higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

RENEWABLE ENERGY TECHNOLOGIES
NQF LEVEL 3

(12041043)

21 November (X-paper)
09:00–12:00

This question paper consists of 6 pages and a 1-page formula sheet.

395Q1N2421

Copyright reserved

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)
RENEWABLE ENERGY TECHNOLOGIES
NQF LEVEL 3
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. Start each section on a new page.
5. Use only blue or black ink.
6. Write neatly and legibly.

Copyright reserved

QUESTION 1

1.1 Compare the use of a conventional electric geyser to a solar thermal system with the aim of reducing greenhouse gas emissions. (2)

1.2 Explain the term *solar energy* as the preferred means of heating water for domestic use. (2)

1.3 Why would municipalities choose to install solar water heating systems in residential areas and townships? Give ONE advantage of SWH systems in addition to your answer. (2)

1.4 Using the data given in the table below, calculate what the payback time would be for the installation of a solar water-heating system by showing the calculations and writing the answer next to the question number (1.4.1–1.4.3) in the ANSWER BOOK.

Variables	Data and calculations
Average consumption of electrical energy per month (Household)	1350 kWh
Electrical energy consumption of a geyser per month	650 kWh
Cost per kWh (cost depend on region/year and municipality)	R3
Electrical energy for hot water generation saved per month by conversion from electric geyser to solar water system	250 kWh
System and installation costs for a 200 litre high- pressure solar water heating system	R28 600
Cost of an equally sized electric geyser	R8 600
Total extra cost for the solar water heating system	1.4.1
Monthly kWh saving in Rand	1.4.2
Payback period in years	1.4.3

(3 × 2) (6)

1.5 Describe in your own words at least FIVE benefits to a homeowner who had a solar water heating system installed as an alternative to conventional hot water generation. (5)

1.6 Indicate the Act relevant to the following:

1.6.1 This Act recognises that water is a natural resource belonging to all people.

1.6.2 This Act explains the worker's rights in terms of safety.

1.6.3 This Act ensures that buildings are designed and build so that people can live and work in a healthy and safe environment.

(3 × 1) (3)

[20]

Copyright reserved

QUESTION 2

2.1 Indicate whether the following statements are TRUE or FALSE. Write only 'True' or 'False' next to the question number (2.1.1–2.1.10) in the ANSWER BOOK.

2.1.1 Conduction is energy emitted in the form of light.

2.1.2 The process where cold fluids rise, and warm fluids sink is called the thermosiphon effect.

2.1.3 The objective of strengthening roof structures is to distribute the extra load added to the roof by the SWH system over a wide enough area of the roof.

2.1.4 Standoff mounting is used on homes with flat or low-pitched roofs.

2.1.5 Two hanger brackets are normally required per collector.

2.1.6 An orientation of the collector towards North is ideal in the southern hemisphere.

2.1.7 Emittance is the situation in which radiation is converted into sensible heat within the material.

2.1.8 Metals are good conductors of heat, while air is a poor conductor of heat.

2.1.9 The absorber is there so that radiant energy can be converted into thermal energy.

2.1.10 A solar water heating system should meet the hot water needs of a home.

(10 × 1) (10)

2.2 A solar thermal water heating system is designed to heat water for a household. The system needs to raise the temperature of 200 litres of water from 20° C to 60° C in one day. The average solar irradiance (solar power per unit area) available is 600 W/m², and the efficiency of the solar collector is 50%.

Determine the minimum collector area required to capture sufficient radiant energy for this purpose. Use the specific heat capacity of water as 4,18 kJ/kg·°C. The assumed duration of maximum daily irradiance is 8 hours. (8)

2.3 Explain why the installation factors listed below, apart from collector orientation, shading and tilt angles, should be considered to ensure optimal system performance and efficient hot water supply and delivery:

2.3.1 System Sizing

2.3.2 Proximity

2.3.3 Water quality

(3 × 3) (9)

Copyright reserved

2.4 State THREE ways to strengthen the rafters that are used to support the solar water heating system. (3)

[30]

☆

QUESTION 3

3.1 Identify any FOUR potential risks or hazards that the solar water heating installer may typically be exposed to when doing a SWH installation. (4)

3.2 List FIVE precautions that should be taken into consideration when using a ladder to gain temporary access to a roof. (5)

3.3 Name and briefly describe the functionality of THREE of the most common harness systems that are used by solar installers when working at heights. (3 × 2) (6)

[15]

☆

QUESTION 4

4.1 Illustrate, by means of a neat, simple line drawing, the internal structure of a basic flat plate collector. Include at least SIX relevant labels. (6)

4.2 Define, in your own words, what a *passive system* is. (2)

4.3 Identify the valve shown in FIGURE 1 below and describe its operation. (7)

☆



FIGURE 1

☆

4.4 Explain the term *scale build-up* in a pipe system. (3)

4.5 When installing a solar water heater (SWH) system you need to assemble the components of the system using copper pipe.



In your own words, explain the process of joining copper pipes by utilising capillary fittings. (8)

4.6 FIGURE 2 below shows general plumbing tools marked a, b and c. Identify each of the tools by writing only the answer next to the letter (a–c) in the ANSWER BOOK. (3)

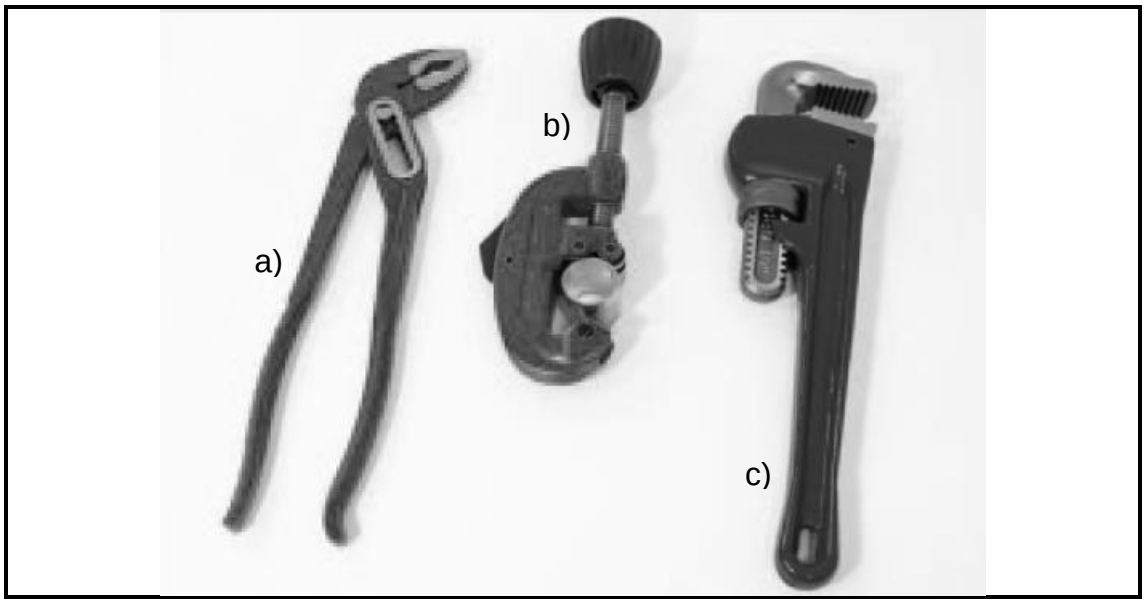

FIGURE 2



4.7 In your own words, describe the commissioning process after a solar water heating system has been installed, and include a simple explanation of the hand-over process to the customer. (6)

[35]

TOTAL: 100

Copyright reserved

(12041043)

FORMULA SHEET

RENEWABLE ENERGY TECHNOLOGIES L3

$\Delta = V \times Ce \times \Delta T$

$\Delta T = T_f - T_i$

$Q = C \times m \times \Delta T$

$Irradiation\ E = P \times t$

Copyright reserved