higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## CHEMICAL TECHNOLOGY N6

**23 JULY 2018**

**This marking guideline consists of 9 pages.**

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## QUESTION 1

1.1 1.1.1 Screen-conveyor dryer
1.1.2 Rotary dryer
1.1.3 Screw-conveyor dryer
1.1.4 Tower dryer
1.1.5 Spray dryer

(5 × 2) (10)

1.2 A tray dryer contains a number of trays in which the material to be dried is placed.✓ Hot air passes over the trays and carries away the evolved water vapour.✓ When the material becomes sufficiently dry, the tray and the dry tray contents are removed.✓ Some tray driers are operated batch-wise✓ and some are operated continuously with the trays containing the wet material entering one end of the drier✓ and, passing slowly through the unit, it emerges at the outlet end with most of the water removed.✓ (6)

1.3
- A tower dryer contains a series of circular trays mounted one above the other on a central rotating shaft.
- Solid feed passes on the top tray and is exposed to a stream of hot air or gas.
- The steam passes across the tray.
- The solid is then scraped off and dropped to the tray below.
- It travels in this way through the dryer, discharging from the bottom of the tower as dry product. (5)

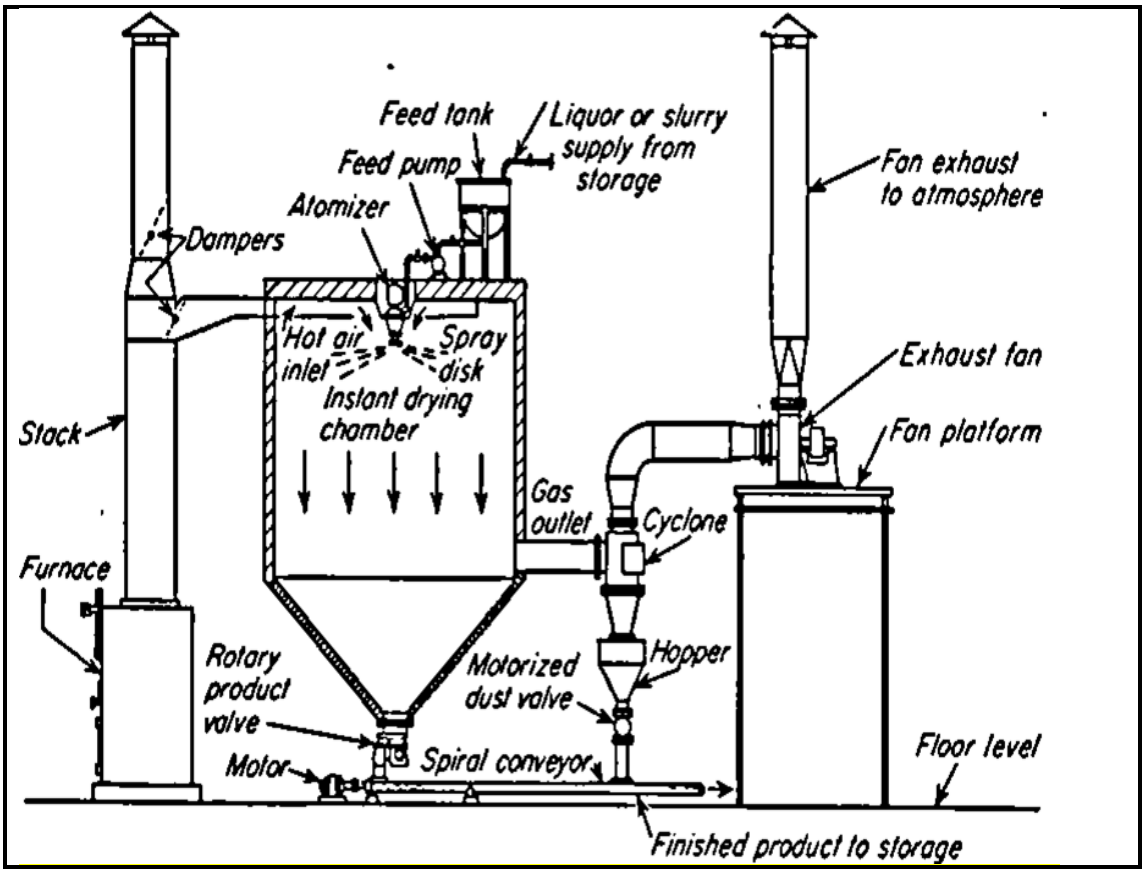
1.4 1.4.1 Equilibrium moisture content is the number of kilograms of water✓ per kilogram of dry solid when the drying limit has been gained✓ by using air at any given temperature✓ and humidity.✓ (4)

1.4.2 Freeze drying is the sublimation of water vapour✓ from ice under high vacuum✓ at temperatures below 0 °C.✓ (3)

1.4.3 If a gas is passed over a wet solid,✓ the rate of drying is the kilograms of water✓ removed per hour.✓ (2)

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1.5




(20)
**[50]**

## QUESTION 2

2.1
2.1.1 large super saturation
2.1.2 poor magma circulation
2.1.3 abnormal needle-like growth
2.1.4 whisker-like growth
2.1.5 crystals

(5 × 1) (5)

2.2
2.2.1 Frothing
2.2.2 Capacity
2.2.3 Economy
2.2.4 Düring's rule
2.2.5 Evaporation

(5 × 1) (5)

2.3 2.3.1 A new solute may be created chemically by adding a third component✓ that will react with the original solute✓ and form an insoluble substance.✓

2.3.2 The third component may act physically✓ by forming with an original solvent,✓ a mixed solvent in which the solubility of the solute is sharply reduced.✓

(2 × 3) (6)

2.4
- Cluster
- Embryo
- Cluster
- Crystals

(4)

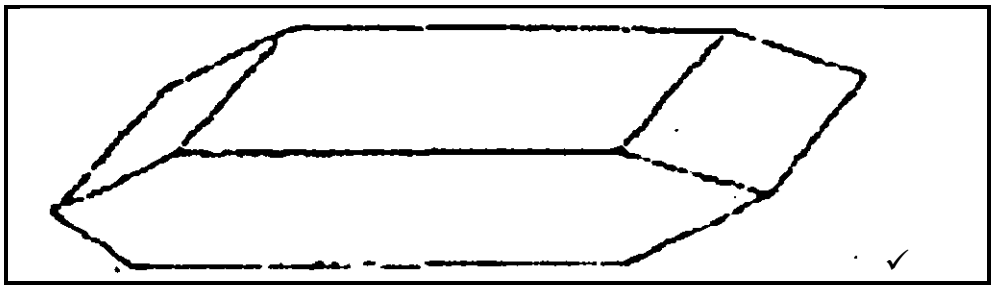
2.5 2.5.1 A small crystal can be in equilibrium with a supersaturated solution.✓ Such equilibrium is unstable✓ because if a large crystal is also present in the solution,✓ the smaller crystals will dissolve✓ and the larger ones will grow✓ until the small crystals disappear.✓

2.5.2 The equilibrium vapour pressure✓ exerted by a component in a liquid solution✓ equals the mole fraction of that component✓ in the solution times the equilibrium vapour pressure the component would exert if it was pure✓ and at the same temperature as the solution.✓

$\rho_a = x_a P_a$✓

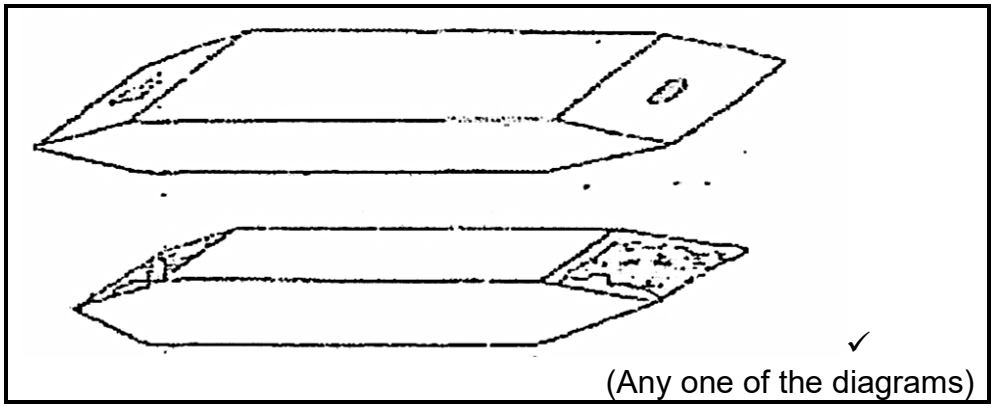
(2 × 6) (12)

2.6 2.6.1



✓

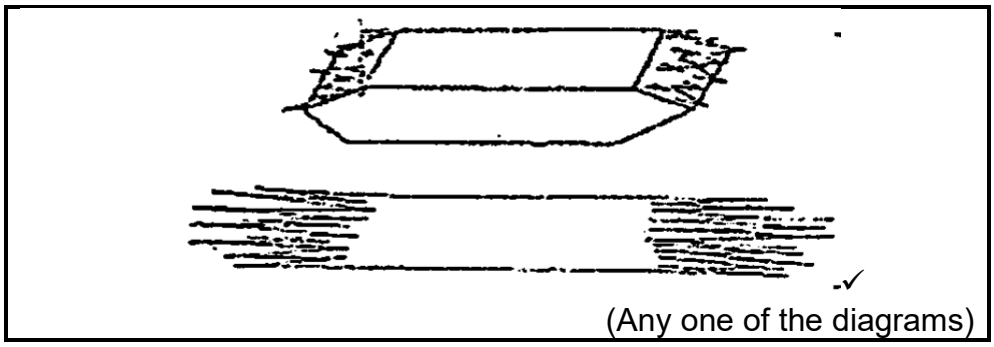
2.6.2



✓

(Any one of the diagrams)

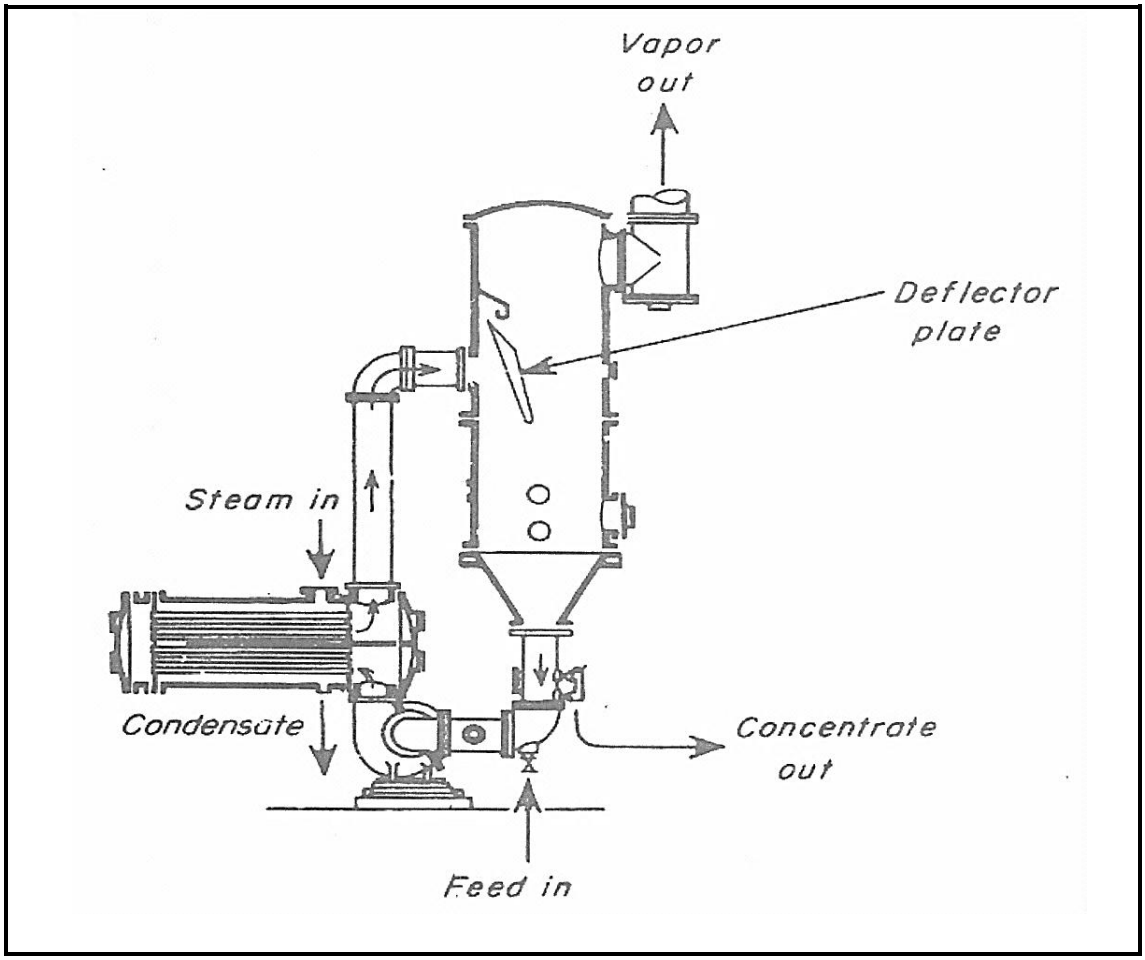
2.6.3



(Any one of the diagrams)

(3 × 1) (3)

2.7




(2 marks must be awarded for the figure) (8)

2.8
- Purity
- Yield
- Energy requirement
- Rates of nucleation and growth (4)

2.9
- High cost
- Internal moving parts which may require considerable maintenance
- Small capacity of single units (3)

**[50]**

## QUESTION 3

3.1
3.1.1 False
3.1.2 True
3.1.3 True
3.1.4 False
3.1.5 True

(5 × 2) (10)

3.2 3.2.1 A body which absorbs all radiant energy✓ received on its surface but reflects✓ and transmits none.✓ (3)

3.2.2 The amount of radiant energy emitted✓ is proportional to the fourth power✓ of the absolute temperature of the heat source.✓ (3)

3.2.3 The instantaneous rate of heat transfer through a homogeneous body by conduction✓ is directly proportional to the temperature difference driving force✓ across the body and to the cross-sectional area of the body✓ through which heat flows. The rate of heat transfer is inversely proportional✓ to the thickness of the body (the length of the path along which heat flows).✓ (5)

3.3
- Reynolds number
- Prandtl number
- Nusselt number
- Péclet number
- Grashof number
- Stanton number (Any 4 × 1) (4)

3.4 In most industries, heat is transferred from one point to another under steady conditions of:

- Temperature difference
- Length of heat-flow path
- Cross-sectional area (3)

3.5
- Chemical method
- Mechanical method (2)

3.6
- Conduction
- Convection
- Radiation (3)

3.7
- Start up
- Shut down
- Steam condensate (3)

3.8
- Fluid
- Total influent
- Fluid condensed or fluid vaporised
- Specific gravity of the fluid
- Viscosity
- Molecular weight of the vapour
- Heat capacity
- Latent heat
- Temperature in or inlet temperature
- Temperature out or outlet temperature
- Design temperature
- Pressure gauge at the inlet or inlet pressure gauge
- Design pressure gauge
- Allowance pressure drop
- Tube layout
- Tube material
- Tube size
- Space limitation
- Position of the heat exchanger (Any 10 × 1) (10)

3.9 $A = \frac{Q}{U\Delta T}$

$= \frac{20\ 000}{90 \times 45}$✓

$= 4{,}938\ \text{m}$ ✓
$= 4{,}938 \times 100$✓
$= 493{,}8\ \text{cm}$ ✓ (4)
**[50]**

**QUESTION 4**

4.1 4.1.1 The decrease in the moisture content of air✓ by an operation where water✓ is transferred from a vapour state to a liquid state✓ (3)

4.1.2 The ratio of the actual humidity of air✓ to the humidity if the air is saturated✓ at the same temperature and total pressure✓ (3)

4.1.3 The amount of heat required to raise the temperature✓ of 1 kg of dry air plus any contained moisture of 1 °C✓ (2)

4.1.4 The volume in $m^3$ occupied by 1 kg of dry air✓ at any specified temperature and pressure plus sufficient water vapour to✓ saturate the air✓ (3)

4.1.5 If a dry thermometer covered with respect to any thermal radiation✓ is placed in air, the thermometer will give✓ a temperature reading as dry-bulb temperature✓ (3)

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4.2
- Natural-draught/Hyperbolic-type cooling tower
- Mechanical-draught cooling tower
- Hybrid or wet/dry cooling tower
- Forced-draught cooling tower (4)

4.3 Adiabatic humidification lines present the relationship between temperature✓ (t) and humidity (H) at different values✓ of the adiabatic saturation temperature.✓ (3)

4.4 The saturated volume of air✓ versus temperature is presented by the curve.✓ (2)

4.5 A mechanical-draught tower may employ forced draught with the fan at the bottom✓ or induced draught with the fan driving the moist air out at the top.✓ In the tower, the temperature of the liquid falls✓ and the temperature and humidity of the air rises.✓ The limiting temperature to which the water can be cooled is the wet-bulb temperature corresponding to the condition of the air inlet.✓ The enthalpy of the air stream does not remain constant,✓ since the temperature of the liquid changes rapidly in the upper position of the tower.✓ Towards the bottom, the temperature of the liquid changes less rapidly because the temperature difference is smaller.✓ At the top of the tower, the temperature falls from the bulk of the liquid to the interface.✓ Thus the liquid is cooled by transfer of sensible heat and by evaporation at the surface/interface.✓ (10)

4.6 4.6.1

$$H_S = \frac{18\,P_S}{29\,(P - P_S)}$$

$$= \frac{18\,(5)}{29\,(101{,}3 - 5)}$$ ✓✓

$$= 0{,}032 \text{ kg per kg of dry air}$$ ✓✓

$$H_a = 0{,}018$$ ✓

$$H_P = \frac{H_a}{H_S} \times 100$$

$$= \frac{0{,}018}{0{,}032} \times 100$$ ✓

$$= 56{,}25\%$$ ✓✓ (8)

4.6.2 $H_a = \frac{18\ P_a}{29\ (P\ - P_a)}$

$0{,}018\ = \frac{18\ P_a}{29\ (101{,}3 - P_a\ )}$ ✓✓

$0{,}522\ (101{,}3 - P_a) = 18\ P_a$✓

$27{,}6026 - 0{,}522\ P_a = 18\ P_a$

$18{,}522\ P_a = 27{,}6026$

$P_a = 1{,}49$ KPa✓✓

$H_R = \frac{P_a}{P_s} \times 100$

$= \frac{1{,}49}{5} \times 100$✓✓

$= 29{,}8\ \%$✓✓ (9)

**[50]**

**TOTAL: 200**

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