



CHAPTER 7

Probability

CONTENTS

1 Expressions of Probability	1
1.1 Exercise 1: Probability	1
2 Prediction	2
2.1 Exercise 2	2
3 Representations for Determining Possible Outcomes	3
3.1 Exercise 3	3
4 Evaluating Expressions involving Probability	5
4.1 Exercise 4	5
5 Assignment: Gardening	6
6 Use of the calculator:... CAsio FX-82ZA Plus	7
7 Answers for Exercises	8
7.1 Exercise 1	9
7.2 Exercise 2	9
7.3 Exercise 3	9
7.4 Exercise 4	10

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1 EXPRESSIONS OF PROBABILITY

Scale that shows certain

From this section you can see that there are three main ways in which we can choose to describe the probability of an event:

- As a fraction: a value that lies between 0 and 1
- As a decimal: the result of computing the fraction.
- As a percentage.

Certain		Very likely	Likely		Unsure			Unlikely	Highly unlikely	Impossible
$\frac{10}{10}$	$\frac{9}{10}$	$\frac{8}{10}$	$\frac{7}{10}$	$\frac{6}{10}$	$\frac{5}{10}$	$\frac{4}{10}$	$\frac{3}{10}$	$\frac{2}{10}$	$\frac{1}{10}$	$\frac{0}{10}$
1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0%

Application of probability:

$$\text{Probability} = \frac{\text{Number of successful outcomes (ASU)}}{\text{Total number of possible outcomes (TNPO)}}$$

E.g. A dice is thrown. What is the probability...

- (a) to throw a four? (b) to throw an uneven number?

(a) $P = \frac{NSO}{TNPO} = \frac{1}{6} \therefore$ The chance to throw a four is 1 out of 6, because a die has only one four.

(b) $P = \frac{NSO}{TNPO} = \frac{3}{6} = \frac{1}{2} \therefore$ The chance to throw an uneven number is 1 out of 2 because there are three uneven numbers on a die.

1.1 Exercise 1: Probability

1. Study the picture below:

If this is the scenario at a parking lot where you are looking for a parking place, what is the chance that you will get a parking place?

2. The following table shows the estimated number of HIV + infections by age group in South Africa.

Age Group	Estimated infections	Estimated Uninfected	Estimated Population	Rate %
15 – 19	398514	2130128	2528642	
20 – 24	664716	1530514	2195230	
25 – 29	720678	1315136	2035814	
30 – 34	540165	1206248	1746413	
35 – 39	381155	1249108	1630263	
40+	395635	2109973	2505608	
TOTAL	3100863	9541107	12641970	

If you were to pick a person at random, what is the probability that:

- 2.1 she/he will be HIV positive?
- 2.2 she/he will be older than 40?
- 2.3 she/he will be between 25 and 29 years old?
- 2.4 she/he will be between 15 and 19 and not infected?
- 2.5 What percentage of the total population of South Africa is HIV +?
- 2.6 Which age group has the highest infection rate?

2 PREDICTION

2.1 Exercise 2

1 Photo: 3000 race bicycles parked for Ironman contest.

From 1978 through 1980 the race was held on the island of Oahu. In 1981 the race was moved to the less urbanized Big Island, keeping the distances the same; a 2.4 miles open water swim, a 112 miles bike ride and a marathon (26 miles 385 yards, 42, 195 km) run.

The most recent Ironman World Championship took place on October 13,2012 .

The current Ironman Hawaii course record was set in 2011 by Craig Alexander (Australia), whose winning time was 8 hrs. 3 mins 56 sec. The women’s course record is

8 hrs. 54 minutes 2 sec, set in 2009 by Chrissie Wellington (Great Britain).

- 1.1 If a competitor randomly picks a bicycle, what is the chance that he picks his own bicycle?
- 1.2 Do the conversion: 2,2 miles = _km
- 1.3 Do the conversion: 112 miles = _km
- 1.4 What was the average speed of Craig Alexander and Chrissie Wellington?

1.5 For how many years have they been running these races now?

1.6 How many people do they expect to take part every year?

3 REPRESENTATIONS FOR DETERMINING POSSIBLE OUTCOMES

3.1 Exercise 3

Tree Diagram:

This is a useful diagram if more than one action must be carried out.

E.g. A family has two children. What is the probability that the family has one girl and one boy?

E.g. Two dice are thrown. Investigate the probability of each of the following:

(a) to throw a four on both the dice. (b) to throw a four on only one of the dice. (c) to throw no four at all.

1 For a surprise party the tuck shop provides chocolates for you and your friends. Everybody can randomly choose 2 chocolates. What is the chance that you first choose a Flake and then a Bar One if you choose randomly from a box. There are 2 of each kind in the box; Bar One's, Flakes, Lunch Bars and Tex chocolates.

Draw a tree diagram and show all the outcomes.

2 Peter has 4 yellow socks and 6 green socks in his drawer. It is dark in the morning as he gets dressed for work and he blindly chooses two socks from his drawer, one after the other without replacement. Draw a tree diagram for this scenario. Determine the probability of Peter choosing a pair of yellow socks.

GRIDS:

This grid shows that there are a total of 12 possible results that could occur. However, there is only one possible way that the result could be "Heads 6". This means that the probability that the coin will land on "Heads" and the dice on "6" is $\frac{1}{12}$

In other words, to calculate the probability of two events happening together you multiply the probability of each event occurring: $\frac{1}{2} \times \frac{1}{6} = \frac{1}{12}$

3 Study the grid below:

		HEADS	TAILS			
D I C E	1	H1	T1			
	2	H2	T2			
	3	H3	T3			
	4	H4	T4			
	5	H5	T5			
	6	H6	T6			
		COIN				

- 3.1 What is the probability that the coin will land on "Heads" and the dice on "6"?
- 3.2 What is the probability that the coin will land on "Tail" and the dice on "6"?
- 3.3 What is the probability that the coin will land on "Tail" and the dice on an even number?
- 3.4 What is the probability that the coin will land on "Tail" and the dice on "7"?
- 4 The two sight values if two dice are thrown can be summarised as in the table.
Complete the table.

Dice 2	6	1;6					6;6
	5			3;5			
	4						
	3						
	2						
	1				4;1		
		1	2	3	4	5	6
		Dice 1					

4 EVALUATING EXPRESSIONS INVOLVING PROBABILITY

4.1 Exercise 4

Test of possible inaccurate results:

- False positive results
- False negative results

These tests include drug tests, pregnancy tests, sobriety tests, disease tests, and genetics tests. Most of these tests are not 100% accurate.

When you have a test that can say 'YES' or 'NO', you have to think of two things:

- It could be wrong if it says 'YES'
- It could be wrong if it says 'NO'

- 1 Suppose that a drug test for an illegal drug is such that it is 98% accurate in the case of that drug and 90% accurate in the case of non-user of drugs:

Represent this information in the table below (complete the table):

	Tests says 'YES'	Tests says 'NO'
Users of drugs		
Non-users of drugs		

- For people who really use illegal drugs, the test results say 'YES' 98% of the time.
- For people who do not use illegal drugs, the test results say 'YES' 10% of the time.
- For people who really use illegal, the test results say 'NO' 2% of the time.
- For people who do not use illegal drugs, the test results say 'NO' 90% of the time.

The test produced 10% False positive; which indicates that the accuracy is not very reliable.

- 2 Pregnancy test: A healthy is expected to show a normal pattern of the levels of pregnancy hormone (HCG= Human Chorionic Gonadotropin) After childbirth, miscarriage or abortion, the level should quickly

decrease to zero. There are basically two types of pregnancy test, namely: **blood and urine** tests, whereof the blood test is more reliable

- 2.1 Differentiate between qualitative and quantitative HCG hormone test. Which one do you think is more accurate in terms of probability? Support your answer.
- 2.2 Assume a drug test is 98% accurate in the case of a drug user and 90% accurate in the case of a non-drug user. Suppose it is known that 10% of the entire population really uses a drug: What is the probability that the test gives 'yes' to the tested individual who really uses this illegal drug?

	The test says YES	The test says NO
Users		
Non users		

- 3 The probability of developing lung cancer is almost 20 times greater in cigarette smokers compared to non-smokers! The probability for a smoker to develop lung cancer is much higher than for a non smoker. As there are other reasons for someone to develop lung cancer this conclusion can not be stated as an absolute scientific fact. Name other causes of lung cancer.
- 4 In marketing one of the products of the cosmetic company, the saleslady made the following probability statement: 80% of the people who used the product now have no acne. What is the probability that the product clears acne on any individual who uses it?

5 ASSIGNMENT: GARDENING

Objective

- 1 The objective of this project is to provide a practical application of the math literacy skills you have learned to date.

Instructions

- 1 You are required to plan and make your own vegetable garden and compost facility.
- 2 Plan your garden. Your plan must include:
 - 2.1 A garden layout diagram showing the size and contours of your garden and location of your composting facility;
 - 2.2 Will this be a dry garden (i.e. depend on rainfall only) or will it be a watered garden (i.e. from a river, pre-hole, rainwater tank or municipal water supply). Show the monthly rainfall data for your area in a graph.
 - 2.3 Types and number of vegetables to be planted (indicate the planting seasons, expected rainfall, average minimum and maximum temperatures in your area).

-
- 2.4 Expected cost to prepare your garden and compost facility (i.e. the initial fixed onetime costs, including the costs of tools that you may need).
 - 2.5 Expected cost for seeds, fertilizer and other operating costs (i.e. costs that you will continue incurring to plant and grow your vegetables).
 - 2.6 Expected crop that you hope to harvest (consider possible losses).
 - 2.7 Planned economic value of your harvest (e.g. the money you will save on buying vegetables; the income you hope to make by selling your vegetables).
 - 2.8 The profitability of your vegetable garden (i.e. the total income minus total costs over a two year period. Show the break-even point for your gardening business).
- 3 Implement your plan and write a short report on the outcome of your project. Indicate the actual results and compare them with your initial plan. Discuss any differences, problems and successes. What have you learned and what will you do differently with your next planting? Include photo's if the garden isn't at school.

Hints

- 1 Visit www.farming-gods.org for more information on vegetable farming.
- 2 Suggested Lay-out of compost facility
- 3 Suggested garden layout

Start timeously. This is your project for the year and it will be assessed at the end of the year.

Investigation measurement: Complete the table

6 USE OF THE CALCULATOR:... CASIO FX-82ZA PLUS

You can also visit the website: www.casiocalcs.co.za

- 1 How to clear (Initialise) your calculator.
Shift; 9; 3; = AC
- 2 Tips:
 - ONLY use **ON** when switching the scientific calculator on.
 - To clear your screen, rather use **AC**. This saves your calculator's temporary memory.
 - See the Δ in the top right corner of the screen.
 - Use the up and down arrows Δ ∇ to review previous calculations.
- 3 How to set your calculator to round off to 2 decimal places: Shift; Mode; 6; now select how many decimal places.

4 How to clear your calculator from rounding off to 2 decimal places.

Shift; Mode; 8; choose 2.

5 To give answers in scientific notation.

Shift; Mode; 8

Norm 1 is the default setting and gives answers in scientific notation.

Norm 2 is generally preferred as answers are only expressed in scientific notation when they are too big to fit on the screen.

6 Exponents:

x^2 ; x

7 Surds:

$\sqrt{\quad}$ and shift $\sqrt{\quad}$

8 Percentages:

8.1 Writing a fraction as a percentage:

Example: Write $\frac{126}{150}$ as a percentage.

Press: 126; ÷; 150; =; ×; 100; =

8.2 Finding the percentage of an amount:

Example: 15% of 1250

Press: 15; ÷; 100; =; ×; 1250; =; SD

8.3 Increase 2000 by 15%

Press: 2000; ×; 1, 15; =

8.4 Decrease 2000 by 15%

Press: 2000 – 15; ÷; 100; =; × 2000; =

9 Converting from a decimal to hours, minutes and seconds

Example: How long will it take to travel a distance of 534 km, if your average speed is 90 km/h?

Time = $\frac{534}{90} = 5,9333$

Press: FACT

10 Converting from hours, minutes and seconds to a decimal. Example: At what speed are you travelling if 150 km takes 1 hour 16 minutes and 17 seconds?

Speed = $\frac{150}{1^{\circ}16^{\circ}17^{\circ}} = 117,98$ km/h

Press: 150; ÷; 1; fact; 16; fact; 17; fact; ÷; =

7 ANSWERS FOR EXERCISES

7.1 Exercise 1

1 $\frac{2}{19}$

2.1 24,5%

2.2 20%

2.3 16%

2.4 84%

2.5 24,53%

2.6 Between 25 – 29 years old. Risky Lifestyle

7.2 Exercise 2

1.1 $\frac{1}{3000}$

1.2 3,86km

1.3 180,25km

2.1 Craig: 28km/h ; Chrissie: 25km/h

2.2 37 years

2.3 Between 3000 and 4000 people.

7.3 Exercise 3

1

2

3.1 $\frac{1}{12}$

3.2 $\frac{1}{12}$

3.3 $\frac{1}{4}$

3.4 0

1

7.4 Exercise 4

	Tests says 'YES'	Tests says 'NO'
1 Users of drugs	98% True positive	2% False negative
Non-users of drugs	10% False positive	90% True Negative

2.1 Qualitative only gives you a "Yes" or a "No", while quantitative gives the actual hormonal levels.

	The test says YES	The test says NO
2.2 Users	$98\% \times 10\% = 9,8\%$	$2\% \times 10\% = 0,2\%$
Non users	$10\% \times 90\% = 9$	$90\% \times 90\% = 81\%$

2.3 Air Pollution

2.4 The probability is 0,8 which means it is not certain but very likely.