higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

REFRIGERATION AND AIR CONDITIONING PROCESSES
NQF LEVEL 4

(6030054)

28 November 2023 (X-paper)
09:00–12:00

Calculators may be used.

This question paper consists of 6 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)
REFRIGERATION AND AIR CONDITIONING PROCESSES
NQF LEVEL 4
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. The diagrams should be clear and neat and a pencil may be used.
6. Write neatly and legibly.

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QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 The dry-bulb temperature is never higher than the wet-bulb temperature.

1.1.2 The standard barometric pressure at sea level is 101.3 kPa.

1.1.3 Sensible cooling causes a rise in the humidity ratio.

1.1.4 Dry bulb temperature of air changes during humidification.

1.1.5 Enthalpy is a form of energy.

(5 × 1) (5)

1.2 State FOUR factors that affect pipe friction in a refrigeration installation. (4)

1.3 Use the following information to answer the questions:

39,6 m^3/min of a mixture of circulated room air and outdoor air enter a cooling coil at 31 °C DB and 18,5 °C WB temperature. The effective surface temperature of the coil is 44 °C. The surface area of the coil is such as would give 12,5 kW of refrigeration with the given entering air state.

Given:
Apparatus dew point:
ω_s = 5,25 g/kg of dry air.
h_s = 17,7 kJ/kg of dry air.

State of entering air:
ω_1 = 8,2 g/kg of dry air
h_1 = 52,5 kJ/kg of dry air
v_1 = 0,872 m^3/kg of dry air.

Calculate the following:

1.3.1 Mass flow rate per min of dry air (3)

1.3.2 Cooling load in kJ/ kg of dry air (3)

1.3.3 Enthalpy of air leaving the coil (2)

1.3.4 Calculate the specific humidity ratio(ω_2)of the air leaving the coil. (3)

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QUESTION 2

2.1 Answer the following questions in relation to vapour compression systems in refrigeration:

2.1.1 Name three possible vapour compression cycles found in refrigeration in relation to the conditions of the refrigerant. (3)

2.1.2 Name two applications of vapour compression refrigeration systems in other than in the domestic use for preserving food. (2)

2.2 Explain the following terms:

2.2.1 Air conditioning

2.2.2 Adiabatic process

(2 × 2) (4)

2.3 State TWO benefits of air conditioning. (2)

2.4 Draw a neat, labelled diagram of a heat pump that uses a refrigeration system. Indicate FOUR major components of a heat pump on the diagram. (5)

2.5 State the following with regard to all-air systems:

2.5.1 TWO advantages

2.5.2 TWO disadvantages

(2 × 2) (4)

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QUESTION 3

3.1 Explain the advantage of using a star-delta starter over a DOL starter. (2)

3.2 FIGURE 1 shows three-phase windings. Draw the windings in the ANSWER BOOK showing a star-connected motor indicating the following:

A L1
B L2
C L3
D A1
E B1
G C1

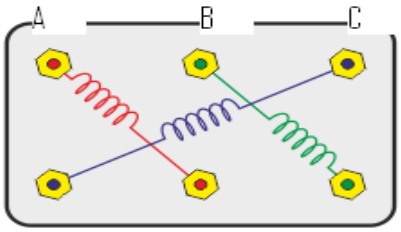


FIGURE 1 (8)

3.3 Answer the following questions based on a star-delta starter.

3.3.1 Name three contactors found in a star-delta starter. (3)

3.3.2 What is the function of the timer in a star-delta starter (2)

3.3.3 What is the purpose of the overload relay in the star-delta starter (1)

3.3.4 Name two push buttons found in the in star-delta starter and their type/state. (4)

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QUESTION 4

4.1 Name the instrument that is used to measure each of the following quantities:

4.1.1 Flow rate

4.1.2 Pressure

4.1.3 Room temperature

(3 × 1) (3)

4.2 Name THREE variables that must be controlled in refrigeration systems.

(3 × 1) (3)

4.3 State TWO factors that determine the length of defrosting in a refrigerating system. (2 × 1) (2)

4.4 Explain the procedure to be followed regarding the refrigerants for the protection of the environment, when removing a charged compressor from the system. (4)

4.5 Why is it necessary to regularly defrost the evaporator? (2)

4.6 What is the effect of sub-cooling the refrigerant in the refrigerating system? (2)

4.7 What is an operating manual of a plant? (2)

4.8 What are the normal operating conditions of a plant? (2)

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QUESTION 5

5.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–C) next to the question number (5.1.1–5.1.4) in the ANSWER BOOK.

5.1.1 Oversizing a plant can lead to …

A excessive loading of the refrigerated space.
B frequently stopping and starting the plant.
C breakage of belts or fans.

5.1.2 Refrigerant leakage will eventually result in …

A oil-control failure.
B traps in the systems.
C high superheat at the compressor suction.

5.1.3 During troubleshooting a plant, the compressor fails to start and there is no humming sound. What will be the cause?

A Mechanical problems in the compressor
B Too much capillary resistance
C Evacuation

5.1.4 What will be the remedy if ice rapidly builds up on the evaporator?

A Replace the door gasket if it is cracked.
B Replace the compressor mounts.
C Replace the heater.

(4 × 1) (4)

5.2 Name FOUR categories of problems relating to the malfunctioning of refrigeration systems. (4)

5.3 How can mechanical faults on a plant be avoided? (2)

5.4 What is the effect of loss of refrigerant from a system? (2)

5.5 What is the result of liquid slugging? (2)

5.6 Name TWO methods of leak detection in a system. (2)

5.7 State FOUR possible causes if the whole system fails to start. (4)

[20]

TOTAL: 100

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