higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T1300**(E)**(A1)T

# NATIONAL CERTIFICATE

# PLANT OPERATION THEORY N2

(11040012)

**1 August 2018 (X-Paper)**
**09:00–12:00**

**A calculator 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 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. Sketches must be large, neat and fully labelled.
5. Write neatly and legibly.

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## QUESTION 1: CHEMISTRY

1.1 Choose an item from COLUMN B that matches a word/term in COLUMN A. Write only the letter (A–F) next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

| COLUMN A | | COLUMN B | |
|---|---|---|---|
| 1.1.1 | Metalloid | A | Mercury |
| 1.1.2 | Iron | B | Alkaline earth metal |
| 1.1.3 | Liquid | C | Silicon |
| 1.1.4 | Calcium | D | Argon |
| 1.1.5 | Noble gas | E | Transitional element |
| | | F | Chlorine |

(5 × 1) (5)

1.2 Make a sketch of the complete structure of an aluminium atom, showing the number of orbitals, their shapes and the number of electrons. Also give the electron configuration. (5)

1.3 Give the IUPAC name of paraffin and acetylene and the formula of each. (4)

1.4 State FOUR uses of hydrogen. (4)

1.5 Write down the formula of each of the following compounds:

1.5.1 Magnesium oxide

1.5.2 Ammonium sulphate

(2 × 1) (2)

1.6 Draw the structural formula of isobutylene. (5)

**[25]**

## QUESTION 2: ENERGY AND FLUID FLOW

2.1 Define or explain the following:

2.1.1 Kinetic energy (2)

2.1.2 Viscosity of fluid (3)

2.2 Explain the concept of latent heat of evaporation and also give ONE example. (4)

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2.3 A pump with 85% efficiency runs for a period of 6 minutes to do 12 MJ of work

Calculate the following

2.3.1 The power of the pump in kW (4)

2.3.2 The power of the source in kW (2)

2.4 A fluid with a linear velocity of 3,5 m/s flows in a pipe with an inside diameter of 40 mm.

Calculate the quantity of fluid flowing in litres per second.

Given: Q = Av (3)

2.5 Determine the linear velocity if the diameter of the pipe is increased to 60 mm with the quantity that you calculated in QUESTION 2.4.

Given: v = Q ÷ A (3)

2.6 An orifice in a pipe creates a pressure of 25 kPa when the flow is 10 000 litres per hour.

Determine the differential pressure across the orifice, when the flow is 15 000 litres per hour. (4)

**[25]**

## QUESTION 3: DISTILLATION AND FRACTIONATION

3.1 Briefly explain the following parts in a fractionation column:

3.1.1 Stripping part (2)

3.1.2 Rectification (3)

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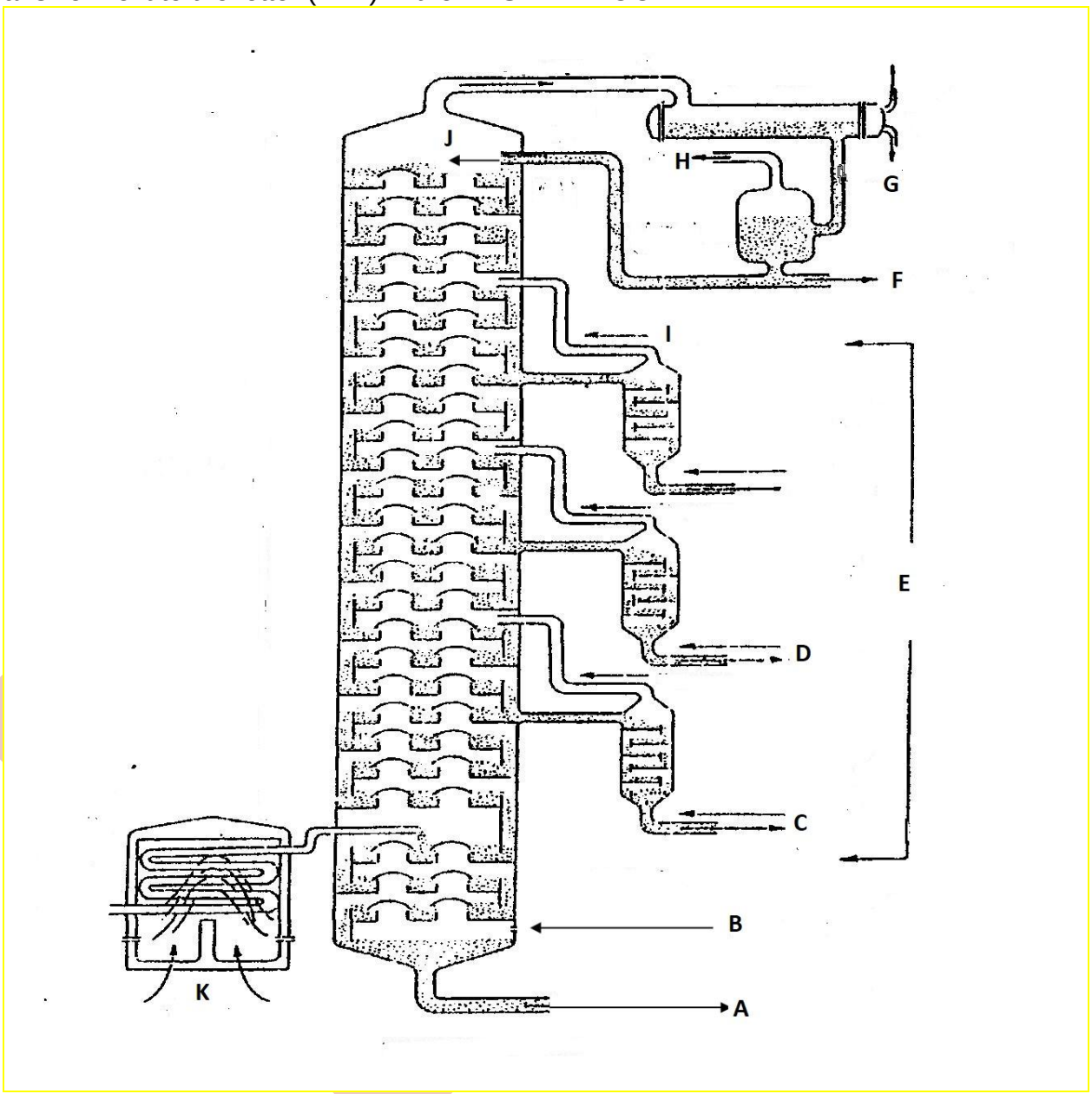
3.2 Label the parts of a crude oil fractionation tower marked A–K. Write only the answer next to the letter (A–K) in the ANSWER BOOK.




(11)

3.3 Explain each of the following:

3.3.1 Partial evaporation

3.3.2 Partial condensation

(2 × 2) (4)

3.4 Give a detailed description of what happens when pressure in a distillation column increases without changing all other variables. (5)

**[25]**

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## QUESTION 4: INSTRUMENTATION

4.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (4.1.1–4.1.5) in the ANSWER BOOK.

4.1.1 A Bourdon tube can be used to measure pressure.

4.1.2 $m^3/s$ refers to a rate variable.

4.1.3 10 °C equals 298 kelvin.

4.1.4 A nucleonic type level meter is suitable to measure the steam level of high pressure boilers.

4.1.5 A venturi tube costs more than an orifice.

(5 × 1) (5)

4.2 Explain the most important requirements of the effective pressure control of any process. (6)

4.3 Explain the difference between the following and state the unit of each:

4.3.1 Heat

4.3.2 Temperature

(2 × 2) (4)

4.4 Name the TWO well-known methods that are used to calibrate pressure gauges. (2)

4.5 Sketch the rotating vane flowmeter operating on the principle of positive displacement. (6)

4.6 Name TWO primary measuring flowmeters used in the industry. (2)

**[25]**

**TOTAL: 100**

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**PLANT OPERATION THEORY N2**

**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. $h_{su} = m\{(h_f + gh_{fg}) + C_s(t_{su} - t_s) - (C_w \times t_w)\}$
23. $m = \rho v$
24. $A = \frac{F}{p}$
25. $K = \frac{mv^2}{2}$
26. $K = W/m^2K$
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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