higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

**NATIONAL CERTIFICATE**

# PLANT OPERATION THEORY N2

(11040012)

**24 November 2022 (X-paper)**
**09:00–12:00**

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

221Q1E2224

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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

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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. Use only a black or blue pen.
6. Write neatly and legibly.

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## QUESTION 1

Various options are given as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The elements of group I are known as **. . .**

A alkali metals
B halides
C noble gases
D alkali earth metals

1.2 Which ONE of the following groups is classified as halogens?

A Li, Na, K
B Ne, Ar, He
C F, Cℓ, Br
D Be, Mg, Ca

1.3 The chemical formula for aluminium sulphate is **. . .**

A $A\ell SO_4$
B $A\ell_2(SO4)_2$
C $A\ell_2SO_4$
D $A\ell_2(SO4)_3$

1.4 A good example of an alkane is **. . .**

A $C_2H_4$
B $C_2H_6$
C $C_2H_2$
D $C_2H_5OH$

1.5 During the formation of an ionic bond, electrons are **. . .**

A shared equally
B shared unequally
C transferred from a metal to a non-metal
D transferred from a non-metal to a metal

(5 × 1) **[5]**

## QUESTION 2

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (2.1–2.5) in the ANSWER BOOK.

2.1 The density of a fluid is the quantity of the fluid per unit volume.

2.2 The working principle of a pressure-type thermometer is based on Charles' law.

2.3 An increase of vapour rate is due to high temperature or too low pressure.

2.4 The basic metric unit of pressure is newton per square metre.

2.5 $m^3/s$ refers to a rate variable.

(5 × 1) **[5]**

## QUESTION 3

3.1 Define each of the following terms:

3.1.1 Matter

3.1.2 Molecule

(2 × 2) (4)

3.2 Explain what the formula $2C_3H_8$ represents. (3)

3.3 Draw an atomic model of aluminium that clearly shows the number of orbitals, its shape and the number of electrons. (5)

3.4 Complete and balance the following chemical reaction equation:

$CaCO_3 + HC\ell \longrightarrow \ldots + \ldots + \ldots$ (3)

3.5 State with the aid of an applicable chemical reaction, THREE preparation methods used to produce carbon monoxide in the industry.

(3 × 2) (6)

**[21]**

## QUESTION 4

4.1 Explain each of the following concepts:

4.1.1 Latent heat of evaporation (2)

4.1.2 Law of Archimedes (4)

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4.2 Calculate the flow rate in $m^3/s$ of water travelling at 5 m/s in a 24 mm pipe.

Given: $Q = A \times V$ (3)

4.3 A turbine is driven by water from a height of 180 m. The mass rate of water through the turbine is 1 500 kg per minute.

Calculate the power of the turbine.

**HINT**: Pe = mgh where Pe = Work done

$$P = \frac{W}{t}$$ (6)

4.4 A brick of 1,2 tons is lying on a cliff 10 metres high.

Given: $Pe = m \times g \times h$

Calculate the:

4.4.1 Weight of the brick (1)

4.4.2 Potential energy that the brick possess in kJ (3)

4.4.3 Kinetic energy in kJ that the brick will attain if it falls freely a distance of 6 metres (3)

**[22]**

## QUESTION 5

5.1 Briefly explain the term *thermal cracking*. (3)

5.2 5.2.1 Make a sketch of a pressure control system in a column where vacuum fractionation is applied.

5.2.2 Explain the operation thereof.

(5 + 5) (10)

5.3 Name FIVE basic products obtained by a fractionation tower.

(5 × 1) (5)

5.4 Name SEVEN problems one can encounter when operating a fractionation tower.

(7 × 1) (7)

**[25]**

## QUESTION 6

6.1 Explain each of the following concepts:

6.1.1 Absolute pressure

6.1.2 Absolute temperature

(2 × 2) (4)

6.2 List SEVEN components of a float level meter.

(7 × 1) (7)

6.3 A pressure gauge indicates the pressure system to 24,5 kPa.

Calculate the absolute equivalents of that pressure in mm Hg if it is measured at sea level.

Given: $P_{(abs)} = P_{(atm)} + P_{(gauge)}$

760 mm = 101,3 kPa (4)

6.4 Give FIVE advantages and TWO disadvantages of venturi tubes.

(5 + 2) (7)

**[22]**

**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. $\rho = \frac{F}{A}$
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. $\rho_1 gh = \rho_2 gh$
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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