higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

PLANT OPERATION THEORY N3

(11040023)

13 April 2021 (X-paper)
09:00–12:00

Nonprogrammable calculators and drawing instruments may be used.

This question paper consists of 5 pages and 1 formula sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
PLANT OPERATION THEORY N3
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. Use only a black or blue pen.
5. Write neatly and legibly.

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QUESTION 1: CHEMISTRY AND CHEMICAL PROCESSES

1.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 The formula of rubber is C_5H_8.

1.1.2 Polyethylene has no available double bonds for vulcanisation.

1.1.3 An exothermic reaction absorbs heat energy.

1.1.4 Safety glasses are the function of PVC plastic.

1.1.5 Molecular masses of polymers are usually high, depending on the degree of polymerisation in solution.

(5 × 1) (5)

1.2 Explain the following:

1.2.1 Homogenous catalyst (2)

1.2.2 Vulcanisation (2)

1.2.3 Polythene (3)

1.3 Give a chemical reaction to produce ethanol by means of a cracking process. (3)

1.4 State FOUR properties of thermoplastic polymers such as PVC. (4)

1.5 Sketch the structures of the following:

1.5.1 Teflon (3)

1.5.2 Butadiene (3)

[25]

QUESTION 2: COMBUSTION, FUELS AND THERMAL INSULATION

2.1 Explain FIVE properties of a cell-type insulation. (5)

2.2 State THREE points to keep in mind, to prevent failure of insulation. (3)

2.3 Name THREE groups of coal. (3)

2.4 Calculate the theoretical amount of combustion air required for the complete combustion of 6 kg of C_2H_5OH.The combustion takes place in the presence of 3% excess air. (7)

2.5 State TWO advantages of liquid fuel. (2)

[20]

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QUESTION 3: STEAM BOILERS AND STEAM TRAPS

3.1 Steam traps are very important and necessary equipment in the steam line.

3.1.1 State TWO main purposes of steam traps. (2)

3.1.2 Explain the reason to remove gases such as air and O_2 from steam traps. (1)

3.1.3 Explain the reason to prevent steam leakage from steam traps. (2)

3.1.4 Name THREE general designs of steam traps. (3)

3.2 Explain the following:

3.2.1 Latent heat (2)

3.2.2 Dry, saturated steam (4)

3.2.3 Saturation temperature (3)

3.2.4 Economiser (3)

[20]

QUESTION 4: HEAT TRANSFER

4.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (4.1.1–4.1.6) in the ANSWER BOOK.

4.1.1 Convection involves the movement of a fluid or a gas.

4.1.2 The heat transfer coefficient is a constant relating to a specific material.

4.1.3 Pressure loss is when the smaller volume medium goes through the tube and the side of the shell handles the larger volumes.

4.1.4 Finned tube heat exchangers are a common design for water-cooling systems.

4.1.5 An electrical heater is a good example of nuclear energy.

4.1.6 Radiation transfers heat between objects without direct contact.

(6 × 1) (6)

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4.2 Make a labelled sketch to illustrate the thermal resistance of heat transfer within the pipe of heat exchangers with the liquor and steam sides indicating all the thermal resistance factors. (7)

4.3 Name FIVE applications that are in use in the industry for direct heat exchangers. (5)

4.4 Define *heat conduction*. (2)
[20]

QUESTION 5: COMPRESSION, COOLING, PUMPS AND INSTRUMENTATION

5.1 Name TWO types of refrigerant used in absorption refrigeration systems working in combination with water. (2)

5.2 Draw a labelled diagram of an elementary control system. (7)

5.3 State SIX characteristics of a refrigerant. (6)
[15]

TOTAL: 100

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FORMULA SHEET

Any applicable formula may be used.

1. $\rho = \frac{p}{gh}$
2. $V = \ell bh$
3. $V = \pi \frac{d^3}{6}$
4. $V = 4\pi \frac{r^3}{3}$
5. $V = x\left(\frac{\pi d^2 h}{12} + V_1\right)$
6. $\Delta P = \rho gh$
7. $V = \pi \frac{d^2}{4} \times h$
8. $p = \frac{F}{A}$
9. $A = \pi r^2$
10. $A = \pi \frac{d^2}{4} = \pi r^2$
11. $\rho_1 gh = \rho_2 gh$
12. $Q = Av$
13. $k = \frac{Q}{\sqrt{h}}$
14. $E = \frac{mv^2}{2}$
15. $E = mgh$
16. $V = \pi DN$
17. $V = \frac{a}{t}$
18. $V = \sqrt{2gh}$
19. $PA = mg$
20. $h_{su} = m\{(h_f + gh_{fg}) + C_s(t_{su} - t_s) - (C_w \times t_w)\}$
21. $m = \rho v$
22. $A = \frac{F}{p}$
23. $Pv = cT$
24. $m = \frac{Pv}{RT}$
25. $n = \frac{Pv}{R_0 T}$
26. $V = A\ell NnR$
27. $K = \frac{Qx}{A\Delta t}$

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