higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## PLANT OPERATION THEORY N3

**27 November 2024**

**This marking guideline consists of 7 pages.**

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## QUESTION 1

1.1 False
1.2 False
1.3 True
1.4 False
1.5 False
1.6 False
1.7 False
1.8 True
1.9 True
1.10 True

(10 ×1) **[10]**

## QUESTION 2: CHEMISTRY AND CHEMICAL PROCESSES

2.1
- They are soft during manufacturing process when pressed or put into moulds. ✓✓
- They harden when they cool down and won't soften when reheated. ✓✓
- They crumble when exposed to heat and lose their characteristics or properties. ✓✓
- They are not soluble in organic solvents.

(Any 3 × 2) (6)

2.2
- Molybdenum III oxide
- Chromium III oxide
- Titanium dioxide
- Vanadium pentoxide
- Tungsten oxide
- Iron oxide

(Any 4 × 1) (4)

2.3 Dehydrogenation is the removal of hydrogen from a molecule. ✓✓

**OR**

A process where the hydrogen content of saturated hydrocarbons and organic compounds is reduced.

(Any 1 × 2) (2)

2.4 $2KCOl_3$ ✓+ $MnO_2$ ✓ ⟶ 2KCl ✓ + $3O_2$ ✓ 1 mark for balancing ✓ (5)

2.5 Catalyst is a substance that speeds up the reaction without taking part in a reaction. (2)

**[19]**

## QUESTION 3: COMBUSTION, FUELS AND THERMAL INSULATION

3.1 80% C:

$= \frac{80}{100} \times 2 \text{ kg}$ ✓

= 1,6 kg Carbon available ✓

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ ✓

12 kg C need 32 kg $O_{2(g)}$ for complete combustion.

1,6 kg C Need X $O_{2(g)}$

$12 \times X = 1,6 \times 32$ ✓

$\frac{12X}{12} = \frac{51,2}{12}$

X = 4,27 kg Oxygen needed ✓

15% S:

$= \frac{0,15}{100} \times 2 \text{ kg}$ ✓

$= 0,15 \times 2 \text{ kg}$

= 0,3 kg Sulphur available ✓

$S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)}$ ✓

32 kg S need 32 kg $O_2$ for complete combustion.

0,3 kg need X $O_{2(g)}$

$32 \times X = 0,3 \times 32$ ✓

$\frac{32X}{32} = \frac{9,6}{32}$

= 0,3 kg Oxygen needed ✓

Total Oxygen needed = 4,27 kg + 0,3 kg ✓

= 4,57 kg Oxygen needed ✓

Total combustion air required:

$$= \frac{4,57}{0,23} \checkmark$$

$$= 19,87 \text{ m}^3 \checkmark$$

(14)

3.2
- Sub-bituminous
- Bituminous
- Semi bituminous
- Anthracite

**OR**

- Anthracite
- Semi-anthracite
- Bituminous
- Pulverized (4)

3.3
- High insulating value
- Long life
- Vermin proof
- Non-corrosive
- Ability to retain it shape and insulating value when wet
- Ease of application and installation

(Any 4 × 1) (4)
**[22]**

## QUESTION 4: STEAM BOILERS AND STEAM TRAPS

4.1 4.1.1 Specific heat capacity is the amount of heat energy required to raise the temperature of a body per unit of mass. ✓

4.1.2 Dry saturated steam is the steam at saturation point (boiling point) corresponding to the pressure without any water in it. ✓

**OR**

This is steam, which does not contain suspended water at all. This means that the steam is at the saturation temperature and has absorbed all of the latent heat of evaporation.

(2 × 1) (2)

4.2 From Steam table:

$t_s$ = 198,3 °C
hf = 845 KJ/Kg
$hf_g$ = 1 945 KJ/Kg

Steam production:
5,3 t/h × 1 000 Kg
= 5 300 Kg/h ✓

Formula: $h = \Delta hf + [x(hfg)]$ ✓

Energy to add = $\left[\frac{(198,3\ °C - 100°C)}{198,3\ °C} \times 845\ KJ/Kg\right]$ ✓ + $\left[0,85 \times 1\ 945\ Kg/Kg\right]$ ✓

= 418,878 KJ/Kg + 1 653,25 KJ/Kg ✓
= 2072,128 KJ/Kg x 5 300 Kg/h ✓
= 10 982 278,4 KJ/h / 1 × $10^6$ ✓
= 10,982 GJ/h ✓ (8)

4.3 When heat is supplied which causes a change in state without a change in temperature. ✓✓ (2)

4.4
- Maximize equipment capacity
- Maximize heat transfer
- Reduces corrosion
- Elimination of water hammer
- Dilution of steam
- Prevent steam losses

(Any 4 × 1) (4)
**[16]**

## QUESTION 5: HEAT TRANSFER

5.1 It is an instrument used to measure high temperatures✓ in furnaces and kilns.✓ (2)

5.2
- Chemical reactions
- Friction (mechanical energy)
- Electrical energy
- Splitting of atoms (nuclear energy) (4)

5.3
- Coolers or chillers
- Heaters or pre-heaters
- Vaporisers or evaporators
- Condensers (4)

5.4
- They need more maintenance
- Contribute to air pollution
- Contribute to water pollution (3)

5.5 Coolers are used to cool a warm (hot) liquid or gas by circulating a cold liquid in the exchanger or by blowing cold air or gas over the exchanger.✓✓ (2)

**[15]**

## QUESTION 6: COMPRESSSION, PUMPS, COOLING AND INSTRUMENTATION

6.1 Displacement or capacity of a pump is the quantity of fluid which it will displace or discharge during one full revolution of the pump. ✓✓ (2)

6.2
- Piston or Plunger pumps
- Diaphragm pumps
- Rotary pumps (3)

6.3 Data:

$V_1 = 50\ m^3$

$T_1 = 250\ °C$

$P_1 = 670\ KPa$

$V_2 = 20\ m^3$

$T_2 = 320\ °C$

$P_2 = ?$

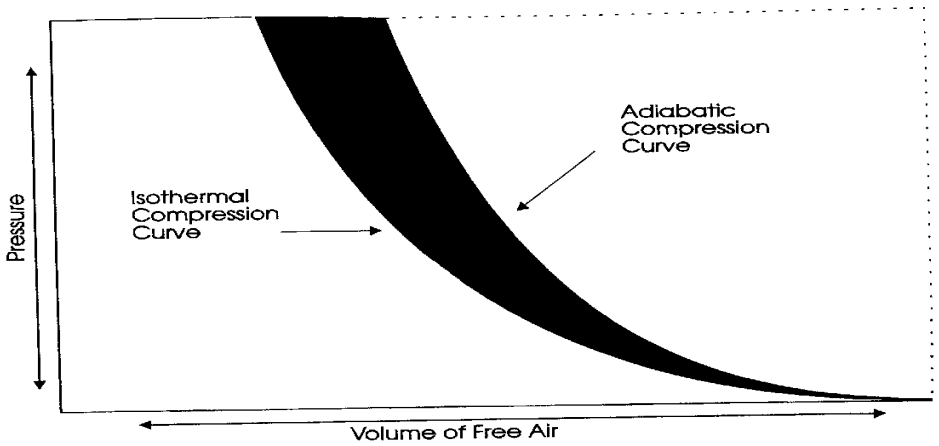
$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \checkmark$$

$$P_2 = \frac{P_1 V_1 \times T_2}{T_1 \times V_2}$$

$$P_2 = \frac{670\ KPa \times 50\ m^3 \times 320\ °C}{250\ °C \times 20\ m^3} \checkmark$$

$= 2\ 144\ KPa \checkmark$ (3)

6.4




Isothermal and Adiabatic Curves

1 mark for adiabatic compression curve. ✓
1 mark for Isothermal compression curve. ✓
1 mark for Pressure in Y-axis. ✓
1 mark for volume I X-axis. ✓ (4)

6.5
- Adiabatic
- Isothermal
- Polytrophic or Practical
- Single stage
- Multi stage

(Any 4 × 1) (4)

6.6 Refrigeration or cooling systems is in a fact just another process to transfer heat from one place to another. ✓✓ (2)

**[18]**

**TOTAL: 100**

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