Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
1a	(Strong) positive correlation	**B1**	2.2a	3rd Know how to interpret a correlation coefficient
		(1)		
1b	Uses a correct formula for the PMCC $r = \frac{S_{pm}}{\sqrt{S_{pp}S_{mm}}} = \frac{7968}{\sqrt{15004 \times 6110}}$ $r = 0.832\ldots$ accept awrt 0.832	**M1** **A1**	1.1b 1.1b	3rd Know how to calculate the PMCC using standard formulae and summary statistics
		(2)		
1c	High populations (in European countries) suggest a high number of medals won OR Low populations (in European countries) suggest a low number of medals won	**B1**	3.2a	3rd Know how to interpret a correlation coefficient
		(1)		
1d	The correlation coefficient would get closer to zero o.e. OR The correlation would be weaker	**B1**	2.2a	3rd Know how to interpret a correlation coefficient
		(1)		
1e	The population value is outside the range of the data	**B1**	3.2b	5th Comment on whether a given claim about correlation is justified
		(1)		
				(6 marks)

Notes

1c Do not accept ‘low in one suggests low in other’ or ‘high in one suggests high in the other’.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
2a	$r = \dfrac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}$ $= \dfrac{-95}{\sqrt{190 \times 143}}$ = −0.576… accept awrt −0.576	**M1** **A1**	1.1b 1.1b	3rd Know how to calculate the PMCC using standard formulae and summary statistics
		(2)		
2b	High finishing position suggests a low fastest lap speed OR Low finishing position suggests a high fastest lap speed	**B1**	3.2a	3rd Know how to interpret a correlation coefficient
		(1)		
2c	Both hypotheses correct using the ρ notation H_0: $\rho = 0$, H_1: $\rho < 0$ Critical value at 5% is −0.4973 −0.5763 < −0.4973, so there is significant evidence to reject H_0 This suggests there is a negative correlation between the finishing position and average speed of fastest lap for motorcycle races	**B1** **B1** **M1 ft** **A1 ft**	2.5 1.1b 2.1 2.2b	7th Be able to test for zero correlation using the PMCC
		(4)		
				(7 marks)
Notes				

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
3a	Uses standard formula for S_{xx} $S_{xx} = \sum x^2 - \frac{\left(\sum x\right)^2}{n}$ $S_{qq} = 2.796 - \frac{7.953^2}{30}$	**M1**	1.1b	3rd Know how to calculate the PMCC using standard formulae and summary statistics
	$S_{qq} = 0.687\ldots$ accept awrt 0.688	**A1**	1.1b	
	Uses standard formula for PMCC $r = \frac{S_{xy}}{\sqrt{S_{xx}S_{xy}}}$ $r = \frac{11\,2247}{\sqrt{0.687 \times 2\,202\,699}}$	**M1**	1.1b	
	$r = 0.009...$ accept awrt 0.009	**A1**	1.1b	
		(4)		
3b	Any sensible reason; for example, The PMCC only suggests that there is no linear relationship between the area of the (top of the) cakes and the quality measure; there could be some other relationship between the two variables o.e.	**B1**	3.2b	3rd Know how to interpret a correlation coefficient
		(1)		
				(5 marks)

Notes

3b Do not accept 'there is no relationship between the area of the cake and quality measure'.

<table>
<tr><th>Q</th><th>Scheme</th><th>Marks</th><th>AOs</th><th>Pearson Progression Step and Progress Descriptor</th></tr>
<tr><td>4a</td><td>Attempts to rank scores, with at least four correct
<table><tr><td>p</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr><tr><td>Rank q</td><td>9</td><td>6</td><td>8</td><td>5</td><td>10</td><td>7</td><td>2</td><td>4</td><td>1</td><td>3</td></tr></table>Attempts to calculate $\sum d^2$ with their ranks
$\sum d^2 = 286$
Uses the correct formula for SRCC with their $\sum d^2$
$r_s = 1 - \frac{6 \times \sum d^2}{n(n^2-1)} = 1 - \frac{6 \times 286}{10(10^2-1)}$
= −0.733… accept awrt −0.73</td><td>M1
M1
M1
A1</td><td>1.1b
1.1b
1.1b
1.1b</td><td>3rd
Know how to calculate Spearman’s rank correlation coefficient</td></tr>
<tr><td></td><td></td><td>(4)</td><td></td><td></td></tr>
<tr><td>4b</td><td>Negative correlation
The most popular courses have higher student satisfaction</td><td>B1
B1</td><td>2.2a
2.4</td><td>5th
Know how to interpret Spearman’s rank correlation coefficient</td></tr>
<tr><td></td><td></td><td>(2)</td><td></td><td></td></tr>
<tr><td>4c</td><td>We do not have the rankings or data for the other courses run by the summer school outside the range of the data o.e.</td><td>B1</td><td>3.2a</td><td>6th
Understand the limitations of Spearman’s rank correlation coefficient</td></tr>
<tr><td></td><td></td><td>(1)</td><td></td><td></td></tr>
</table>

4d	No change because the ranks would remain the same	**B1**	2.4	3rd Know how to calculate Spearman's rank correlation coefficient
		(1)		
				(8 marks)
Notes				

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
5a	Uses standard formula for PMCC $r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}$ $r = \frac{-991.138}{\sqrt{17.96 \times 702114}}$ = −0.279… accept awrt –0.279	**M1** **A1**	1.1b 1.1b	3rd Know how to calculate the PMCC using standard formulae and summary statistics
		(2)		
5b	Rearranges $x = \frac{w}{2.2}$ to get $w = 2.2x$ Multiplies S_{xx} by 2.2^2 to find S_{ww} $S_{ww} = 86.9264$	**M1** **A1**	1.1b 1.1b	4th Know the effect of coding on a correlation coefficient
		(2)		
5c	–0.279 or their answer to **b**	**B1**	2.2a	4th Know the effect of coding on a correlation coefficient
		(1)		
5d	Any two sensible limitations; for example, • very small sample • other variables not considered • different shops offer bikes at different prices • data taken from a US website	**B2**	3.2b	5th Comment on whether a given claim about correlation is justified
		(2)		
				(7 marks)
Notes				

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
6a	Uses standard formula for PMCC $r = \dfrac{S_{px}}{\sqrt{S_{pp} \times S_{xx}}}$	**M1**	1.1b	3rd Know how to calculate the PMCC using standard formulae and summary statistics
	$S_{xx} = 29516 - \dfrac{1300^2}{61}$ $= 1811\,082\ldots$	**A1**	1.1b	
	$r = \dfrac{-1320}{\sqrt{5268 \times 1811.082}}$	**M1**	1.1b	
	$= -0.427\ldots$	**A1**	1.1b	
		(4)		
6b	−0.427 … or their answer to **a**	**B1**	2.2a	4th Know the effect of coding on a correlation coefficient
		(1)		
6c	Sensible statement and reason; for example, Cannot tell because, • correlation is weak • a lot of scatter at 1032 hPa • not many points at 1032 hPa • need to consider other variables	**B1** **B1**	3.2a 3.2b	3rd Know how to interpret a correlation coefficient
		(2)		
				(7 marks)
Notes				

<table>
<tr><th>Q</th><th>Scheme</th><th>Marks</th><th>AOs</th><th>Pearson Progression Step and Progress Descriptor</th></tr>
<tr><td rowspan="2">7a</td><td>Attempts to rank scores, with at least four pairs correct

Deals with tied ranks correctly

<table><tr><td>Rating rank</td><td>6</td><td>9</td><td>2</td><td>7</td><td>10</td><td>1</td><td>4</td><td>3</td><td>8</td><td>5</td></tr><tr><td>Cost rank</td><td>4.5</td><td>9</td><td>1</td><td>6</td><td>10</td><td>3</td><td>2</td><td>7</td><td>8</td><td>4.5</td></tr></table>
$d^2 = 28.5$

$r_s = 1 - \frac{6 \times 28.5}{990}$

$r_s = 0.827\ldots$ accept awrt 0.827</td><td>M1

M1

M1

M1

A1</td><td>1.1b

1.1b

1.1b

1.1b

1.1b</td><td>4th

Know how to deal with tied ranks</td></tr>
<tr><td></td><td>(5)</td><td></td><td></td></tr>
<tr><td rowspan="2">7b</td><td>Both hypotheses correct using the ρ notation
$H_0: \rho = 0$, $H_1: \rho \neq 0$

Critical value for two-tailed test at 5% is 0.6485

$|r_s| > 0.6485$ so there is significant evidence to reject H_0

The claim is correct at the 5% level
OR
There is sufficient evidence to support the claim (that washing machine rating is correlated to cost of washing machine)</td><td>B1

B1

M1

A1</td><td>2.5

1.1b

2.1

2.2b</td><td>7th

Be able to test for zero correlation using Spearman’s rank correlation coefficient</td></tr>
<tr><td></td><td>(4)</td><td></td><td></td></tr>
<tr><td rowspan="2">7c</td><td>Any sensible limitation; for example,
Ranks, not raw data, used to calculate r_s
Other variables have not been considered, e.g.where the machine was bought, in sale or full price, when they were purchased
Small sample size
Rating is a subjective measure</td><td>B1</td><td>3.2b</td><td>6th

Understand the limitations of Spearman’s rank correlation coefficient</td></tr>
<tr><td></td><td>(1)</td><td></td><td></td></tr>
<tr><td colspan="5">(10 marks)</td></tr>
</table>

Notes