

# Handout for Mathematics in PISA session

## Handout-4

### Question 1: PENGUINS

PM921Q01

Normally, a penguin couple produces two eggs every year. Usually the chick from the larger of the two eggs is the only one that survives.

With rockhopper penguins, the first egg weighs approximately 78 g and the second egg weighs approximately 110 g.

By approximately how many percent is the second egg heavier than the first egg?

- A 29%
- B 32%
- C 41%
- D 71%



### Question 2: PENGUINS

PM921Q02 – 0 1 9

Jean wonders how the size of a penguin colony will change over the next few years. In order to determine this, he makes the following assumptions:

- At the beginning of the year, the colony consists of 10 000 penguins (5 000 couples).
- Each penguin couple raises one chick in the spring of each year.
- By the end of the year 20% of all the penguins (adults and chicks) will die.

At the end of the first year, how many penguins (adults and chicks) are there in the colony?

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## Question 3: PENGUINS

PM921Q03

Jean assumes the colony will continue to grow in the following manner:

- At the beginning of each year, the colony consists of equal numbers of male and female penguins who form couples.
- Each penguin couple raises one chick in the spring of each year.
- By the end of each year 20% of all the penguins (adults and chicks) will die.
- One year old penguins will also raise chicks.

Based on the above assumptions, which of the following formulae describes the total number of penguins,  $P$ , after 7 years?

- A  $P = 10\,000 \times (1.5 \times 0.2)^7$
- B  $P = 10\,000 \times (1.5 \times 0.8)^7$
- C  $P = 10\,000 \times (1.2 \times 0.2)^7$
- D  $P = 10\,000 \times (1.2 \times 0.8)^7$

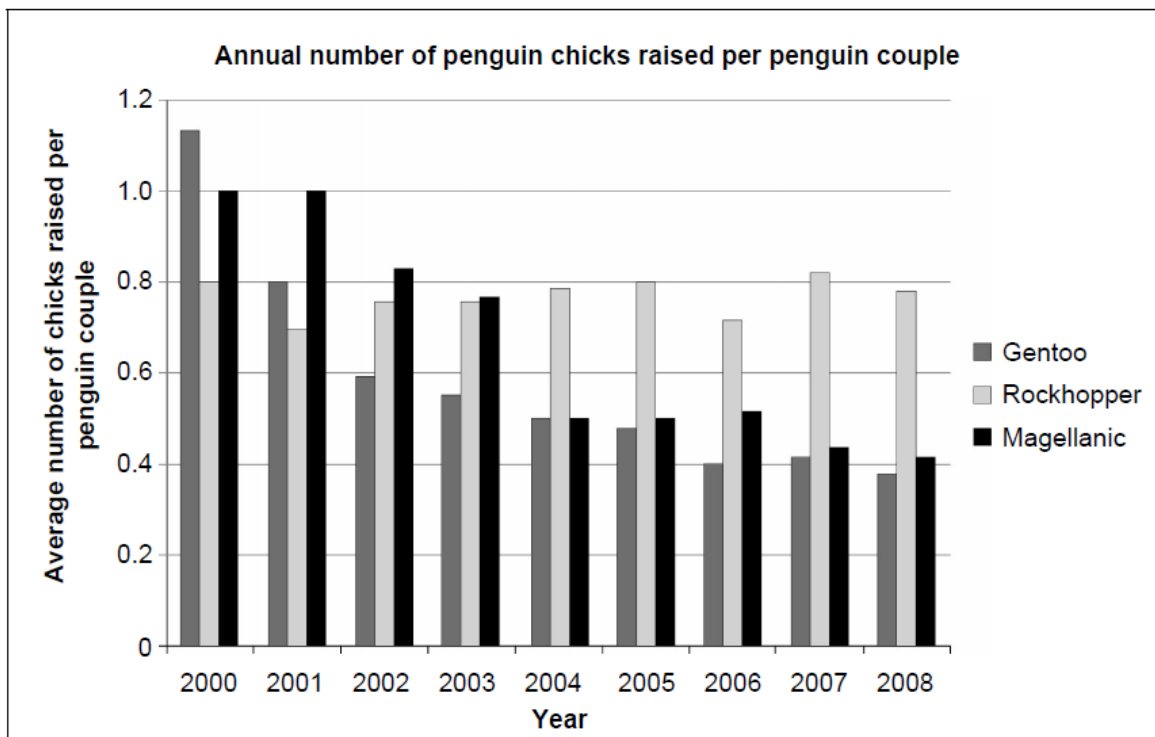
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## Question 4: PENGUINS

PM921Q04

After he gets home from his trip, Jean Baptiste has a look on the Internet to see how many chicks a penguin couple raise on average.

He finds the following bar chart for the three penguin types Gentoo, Rockhopper and Magellanic.



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Based on the chart above, are the following statements about these three penguin types true or false?

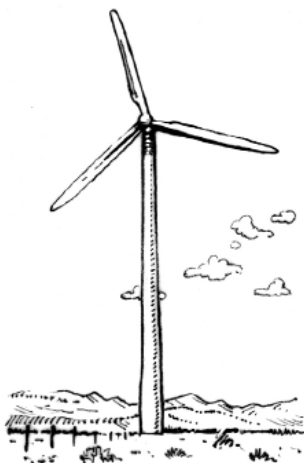
Circle "True" or "False" for each statement.

Statement	Is the statement true or false?
In 2000, the average number of chicks raised per penguin couple was larger than 0.6.	True / False
In 2006, on average, less than 80% of penguin couples raised a chick.	True / False
By about 2015 these three penguin types will be extinct.	True / False
The average number of Magellanic penguin chicks raised per penguin couple decreased between 2001 and 2004.	True / False

## POWER OF THE WIND

Zedtown is considering building some wind power stations to produce electricity.

The Zedtown Council gathered information about the following model.



Model:	E-82
Height of tower:	138 metres
Number of rotor blades:	3
Length of one rotor blade:	40 metres
Maximum speed of rotation:	20 rotations per minute
Price for construction:	3 200 000 zeds
Turnover:	0.10 zeds per kWh generated
Maintenance cost:	0.01 zeds per kWh generated
Efficiency:	Operational 97% of the year

Note: kilowatt hours (kWh) is a measure of electrical energy.

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## Question 1: POWER OF THE WIND

PM922Q01

Decide whether the following statements about the E-82 wind power station can be deduced from the information provided. Circle "Yes" or "No" for each statement.

Statement	Can this statement be deduced from the information provided?
The construction of three of the power stations will cost more than 8 000 000 zeds in total.	Yes / No
The maintenance costs for the power station correspond to approximately 5% of its turnover.	Yes / No
The maintenance costs for the wind power station depend on the amount of kWh generated.	Yes / No
On exactly 97 days a year, the wind power station is not operational.	Yes / No

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## Question 2: POWER OF THE WIND

PM922Q02

Zedtown wants to estimate the costs and the profit that would be created by constructing this wind power station.

Zedtown's mayor proposes the following formula for estimating the financial gain,  $F$  zeds, over a number of years,  $y$ , if they build the E-82 model.

$$F = \underbrace{400\,000 y}_{\text{Profit from the yearly production of electricity}} - \underbrace{3\,200\,000}_{\text{Costs of building the wind power station}}$$

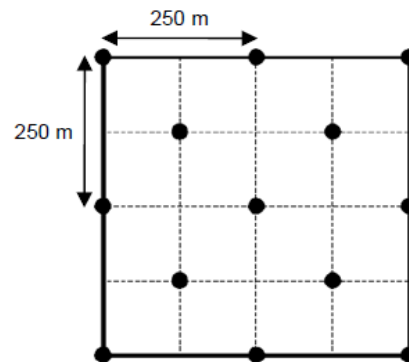
## Question 3: POWER OF THE WIND

PM922Q03 – 0 1 9

Zedtown has decided to erect some E-82 wind power stations in a square field (length = breadth = 500 m).

According to building regulations, the minimum distance between the towers of two wind power stations of this model has to be five times the length of a rotor blade.

The town mayor has made a suggestion for how to arrange the wind power stations in the field. This is shown in the diagram opposite.



● = wind power station tower  
Note: Drawing is not to scale.

Explain why the town mayor's suggestion does not meet the building regulations. Support your arguments with calculations.

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## Question 4: POWER OF THE WIND

PM922Q04 – 0 1 2 9

What is the maximum speed that the ends of the rotor blades for the wind power station move? Describe your solution process and give the result in **kilometres per hour** (km/h). Refer back to the information about the E-82 model.

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Maximum speed: ..... km/h