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Department:  
Higher Education and Training  
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL CERTIFICATE**  
**PLANT OPERATION THEORY N2**

(11040012)

**31 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

**DEPARTMENT OF HIGHER EDUCATION AND TRAINING**  
**REPUBLIC OF SOUTH AFRICA**  
NATIONAL CERTIFICATE  
PLANT OPERATION THEORY N2  
TIME: 3 HOURS  
MARKS: 100


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**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]**

**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<sup>3</sup>.

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]

**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**

**FORMULA SHEET**

Any applicable formula may be used.

1.  $\rho = \frac{p}{gh}$

17.  $E = mgh$

2.  $V = lbh$

18.  $V = \pi DN$

3.  $V = \pi \frac{d^3}{6}$

19.  $V = \frac{a}{t}$

4.  $V = 4\pi \frac{r^3}{3}$

20.  $V = \sqrt{2gh}$

5.  $V = x \left( \frac{\pi d^2 h}{12} + V_1 \right)$

21.  $PA = mg$

6.  $\Delta P = \rho gh$

22.  $h_{su} = m \{ \epsilon (h_f + gh_{fg}) + C_s(t_{su} - t_s) - (C_w \times t_w) \}$

7.  $V = \pi \frac{d^2}{4} \times h$

23.  $m = \rho v$

8.  $\rho = \frac{F}{A}$

24.  $A = \frac{F}{p}$

9.  $A = \pi d^2$

25.  $K = \frac{mv^2}{2}$

10.  $A = \pi \frac{d^2}{4} = \pi r^2$

26.  $K = W\ddot{y}$

11.  $A = 4\pi r^2$

27.  $Pv = cT$

12.  $R = \frac{\text{output}}{\text{input}} \times 100\%$

28.  $m = \frac{Pv}{RT}$

13.  $\rho_1 gh = \rho_2 gh$

29.  $n = \frac{Pv}{R_0 T}$

14.  $Q = Av = C$

30.  $V = A\ell NnR$

15.  $k = \frac{Q}{\sqrt{h}}$

31.  $K = \frac{Qx}{A\Delta t}$

16.  $E = \frac{mv^2}{2}$