



Rewarding Learning

General Certificate of Secondary Education  
2019

Centre Number

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Candidate Number

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## Further Mathematics

Unit 3  
Statistics



[GFM31]

\*GFM31\*

FRIDAY 21 JUNE, AFTERNOON

### TIME

1 hour.

### INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

**You must answer the questions in the spaces provided.**

**Do not write outside the boxed area on each page.**

Complete in black ink only. **Do not write with a gel pen.**

All working **must** be clearly shown in the spaces provided. Marks may be awarded for partially correct solutions.

Where rounding is necessary give answers correct to **2 decimal places** unless stated otherwise.

Answer **all seven** questions.

### INFORMATION FOR CANDIDATES

The total mark for this paper is 50.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You may use a calculator.

The Formula Sheet is on page 2 and the Normal Probability Table is on page 3.

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## FORMULA SHEET

### STATISTICS

Statistical measures: Mean =  $\frac{\Sigma fx}{\Sigma f}$

$$\text{Standard deviation} = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - (\bar{x})^2}$$

where  $\bar{x}$  is the mean

Probability:  $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$$P(A | B) = \frac{P(A \cap B)}{P(B)}$$

Bivariate Analysis: Spearman's coefficient of rank correlation is given by

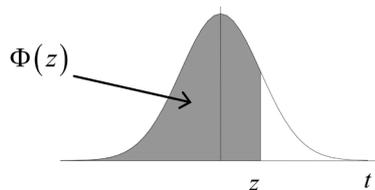
$$r = 1 - \frac{6 \Sigma d^2}{n(n^2 - 1)}$$



# NORMAL PROBABILITY TABLE

Table of  $\Phi(z)$

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
<b>0.0</b>	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
<b>0.1</b>	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
<b>0.2</b>	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
<b>0.3</b>	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
<b>0.4</b>	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
<b>0.5</b>	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
<b>0.6</b>	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
<b>0.7</b>	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
<b>0.8</b>	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
<b>0.9</b>	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
<b>1.0</b>	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
<b>1.1</b>	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
<b>1.2</b>	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
<b>1.3</b>	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
<b>1.4</b>	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
<b>1.5</b>	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
<b>1.6</b>	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
<b>1.7</b>	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
<b>1.8</b>	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
<b>1.9</b>	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
<b>2.0</b>	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
<b>2.1</b>	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
<b>2.2</b>	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
<b>2.3</b>	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
<b>2.4</b>	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
<b>2.5</b>	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
<b>2.6</b>	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
<b>2.7</b>	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
<b>2.8</b>	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
<b>2.9</b>	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
<b>3.0</b>	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990



[Turn over



- 1 A solicitor recorded the times, to the nearest minute, spent with clients. The table below shows a summary of the times.

Time (minutes)	Frequency			
10–14	8			
15–19	16			
20–24	34			
25–29	27			
30–34	10			
35–39	5			

- (i) Calculate an estimate of the mean time. You **must** show your working.

Answer \_\_\_\_\_ minutes [2]



(ii) Calculate an estimate of the standard deviation of the times. You **must** show your working.

Answer \_\_\_\_\_ minutes [3]



2 Rebekah takes 2 beads at random, without replacement, from a bag containing 6 blue and 4 green beads.

(i) What is the probability that both beads are the same colour?

Answer \_\_\_\_\_ [2]

Rebekah takes a third bead from the remaining 8 beads in the bag.

(ii) What is the probability that all 3 beads are the same colour?

Answer \_\_\_\_\_ [2]



(iii) Given that the first two beads are the same colour, what is the probability that the third bead is also the same colour as the first two?

Answer \_\_\_\_\_ [2]



- 3 Two boys and twelve girls sat a piano examination.
- One boy scored 95% and the other boy scored 76%.
- The mean of the girls' results was 82%.
- The standard deviation of the girls' results was 6%.
- (i) Calculate the mean of all 14 results.

Answer \_\_\_\_\_ % [2]



(ii) Calculate the standard deviation of all 14 results.

Answer \_\_\_\_\_ % [4]

[Turn over



4 (a) Using Pascal's triangle, write out the expansion of  $(p + q)^6$

Answer \_\_\_\_\_ [2]



(b) A bag contains a large number of red pens and black pens.

The probability that a pen, chosen at random from the bag, is black is  $\frac{4}{5}$ .

Jill picks 6 pens, chosen at random, from the bag.

Find the probability that

(i) none of the pens is red,

Answer \_\_\_\_\_ [3]

(ii) at least 2 of the pens are red.

Answer \_\_\_\_\_ [3]

[Turn over



5 A farmer sold a large number of eggs.

The weights of the eggs were normally distributed with mean 56.84 g and standard deviation 5.6 g.

Eggs weighing over 63 g were graded as large.

Find the probability that an egg, chosen at random, was graded as large.

Answer \_\_\_\_\_ [4]





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**[Turn over**

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- 6 A café recorded the number of hot soups sold and the temperature outside at lunchtime on nine particular days. The results are shown in the table below.

<b>Temperature (°C)</b>	3	5	20	17	10	9	13	15	12
<b>Hot soups sold</b>	106	98	20	38	68	80	55	44	68
<b>Ranks (Temperature)</b>									
<b>Ranks (Hot soups sold)</b>									

- (i) Write down, in the table above, the rank orders for the temperatures and the numbers of hot soups sold. [2]
- (ii) Calculate Spearman's coefficient of rank correlation.

Answer \_\_\_\_\_ [4]



(iii) Interpret your answer to part (ii).

Answer \_\_\_\_\_ [1]

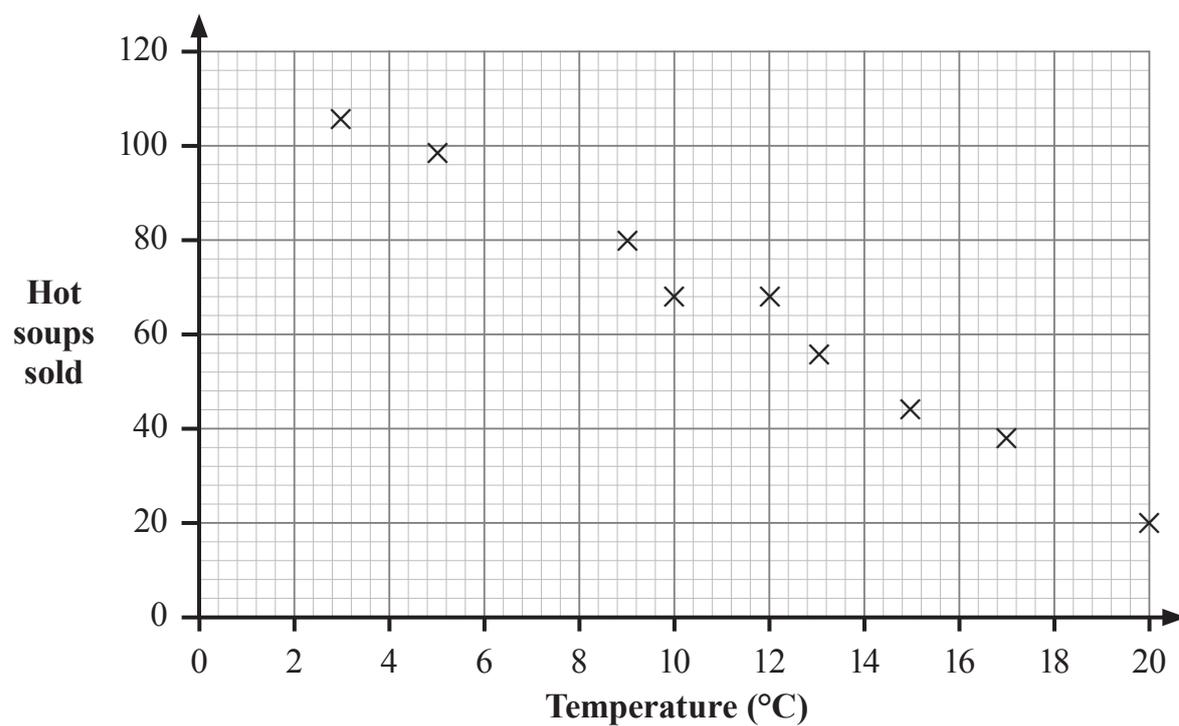
(iv) Calculate the mean temperature and the mean number of hot soups sold.

Answer Mean temperature \_\_\_\_\_ °C

Mean number of hot soups sold \_\_\_\_\_ [1]



The data from the table are plotted on the graph below.



(v) Draw your line of best fit on the graph.

[2]



(vi) Determine the equation of the line of best fit which you have drawn.

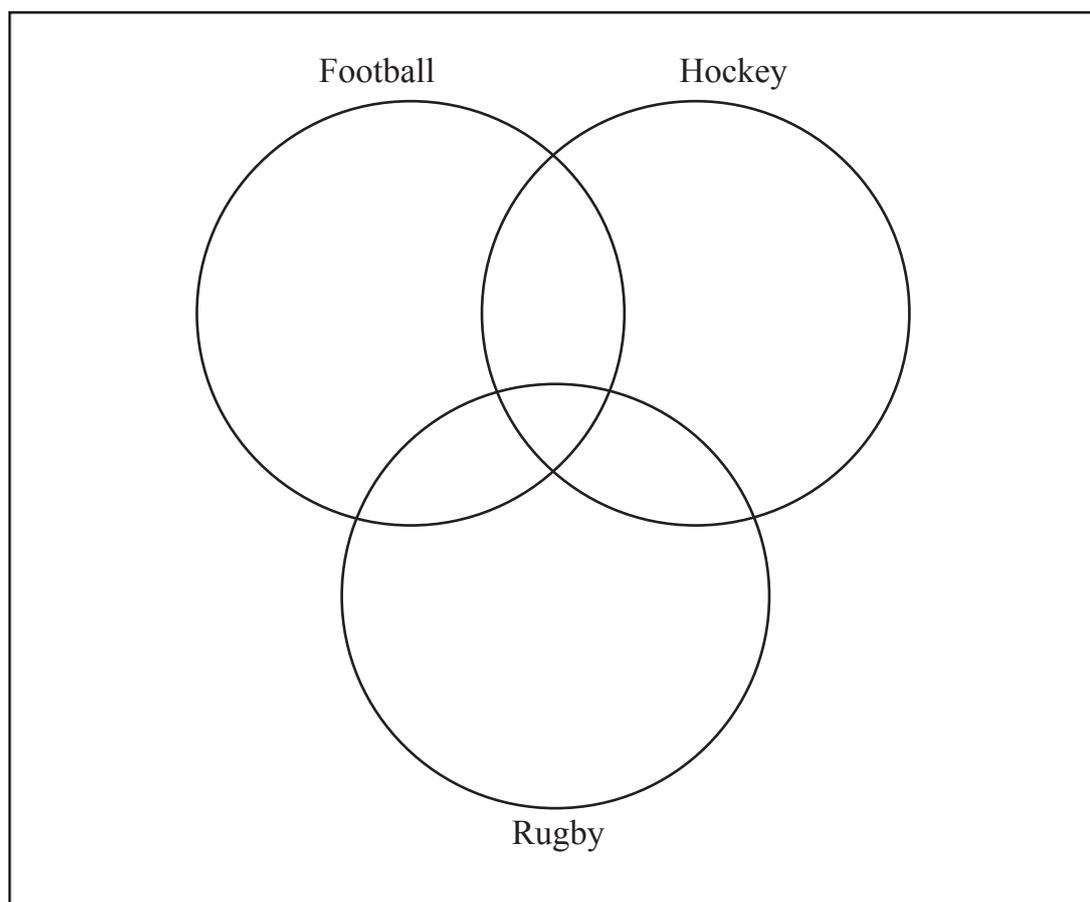
Answer \_\_\_\_\_ [3]



- 7 At Eastwood Boys Comprehensive, 120 new pupils were allowed to sign up for three after school sports activities – football, hockey and rugby.

Each pupil signed up for **at least** one activity.

17 chose football only  
12 chose hockey only  
30 chose rugby only  
25 chose all three activities  
39 did not choose rugby



- (i) Using the Venn diagram opposite, find the probability that a new pupil, selected at random, chose both football and hockey.

Answer \_\_\_\_\_ [5]

- (ii) Calculate the probability that a new pupil, chosen at random, chose exactly two activities.

Answer \_\_\_\_\_ [3]

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**THIS IS THE END OF THE QUESTION PAPER**

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<b>For Examiner's use only</b>	
<b>Question Number</b>	<b>Marks</b>
1	
2	
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<b>Total Marks</b>	
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Examiner Number

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