass into vapour phase,✓ and then cooling the vapour to recover such constituents in liquid form by condensation.✓ (3)

3.2



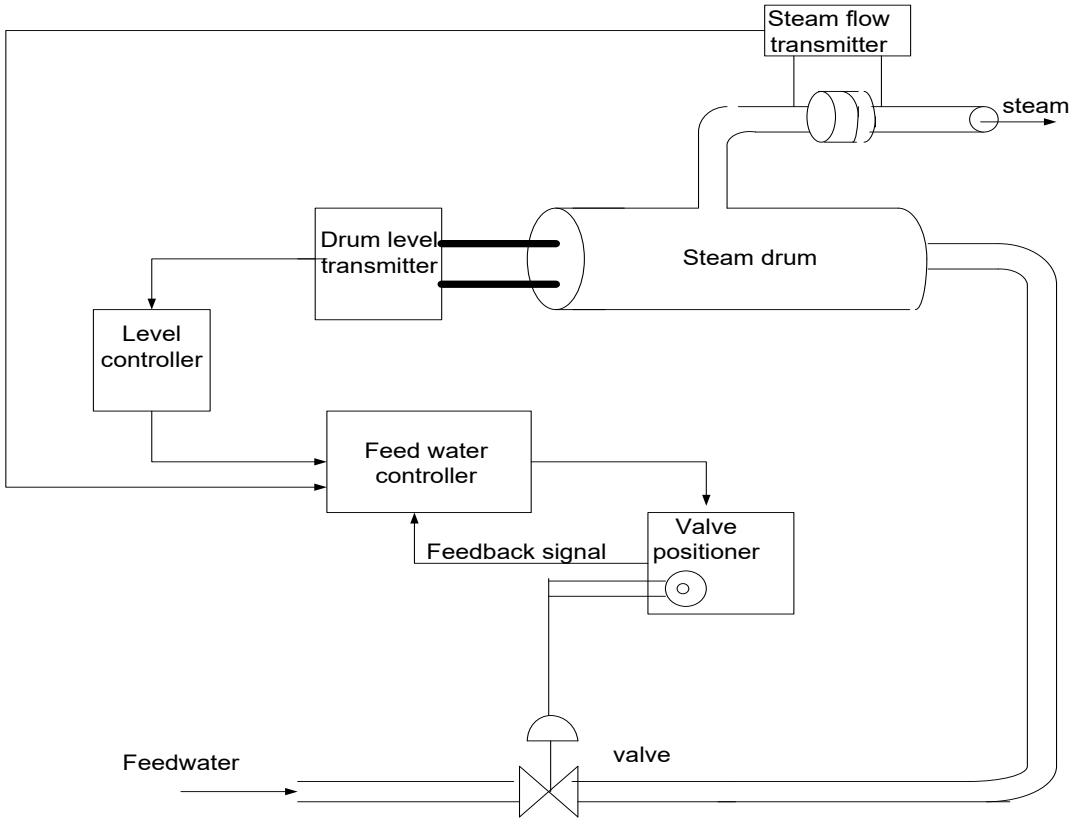
(4)

3.3



(5)

3.4



With two-element control, steam flow rate is measured and transmitted to a proportional positioning controller which compares the flow rate to the desired set point.✓✓ If any deviation exists, a control signal is transmitted to the feed water controller to increase or decrease the feed water flow.✓✓ A secondary signal is also sent to the feed water controller from the drum level controller. In effect, the drum level controller modifies the set point or control point of the steam-feed water system as necessary to correct for level changes resulting from unequal steam and feed water flows.✓✓ (12)

3.5

- Air foil segment
- Burner differential
- Boiler differential
- Air heat differential
- Venturi section
- Piezometer ring
- Orifice segment
- Venturi section of flow tube (Any 6 × 1) (6)

[30]

QUESTION 4: INTRINSIC SAFETY

4.1
- The presence of a flammable liquid, gas, dust or fibre in an ignitable concentration
- Presence of a source of ignition
- When the source comes in contact with the ignitable material (3)

4.2
- The enclosure must withstand a hydrostatic pressure of four times the maximum pressure observed during the explosive test
- The enclosure must not have an external case temperature high enough to ignite the surrounding atmosphere (2)

4.3 This test is conducted with all secondary winding short-circuited✓ and primary windings at rated voltage for six hours✓ or until burnout,✓ whichever occurs first. The transformer must not ignite during the test.✓ (4)

4.4
- Class I —Locations in which flammable gases or vapours may or may not be in sufficient quantities to produce explosive or ignitable mixtures.
- Class II—Locations in which combustible dust, either in suspension, intermittently, or periodically may or may not be in sufficient quantities to produce explosive or ignitable mixtures.
- Class III—Locations in which ignitable fibres may or may not be in sufficient quantities to produce explosive or ignitable mixtures. (3 × 2) (6)

[15]

TOTAL: 100

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