Duncraig Senior High School
Mathematical Methods Year 12
Investigation 3 2016 (8%)
Time Allowed: 50 mins

Calculators allowed. One page (two sides) of notes permitted.
Show all working for full marks to be given.

Name : SOLUTIONS

Total Marks: ~~40~~ 35

Part 1 Real world data and sampling

Question 1 [~~3~~ 2 marks]

Why is sampling an important process in today's world?

✓ • Can be effective in finding things out about a population.
✓ • saves time and money
✓ • Government increasingly need information about growing populations and trends
• increase in data collection

Question 2 [2 marks]

Read the excerpt taken from an online news website and then comment on the Australian statistic mentioned.

The Middle East is in the middle of a hellish heatwave right now

AUGUST 13, 2016

THOUGHT your average Aussie summer was rough? The Middle East is currently facing one of its most extreme heatwaves ever, with experts warning temperatures are getting almost too hot for human survival. Climate scientists say it's evidence that the planet needs to cut down on its greenhouse gas emissions, especially given heatwaves can be fatal.

HOW HOT IS THE MIDDLE EAST RIGHT NOW?

Over the past month, temperatures in Kuwait and Iraq have soared to 54°C, while Baghdad, the capital of Iraq, has seen temperatures of 43°C and higher nearly every day for almost two straight months.

Meanwhile, parts of the United Arab Emirates and Iran were dealt historic temperatures reaching 60°C.

To put that into perspective, the hottest single day on record for the whole of Australia was 40·3°C, back in January 2013. Zainab Guman, a 26-year-old university student from Basra, told The Washington Post it felt like "walking into a fire" when she left the house.

✓ How is 40.3°C arrived at for Australia?
✓ Was that the lowest temperature reported on that day anywhere in Australia?

Question 3 [6 marks]

The Principal has met with you and you have been given the task of selecting a random sample of students from the school population to administer a simple questionnaire to them. The students will each be given the same questionnaire on the following topics: mobile phone use, uniforms and silent reading. The questionnaire has already been designed for you.

Student numbers in the school:

Year 7 : 280	Year 8 : 260	Year 9 : 245
Year 10 : 260	Year 11 : 220	Year 12 : 215

Year lists of students are available to you in alphabetical order.

Describe in detail how you would carry out this task.

1. Obtain alphabetic lists of students.
2. Assign a number to each student.
   - Yr 7 1 – 280
   - Yr 8 281 – 540
   - Yr 9 541 – 785
   - Yr 10 786 – 1045
   - Yr 11 1046 – 1265
   - Yr 12 1266 – 1480

   ✓
3. Select a sample size, say 50. ✓
4. Stratified random sample.
   - Yr 7 $\frac{280}{1480} \times 50 = 10$
   - Yr 8 $\frac{260}{1480} \times 50 = 9$
   - Yr 9 $= 8$
   - Yr 10 $= 9$
   - Yr 11 $= 7$
   - Yr 12 $= 7$

   ✓✓ 50
5. Use a random number generator on a calculator to generate random numbers from 1 to 1480.
   e.g. 782 → Yr 9 student
   Record/highlight on master list. ✓
   Take care to complete each strata.
   Ignore repeated numbers

2 6

Question 4 **[2, 2, 3 = 7 marks]**

Comment constructively on each of these situations.

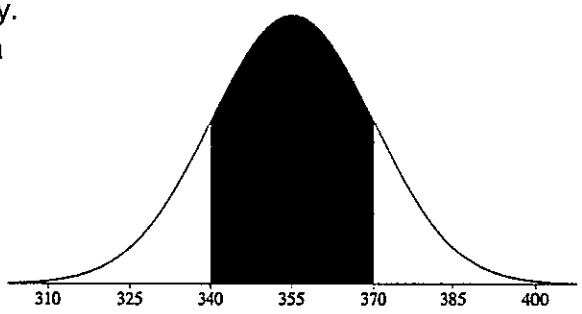
Situation One

The Shokken Electrical Company produces a key component for medical equipment. To save money, the company decides to test every 5th component.

✓✓ Not a good idea to save money, don't take shortcuts with medical equipment. Systematic or array sampling is good in theory, but not here.

Situation Two

Dodgy Dave produces 360g packets of oat bran in a factory. A sample of 28 packets are weighed and the following data is obtained as shown in the graph where the mean = 355g and the standard deviation = 15g.



$P(x \leq 360) = 0.63$

✓ More than half the packets are below expected
✓ weight and the variation is too much.
The machinery needs adjusting.

Situation Three

Jana's friend Chris rolled a normal die four times and repeated that sampling process three times. The proportion of odd numbers in each sampling process are recorded as follows:

Sample 1 : 0·5 Sample 2 : 0·25 Sample 3 : 0·25

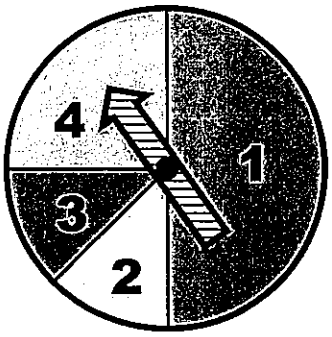
Jana concluded that the die must be biased or numbered with more even than odd numbers, possibly like this 1, 2, 2, 3, 4, 4.

✓ Sampling method is valid but limited ⇒ needs to be bigger.
✓ Any conclusion is possible with little sampling information available.
The size of each sample should have been bigger.

Part 2 Simulation problems

Question 5 **[3, ~~7~~ 4 = ~~10~~ 7 marks]**

This spinner has four different sections. Acute angles are 45°.



a) Design a simulation for this spinner. Describe how your simulation will work.

1. Use a random number generator to generate numbers from 1 to 8. ✓
2. Assign as follows:

Section on spinner	Random numbers
1	1, 2, 3, 4
2	5
3	6
4	7, 8

In proportion to the area. ✓✓

b) Run your simulation 20 times. Record your results in a neat and organised way. Comment on and compare your results to what is expected.

Section	Tally	Total
1	𝍸 𝍸 ||	12
2	|	1
3	|	1
4	𝍸 |	6
		20

✓✓

Results approximated expected results. ✓

Sample size is small. ✓

Question 6 [2, 1, 2, 2, 1, 4 = 12 marks]

A sample is drawn from a normal distribution where the mean = 65 and SD = 11.
For this sample, mean = 64·2 and SD = 10·6.

1	22	39	42	47	47	47	47	48	49	49	49	50	50	50	50	51	51	52	52	52	20
21	53	53	53	53	54	54	55	55	55	55	56	57	57	57	58	58	58	58	59	59	40
41	59	60	60	60	60	60	61	61	61	61	62	62	62	62	63	63	63	63	63	63	60
61	63	63	63	64	64	64	64	64	65	65	65	65	66	66	66	66	67	67	67	67	80
81	67	67	67	67	68	68	68	69	69	69	69	70	70	70	71	71	71	71	71	71	100
101	72	72	72	72	72	72	72	73	73	73	73	73	73	73	74	74	75	75	76	76	120
121	77	77	77	77	78	79	81	81	82	83	85	85	87	87	87						135

a) How many items are there in this sample? Is the sample size reasonable?

135. Yes, assuming the distribution is large 1000 → 2000. ✓ ✓

b) Why doesn't the mean and SD of the sample match the population measurements?

Because it is just a sample. This is to be expected when sampling. ✓

c) If somebody else saw this sample and wondered if data was missing from the blank cells in the table what would your response be?

$P(X \geq 88) \approx 0.01$ or $X \sim N(10.6, 64.2)$

There is a less than 2% chance that values above 87 exist. So unlikely to be any further data. ✓✓

d) Randomly select 5 results from the sample above. Describe how you did this and list your sample here.

1. Assign each value a number from 1 to 135. Ignore repeats.

randList(5, 1, 135) = {7, 5, 29, 79, 87}

Random Number

7 → 47
5 → 47
29 → 55
79 → 67
87 → 68

✓✓

Question 6 continued

e) How does your sample of 5 compare to the population and the sample given above?

47, 47, 55, 67, 68

$\bar{x} = 56.8$ Different but not far off

SD = 9.2 the results for the bigger sample.

✓

f) Using randNorm(SD, Mean, Sample size) on your calculator, generate your own sample of 10 from the population where the Mean = 65 and SD = 11. Round each item to the nearest whole number. List your sample here. Find the mean and SD. Compare to other results mentioned in this question.

randList(11, 65, 10) = {68, 79, 66, 65, 63, 55, 58, 47, 50, 60}

$\bar{x} = 61.1$ SD = 8.8 ✓✓

Mean is higher than 5 sample above.

Spread is lower.

This would tend to happen with a bigger sample, less spread, and mean closer to the expected mean.

✓✓