



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE PLANT OPERATION THEORY N3

31 JULY 2018

This marking guideline consists of 6 pages.

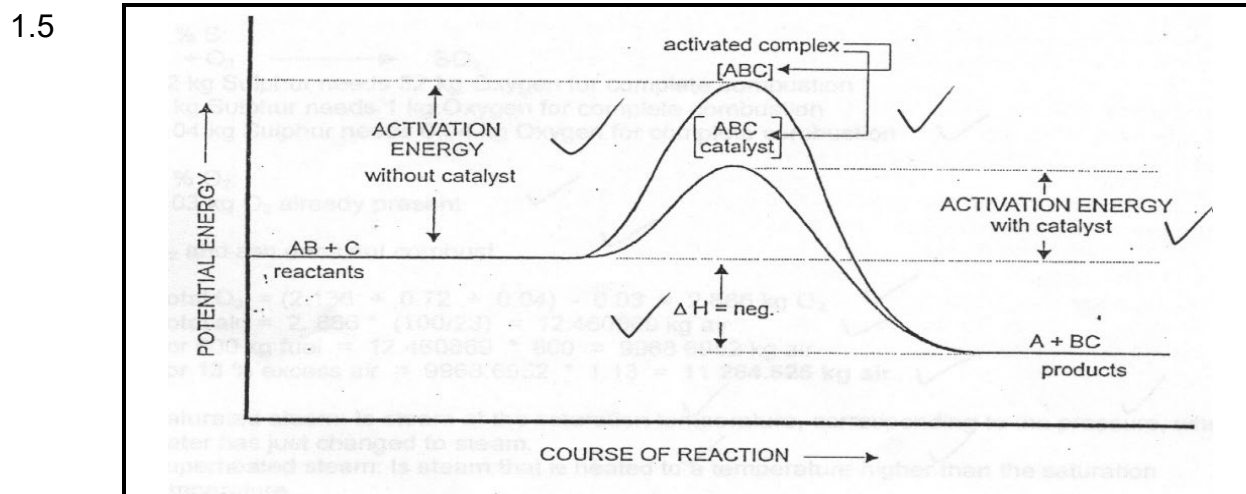
QUESTION 1

- 1.1
- Chain reaction of atoms within the reacting molecule
 - Rearrangement of atoms in all the reacting molecules without loss of atoms (monomer and polymer)
 - A ring bond of atoms splitting and bonding with another ring bond (molecule) with the aid of a catalyst
- (3)

- 1.2
- It is the reaction of solid fuel or coal with air, O₂, steam, and CO₂ or a mixture of these gases✓ to produce gaseous products that can be used as an energy source.✓
- (2)

- 1.3
- $$\begin{array}{ccccccc} \checkmark & \checkmark & \checkmark & & \checkmark \\ -\text{CH}_2 & \text{C} & (\text{CH}_3) & = & \text{CH} & \text{CH}_2 & - \end{array}$$
- (4)

- 1.4
- Become soft and melt when heated
 - Become hard again without losing their properties when they cool down again
 - Acid resistance
 - Reasonably dissolve in organic solvents like acetone and benzene
- (Any relevant 4 × 1)
- (4)



The role of catalyst is to cause (produce) an activated complex at a lower temperature or energy level than would be caused without a catalyst.✓ In the case of heterogeneous catalysis the reactants are absorbed on the surface of the catalyst and this, requiring less energy to react, weakens the bonds of the reagents.✓ In other cases the catalyst causes intermediate reactions, which immediately cause dissociation of the reagents and then the final reaction(s) leaving the catalyst unchanged.✓

(Any relevant 7 × 1)

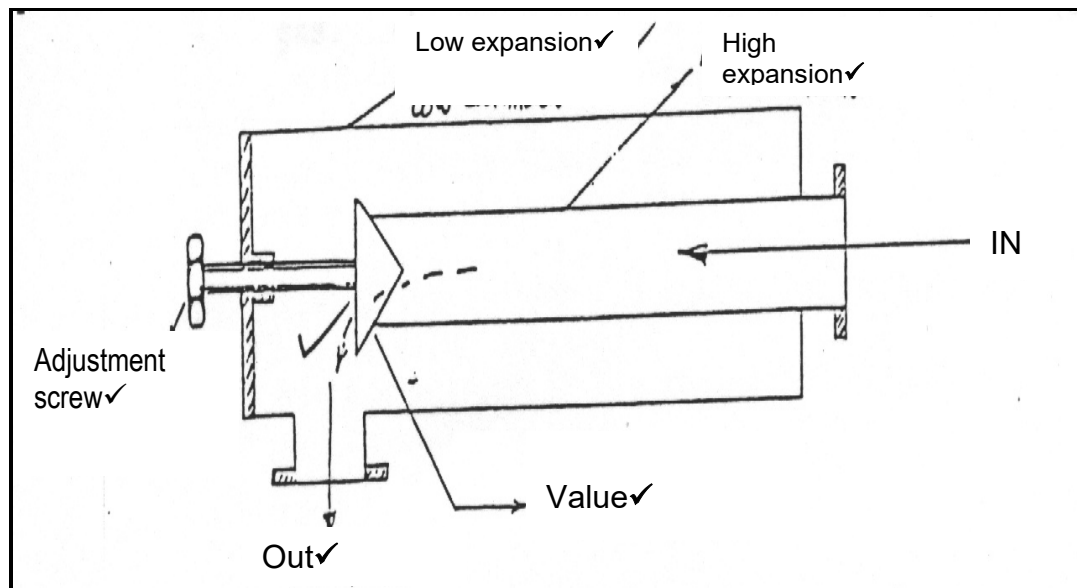
(7)
[20]

QUESTION 2

- 2.1
- Granular
 - Reflective
 - Cell-type or cellular
 - Fibrous
- (Any relevant 4 × 1) (4)
- 2.2
- Economical reasons
 - Process control
 - Safety
- (Any relevant 3 × 1) (3)
- 2.3
- Waterproofing
 - Vibration
 - Physical maltreatment
- (Any relevant 3 × 1) (3)
- 2.4 All the requirements for complete combustion must prevail.✓ The combustible elements such as carbon, hydrogen and sulphur combine with oxygen to form completely combusted products such as carbon dioxide, water vapour and sulphur dioxide.✓ (2)
- 2.5
- 2.5.1
- $$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O \checkmark$$
- $$0,2 + 70 \text{ m}^3 H_2 \text{ requires } = 14 \times \frac{1}{2}$$
- $$= 7 \text{ m}^3 O_2 \checkmark$$
- $$CO + \frac{1}{2}O_2 \rightarrow CO_2 \checkmark$$
- $$0,35 \times 70 \text{ CO requires } = 24,5 \times 0,5$$
- $$= 12,25 \text{ m}^3 O_2 \checkmark$$
- $$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \checkmark$$
- $$0,3 \times 70 \text{ CH}_4 \text{ requires } = 21 \times 2$$
- $$= 42 \text{ m}^3 O_2 \checkmark$$
- $$\text{Total } O_2 \text{ requirements } = 7 + 12,25 + 42 - (0,15 \times 70) \checkmark$$
- $$= 61,25 - 10,5$$
- $$= 50,75 \text{ m}^3 O_2 \checkmark \quad (8)$$
- 2.5.2
- $$\text{Total air required at 3\% excess air } = \frac{50,75 \times 103}{21} \checkmark$$
- $$= 248,92 \text{ m}^3 \text{ air} \checkmark \quad (2)$$
- [22]**

QUESTION 3

3.1



(Any relevant 4 × 1)

(4)

- When the steam trap is cold, the valve is open, draining air and condensate.
- When hot steam enters the trap, the tube expands and closes the opening.
- Due to that, steam flow ceases and the valve again cools down and opens.
- Condensate flows in again and the process repeats.

(Any relevant 4 × 1)

(4)

- 3.2 3.2.1 After the flu-gas leaves the superheated tubes, it still contains energy.✓ This energy is utilised to heat feed water by means of the economiser. This is conducted to the feed water causing the water temperature to rise.✓
- 3.2.2 It increases the hot boiler feed-water energy. From the bottom of the steam drum,✓ with the aid of circulation it is pumped through the tubes above the combustion chamber of the steam boiler back to the steam drum.✓
- 3.2.3 Preheated flu-gas exiting the economiser to the stack still contains heat energy.✓ A preheater or recuperator is used to transfer this energy to the combustion air, which, simultaneously with the fuel, goes into the boiler.✓
- (3 × 2) (6)

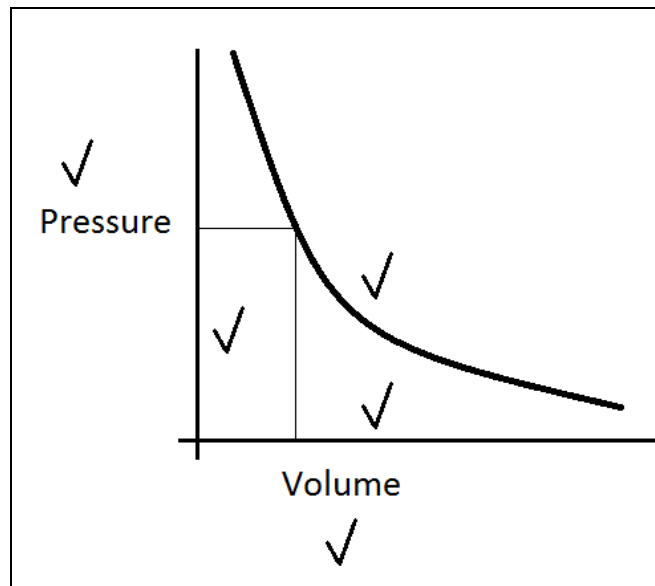
- 3.3 • Mechanical
- Thermostatic
- Thermodynamic
- (3)
[17]

QUESTION 4

- 4.1
- Impure or dirty material
 - High pressure medium or material
 - Water
 - Hot media
 - Smaller volume
 - Noncondensable gasses or vapours
- (6)
- 4.2
- Spray ponds
 - Cooling towers
 - Absorbers
 - Steam strippers
 - Fractionation columns
- (Any 3 × 1) (3)
- 4.3
- Air or gas build-up due to poor venting
 - Incorrect inlet and outlet pipe diameter for the volume to be processed
 - Use of wrong temperatures, pressures or flows not according to design specifications
 - Excessive deposits in exchangers
 - Excessive spacing between baffles and shell or baffles and tubes due to corrosion
 - Tube leakage
 - Poor drainage from the exchanger
- (Any relevant 6 × 1) (6)
- 4.4
- 4.4.1 They improve the contact time between the heating medium and the heated medium.✓ In cross-flow baffles the tubes fit tighter in the baffles, but portions of the baffles are cut-away.✓ The baffles are placed in such a way that the cut away part alternates from the top to bottom so that the cross flow is achieved.✓
- (Any relevant 3 × 1) (3)
- 4.4.2 Thermal resistance to heat transfer is made up of several individual resistances, for example condensate film, metal wall or heating surface, and scale liquor-side.✓ Heat transfer coefficient is the sum of the inverse of the resistances.✓
- (Any relevant 2 × 1) (2)
- [20]**

QUESTION 5

5.1



(5)

- 5.2 When air is compressed, its volume is reduced✓ and its pressure is increased.✓ Also, due to the heat of compression, the temperature of the air will increase.✓ If the heat of compression, causing the increase in temperature could be removed as quickly as it is generated,✓ then the temperature of the air would remain constant and power required to drive the compressor would be substantially reduced.✓ (Any relevant 5 × 1) (5)

- 5.3 5.3.1 The vapour is withdrawn from the evaporator by absorbing it in a liquid.✓ The resulting solution, called the strong solution,✓ is then heated and the vapour is driven off at a higher pressure so that it may then be condensed.✓ This condensed vapour or liquid refrigerant is then passed through an expansion valve into the evaporator which is at a lower pressure,✓ where it absorbs heat and is vaporised once more.✓ (Any relevant 5 × 1) (5)

- 5.3.2 It is the ratio of the capacity to the displacement expressed in percent.✓ The capacity is always less than the displacement because of clearance between the piston and the cylinder heads,✓ leakage through valves and other losses.✓ (Any relevant 3 × 1) (3)

- 5.3.3 The compressor has two or more cylinders or different sizes.✓ The largest is the first stage or low-pressure cylinder✓ and the smallest one is the last stage or high-pressure cylinder.✓ (3)
(Any relevant 3 × 1) [21]

TOTAL: 100