higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

RENEWABLE ENERGY TECHNOLOGIES
NQF LEVEL 4

(12041044)

17 November 2022 (X-paper)
09:00–12:00

This question paper consists of 10 pages.

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TIME: 3 HOURS
MARKS: 100

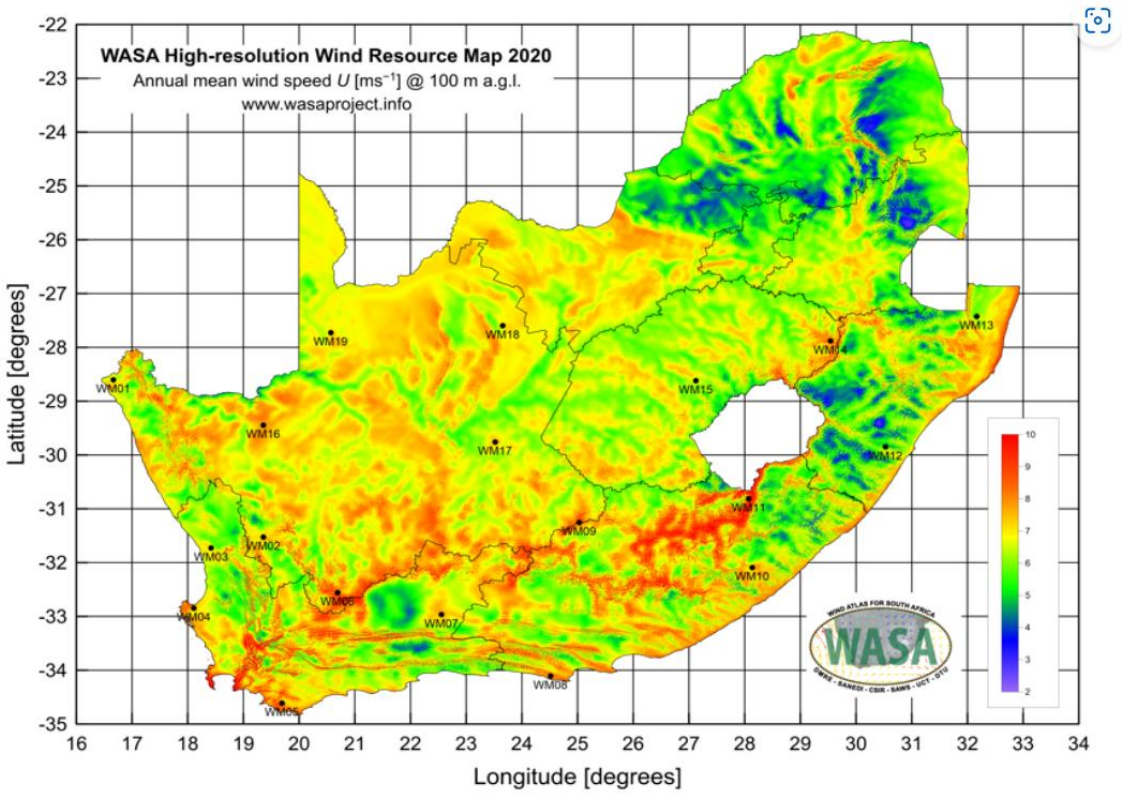
INSTRUCTIONS AND INFORMATION

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 question on a new page.
5. Write neatly and legibly.

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QUESTION 1

1.1 Review the WASA resource map FIGURE 1 below, and answer the questions that follow.



WASA High Resolution Wind Resource Map: mean wind speed [ms^{-1}] @ 100 m a.g.l. Dec 2020 (3.3 km WRF + 250 m WAsP modelling)

FIGURE 1
Source: Wind Atlas for South Africa (WASA) SANEDI (wasaproject.info)

1.1.1 List the FOUR regions that are the most favourable for wind energy projects in South Africa. (4)

1.1.2 Motivate why you have identified the regions referred to in QUESTION 1.1.1 (1)

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1.2 Unlike other conventional fossil-fuel technologies, over 90% of the total cost of wind-turbine projects is related to 'upfront' costs. A few elements that make up the upfront costs include:

- Electrical installation
- Wind-turbine foundation
- Turbine
- Grid connection
- Land rent

List the above-mentioned elements in order of HIGHEST share of total costs to LOWEST. (5)

1.3

'The president said through its Hydrogen South Africa Strategy, government and its partners have successfully deployed hydrogen fuel cells to provide electricity in schools and to field hospitals established as part of the country's Covid-19 response.'

[Source: Extract from *https://businesstech.co.za/news/technology/469602/south-africa-to-build-and-sell-hydrogen-fuel-technology*]

Answer the following questions:

1.3.1 Explain why it may be considered a worthwhile investment for South Africa to participate in the fuel-cell industry. Your answer must highlight the competitive advantage South Africa has compared to other countries. (3)

1.3.2 Name FIVE advantages of hydrogen and fuel-cell technology. (5)

1.4 It is evident that South Africa has great potential for the generation of electricity by means of wind-powered systems. There is subsequently no doubt that there are several impacts associated with wind-power and wind farm developments (7)

List at least SEVEN impacts of wind-powered systems.

[25]

QUESTION 2

2.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (2.1.1–2.1.5) in the ANSWER BOOK.

2.1.1 Warm air is more dense than cold air and therefore sinks down.

2.1.2 As air rises, it creates low atmospheric (air) pressure.

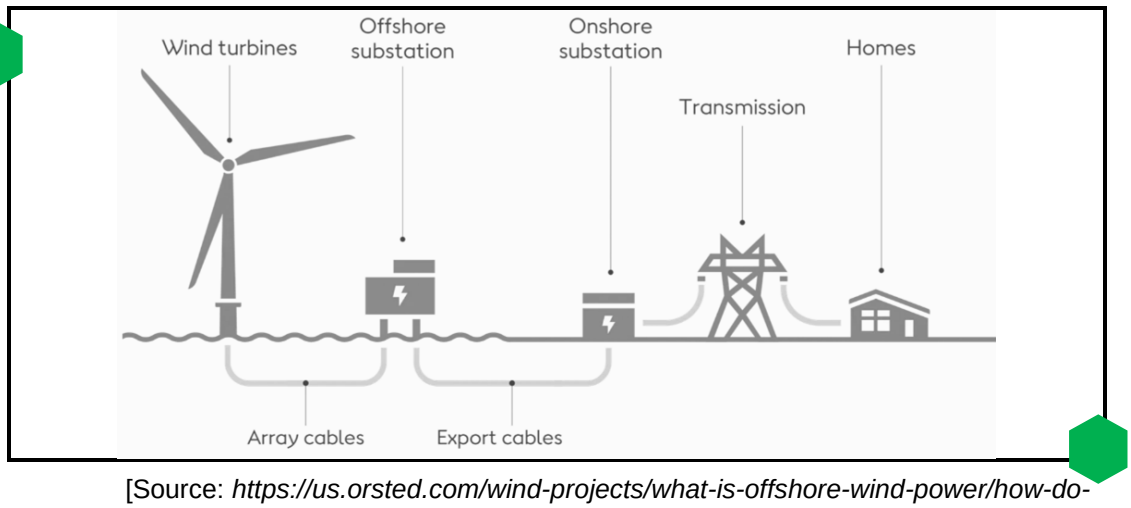
2.1.3 Wind, or air in motion, often moves from areas where it is colder to areas where it is warmer.

2.1.4 Wind blows faster when the distance between high- and low-pressure zones are large.

2.1.5 Wind is caused by solar convection that is absorbed differentially by the earth's surface and converted through radiation processes due to temperature and air-pressure differences.

(5 × 1) (5)

2.2 FIGURE 2 below is an illustration of an offshore wind farm. Study FIGURE 2 and answer the questions that follow.



[Source: *https://us.orsted.com/wind-projects/what-is-offshore-wind-power/how-do-offshore-wind-turbines-work*]

FIGURE 2

2.2.1 Describe the energy conversion (or transformation) process. (3)

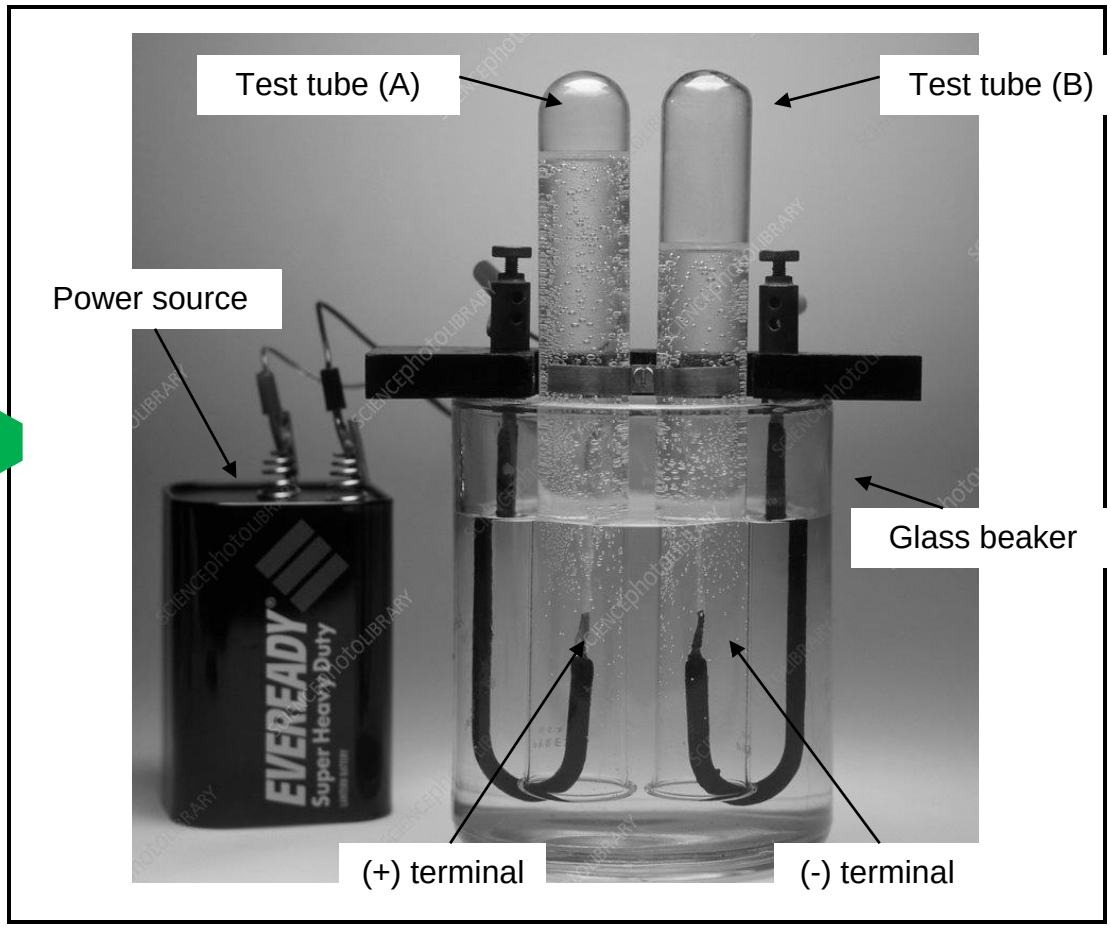
2.2.2 The design of the rotor blades plays an important role in the efficiency of one of the energy conversion elements.

Name the TWO forces at work at the rotor blades. (2)

2.3 Explain why fuel cells provide interesting opportunities for eMobility concepts. (7)

2.4 FIGURE 3 below is an image of the Hoffman apparatus that is used to carry out water electrolysis for hydrogen generation.

Study FIGURE 3 and answer the questions that follow.



[Source: https://www.sciencephoto.com/media/4184/view/electrolysis-of-water]

FIGURE 3

2.4.1 Identify the terminal that will be the CATHODE and the terminal that will be the ANODE. (2)

2.4.2 Explain the process that takes place when the power source is applied. (6)

[25]

QUESTION 3

3.1 With respect to hazards related to wind-turbine technologies, match a description from COLUMN B with a term in COLUMN A. Write only the letter (A–G) next to the question number (3.1.1–3.1.6) in the ANSWER BOOK.

COLUMN A		COLUMN B	
3.1.1	Lockout/Tagout	A	electrical shock and burns from arc flashes
3.1.2	Electrical hazards	B	being exposed to falling with potentially dangerous consequences
3.1.3	Safety checklist	C	when substances can cause illnesses, skin irritation or breathing problems
3.1.4	Working at heights	D	used to determine compliance to standards and to ensure consistency
3.1.5	Chemical hazards	E	occurs frequently throughout all phases of construction and maintenance of wind turbines
3.1.6	Falling hazards	F	to prevent the DC or AC circuits from inadvertently re-energising
		G	a membrane that separates two electrodes of a fuel cell

(6 × 1) (6)

3.2 You are supervising a group of artisans who are required to install medium-sized wind turbines. Because they are not familiar with working at heights, they are all nervous and therefore require assurance that they will be safe in doing so.

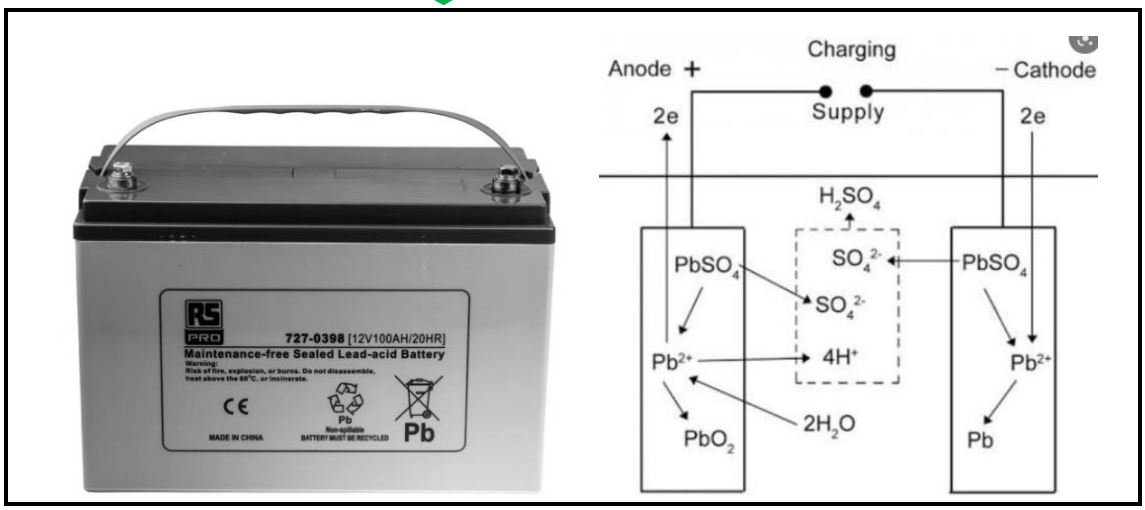
Provide a list of SIX mitigating methods that will potentially assist in ensuring the safety of workers when working at heights. (6)

3.3 Give THREE aspects how employees can be involved in health and safety processes and procedures. (3)

[15]

QUESTION 4

4.1 FIGURE 4 below contains an image of a lead-acid battery and an illustration of the chemical behaviour during charging. Study FIGURE 4 and answer the questions that follow.



[Source: http://hyperphysics.phy-astr.gsu.edu/hbase/electric/leadacid.html]

FIGURE 4

4.1.1 Explain the chemical reaction that takes place during charging. (4)

4.1.2 List SEVEN requirements for effective battery enclosure and maintenance. (7)

4.2 An experiment is conducted on an IKS H_2 Junior trainer to measure the efficiency of the electrolyser. The potential difference and hydrogen volume are given at two current settings, at the respective time intervals.

Study TABLE 1 and 2 below and answer questions 4.2.1 – 4.2.2 in your answer book.

TABLE 1: Measurement data

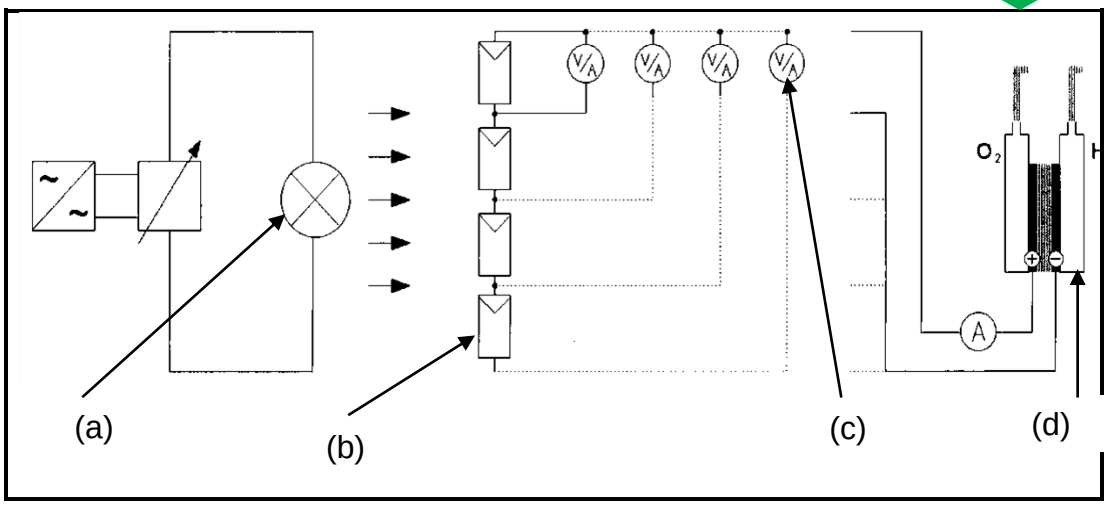
I (mA)	V (V)	T (mins)	H_2 start vol. (ml)	H_2 end vol. (ml)	H_2 Δ vol (ml)
100	1.8	8	0	4	4
500	2	4	8	23	15

TABLE 2: Calculating data

I (mA)	$E_{ch} = H_o \times V_{exp}$ = …(J)	$E_{el} = V \times I \times t$ = …(J)	η = …(%)
100	46.8 J	***(4.2.1)***	***(4.2.2)***
500	175.5 J	240J	*73,12%*

(6)

4.3 FIGURE 5 below is a circuit diagram for an experiment where the electrolyser is powered by FOUR PV solar cells connected in series. Study FIGURE 5 and TABLE 3 to answer the questions that follow.



[Source: IKS Fuel-cell Experiment, Student Guide]

FIGURE 5

Quantity of PV solar cells	1	2	3	4
V_{oc} (mV)	0,6	1,2	1,8	2,4
I_{sc} (mA)	152	151	152	150
$I_{electrolyser}$ (mA)	0	0	70	160

(Hypothetical results for the experiment in FIGURE 5)

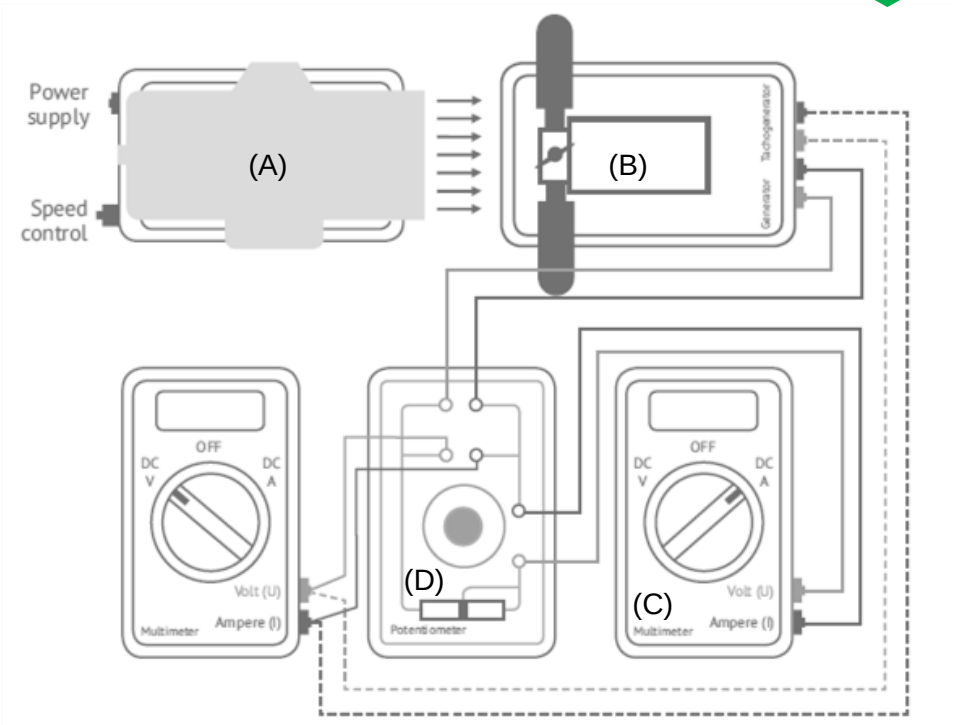
TABLE 3

4.3.1 Give the names of the components in FIGURE 5 labelled (a–d). Write only the name next to the letter (a–d) in the ANSWER BOOK. (4 × 1) (4)

4.3.2 Write down the TWO chemical reactions that can be expected to happen at the anode and cathode terminal respectively. (4)

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4.4 Study FIGURE 6 below to answer the following questions.



Source: S4GJ/GIZ

FIGURE 6

4.4.1 Name the items in FIGURE 6 labelled A-D (4)

4.4.2 State the function of the item labelled C. (3)

4.4.3 State which of the items in FIGURE 6 are necessary for creating motion by airflow. (1)

4.4.4 List THREE possible causes for faulty readings when using the item labelled C. (3)

[35]

TOTAL: 100

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