higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

CHEMICAL PLANT OPERATION N5

(8050015)

9 April 2020 (X-paper)
09:00–12:00

Calculators may be used.

This question paper consists of 5 pages and 1 addendum.

187Q1A2009

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
CHEMICAL PLANT OPERATION N5
TIME: 3 HOURS
MARKS: 100

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

Give a word or term for each of the following descriptions. Write only the answer next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The form or manifestation of energy that flows from one object or system to another under the influence of temperature difference

1.2 Amount of heat required to raise the temperature of one gram of water from 14,5 °C to 15,5 °C

1.3 Operation in which conditions within the process or system do not change with time, that is, from one moment to another

1.4 It refers to the difference in energy between the products of the reaction and the reactants

1.5 A mixer that is used for dry powders and thin pastes

(5 × 1) **[5]**

QUESTION 2

Choose a description from COLUMN B that matches an item in COLUMN A. Write only the letter (A–F) next to the question number (2.1–2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1	Steam turbine	A	cyclone
2.2	Vaporising burner	B	used for dense solids in liquids and heavy dry powders
2.3	Centrifugal separator	C	nozzle and blades
2.4	Tumbling mixer	D	cigarette lighters
2.5	Banbury	E	used for dry powders and thin pastes
		F	used for heavy, stiff or gummy materials

(5 × 1) **[5]**

QUESTION 3

3.1 Determine the heat of reaction, at 1 000 K and one atmosphere of the following reaction: ½ H_2 + ½ $C\ell_2$ → $HC\ell$

Given: The heat of formation of hydrogen chloride is -92 300 kJ/Kmol. (10)

3.2 Describe the operation of the following:

3.2.1 Radial flow turbines

3.2.2 Axial flow turbines

(2 × 4) (8)

3.3 Name TWO types of gas turbines. (2)
[20]

QUESTION 4

4.1 Name and briefly describe the criteria for the good combustion of fuel. (8)

4.2 Draw a neat, fully labelled diagram of a nozzle-discharge centrifuge. (8)

4.3 Write brief notes on the operation of a cyclone. (7)

4.4 Name TWO types of blades used in a two-arm kneader. (2)
[25]

QUESTION 5

5.1 The composition of the combined feed to a reactor at entrance and the products leaving the reactor is as follows:

	Combined feed (mol%)	Product from reactor (mol%)
C_6H_{14}	0 mol percent	5,0 mol percent
C_7H_{14}	0 mol percent	15,0 mol percent
C_8H_{18}	3,1 mol percent	20,0 mol percent
$C_{11}H_{24}$	8,5 mol percent	23,8 mol percent
$C_{12}H_{24}$	18,2 mol percent	12,2 mol percent
$C_{15}H_{32}$	35,2 mol percent	10,0 mol percent
$C_{18}H_{36}$	35,0 mol percent	14,0 mol percent

Use the C-atom balance to calculate the ratio of the number of moles of the product leaving the reactor to the number of moles of the combined feed. (10)

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5.2 Briefly explain the operation of the following:

5.2.1 Atomising oil burners (5)

5.2.2 Impact wheels (6)
[21]

QUESTION 6

6.1 Write brief notes on the following:

6.1.1 Two-arm kneader

6.1.2 Muller mixer

(2 × 5) (10)

6.2 What are the FOUR conditions to be considered when maximising the chemical conversion of sulphur dioxide to sulphur trioxide? (4)

6.3 State FIVE uses of nitric acid. (5)

6.4 State THREE methods used in the preparation of nitric acid. (3)

6.5 Balance the following reaction:

$C_6H_6 + Cl_2 \rightarrow$ (2)
[24]

TOTAL: 100

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ADDENDUM

Mean molar heat capacities of gases at constant pressure [kJ/(kmol.K)]

K	H_2	N_2	CO	Air	O_2	$HC\ell$	$C\ell_2$	H_2O	CO_2	SO_2	SO_3	CH_4	C_2H_4	C_2H_6	NH_3
298	28.84	29.13	29.18	29.18	29.39	29.13	33.99	33.57	37.57	40.14	50.69	35.79	43.74	52.87	35.50
400	29.01	29.21	29.32	29.32	29.75	29.19	34.57	33.94	39.23	41.68	54.77	38.31	48.85	59.31	37.21
500	29.15	29.35	29.45	29.45	30.18	29.24	35.16	34.40	40.07	43.32	58.42	41.03	53.71	65.56	38.76
600	29.19	29.53	29.67	29.69	30.65	29.32	35.58	34.93	42.72	44.81	61.63	43.84	58.29	71.56	40.19
700	29.24	29.98	29.98	30.02	31.14	29.43	35.86	35.35	44.15	46.11	64.40	46.69	62.46	77.26	41.55
800	29.31	30.27	30.27	30.34	31.60	29.60	36.10	35.90	45.43	47.23	66.80	49.46	66.26	83.30	42.89
900	29.36	30.61	30.61	30.64	32.00	29.78	36.30	36.49	46.54	48.17	68.85	52.23	69.73	87.39	44.23
1000	29.46	30.93	30.93	30.94	32.37	30.00	36.45	37.08	47.56	49.01	70.27	54.66	72.91	91.93	45.56
1100	29.57	31.24	31.24	31.27	32.70	30.25	36.59	37.68	48.50	49.75	72.27	57.06	75.91	96.20	46.86
1200	29.69	31.56	31.56	31.56	33.02	30.49	36.74	38.29	49.35	50.43	73.72	59.43	78.66	100.00	48.16
1300	29.89	31.84	31.84	31.93	33.32	30.75	36.85	38.89	50.10	51.01	75.11	61.49	81.15	103.09	49.44
1400	30.07	32.09	32.09	32.13	33.60	31.00	36.94	39.45	50.82	51.53	76.36	63.47	83.51	107.17	50.71
1500	30.23	32.34	32.34	32.38	33.84			40.01	51.43						
1600	30.39	32.58	32.58	32.61	34.05			40.56	51.99						
1700	30.56	32.79	32.79	32.79	34.23			40.03	52.54						
1800	30.75	32.67	33.00	33.01	34.40			41.47	53.18						
1900	30.97	32.86	33.20	33.24	34.66			41.84	53.43						
2000	31.12	33.03	33.37	33.41	34.83			42.53	53.74						
2100	31.32	33.20	33.52	33.56	34.98			42.98	54.25						
2200	31.48	33.35	33.70	33.70	35.12			43.41	54.56						

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