

**Paper Reference(s) 8PS0/02**  
**Pearson Edexcel Level 3 GCE**

## **Psychology**

**Advanced Subsidiary**

**PAPER 2: Biological Psychology and Learning Theories**

**Monday 22 May 2023 – Afternoon**

**Formulae and statistical tables Booklet**

**DO NOT RETURN THIS BOOKLET WITH  
THE QUESTION PAPER.**

**Standard deviation (sample estimate)**

$$\sqrt{\left( \frac{\sum (x - \bar{x})^2}{n - 1} \right)}$$

**Spearman's rank correlation coefficient**

$$1 - \frac{6 \sum d^2}{n(n^2 - 1)}$$

## Critical values for Spearman's rank

Level of significance for a one-tailed test					
	0·05	0·025	0·01	0·005	0·0025
Level of significance for a two-tailed test					
N	0·10	0·05	0·025	0·01	0·005
5	0·900	1·000	1·000	1·000	1·000
6	0·829	0·886	0·943	1·000	1·000
7	0·714	0·786	0·893	0·929	0·964
8	0·643	0·738	0·833	0·881	0·905
9	0·600	0·700	0·783	0·833	0·867
10	0·564	0·648	0·745	0·794	0·830
11	0·536	0·618	0·709	0·755	0·800
12	0·503	0·587	0·678	0·727	0·769
13	0·484	0·560	0·648	0·703	0·747
14	0·464	0·538	0·626	0·679	0·723
15	0·446	0·521	0·604	0·654	0·700
16	0·429	0·503	0·582	0·635	0·679
17	0·414	0·485	0·566	0·615	0·662
18	0·401	0·472	0·550	0·600	0·643
19	0·391	0·460	0·535	0·584	0·628
20	0·380	0·447	0·520	0·570	0·612
21	0·370	0·435	0·508	0·556	0·599
22	0·361	0·425	0·496	0·544	0·586
23	0·353	0·415	0·486	0·532	0·573

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Level of significance for a one-tailed test					
	0·05	0·025	0·01	0·005	0·0025
Level of significance for a two-tailed test					
N	0·10	0·05	0·025	0·01	0·005
24	0·344	0·406	0·476	0·521	0·562
25	0·337	0·398	0·466	0·511	0·551
26	0·331	0·390	0·457	0·501	0·541
27	0·324	0·382	0·448	0·491	0·531
28	0·317	0·375	0·440	0·483	0·522
29	0·312	0·368	0·433	0·475	0·513
30	0·306	0·362	0·425	0·467	0·504

The calculated value must be equal to or exceed the critical value in this table for significance to be shown.

## Chi-squared distribution formula

$$\chi^2 = \sum \frac{(O - E)^2}{E} \quad df = (r - 1)(c - 1)$$

## Critical values for chi-squared distribution

Level of significance for a one-tailed test						
	0.10	0.05	0.025	0.01	0.005	0.0005
Level of significance for a two-tailed test						
df	0.20	0.10	0.05	0.025	0.01	0.001
1	1.64	2.71	3.84	5.02	6.64	10.83
2	3.22	4.61	5.99	7.38	9.21	13.82
3	4.64	6.25	7.82	9.35	11.35	16.27
4	5.99	7.78	9.49	11.14	13.28	18.47
5	7.29	9.24	11.07	12.83	15.09	20.52
6	8.56	10.65	12.59	14.45	16.81	22.46
7	9.80	12.02	14.07	16.01	18.48	24.32
8	11.03	13.36	15.51	17.54	20.09	26.12
9	12.24	14.68	16.92	19.02	21.67	27.88
10	13.44	15.99	18.31	20.48	23.21	29.59
11	14.63	17.28	19.68	21.92	24.73	31.26
12	15.81	18.55	21.03	23.34	26.22	32.91
13	16.99	19.81	22.36	24.74	27.69	34.53
14	18.15	21.06	23.69	26.12	29.14	36.12

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Level of significance for a one-tailed test						
	0·10	0·05	0·025	0·01	0·005	0·0005
Level of significance for a two-tailed test						
df	0·20	0·10	0·05	0·025	0·01	0·001
15	19·31	22·31	25·00	27·49	30·58	37·70
16	20·47	23·54	26·30	28·85	32·00	39·25
17	21·62	24·77	27·59	30·19	33·41	40·79
18	22·76	25·99	28·87	31·53	34·81	42·31
19	23·90	27·20	30·14	32·85	36·19	43·82
20	25·04	28·41	31·41	34·17	37·57	45·32
21	26·17	29·62	32·67	35·48	38·93	46·80
22	27·30	30·81	33·92	36·78	40·29	48·27
23	28·43	32·01	35·17	38·08	41·64	49·73
24	29·55	33·20	36·42	39·36	42·98	51·18
25	30·68	34·38	37·65	40·65	44·31	52·62
26	31·80	35·56	38·89	41·92	45·64	54·05
27	32·91	36·74	40·11	43·20	46·96	55·48
28	34·03	37·92	41·34	44·46	48·28	56·89
29	35·14	39·09	42·56	45·72	49·59	58·30
30	36·25	40·26	43·77	46·98	50·89	59·70

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<b>Level of significance for a one-tailed test</b>						
	<b>0·10</b>	<b>0·05</b>	<b>0·025</b>	<b>0·01</b>	<b>0·005</b>	<b>0·0005</b>
<b>Level of significance for a two-tailed test</b>						
<b>df</b>	<b>0·20</b>	<b>0·10</b>	<b>0·05</b>	<b>0·025</b>	<b>0·01</b>	<b>0·001</b>
<b>40</b>	47·27	51·81	55·76	59·34	63·69	73·40
<b>50</b>	58·16	63·17	67·51	71·42	76·15	86·66
<b>60</b>	68·97	74·40	79·08	83·30	88·38	99·61
<b>70</b>	79·72	85·53	90·53	95·02	100·43	112·32

The calculated value must be equal to or exceed the critical value in this table for significance to be shown.

## Mann-Whitney U test formulae

$$U_a = n_a n_b + \frac{n_a(n_a + 1)}{2} - \sum R_a$$

$$U_b = n_a n_b + \frac{n_b(n_b + 1)}{2} - \sum R_b$$

(U is the smaller of  $U_a$  and  $U_b$ )

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Critical values for the Mann-Whitney U test

N <sub>a</sub>	N <sub>b</sub>															
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
p ≤ 0·05 (one-tailed), p ≤ 0·10 (two-tailed)																
5	4	5	6	8	9	11	12	13	15	16	18	19	20	22	23	25
6	5	7	8	10	12	14	16	17	19	21	23	25	26	28	30	32
7	6	8	11	13	15	17	19	21	24	26	28	30	33	35	37	39
8	8	10	13	15	18	20	23	26	28	31	33	36	39	41	44	47
9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54
10	11	14	17	20	24	27	31	34	37	41	44	48	51	55	58	62
11	12	16	19	23	27	31	34	38	42	46	50	54	57	61	65	69
12	13	17	21	26	30	34	38	42	47	51	55	60	64	68	72	77
13	15	19	24	28	33	37	42	47	51	56	61	65	70	75	80	84
14	16	21	26	31	36	41	46	51	56	61	66	71	77	82	87	92
15	18	23	28	33	39	44	50	55	61	66	72	77	83	88	94	100

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		N <sub>b</sub>																	
N <sub>a</sub>		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
p ≤ 0·05 (one-tailed), p ≤ 0·10 (two-tailed)																			
16	19	25	30	36	42	48	54	60	65	71	77	83	89	95	101	107			
17	20	26	33	39	45	51	57	64	70	77	83	89	96	102	109	115			
18	22	28	35	41	48	55	61	68	75	82	88	95	102	109	116	123			
19	23	30	37	44	51	58	65	72	80	87	94	101	109	116	123	130			
20	25	32	39	47	54	62	69	77	84	92	100	107	115	123	130	138			

		N <sub>b</sub>																
N <sub>a</sub>		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
p ≤ 0.01 (one-tailed), p ≤ 0.02 (two-tailed)																		
5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
6	2	3	4	6	7	8	9	11	12	13	15	16	18	19	20	22		
7	3	4	6	7	9	11	12	14	16	17	19	21	23	24	26	28		
8	4	6	7	9	11	13	15	17	20	22	24	26	28	30	32	34		
9	5	7	9	11	14	16	18	21	23	26	28	31	33	36	38	40		
10	6	8	11	13	16	19	22	24	27	30	33	36	38	41	44	47		
11	7	9	12	15	18	22	25	28	31	34	37	41	44	47	50	53		
12	8	11	14	17	21	24	28	31	35	38	42	46	49	53	56	60		
13	9	12	16	20	23	27	31	35	39	43	47	51	55	59	63	67		
14	10	13	17	22	26	30	34	38	43	47	51	56	60	65	69	73		
15	11	15	19	24	28	33	37	42	47	51	56	61	66	70	75	80		
16	12	16	21	26	31	36	41	46	51	56	61	66	71	76	82	87		
17	13	18	23	28	33	38	44	49	55	60	66	71	77	82	88	93		

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		N <sub>b</sub>																	
N <sub>a</sub>		5	6	7	8	9	10	11	12	12	13	14	15	16	17	18	19	20	
p ≤ 0·01 (one-tailed), p ≤ 0·02 (two-tailed)																			
18	14	19	24	30	36	41	47	53	59	65	70	76	82	88	94	100			
19	15	20	26	32	38	44	50	56	63	69	75	82	88	94	101	107			
20	16	22	28	34	40	47	53	60	67	73	80	87	93	100	107	114			

		N <sub>b</sub>																	
N <sub>a</sub>		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
p ≤ 0.025 (one-tailed), p ≤ 0.05 (two-tailed)																			
5	2	3	5	6	7	8	9	11	12	13	14	15	17	18	19	20	20		
6	3	5	6	8	10	11	13	14	16	17	19	21	22	24	25	27	27		
7	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	34		
8	6	8	10	13	15	17	19	22	24	26	29	31	34	36	38	41	41		
9	7	10	12	15	17	20	23	26	28	31	34	37	39	42	45	48	48		
10	8	11	14	17	20	23	26	29	33	36	39	42	45	48	52	55	55		
11	9	13	16	19	23	26	30	33	37	40	44	47	51	55	58	62	62		
12	11	14	18	22	26	29	33	37	41	45	49	53	57	61	65	69	69		
13	12	16	20	24	28	33	37	41	45	50	54	59	63	67	72	76	76		
14	13	17	22	26	31	36	40	45	50	55	59	64	67	74	78	83	83		
15	14	19	24	29	34	39	44	49	54	59	64	70	75	80	85	90	90		
16	15	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98	98		
17	17	22	28	34	39	45	51	57	63	67	75	81	87	93	99	105	105		

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		N <sub>b</sub>																	
N <sub>a</sub>		5	6	7	8	9	10	11	12	12	13	14	15	16	17	18	19	20	
p ≤ 0·025 (one-tailed), p ≤ 0·05 (two-tailed)																			
18	18	24	30	36	42	48	55	61	67	74	80	86	93	99	106	112			
19	19	25	32	38	45	52	58	65	72	78	85	92	99	106	113	119			
20	20	27	34	41	48	55	62	69	76	83	90	98	105	112	119	127			

		N <sub>b</sub>															
N <sub>a</sub>		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
p ≤ 0.005 (one-tailed), p ≤ 0.01 (two-tailed)																	
5	0	1	1	2	3	4	5	6	7	7	8	9	10	11	12	13	
6	1	2	3	4	5	6	7	9	10	11	12	13	15	16	17	18	
7	1	3	4	6	7	9	10	12	13	15	16	18	19	21	22	24	
8	2	4	6	7	9	11	13	15	17	18	20	22	24	26	28	30	
9	3	5	7	9	11	13	16	18	20	22	24	27	29	31	33	36	
10	4	6	9	11	13	16	18	21	24	26	29	31	34	37	39	42	
11	5	7	10	13	16	18	21	24	27	30	33	36	39	42	45	48	
12	6	9	12	15	18	21	24	27	31	34	37	41	44	47	51	54	
13	7	10	13	17	20	24	27	31	34	38	42	45	49	53	56	60	
14	7	11	15	18	22	26	30	34	38	42	46	50	54	58	63	67	
15	8	12	16	20	24	29	33	37	42	46	51	55	60	64	69	73	
16	9	13	18	22	27	31	36	41	45	50	55	60	65	70	74	79	
17	10	15	19	24	29	34	39	44	49	54	60	65	70	75	81	86	

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		N <sub>b</sub>																
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
N <sub>a</sub>	p ≤ 0.005 (one-tailed), p ≤ 0.01 (two-tailed)																	
18	11	16	21	26	31	37	42	47	53	58	64	70	75	81	87	92		
19	12	17	22	28	33	39	45	51	56	63	69	74	81	87	93	99		
20	13	18	24	30	36	42	48	54	60	67	73	79	86	92	99	105		

The calculated value must be equal to or less than the critical value in this table for significance to be shown.



## **Wilcoxon Signed Ranks test process**

- Calculate the difference between two scores by taking one from the other
- Rank the differences giving the smallest difference Rank 1

**Note: do not rank any differences of 0 and when adding the number of scores, do not count those with a difference of 0, and ignore the signs when calculating the difference**

- Add up the ranks for positive differences
- Add up the ranks for negative differences
- T is the figure that is the smallest when the ranks are totalled (may be positive or negative)
- N is the number of scores left, ignore those with 0 difference

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## Critical values for the Wilcoxon Signed Ranks test

n	Level of significance for a one-tailed test		
	0·05	0·025	0·01
	Level of significance for a two-tailed test		
	0·1	0·05	0·02
<b>N = 5</b>	<b>0</b>	<b>—</b>	<b>—</b>
<b>6</b>	<b>2</b>	<b>0</b>	<b>—</b>
<b>7</b>	<b>3</b>	<b>2</b>	<b>0</b>
<b>8</b>	<b>5</b>	<b>3</b>	<b>1</b>
<b>9</b>	<b>8</b>	<b>5</b>	<b>3</b>
<b>10</b>	<b>11</b>	<b>8</b>	<b>5</b>
<b>11</b>	<b>13</b>	<b>10</b>	<b>7</b>
<b>12</b>	<b>17</b>	<b>13</b>	<b>9</b>

The calculated value must be equal to or less than the critical value in this table for significance to be shown.