



**higher education  
& training**

Department:  
Higher Education and Training  
**REPUBLIC OF SOUTH AFRICA**

# **MARKING GUIDELINE**

**NATIONAL CERTIFICATE**

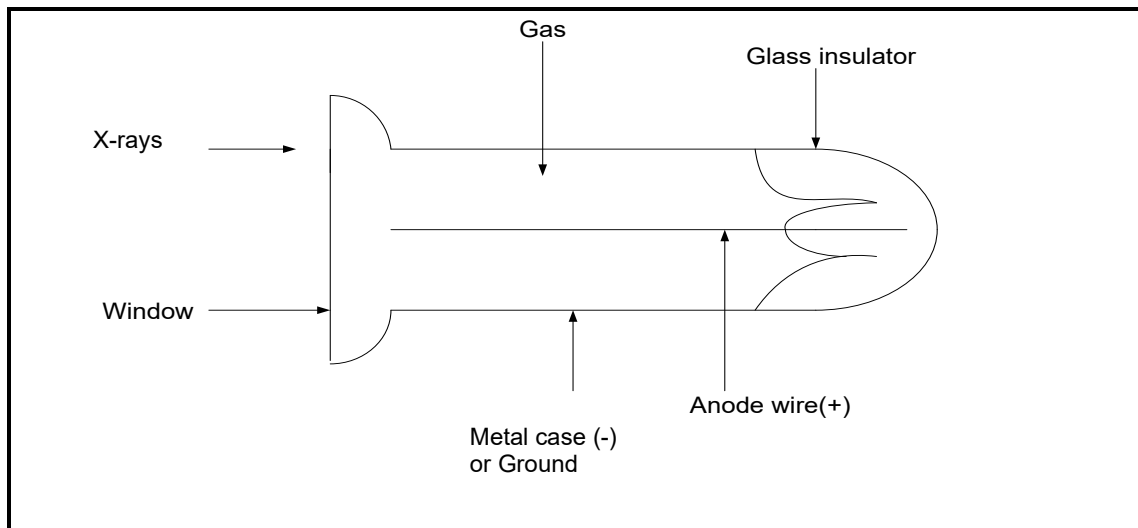
**INDUSTRIAL INSTRUMENTS N6**

**24 JULY 2018**

**This marking guideline consists of 7 pages.**

**SECTION A: ANALYSERS****QUESTION 1**

1.1



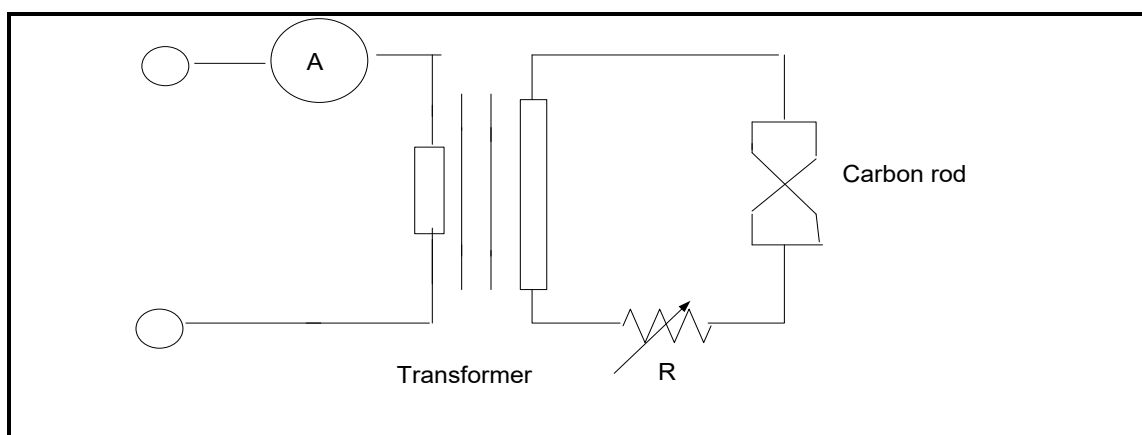
(5)

1.2

- It is a small tube filled with gas at a pressure less than the atmospheric pressure with a fine-wire anode stretched along its axis.
- A potential of 500 to 3 000 V is placed between the wire and the metal shell, so that X-ray photons entering the tube will initiate a cumulative ionisation process, giving rise to an electric impulse.
- X-rays enter the counter at one end through a window of X-ray transparent material.
- Counters are filled with a mixture of argon or krypton with a trace of chloride or another halogen gas.
- The output of the tube is connected to a suitable amplifier and counting circuit.

(5)

1.3



(3)

The arc makes use of a high voltage and is self-starting, as voltage produced on the secondary of the transformer is sufficient to break down the electrode gap. The arc strikes alternately from each electrode on each cycle.

(2)

- 1.4      1.4.1      F  
           1.4.2      G  
           1.4.3      A  
           1.4.4      B  
           1.4.5      C  
           1.4.6      D

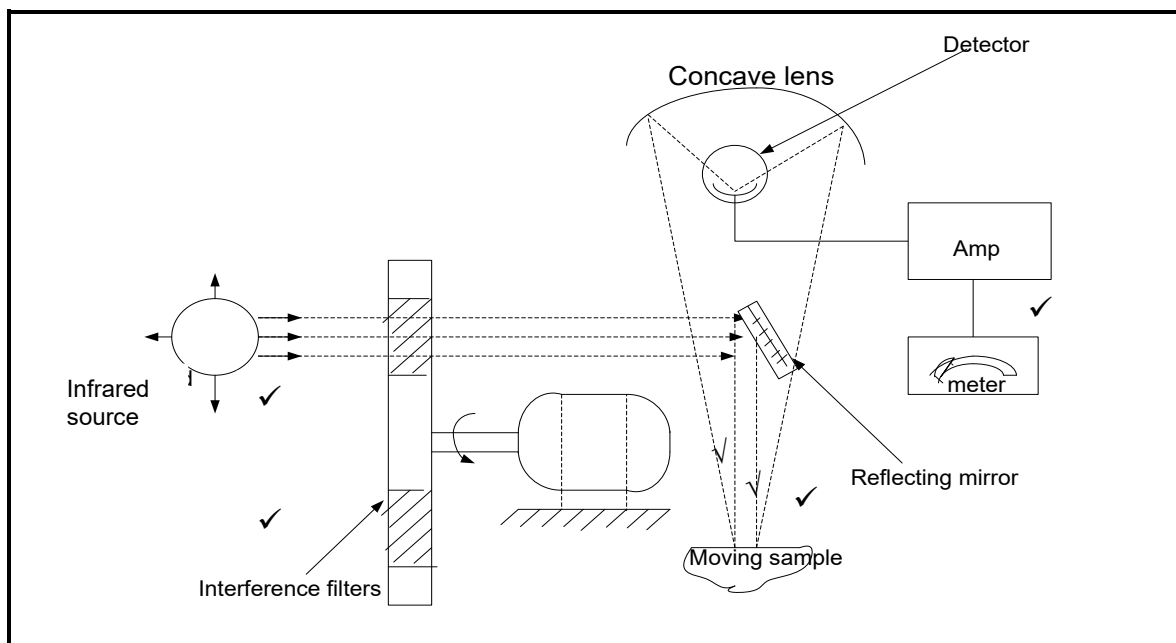
(6 × 1)      (6)

- 1.5      The amount of absorption of a specific wavelength of infrared energy which is proportional to the gas concentration in the mixture

When energy of a given frequency passes through a compound with molecules of the same vibration frequency, the energy is absorbed by the molecules causing its natural vibration to increase, thus radiation energy is absorbed and converted to kinetic energy.

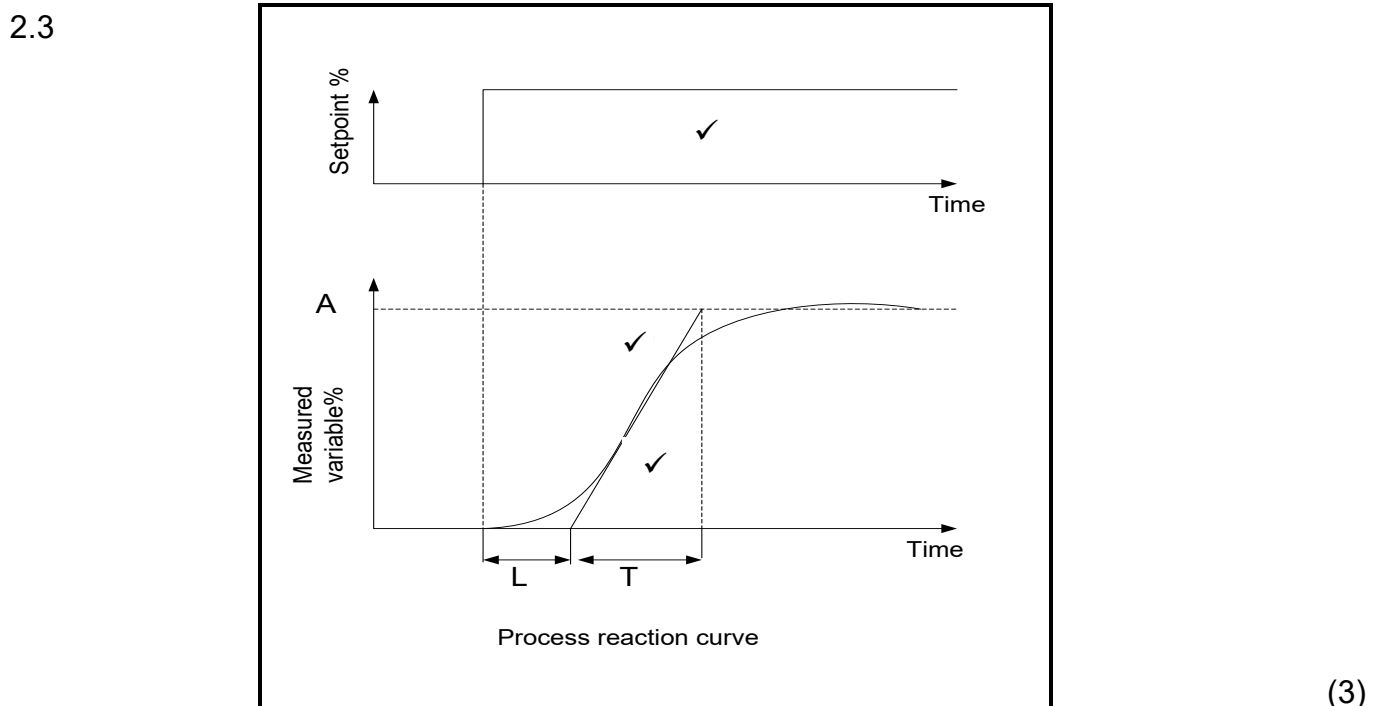
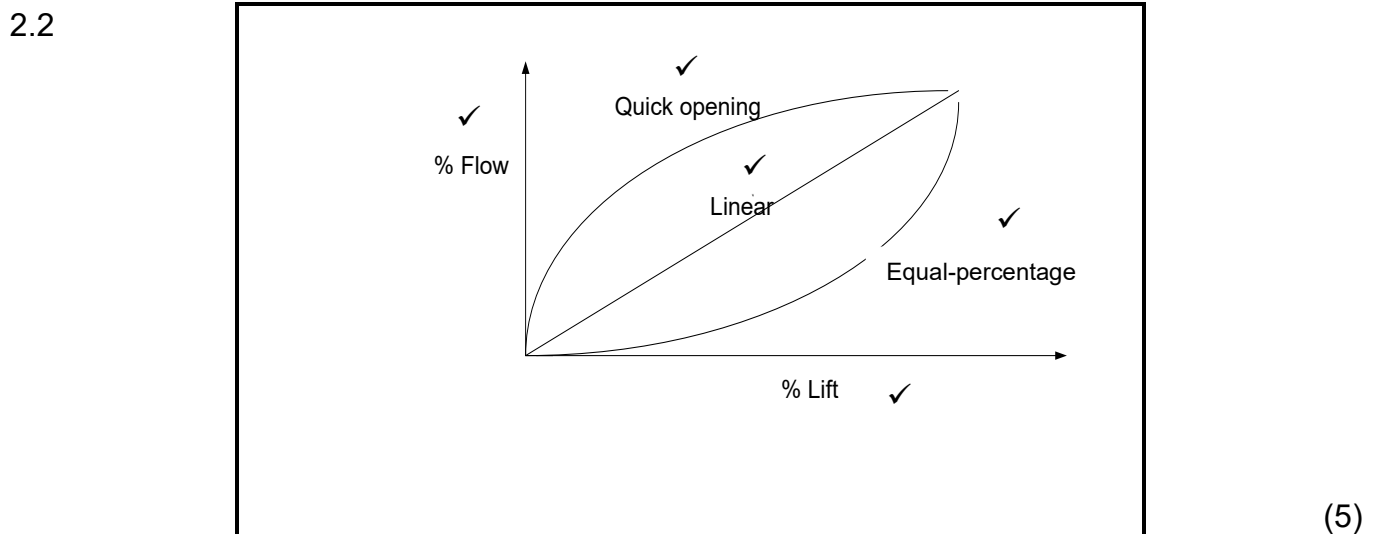
(3)

1.6

(6)  
[30]**TOTAL SECTION A:      30**

**SECTION B: AUTOMATIC CONTROLLERS AND VALVES****QUESTION 2**

- 2.1
- Split range control is when one common controller signal commands two or more control valves.
  - Override control is when two or more control loops are connected to a common valve in such a way that under normal conditions, the normal control loop is in command of the valve. However, if some abnormal conditions arise, one of the other loops automatically takes over control to keep operation within safe limits.
- (2 × 2) (4)



A tangent is drawn onto the process reaction curve at the point of inflection as shown in the sketch.✓

L is the time between the step change and the point where this tangent straight line crosses the initial value of the controlled variable.✓

By analysing the reaction curve, the controllability of the loop can be accessed with reasonable accuracy from two characteristics of the reaction curve:

- The reaction rate(T)✓
- The time lag(L) (3)

2.4 2.4.1 It is the time taken for a detecting element to reach equilibrium with the process so that the detecting element accurately represents the process. (2)

- 2.4.2
- It is the time taken for the process to respond to the correcting element. The rate of the response will depend on the capacity of the process, the content of the process and the rate of transfer.
  - When a process is heated up, the delay in time for the whole process to reach the desired temperature is called process lag. (Any 1 × 2) (2)

- 2.5
- *Proportional band*(%) =  $1,6 Pbu = 1,6 \times 52 = 83,2\%$
  - *Integral rate*  $\left(\frac{r}{min}\right) = \frac{2}{pu} = \frac{2}{0,5} = 4 r/min$
  - *Derivative time*(min) =  $\frac{Pu}{8} = \frac{0,5}{8} = 0,0625 min$  (3 × 2) (6)
- [25]**

**TOTAL SECTION B: 25**

## SECTION C: DISTILLATION COLUMN AND STEAM BOILERS

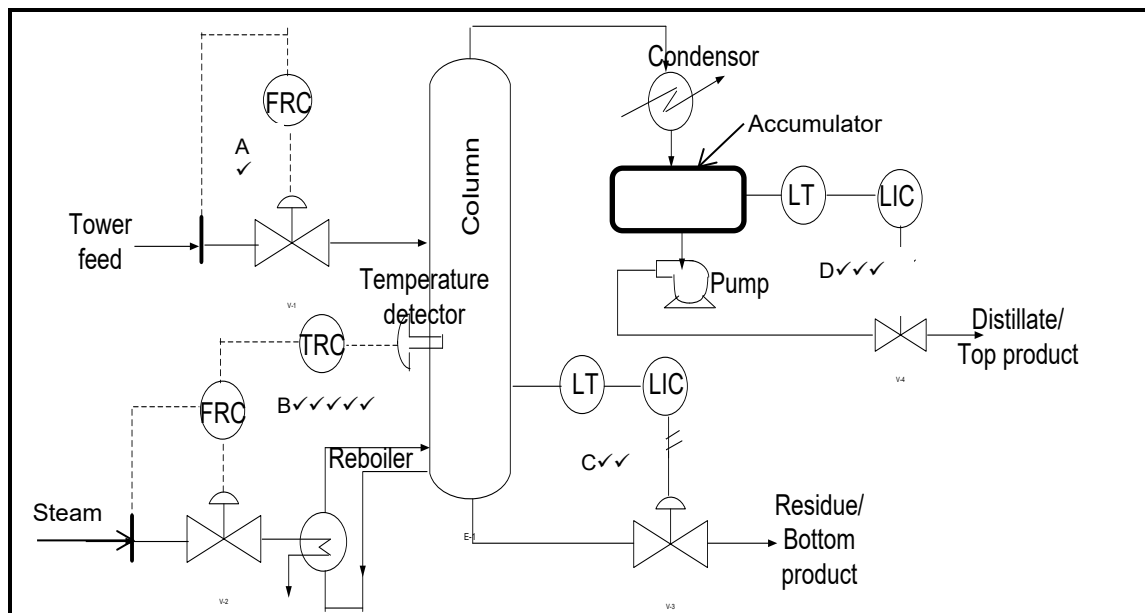
### QUESTION 3

- 3.1 The liquid mixture (e.g. butane = lighter material and pentane = heavier material), that has to be separated, is fed into the middle of the distillation column. If the temperature is varied, some of the lighter material will go into vapour phase, but also some of the heavier material. The vapour phase, however, is richer in lighter material than heavier material. This vapour is then allowed to condense and vaporised again. Repeating this process, will result in pure lighter material as the top product and heavier material as the bottom product. (5)
- 3.2 Small boilers with relatively high storage volumes and slow changing loads (2)
- 3.3 Integral action should not be used because of the resulting instability, which is due to integration of the swell on load changes which must later be removed. (2)

## 3.4 Air-to-open control valve

When air supply stops, the control valve must close the supply of fuel. (2)

## 3.5



(11)

## 3.6

- Most distillation control systems are based on maintaining the column pressure at some constant value.
- Any variation of pressure will upset the control system, by changing the equilibrium condition of the material in the column.
- A set point for pressure is a compromise between two extremes.
- The pressure must be high enough to cause condensation of the overhead vapours
- by heat exchange with the cooling medium (chilled water).
- On the other hand, the pressure must be low enough to allow evaporation of the bottom liquid
- by heat exchange with the heating medium (steam).
- It is usually more economical to select the lowest pressure.

(8)  
[30]**TOTAL SECTION C: 30****SECTION D: INTRINSIC SAFETY****QUESTION 4**

## 4.1

- Flammable substance✓ – It needs to be present in a sufficient quantity to produce an ignitable or explosive mixture.✓
- Oxidiser✓ – It must be present in a sufficient quantity in combination with a flammable substance to produce an explosive mixture. Most common is air (O<sub>2</sub>).✓
- Source of ignition✓ – A spark or high heat must be present.✓ (3 × 2) (6)

- 4.2 The flash point of a flammable liquid is the lowest temperature at which a sufficient quantity of vapour will arise to permit ignition under laboratory conditions. (2)
- 4.3
- Explosion-proof method
  - Intrinsically safe method
  - Dust-ignition-proof method
  - Nonincentive technique
- (4)
- 4.4
- Hazardous locations are areas where flammable liquids, gases or vapours or combustible dusts exist in sufficient quantities to produce an explosion or fire.
  - Hazardous locations can also be described as those locations where electrical equipment might be installed and which, by their nature, might present a condition which could become explosive if the elements for ignition are present.
  - Hazardous locations are locations where both a fuel and an ignition source are present under normal and abnormal conditions. (Any 3 × 1) (3)
- [15]**
- TOTAL SECTION D: 15**  
**GRAND TOTAL: 100**