



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

PLANT OPERATION THEORY N3

(11040023)

7 April 2020 (X-paper)
09:00–12:00

This question paper consists of 4 pages and 1 formula sheet.

154Q1A2007

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NATIONAL CERTIFICATE
PLANT OPERATION THEORY N3
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. Use only a black or blue pen.
 5. Write neatly and legibly.
-

QUESTION 1: CHEMISTRY AND CATALYSTS

- 1.1 Polymers play an important role in the chemistry of polymerisation.
- 1.1.1 Define *polycondensation*.  (2)
- 1.1.2 Name THREE classifications of polymers and give ONE example of each. (3 × 2) (6)
- 1.1.3 Write down a structure to explain polybutadiene. (3)
- 1.2 Choose the correct word or words from those given in brackets. Write only the word or words next to the question number (1.2.1–1.2.4) in the ANSWER BOOK.
- 1.2.1 (Vulcanisation/Carbonisation) is the process where the substance is heated to form bridges between the chains.
- 1.2.2  (Vulcanisation/Carbonisation) is the process where intensive cracking of residue material such as pitch and tar are used to produce other products such as fuel, gas and gasoline.
- 1.2.3 (Vulcanisation/Carbonisation) refers to the coke making process.
- 1.2.4 (Vulcanisation/Carbonisation) refers to cross-links that make the rubber harder. (1 × 4) (4)
- 1.3 Use the following information to draw a labelled schematic graph to show the role of a catalyst in an exothermic reaction:
- energy
 - time
 - energy required without catalyst
 - reaction time is shorter with the catalyst 
 - energy required with catalyst
 - final energy
- (6)
- 1.4 Oxygen can be obtained from potassium chlorate with manganese dioxide acting like a catalyst. Answer the following questions:
- 1.4.1 Give the formula for the catalyst. (1)
- 1.4.2 State whether the above catalyst is homogenous OR heterogenous.  (1)
- 1.4.3 Explain why the above reaction are classified as an endothermic reaction. (2)

[25]

QUESTION 2: COMBUSTION, COKING AND GASIFICATION OF COAL

- 2.1 Name FIVE products formed from complete combustion. (5 × 1) (5)
- 2.2 Make a neat, labelled sketch to illustrate a water-tube boiler, including the following sections:
- economiser
 - superheater
 - superheated steam outlet
 - evaporator;
 - heat from gas turbine 
 - feedwater
 - steam and water drum
 - circulation pump
- (9)
- 2.3 Explain step-by-step the analysis of the changes that occur during the heating of coal.  (5)
- 2.4 Define *ash* as the waste from coal. (1)
- [20]**

QUESTION 3: HEAT TRANSFER, HEAT EXCHANGER AND THERMAL INSULATION

- 3.1 Explain the FOUR effects of heat on the molecular movement in a substance. (4)
- 3.2 Write the reaction that takes place when manufacturing ethanol from ethylene.  (4)
- 3.3 State TWO properties of liquid as used in heat exchangers. (2 × 1) (2)

3.4 Describe the following things should be kept in mind in order to extend the lifetime and operation of heat exchangers.

3.4.1 Specifications and limits (4)

3.4.2 Corrosive material  (2)

3.5 Choose SIX characteristic properties that thermal insulation material should have from the list below.

long life; to reduce the amount of heat lost; vermin proof; high insulating value; non-corrosive; cell-type isolation; prevents the temperature inside the power plant building from becoming uncomfortably high; asbestos; fibrous insulation; to keep process temperatures steady; prevent injury to personnel due to contact with the bare surfaces of the pipe; granular insulation; calcium silicate; diatomaceous silica; cellular glass; ease of installation; ability to retain its shape; reflective insulation

(6 × 1) (6)

3.6 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (3.6.1–3.6.3) in the ANSWER BOOK.

3.6.1 One of the reasons for using thermal insulation material is to keep the process temperature steady. 

3.6.2 Thermal insulation material must contain a little solid material.

3.6.3 Air or gas moves between cavities in cellular insulation.

(3 × 1) (3)
[25]

QUESTION 4: PUMPS AND COMPRESSION

4.1 Make a neat, labelled sketch of a plunger pump and include the following sections:

- supply pipe
- air container
- stop valve
- foot valve
- cases packing
- sieve 
- stop valve
- external packed
- axle
- plunger

(10)

- 4.2 Explain the advantages of *multistage compression* compared to *single-stage compression*.  (2 × 2) (4)
- 4.3 Name TWO types of forced draught towers. (2 × 1) (2)
- [16]**

QUESTION 5: INSTRUMENTATION AND CONTROL SYSTEM

- 5.1 Define the following terms:
- 5.1.1 Resistive transmitter
- 5.1.2 Piezoelectrical transmitter  (2 × 2) (4)
- 5.2 Draw a neat, labelled on-off control graph of automatic control actions and include the following parameters:
- temperature
 - time
 - output
 - setting
 - heater off
 - heater on  (6)
- 5.3 Explain the advantages of *electrical transmitters* compared to *pneumatic transmitters*. (4)
- [14]**

TOTAL: 100

FORMULA SHEET

Any applicable formula may be used.

$$1. \quad \rho = \frac{P}{gh}$$

$$2. \quad V = \ell bh$$

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

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

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

$$6. \quad \Delta P = \rho gh$$

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

$$8. \quad p = \frac{F}{A}$$

$$9. \quad A = \pi r^2$$

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

$$11. \quad \rho_1 gh = \rho_2 gh$$

$$12. \quad Q = Av$$

$$13. \quad k = \frac{Q}{\sqrt{h}}$$

$$14. \quad E = \frac{mv^2}{2}$$

$$15. \quad E = mgh$$

$$16. \quad V = \pi DN$$

$$17. \quad V = \frac{a}{t}$$

$$18. \quad V = \sqrt{2gh}$$

$$19. \quad PA = mg$$

$$20. \quad h_{su} = m \{ (h_f + gh_{fg}) + C_s(t_{su} - t_s) - (C_w \times t_w) \}$$

$$21. \quad m = \rho v$$

$$22. \quad A = \frac{F}{p}$$

$$23. \quad Pv = cT$$

$$24. \quad m = \frac{Pv}{RT}$$

$$25. \quad n = \frac{Pv}{R_0 T}$$

$$26. \quad V = A \ell N n R$$

$$27. \quad K = \frac{Qx}{A \Delta t}$$