higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

PLANT OPERATION THEORY N2

(11040012)

1 December 2023 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 pages and a formula sheet.

221Q1G2301

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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 section on a new page.
5. Use only 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 Neutrons have a negative charge.

1.2 H_2 is a component in natural gas.

1.3 Power refers to the work done per mass.

1.4 A Bourdon tube can be used to measure pressure.

1.5 A Venturi tube costs relative more than an orifice.

(5 × 1) **[5]**

QUESTION 2

Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–I) next to the question number (2.1–2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1	Energy of an object due to its position	A	Methane
2.2	The number of electrons found in the 2p orbitals of nitrogen	B	Noble gas
2.3	It is a good example of a chemically very reactive hydrocarbon	C	Watt
2.4	A colourless, odourless gas	D	Kinetic energy
2.5	Unit that measures power	E	$C_{18}H_{38}$
		F	Potential energy
		G	3
		H	Ethene / Acetylene
		I	Joule

(5 × 1) **[5]**

QUESTION 3

3.1 Define the following terms:

3.1.1 Element

3.1.2 Isotopes

(2 × 2) (4)

3.2 Write down the names of the following compounds:

3.2.1 KOH

3.2.2 $CaCO_3$

(2 × 2) (4)

3.3 *Hydrocarbons* are organic compounds that are made up of only carbon and hydrogen.

Name FOUR physical properties of *paraffin*. (4)

3.4 3.4.1 Make a neat labelled sketch of the Haber process used for the manufacturing of *Ammonia* gas.

3.4.2 Describe a test to identify *Ammonia* gas.

(7 + 3) (10)

[22]

QUESTION 4

4.1 Define the following terms:

4.1.1 One *joule* (2)

4.1.2 *Latent* heat of evaporation (3)

4.2 Heat is a form of energy that can be transferred from one form to another.

Explain the different effects that heat will have on a substance. (4)

4.3 A projectile with a mass of 8 kg is shot vertically upwards with an initial velocity of 25 m/s. Calculate the following:

4.3.1 The initial kinetic energy of the projectile. (3)

4.3.2 The height that the projectile would reach. (4)

4.4 Draw a graph to indicate how the loss of pressure in pipes is affected by the diameter of the pipe. (4)

[20]

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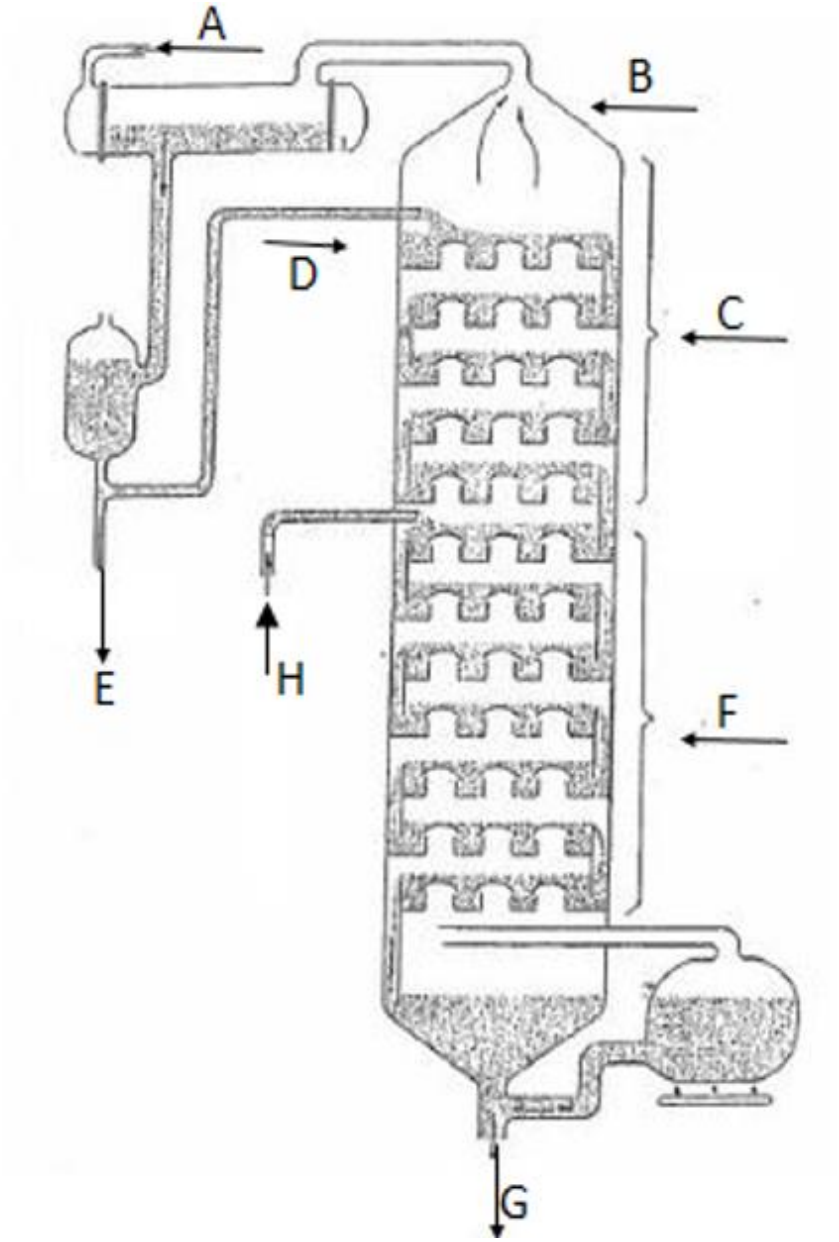
QUESTION 5

5.1 Define the term *fractionation*. (2)

5.2 Explain the influence of process variables concerning heat balance on the fractionation process. (8)

5.3 Briefly discuss general mechanical faults that might occur when a fractionating tower overflows due to overloading. (6)

5.4 Label the components A–H of the distillation tower column below. Write only the answer next to the letter (A–H) in the ANSWER BOOK.



(8 × 1) (8)

[24]

QUESTION 6

6.1 Name THREE elements that measuring instruments consist of, and give an applicable example of each element. (6)

6.2 Convert the following temperatures:

6.2.1 75 ºC to K

6.2.2 25 K to ºC

(2 × 2) (4)

6.3 Calculate the difference in mercury levels of an open U-tube manometer if the differential pressure is 85 kPa. The density of mercury is 13 600 kg/m^3 (4)

6.4 Explain the terms absolute pressure and absolute temperature. (4)

6.5 6.5.1 Make a neat, labelled sketch of a *spiral-type bimetal* thermometer.

6.5.2 Give a brief explanation of the operation of the *spiral-type bimetal* thermometer.

(4 + 2) (6)

[24]

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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