higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T1300**(E)**(A6)T

NATIONAL CERTIFICATE

PLANT OPERATION THEORY N2

(11040012)

6 August 2019 (X-Paper)
09:00–12:00

Nonprogrammable 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 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. Sketches must be large, neat and fully labelled.
5. Write neatly and legibly.

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QUESTION 1: CHEMISTRY

1.1 Various options are given as possible answers to the following questions. Choose the answers and write only the letter (A–D) next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 The simplest part of an element that can participate in a chemical reaction:

A Molecule
B Atom
C Compound
D Mixture

1.1.2 Which ONE of the following represents the correct electron configuration of $^{19}_{9}\mathrm{F}$:

A $1s^2\ 2s^2\ 2p^5$
B $1s^2\ 2s^2\ 2p^6$
C $1s^2\ 2s^1\ 2p^6$
D $1s^2\ 2s^2\ 2p^6\ 3p^2\ 3p^5\ 4s^1$

1.1.3 In an ionic bonding …

A metal attracts electrons.
B transfer of electrons occurs.
C metal becomes the negative ion.
D nonmetal becomes the cation.

1.1.4 The IUPAC name of alkane:

A Acetylene
B Naphthalene
C Paraffin
D Olefin

1.1.5 The general formula of alkene:

A C_nH_{2n}
B C_nH_{2n+2}
C C_nH_{2n-2}
D C_nH_{2n+4}

(5 × 1) (5)

1.2 Define the term *isotopes* and give a complete example. (5)

1.3 Elements in Group IIIV or 0 are called inert gases.

1.3.1 Why are they called inert or unreactive gases? (2)

1.3.2 Give an example of a noble gas. (1)

1.4 Calculate the molecular mass of $MgSO_4$. (4)

1.5 List SIX uses of hydrogen. (6)

1.6 Write down the names of each of the following compounds:

1.6.1 KOH

1.6.2 H_2SO_4

(2 × 1) (2)
[25]

QUESTION 2: ENERGY AND FLUID FLOW

2.1 Discuss each of the following factors which cause loss of pressure in pipes:

2.1.1 Density of the liquid (2)

2.1.2 Viscosity of the liquid (2)

2.2 State the law of conservation of energy. (3)

2.3 A pump system is driven by water at a rate of 150 m^3/sec from a height of 75 m.

Determine the power of the pump in MW. Ignore any energy loss through friction.

NOTE: Accept that the density of water is 1 000 kg/m^3.

Given: $P = \frac{F}{t}$, $F = v \times \rho \times g \times h$ (4)

2.4 Water in a pipeline flows at a rate of 20 000 litres per hour at a velocity of 5 meters per second.

Calculate the pipe diameter. Given: Q = A × V (4)

2.5 Explain the regeneration of hydroelectricity. (6)

2.6 Write brief notes on *tidal force* and an important requirement for it to operate. (4)
[25]

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QUESTION 3: DISTILLATION AND FRACTIONATION

3.1 Explain the difference between *fractionation* and *distillation*. (4)

3.2 Explain temperature gradient as a control variable for the effective operation of a distillation tower to produce a high-quality product. (5)

3.3 Packed towers are smaller and used for special application in the industry.

3.3.1 Give TWO disadvantages of packed towers. (2)

3.3.2 Name TWO main types of packing material used in packed towers. (2)

3.4 List 12 components of a typical ordinary distillation tower. (12)
[25]

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 pH meters refer to sensory elements.

4.1.2 Absolute pressure = gauge pressure + atmospheric pressure.

4.1.3 A dead-mass tester is based on Dalton's law.

4.1.4 The unit of temperature is joule.

4.1.5 A venture tube costs relatively more than an orifice.

(5 × 1) (5)

4.2 Name THREE elements of measurements and give ONE example of each.
(3 × 2) (6)

4.3 Draw a labelled sketch of a sectional installation of a typical thermocouple and name TWO typical conductor material that is used. (7)

4.4 The density of mercury is 13 600 kg/m^3.

Calculate the atmospheric pressure in kPa if the reading on a mercury level is 915 mm. Given: P = ρ × g × h (3)

4.5 Name FOUR types of thermometers. (4)
[25]

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