higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

RENEWABLE ENERGY TECHNOLOGIES
NQF LEVEL 4

(12041044)

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

This question paper consists of 8 pages.

497Q1N2328

Copyright reserved

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)
RENEWABLE ENERGY TECHNOLOGIES
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. Write neatly and legibly.

Copyright reserved

QUESTION 1

1.1 The transitions from coal-powered energy generation to renewable energy is globally encouraged. However, before roll-out, it is important to complete an LCA on the renewable energy technology being considered.

1.1.1 Define the following acronyms:

(a) LCA
(b) NREL

(2 × 1) (2)

1.1.2 Name the top TWO countries globally that have the highest cumulative installed wind power capacity. (2)

1.1.3 Explain what the purpose of the LCA study of energy systems is. (3)

1.1.4 Illustrate by means of a simple diagram a representation of the possible transition from coal to renewable/ clean energy in South Africa. (4)

1.1.5 There are some ‘doubters’ on whether wind energy systems can be considered a viable solution to address the energy demand and the impact on climate change.

List FOUR advantages of wind power generation. (4)

1.2 The concept of using hydrogen as an energy system is not new. Hydrogen has been used in both industrial and domestic applications and then advanced into vehicle application in the 1980s.

With regard to the hydrogen economy and the considerably scarce application of hydrogen energy systems, answer the following questions:

1.2.1 What is the key limitation in implementing a hydrogen economy? (1)

1.2.2 In your own words, explain why hydrogen energy is not typically used on the same scale as fossil fuels. (6)

1.2.3 List a minimum of THREE current applications of fuel cells. (3)

[25]

Copyright reserved

QUESTION 2

2.1 Write a brief description of how wind is caused. (5)

2.2 FIGURE 1 below is a schematic of the main components in the nacelle of a wind turbine. Name any FOUR of the numbered parts by writing the number and the name of the part in your ANSWER BOOK. (4)

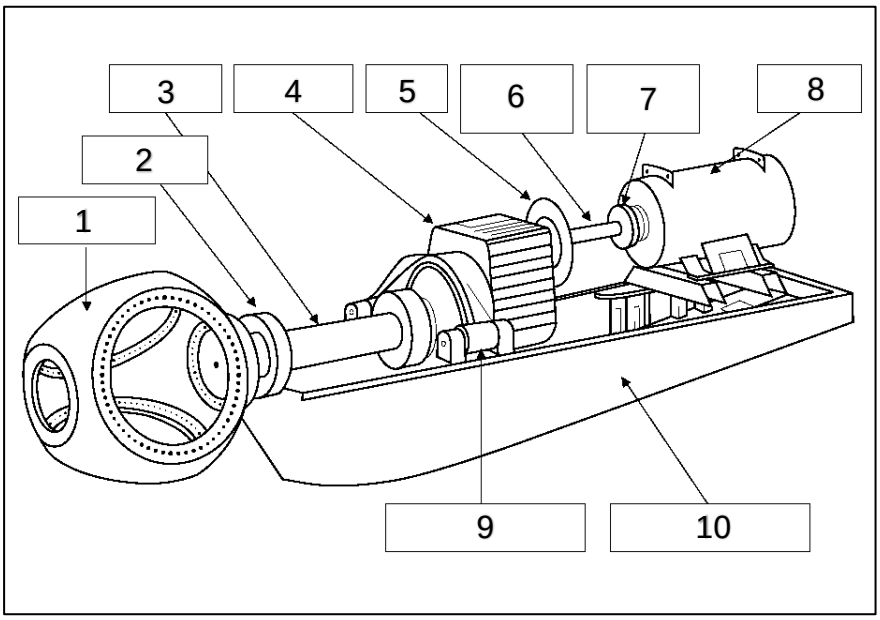


Figure 1
Image source: S4GJ/GIZ

2.3 Complete the reaction below by considering the redox reaction when a DC voltage is applied to an electrolyser that contains pure water. Write only the ANSWER at (a) and (b) in your answer book. (2)

$$2H_2O_{(i)} \rightarrow (a)_{(g)} + (b)_{(g)}$$

2.4 The processes by which fuel cells provide an electric current differ slightly from the battery processes.

Define the distinct differences between the two processes. (6)

2.5 Study FIGURE 2 below, which illustrates a PHEV configuration.

Write down the component names labelled 2.3.1-2.3.4 in the ANSWER BOOK.

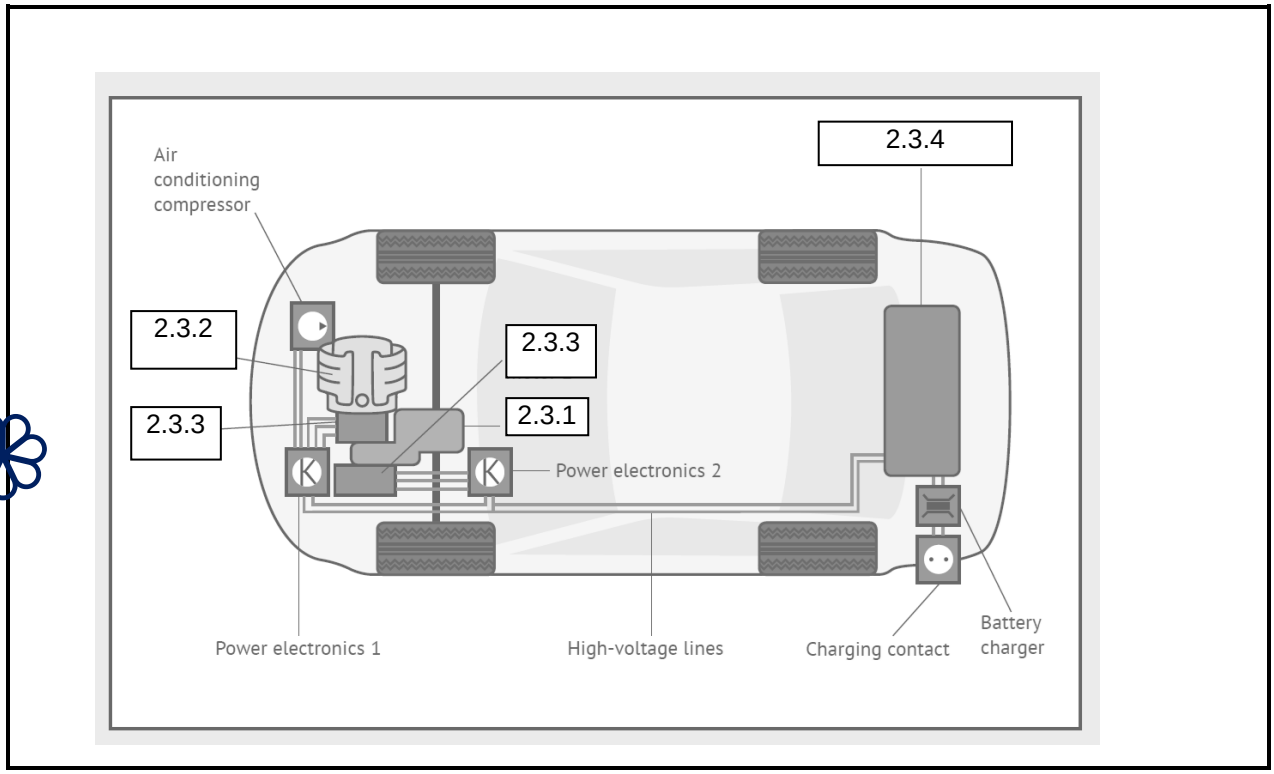


FIGURE 2
Image source: S4GJ/GIZ

(4)

2.6 Considering your knowledge related to modern eco-car types, define the destinct characteristics of the vehicle types listed below:

2.6.1 HEV (2)

2.6.2 FCEV (2)

[25]

QUESTION 3

3.1 The small-scale wind farm project that you are leading has successfully been approved by all the associated investors and construction can now commence.

3.1.1 As the project leader, list FIVE OHS risks associated with the construction of the wind turbines on the farm. (5)

3.1.2 It is said that safety checklists are the best way to reduce accidents in the workplace.



Explain how safety checklists can assist with improving safety and why many companies implement this strategy. (5)

3.2 Explain practicable steps to ensure the prevention of harm to employees related to wind turbine technologies whilst planning to execute Lifting operations. (5)

[15]

QUESTION 4

4.1 Considering an experiment that can be carried out using the wind turbine training kits, match the descriptions in COLUMN B with the term in COLUMN A. Write only the letter (A−L) next to the question number (4.1.1−4.1.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
4.1.1	Open-circuit voltage	A	the angle between the edge of the blade and the plane of the blade's rotation
4.1.2	Generator		
4.1.3	Short-circuit current	B	an electric machine that converts mechanical (rotational) energy into electrical energy
4.1.4	HAWT		
4.1.5	Pitch	C	the wind speed at which a wind turbine begins to generate power
4.1.6	Blades	D	usually made of porous carbon containing platinum or platinum catalyst
4.1.7	Output		
4.1.8	Cut-in wind speed	E	the angle between the line of the chord of an aerofoil and the relative airflow
4.1.9	Angle of attack		
4.1.10	Anemometer	F	the rotor axis and the shaft are parallel to the ground and the blades are perpendicular to the ground
		G	the positive and negative terminals are directly connected with a low-resistance conductor
		H	the difference in potential between the terminals of a cell in no-load conditions
		I	flat long panels connected to the rotor hub providing the aerodynamic active surface
		J	energy or power provided per time unit
		K	a rechargeable battery or cell (also 'secondary battery')
		L	an instrument used to measure the velocity or speed of wind

(10 × 1) (10)

Copyright reserved

4.2 An experiment is carried out using the instruments below.

Study FIGURE 3 and answer the questions that follow.

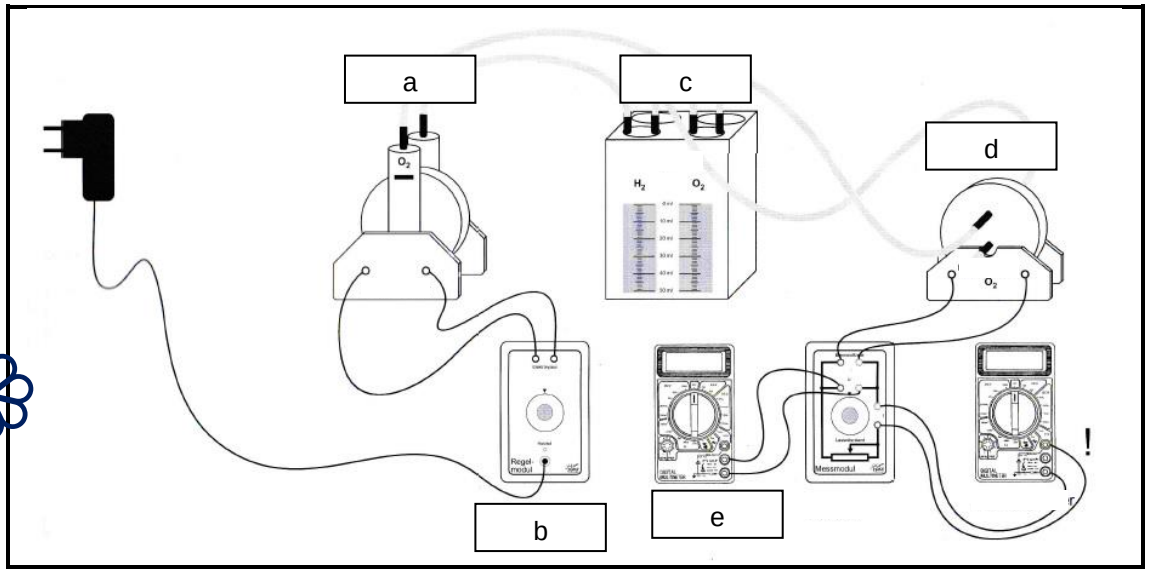


FIGURE 3
Image source: S4GJ/GIZ

4.2.1 List the instruments labelled a − e. (5)

4.2.2 Explain the function of item a. (4)

4.2.3 The TABLE below shows the results taken from an experiment to evaluate the performance of the fuel cell. Answer by writing down the values next to question (a – b) in the ANSWER BOOK.

I (mA)	V (V)	P (mW)
200	0.56	(a)
400	(b)	280
600	0.84	540

(2)

4.3 From your understanding of the chemical reaction that happens in a lead acid battery, mention the electrodes and electrolyte being used. (3)

4.4 Illustrate by means of a simple line diagram overcurrent protection for four individual batteries connected in parallel. (4)

4.5 As an expert in your field reference THREE of the precautions required when handling and maintaining batteries. (3)

4.6 Considering the importance of handling and maintaining in the correct manner, share your opinion on the FOUR most common causes that batteries fail. (4)

[35]

TOTAL: 100

Copyright reserved.