higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T340**(E)**(J23)T

NATIONAL CERTIFICATE

CHEMICAL TECHNOLOGY N6

(15040106)

23 July 2018 (X-Paper)
09:00–12:00

Calculators may be used.

This question paper consists of 6 pages and 1 formula sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
CHEMICAL TECHNOLOGY N6
TIME: 3 HOURS
MARKS: 200

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Sketches must be large, neat and fully labelled.
5. Write neatly and legibly.

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QUESTION 1

1.1 Give ONE term for each of the following descriptions. Write only the term next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 Dryer with a chamber consisting of a series of separate sections each with its own fan and air heater

1.1.2 Dryer where wet feed enters one end of the cylinder and dry material discharges from the other end

1.1.3 Dryer were solid feed in one end is conveyed/pushed slowly through the heated zone and discharges from the other end

1.1.4 Dryer where solid feed dropped on the topmost tray is exposed to a stream of hot air or gas which passes across the tray for a short time

1.1.5 Dryer where moisture is rapidly vaporised from droplets leaving the residual particles of dry solids which are then separated from a gas stream

(5 × 2) (10)

1.2 Write brief notes on the tray dryer. (6)

1.3 Describe the operation of a tower dryer. (5)

1.4 Define each of the following terms:

1.4.1 Equilibrium moisture content (4)

1.4.2 Freeze drying (3)

1.4.3 Rate of drying (2)

1.5 Draw and label a diagram of a spray dryer. (20)
[50]

QUESTION 2

2.1 Complete the following paragraph by writing down the missing word or words next to the question number (2.1.1–2.1.5) in the ANSWER BOOK.

Growth-related spurious nucleation occurs at (2.1.1) … or accompanies (2.1.2) … and is characterised by (2.1.3) … and (2.1.4) … from the end of the (2.1.5) … which, under these conditions, may grow much faster than the sides. (5 × 1) (5)

2.2 Give ONE answer for each of the following descriptions. Write only the answer next to the question number (2.2.1–2.2.5) in the ANSWER BOOK.

2.2.1 Mass of bubbles that forms on the surface of a liquid

2.2.2 Number of kilograms (kg) of water vaporised per hour

2.2.3 Number of kilograms (kg) vaporised per kilograms (kg) of steam fed to the unit

2.2.4 Linear relationship that exists between the temperature at which two solutions exert the same vapour pressure

2.2.5 Operation where fluid changes from a liquid state to a vapour state

(5 × 1) (5)

2.3 Define each of the following terms:

2.3.1 Precipitation

2.3.2 Salting

(2 × 3) (6)

2.4 List FOUR stages of the evolution of crystals in sequence. (4)

2.5 Write brief notes on each of the following:

2.5.1 Ostwald ripening

2.5.2 Raoult's law

(2 × 6) (12)

2.6 Draw the structure of each of the following:

2.6.1 Good growth

2.6.2 Veiled growth

2.6.3 Spikewise growth

(3 × 1) (3)

2.7 Draw and label the structure of a forced-circulation evaporator. (8)

2.8 List FOUR principles of crystallisation. (4)

2.9 Give THREE disadvantages of an agitated-film evaporator. (3)

[50]

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QUESTION 3

3.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (3.1.1–3.1.5) in the ANSWER BOOK.

3.1.1 Logarithmic-mean values of heat transfer areas are applicable to open cylindrical bodies or circular section.

3.1.2 The design of a heat exchanger is customary to allow for fouling effects by adding extra heating surface areas.

3.1.3 Most heat exchangers are equipped with floating heads or expansion joints to handle the volume changes of metallic parts with temperature variation.

3.1.4 The fraction of incident radiation absorbed by a material is called emissivity.

3.1.5 Cooling towers are widely used by industrial concerns to reduce the amount of water purchased and to decrease softening costs.

(5 × 2) (10)

3.2 Define each of the following:

3.2.1 Black body (3)

3.2.2 Stefan-Boltzmann law (3)

3.2.3 Fourier's law (5)

3.3 List FOUR dimensional numbers used in heat-transfer calculations. (4)

3.4 Name THREE steady conditions of heat transfer in a homogeneous body. (3)

3.5 Name TWO methods of cleaning a heat exchanger. (2)

3.6 List THREE methods of heat transfer. (3)

3.7 List THREE standard methods of operating a heat exchanger. (3)

3.8 Name 10 items needed for the design of a heat exchanger. (10)

3.9 Calculate the area (in cm) of heat transfer on a metal body if 20 000 J of heat is transferred, the overall heat coefficient is 90 $J/m^2.K$ and the change in temperature is 45 °C. (4)

[50]

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QUESTION 4

4.1 Define each of the following terms:

4.1.1 Dehumidification (3)

4.1.2 Percentage humidity (3)

4.1.3 Humid heat (2)

4.1.4 Saturated volume (3)

4.1.5 Dry-bulb temperature (3)

4.2 Name FOUR types of cooling towers. (4)

4.3 Write brief notes on adiabatic humidification lines. (3)

4.4 Write brief notes on air volume lines. (2)

4.5 Write notes on the mechanical draught tower. (10)

4.6 A room is at $1{,}112 \times 10^2$ Pa (abs) and contains 0,018 kg H_2O vapour per kg of dry air. The room temperature is 32,9 °C. The saturation vapour pressure of water is 5 kPa.

Determine the following:

4.6.1 Percentage humidity of air (8)

4.6.2 Percentage relative humidity of air (9)

[50]

TOTAL: 200

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FORMULA SHEET

$$Q = UA\Delta t$$

$$qs = mCp\Delta t$$

$$Q = q_S + q_V$$

$$qv = m^1 h_{fg}$$

$$Q(TOTAL\ ) = \left(K\ A\ \Delta\frac{t}{x}\right) + (\ K\ A\ \Delta\frac{t}{x})^2 + (\ K\ A\ \Delta\frac{t}{x})^3$$

$$\frac{1}{UA} = \frac{1}{h^1 A^1 f} + \frac{1}{h^{11} A^{11} f} + \frac{x_w}{K.A_w}$$

$$\Delta t_{lm} = \frac{\Delta t_2 - \Delta t_1}{ln\frac{\Delta t_2}{\Delta t_1}}$$

$$H_a = \frac{18Pa}{29(P - pa)}$$

$$H_S = \frac{19Ps}{29(P - ps)}$$

$$H_P = H_R\left(\frac{P - ps}{P - pa}\right)$$

$$H_R = \frac{Pa}{Ps} \bullet 100$$

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