<table>
<tr><th>Question Number</th><th>Scheme</th><th>Notes</th><th>Marks</th></tr>
<tr><td rowspan="2">1(a)</td><td rowspan="2"><table>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>C</td><td>3</td><td>2</td><td>1</td><td>5</td><td>4</td></tr>
<tr><td>M</td><td>2</td><td>4</td><td>1</td><td>5</td><td>3</td></tr>
<tr><td>d</td><td>1</td><td>-2</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>d^2</td><td>1</td><td>4</td><td>0</td><td>0</td><td>1</td></tr>
</table></td><td>Attempt to rank at least 1 row with at least 3 correct. Allow reverse rankings.</td><td>M1</td></tr>
<tr><td>Attempt at d^2 for their rankings, can be implied by $\sum d^2 = 6$</td><td>M1</td></tr>
<tr><td></td><td>$\sum d^2 = 6$</td><td>Can be implied by correct answer. Must come from correct rankings.</td><td>A1</td></tr>
<tr><td></td><td>$r_s = 1 - \frac{6(6)}{5(24)}$</td><td>(dep on 1st M1) Use of correct formula with their $\sum d^2$</td><td>dM1</td></tr>
<tr><td></td><td>$r_s = 0.7$</td><td>0.7 o.e.
Must come from correct rankings.</td><td>A1</td></tr>
<tr><td></td><td></td><td></td><td>(5)</td></tr>
<tr><td>1(b)</td><td>$H_0 : \rho = 0, H_1 : \rho > 0$</td><td>Both correct in terms of ρ or ρ_s. Must be compatible with their ranking.</td><td>B1</td></tr>
<tr><td></td><td>cv 0.9 or cr $r_s \geq 0.9$</td><td>0.9
sign should match H_1 or their r_s</td><td>B1</td></tr>
<tr><td></td><td>$r_s = 0.7$ does not lie in cr so do not reject H_0</td><td>Correct non-contextual statement e.g. “do not reject H_0”, “not in critical region”, “not significant”, “no positive correlation”.
$|\text{test value}|$ or $|\text{cv}| > 1$ award M0</td><td>M1</td></tr>
<tr><td></td><td>Data does not support plant biologist’s claim.</td><td>Correct conclusion in context. Must mention “biologist’s claim” o.e. or moisture and plant coverage. All previous marks in (b) must have been scored.</td><td>A1ft</td></tr>
<tr><td>SC</td><td colspan="2">For use of two-tailed test:
May score B0B1M1A0 for cv = 1(.000) and ‘not significant’ oe</td><td></td></tr>
<tr><td></td><td></td><td></td><td>(4)</td></tr>
<tr><td></td><td></td><td></td><td>Total 9</td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Scheme</th><th>Notes</th><th>Marks</th></tr>
<tr><td>2</td><td>H_0 : Diet and health are independent (or not associated).
H_1 : Diet and health are not independent (or associated).</td><td>“diet” and “health” mentioned at least once. Use of correlation is B0.</td><td>B1</td></tr>
<tr><td></td><td>
<table>
<tr><th>EXPECTED</th><th>Good health</th><th>Poor health</th><th>Totals</th></tr>
<tr><td>Good diet</td><td>83.19</td><td>10.81</td><td>94</td></tr>
<tr><td>Poor diet</td><td>93.81</td><td>12.19</td><td>106</td></tr>
<tr><td>Totals</td><td>177</td><td>23</td><td>200</td></tr>
</table>
</td><td>Attempt $\frac{\text{RT}\times\text{CT}}{\text{GT}}$
with at least one correct to 1dp;
all correct to 1dp.</td><td>M1;
A1</td></tr>
<tr><td></td><td>
<table>
<tr><td>Observed</td><td>Expected</td><td>$\frac{(O-E)^2}{E}$</td><td>$\frac{O^2}{E}$</td></tr>
<tr><td>86</td><td>83.19</td><td>0.095</td><td>88.905</td></tr>
<tr><td>8</td><td>10.81</td><td>0.730</td><td>5.920</td></tr>
<tr><td>91</td><td>93.81</td><td>0.084</td><td>88.274</td></tr>
<tr><td>15</td><td>12.19</td><td>0.648</td><td>18.458</td></tr>
<tr><td colspan="2">Totals</td><td>1.557</td><td>201.557</td></tr>
</table>
</td><td>Attempt at $\frac{(O-E)^2}{E}$
or $\frac{O^2}{E}$ with their values with 2 correct or 2 correct f.t.
Allow 2sf for this mark.</td><td>M1</td></tr>
<tr><td></td><td>$\sum\frac{(O-E)^2}{E}$ or $\sum\frac{O^2}{E}-200=1.557$</td><td>awrt 1.6</td><td>A1</td></tr>
<tr><td></td><td>$\nu=(2-1)(2-1)=1$
$\chi^2_1(5\%)=3.841$</td><td>1 (may be implied)
3.841
NB: may see $\chi^2_3(5\%)=7.815$ for f.t.
NB: p-value 0.212 but scores B0B0 on its own</td><td>B1
B1f.t.</td></tr>
<tr><td></td><td>$\chi^2=1.557$ does not lie in cr so insufficient evidence to reject H_0</td><td>For correct non-contextual statement linking their test statistic and their cv.</td><td>M1</td></tr>
<tr><td></td><td>E.g. Diet and health are independent or
There is no association between diet and health or
The doctor’s belief is not supported by this data.</td><td>Dependent on a cv of 3.841 and 3rd M1
Correct conclusion in context with “diet” and “health” or “doctor”. Condone “connection” or “relationship” but not “correlation”.</td><td>A1ft</td></tr>
<tr><td></td><td></td><td></td><td>(9)</td></tr>
<tr><td></td><td></td><td></td><td>Total 9</td></tr>
</table>

Question Number	Scheme	Notes	Marks
3.			
3(a)	$\overline{x} = \frac{1}{2}(11.52 + 13.75) = 12.635$	12.635 (may be implied by correct CI)	B1
		Use of 1.96	B1
	$\left(\frac{\sigma}{\sqrt{n}} = \right)\frac{13.75 - 12.635}{1.96} (= 0.56887...)$ $\left(\frac{\sigma}{\sqrt{n}} = \right)\frac{13.75 - 11.52}{2 \times 1.96} (= 0.56887...)$	For attempt at standard error (may be implied by awrt 0.569)	M1
		Use of 1.6449 or better (1.644853…from calc) Use of 1.64 or 1.65 is B0	B1
	$12.635 \pm 1.6449 \times 0.56887...$	For $(\text{their } \overline{x}) \pm (\text{their } 1.6449)\left(\text{their } \frac{\sigma}{\sqrt{n}}\right)$ their $\frac{\sigma}{\sqrt{n}}$ must be numerical	M1
	90% CI is $(11.699..., 13.5707...)$	awrt $(11.7, 13.6)$ from correct working Correct answer with no working scores B1B1M1B0M1A1	A1
			(6)
3(b)	$4 \times 0.9^3 \times 0.1$ $= 0.2916$	$4p^3(1-p)$ (where $0 < p < 1$) awrt 0.292	M1 A1
			(2)
			Total 8

Question Number	Scheme	Notes	Marks
4. (a)	Label academic (1-1680) and vocational (1-2520)	For numbering/labelling/ordering (o.e.) students in **each** group	B1
	Use **random** numbers to select from each group.	For use of random sample/numbers/selection	B1
	28 academic and 42 vocational	Both numbers correct with the associated group	B1
			(3)
4(b)	$H_0 : \mu_v - \mu_a = 0$ $H_1 : \mu_v - \mu_a > 0$	If the hypotheses are given in terms of $\mu_a - \mu_b$, a and b must be defined.	B1
	$\text{se} = \sqrt{\frac{70}{80} + \frac{60}{50}}$	Correct attempt at se – condone slip in sample sizes.	M1
	$z = \frac{62-57}{\sqrt{\frac{70}{80} + \frac{60}{50}}}$	Dep on previous M1 standardising with (62 – 57) and their se (Allow $\pm$)	dM1
	$z = 3.471...$ (or probability of 0.0003)	awrt ± 3.47 (or awrt 0.0003)	A1
	cv $z = 1.6449$	Allow $\pm$ but signs must be compatible Or allow comparison with probability of 0.05	B1
	Reject H_0 / significant	Dependent on 2nd M1. A correct non-contextual statement based on their **normal** cv and their test statistic.	dM1
	There is evidence that the **mean(o.e.)** basic skills score for **vocational** students is greater than the **mean** basic skills score for **academic** students.	Correct comment in context. Must mention "mean", "academic" and "vocational". Allow f.t. on their normal cv and their test statistic.	A1f.t.
			(7)
4(c)	Mean / $\bar{X}_a$ (basic skills) score for academic students and mean/ $\bar{X}_v$ (basic skills) score for vocational students…	Must mention **both** means.	B1
	…have (approximately) a normal distribution (as sample sizes are large.)	Must mention normal.	B1
			(2)
4(d)	Sample**s** are (large enough) so that $s^2 = \sigma^2$	Must imply for both samples	B1
			(1)
4(e)	Test no longer significant so insufficient evidence to reject H_0	Can be implied by correct comment in context.	M1
	Insufficient evidence that mean (basic skills) **score** for vocational students is greater than the mean (basic skills) **score** for academic students/There is no longer a difference in **scores**/Academic students have improved their mean (basic skills) **score**.	Must mention scores (o.e).	A1
			(2)
4(f)	The course was **effective** (o.e.)	Dep on a significant result in (b) and a non-significant result in (e)	B1
			(1)
			Total 16

<table>
<tr><th>Question Number</th><th>Scheme</th><th>Notes</th><th>Marks</th></tr>
<tr><td>5.(a)</td><td>Relief of symptoms is either a “success” or a “failure”.
The probability the medicine being a success is constant.
Samples from different medical practices are independent.</td><td>Any 2. Context required in one assumption.</td><td>B1 B1</td></tr>
<tr><td></td><td></td><td></td><td>(2)</td></tr>
<tr><td>5(b)</td><td>$\text{Mean} = \dfrac{0\times4+1\times6+2\times3+...+8\times2}{50} = 3.54*$</td><td>At least two correct terms on the numerator and 50 on the denominator,
fully correct expression or $\dfrac{177}{50}$
dep on M1 scored cso.</td><td>M1,
A1cso</td></tr>
<tr><td></td><td></td><td></td><td>(2)</td></tr>
<tr><td>5(c)</td><td>$p = \dfrac{3.54}{8} = 0.4425$</td><td>Can be implied by at least 1 correct value for f or g.</td><td>B1</td></tr>
<tr><td></td><td>$f = 50\times C_4^8 \times 0.4425^4 \times 0.5575^4 = 12.96$
$g = 50\times 0.4425^8 = 0.07$</td><td>Use of Bin(50, p) for M1,
Allow awrt 12.96, awrt 0.07</td><td>M1A1A1</td></tr>
<tr><td></td><td></td><td></td><td>(4)</td></tr>
<tr><td>5(d)</td><td>H_0 : Binomial distribution is a suitable model
H_1 : Binomial distribution is not a suitable model</td><td>Both hypotheses correct
If parameters used then B0.</td><td>B1</td></tr>
<tr><td></td><td rowspan="2"><table>
<tr><th>No of successes</th><th>O</th><th>E</th><th>$\dfrac{(O-E)^2}{E}$</th><th>$\dfrac{O^2}{E}$</th></tr>
<tr><td>0,1,2</td><td>13</td><td>11.66</td><td>0.154</td><td>14.494</td></tr>
<tr><td>3</td><td>12</td><td>13.07</td><td>0.088</td><td>11.018</td></tr>
<tr><td>4</td><td>10</td><td>12.96</td><td>0.676/7</td><td>7.716</td></tr>
<tr><td>5,6,7,8</td><td>15</td><td>12.31</td><td>0.588/7</td><td>18.278</td></tr>
<tr><td></td><td>50</td><td>50</td><td>1.506</td><td>51.506</td></tr>
</table></td><td>Combining 0,1,2 or 5,6,7,8.</td><td>M1</td></tr>
<tr><td></td><td>M1 for attempting $\dfrac{(O-E)^2}{E}$ or $\dfrac{O^2}{E}$
with at least 2 correct expressions or 2 correct values to 2sf.</td><td>M1</td></tr>
<tr><td></td><td>$\sum\dfrac{(O-E)^2}{E} = \sum\dfrac{O^2}{E} - 50 = 1.50...$</td><td>awrt 1.5 (calculator: 1.50498…)</td><td>A1</td></tr>
<tr><td></td><td>$\nu = 4-2 = 2, \chi^2_2(10\%) = 4.605$</td><td>2 can be implied by 4.605 seen
Only f.t. $\nu = r-2$</td><td>B1
B1f.t.</td></tr>
<tr><td></td><td>Insufficient evidence to reject H_0</td><td>For correct non-contextual statement linking their test statistic and their cv.</td><td>M1</td></tr>
<tr><td></td><td>Data is consistent with a binomial distribution (oe)</td><td>A correct comment suggesting that binomial model is suitable / good fit.
Hypotheses wrong way around scores A0 here. Condone parameters here.</td><td>A1</td></tr>
<tr><td></td><td></td><td></td><td>(8)</td></tr>
<tr><td></td><td></td><td></td><td>Total 16</td></tr>
</table>

Question Number	Scheme	Notes	Marks
6(a)	$W = B - 1.1R$	May be implied by correct mean or variance	M1
	$W \sim \text{N}(55 - 1.1\times 51, 1.3^2 + 1.1^2 \times 1.2^2)$ or $W \sim \text{N}(-1.1, 3.4324)$	$(\pm)1.1$, awrt 3.43 (may be seen in standardisation)	A1, A1
	$\text{P}(W < 0) = \text{P}\left(Z < \dfrac{0+1.1}{\sqrt{3.4324}}\right)$	Standardising with their mean and their sd. leading to a probability > 0.5	M1
	$= \text{P}(Z < 0.5937...)$		
	$= 0.7224$ or 0.7237	**awrt 0.72**	A1
			(5)
6(b)	$X = B_1 - B_2$	May be implied by correct mean or variance	M1
	$X \sim \text{N}(55 - 55, 2\times 1.3^2)$ or $X \sim \text{N}(0, 3.38)$	$0, 3.38$	A1, A1
	$\text{P}\left(Z > \dfrac{1-0}{\sqrt{3.38}}\right)$ or $\text{P}\left(Z < \dfrac{-1-0}{\sqrt{3.38}}\right)$	dep on 1st M1 for standardising with their mean and their sd.	dM1
	$\text{P}(\lvert X\rvert > 1) = 2\times \text{P}(X > 1)$	For $2\times$ seen or implied	M1
	$= 2\times \text{P}(Z > 0.5439...)$ $= 2\times(1 - 0.7054)$	2×0.2946 or 2×0.2932 (calc)	
	$= 0.5892$	**awrt 0.59**	A1
			(6)
6(c)	$V = B_1 + B_2 + B_3 + B_4 + B_5 + B_6 + B_7 + B_8 + B_9 + B_{10} + S$ $Y = R_1 + R_2 + R_3 + R_4 + R_5 + R_6 + R_7 + R_8 + R_9 + R_{10} + R_{11} + S$	May be implied by either correct distribution	M1
	$V \sim \text{N}(553, 16.94)$ and $Y \sim \text{N}(564, 15.88)$	Both correct	A1
	$D = Y - V$ so $D \sim \text{N}(11\times 51 - 10\times 55,\ 11\times 1.2^2 + 10\times 1.3^2 + 2\times 0.2^2)$ or $D \sim \text{N}(11,\ 32.82)$	Attempt at their difference for the mean, and their sum for the variance.	M1
		$(\pm)11$ and awrt 32.8	A1
	$\text{P}(D > 0) = \text{P}\left(Z > \dfrac{0-11}{\sqrt{32.82}}\right)$	dep on 1st M1 for standardising using their mean and their standard deviation leading to a probability > 0.5	dM1
	$= \text{P}(Z > -1.920...)$		
	$= 0.9726$	**awrt 0.973**	A1
			(6)
			Total 17