higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

PLANT OPERATION THEORY N2

(11040012)

6 August 2021 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

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

225Q1G2106

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
PLANT OPERATION THEORY N2
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. Start each question on a new page.
5. Only use a black or blue pen.
6. Write neatly and legibly.

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QUESTION 1

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The unit for measuring energy is joule.

1.2 Energy variables can be defined as the power to do work and are measured in Watt.

1.3 In the stripping section of a distillation tower, the heavy products also become a vapour.

1.4 Hydrogen refers to a noble-gas structure.

1.5 Newton per square meter equals Pascal.

(5 × 1) **[5]**

QUESTION 2: CHEMISTRY

2.1 A certain atom has an atomic number of eight (8) and a mass number of sixteen (16).

2.1.1 Give the name of this atom. (2)

2.1.2 Draw a neat, labelled sketch of an atom showing all parts. (6)

2.2 Give the name of each of the following groups in the periodic table of elements:

2.2.1 Group I

2.2.2 Group VII

(2 × 2) (4)

2.3 Alkanes burn in air to form gas and water.

2.3.1 Give the name of the gas formed. (2)

2.3.2 List THREE physical properties of alkanes. (3)

2.3.3 Draw the structure of cyclopropane and write its molecular formula. (4)

2.4 Show, with the aid of an appropriate chemical reaction, the method for the preparation of hydrogen by the action of water on metals. (6)

[27]

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QUESTION 3: ENERGY AND FLUID FLOW

3.1 Explain the term *total equivalent pressure head* and give the formula to calculate the pressure head. (5)

3.2 A pump system used to empty a well has a 25 m inlet with a radius of 5 m.

Calculate:

3.2.1 The work done, in megajoule, by the pump to empty the well if only 70% can be efficiently recovered. (3)

3.2.2 The input power which is 75% efficient if it takes one second to complete the task.

NOTE: The density of water is 1 000 kg/m^3.

Formulae: $W = V \times \rho \times g \times h \times \mu$
$P = W \div t$
$V = \pi d^2 \div 4$ (4)

3.3 Determine the differential pressure across an orifice in a pipe when the flow is 16 000 litres per hour if the same orifice creates a pressure difference of 25 kPa when the flow is 12 000 litres per hour. (5)

3.4 3.4.1 Name TWO types of viscosity and give its units. (2 × 2) (4)

3.4.2 Explain how pressure and temperature influence the viscosity of fluids. (2 + 2) (4)
[25]

QUESTION 4: DISTILLATION AND FRACTIONATION

4.1 What is the difference between the *top* and *bottom* products produced during distillation? (3 + 3) (6)

4.2 Explain the reflux in a distillation process. (4)

4.3 Draw a neat, labelled sketch of a typical packed distillation tower with a condenser and reflux drum. (8)

4.4 Explain the term *cracking*. (3)
[21]

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QUESTION 5: INSTRUMENTATION

5.1	Name TWO scales that can be used to measure temperature.		(2)
5.2	Explain, with the aid of a sketch, how the linear expansion of metals is used for measuring temperature.		(6)
5.3	Give FOUR advantages and TWO disadvantages of a pitot tube.	(4 + 2)	(6)
5.4	Briefly define and explain the operating principle of flow-rate meters.		(8)
			[22]
		TOTAL:	**100**

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FORMULA SHEET

Any applicable formula may be used.

1. $\rho = \frac{p}{gh}$
2. $V = lbh$
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. $\Delta P = \rho g h$
7. $V = \pi\frac{d^2}{4} \times h$
8. $\rho = \frac{F}{A}$
9. $A = \pi d^2$
10. $A = \pi\frac{d^2}{4} = \pi r^2$
11. $A = 4\pi r^2$
12. $R = \frac{output}{input} \times 100\%$
13. $\rho_1 g h = \rho_2 g h$
14. $Q = Av = C$
15. $k = \frac{Q}{\sqrt{h}}$
16. $E = \frac{mv^2}{2}$
17. $E = mgh$
18. $V = \pi DN$
19. $V = \frac{a}{t}$
20. $V = \sqrt{2gh}$
21. $PA = mg$
22. $h_{su} = m\{\rightleftarrows(h_f + gh_{fg}) + C_s(t_{su} - t_s) - (C_w \times t_w) \rightleftarrows \rightleftarrows\}$
23. $m = \rho v$
24. $A = \frac{F}{p}$
25. $K = \frac{mv^2}{2}$
26. $K = W\ddot{y}$
27. $Pv = cT$
28. $m = \frac{Pv}{RT}$
29. $n = \frac{Pv}{R_0 T}$
30. $V = A\ell NnR$
31. $K = \frac{Qx}{A\Delta t}$

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