higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T1310**(E)**(A2)T

# NATIONAL CERTIFICATE

# PLANT OPERATION THEORY N3

(11040023)

**2 August 2019 (X-Paper)**
**09:00–12:00**

**Non-programmable calculators 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 N3
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. Write neatly and legibly.

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## QUESTION 1: CHEMISTRY AND CHEMICAL PROCESSES

1.1 State FOUR factors that determine conditions under which the low temperature carbonisation process is operated. (4)

1.2 Using $NO_{(gas)}$ as a catalyst, write down the chemical reaction to produce $CO_2$ as a product in a homogeneous catalysis reaction. (5)

1.3 All types of plastic have different uses.

Give ONE use each of the following plastics:

1.3.1 Polyethylene (2)

1.3.2 Perspex (1)

1.3.3 PVC (1)

1.4 Give the balanced reaction for obtaining oxygen from potassium chloride with the help of manganese dioxide as a catalyst. (5)

1.5 Polymerisation of solutions is one of the methods of enlarging monomers to form polymers.

Write brief notes on *polymerisation of solutions*. (5)

1.6 Explain the term *heterogeneous catalysis.* (2)

**[25]**

## QUESTION 2: COMBUSTION, FUELS AND THERMAL INSULATION

2.1 Granular insulation can be used to reduce the transfer of heat from one place to another.

2.1.1 Give ONE advantage of granular insulation material. (1)

2.1.2 Give ONE example of granular insulation. (1)

2.1.3 Explain the construction of granular insulation. (3)

2.2 Give TWO disadvantages of solid fuel. (2)

2.3 Give FOUR advantages of natural gas fuel over coal. (4)

2.4 Name FOUR requirements for complete combustion. (4)

**[15]**

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## QUESTION 3: STEAM BOILERS AND STEAM TRAPS

3.1 Briefly explain the following terms:

3.1.1 Enthalpy (2)

3.1.2 Economiser (2)

3.2 Heat is added to wet steam, which is 70% dry, to get superheated steam at 250 °C. The steam pressure is at 29 bar (absolute pressure).

Accept that the CP value of the steam is 6,8 KJ/Kg.k

Given: $h_{Su} = hf + (x\ hfg) + [C_s\ (t_{Su} - ts)]$

If 3 tons of steam per hour is required, calculate the energy added to the steam in GJ/h. (6)

3.3 Draw a temperature-enthalpy graph to indicate the critical temperature point showing the properties of steam as water changes to steam. (7)

3.4 Name THREE categories of steam traps. (3)
**[20]**

## QUESTION 4: HEAT TRANSFER

4.1 List FIVE applications of direct heat exchangers in the industry. (5)

4.2 Heat exchange is a way of transferring heat either directly or indirectly.

Name and explain SIX media through the tube side of heat exchangers. (6 × 2) (12)

4.3 List THREE mechanisms or methods of heat transfer. (3)
**[20]**

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## QUESTION 5: COMPRESSION, COOLING, PUMPS AND INSTRUMENTATION

5.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (5.1.1–5.1.5) in the ANSWER BOOK.

5.1.1 In vacuum pumps, the suction pressure is higher than the atmospheric pressure.

5.1.2 Piston compressors are designed to handle big volumes of gas.

5.1.3 Velocity pressure is the resistance a fluid must overcome to flow in a pipe.

5.1.4 In sliding vane pumps, air pockets are trapped between the wall and the vain.

5.1.5 Rotary pumps run silently at high speeds and force the liquid through gears.

(5 × 1) (5)

5.2 Make a neat, labelled drawing of a typical sectional view of a sliding vane type gas compressor. (6)

5.3 Explain the operation of rotary pumps. (4)

5.4 Name THREE types of reciprocating pumps. (3)

5.5 Explain the term *absolute pressure*. (2)

**[20]**

**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. $p = \frac{F}{A}$
9. $A = \pi r^2$
10. $A = \pi \frac{d^2}{4} = \pi r^2$
11. $\rho_1 gh = \rho_2 gh$
12. $Q = Av$
13. $k = \frac{Q}{\sqrt{h}}$
14. $E = \frac{mv^2}{2}$
15. $E = mgh$
16. $V = \pi DN$
17. $V = \frac{a}{t}$
18. $V = \sqrt{2gh}$
19. $PA = mg$
20. $h_{su} = m\{(h_f + gh_{fg}) + C_s(t_{su} - t_s) - (C_w \times t_w)\}$
21. $m = \rho v$
22. $A = \frac{F}{p}$
23. $Pv = cT$
24. $m = \frac{Pv}{RT}$
25. $n = \frac{Pv}{R_0 T}$
26. $V = A\ell NnR$
27. $K = \frac{Qx}{A\Delta t}$

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