Cambridge Assessment International Education

Cambridge International AS & A Level

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2021**

MARK SCHEME

Maximum Mark: 30

Published

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Examples of how to apply the list rule
State **three** reasons…. [3]

A

1. Correct	✓	**2**
2. Correct	✓	
3. Wrong	×	

B **(4 responses)**

1. Correct, Correct	✓, ✓	**3**
2. Correct	✓	
3. Wrong	ignore	

C **(4 responses)**

1. Correct	✓	**2**
2. Correct, Wrong	✓, ×	
3. Correct	ignore	

D **(4 responses)**

1. Correct	✓	**2**
2. Correct, CON (of 2.)	×, (discount 2)	
3. Correct	✓	

E **(4 responses)**

1. Correct	✓	**3**
2. Correct	✓	
3. Correct, Wrong	✓	

F **(4 responses)**

1. Correct	✓	**2**
2. Correct	✓	
3. Correct CON (of 3.)	× (discount 3)	

G **(5 responses)**

1. Correct	✓	**3**
2. Correct	✓	
3. Correct Correct CON (of 4.)	✓ ignore ignore	

H **(4 responses)**

1. Correct	✓	**2**
2. Correct	×	
3. CON (of 2.) Correct	(discount 2) ✓	

I **(4 responses)**

1. Correct	✓	**2**
2. Correct	×	
3. Correct CON (of 2.)	✓ (discount 2)	

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
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ecf	error carried forward
I	ignore

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Question	Answer	Marks
1(a)	0.5 cm^3 of the stock solution **;** *idea of* adding 9.5 cm^3 of buffer / water / filling to the 10 cm^3 mark with buffer / water (in a volumetric flask) **;**	**2**
1(b)(i)	*idea that* (result / it, is) quantitative / AW **;** ora	**1**
1(b)(ii)	*independent variable:* concentration of ONPG / substrate **;** *dependent variable:* absorbance (on colorimeter) **;**	**2**
1(c)(i)	*any **eight** from:* 1 *ref. to* preparing / using at least five concentrations of ONPG 2 stated range of five dilutions, from 1%v down, with % units 3 method of keeping β-galactosidase / enzyme, cold (prior to use) **;** 4 *idea of* bringing enzyme and substrate to temperature / equilibrating, before mixing **;** 5 method of keeping reactants / reaction mixture, at, constant / controlled / stated / standardised, temperature **;** 6 same / constant / stated / standardised / known, volume / concentration / mass of, **X** / inhibitor **;** 7 same / constant / stated / standardised / known, volume of, ONPG / substrate **;** 8 same / constant / stated / standardised / known, volume / concentration, of β-galactosidase / enzyme **;** 9 *ref. to* measuring absorbance / intensity of colour (on colorimeter) after one set time **;** 10 additional detail of use of colorimeter **;** 11 repeat at least twice / three replicates, and calculate mean **;** 12 *idea of* repeating, whole experiment / range of concentrations, without **X** / inhibitor **;** 13 named hazard and risk and precaution **;**	**8**
1(c)(ii)	1 curve, to the right of / below, original curve **;** 2 curve / line, must meet the plateau of original curve on the graph **;**	**2**
1(c)(iii)	1 correct placement of V_{max} **;** 2 correct placement of K_m **;**	**2**
1(c)(iv)	(reaction with competitive inhibitor / **X**) has higher / has increased / increases, K_m value (compared to no inhibitor) **;**	**1**

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Question	Answer	Marks
1(d)	*assume ref. to PPI unless specific treatment stated* any **three** from: 1 *idea that* PPI overall is more effective / is immediately effective, on improvement / removal (of symptoms) **;** 2 **either** at 12 and 16 weeks / later, overlap of error bars means difference (in effect between PPI and H_2RA) is not significant **;** **or** at 4 and 8 weeks / earlier, no overlap of error bars – suggesting difference (in effect, between PPI and H_2RA) may be, significant **;** 3 no statistical test to compare groups / t test, done (to test for significance) **;** 4 *idea that* H_2RA is catching up / may be better in the long term **;** 5 AVP **; ;** *any **two** from:* • less than 50% patients reported no symptoms • no information on severity of symptoms pre-trial • no data on side effects • size of the two test groups not given • no data on long term effects (where H_2RA may be better)	**3**

Question	Answer	Marks
2(a)(i)	*idea of* compare / AW, observed and expected (data / results / ratios / phenotypes) **or** data is categoric / discrete / discontinuous / nominal **;**	**1**
2(a)(ii)	*idea of* no (significant) difference between the observed and the expected (results) **or** *idea of* difference between observed and expected (results) is due to chance **;**	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(iii)</td><td>
<table>
<tr><th>offspring phenotype</th><th>O</th><th>E</th><th>$\frac{(O-E)^2}{E}$</th></tr>
<tr><td>purple axial flowers</td><td>1756</td><td>1882 (A 1881)
(1881.56250)</td><td>8.44
(8.379175)</td></tr>
<tr><td>purple, terminal flowers</td><td>653</td><td>627
(627.18750)</td><td>1.08
(1.062338)</td></tr>
<tr><td>white, axial flowers</td><td>702</td><td>627
(627.18750)</td><td>8.97
(8.923823)</td></tr>
<tr><td>white, terminal flowers</td><td>234</td><td>209 ;
(209.06250)</td><td>2.99 ;
(2.974608)</td></tr>
<tr><td colspan="3">χ^2 =</td><td>21.48 ;
(21.339944)</td></tr>
</table>
χ^2 = 21.33 / 21.34 / 21.48 for mp3 (to allow for using calculator values or rounded values)
</td><td>3</td></tr>
<tr><td>2(a)(iv)</td><td><u>7.82</u> ;</td><td>1</td></tr>
</table>

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Question	Answer	Marks
2(a)(v)	*apply ecf as needed* 1 reject (null hypothesis) and state that, the calculated value / χ^2 , is higher than, 7.82 / the critical value / the critical value they give in **(iv)** from the table ; 2 *If null hypothesis rejected:* (between O and E): there is a significant difference / the difference **is not** due to chance *idea that* there is a **less** than 5% probability that the difference **is** due to chance / there is a **more** than 95% probability that the difference is **not** due to chance ; 3 *From mp1 If null hypothesis rejected or mp2 If there **is a** significant difference / AW stated* *idea that:* genes are on the same chromosome / are not on different chromosomes / are linked / show autosomal linkage / do not assort independently ; ***A*** *idea of, '*may be / can be', throughout	**3**

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State **three** reasons…. [3]

A

1. Correct	✓	**2**
2. Correct	✓	
3. Wrong	×	

B **(4 responses)**

1. Correct, Correct	✓, ✓	**3**
2. Correct	✓	
3. Wrong	ignore	

C **(4 responses)**

1. Correct	✓	**2**
2. Correct, Wrong	✓, ×	
3. Correct	ignore	

D **(4 responses)**

1. Correct	✓	**2**
2. Correct, CON (of 2.)	×, (discount 2)	
3. Correct	✓	

E **(4 responses)**

1. Correct	✓	**3**
2. Correct	✓	
3. Correct, Wrong	✓	

F **(4 responses)**

1. Correct	✓	**2**
2. Correct	✓	
3. Correct CON (of 3.)	× (discount 3)	

G **(5 responses)**

1. Correct	✓	**3**
2. Correct	✓	
3. Correct Correct CON (of 4.)	✓ ignore ignore	

H **(4 responses)**

1. Correct	✓	**2**
2. Correct	×	
3. CON (of 2.) Correct	(discount 2) ✓	

I **(4 responses)**

1. Correct	✓	**2**
2. Correct	×	
3. Correct CON (of 2.)	✓ (discount 2)	

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Mark scheme abbreviations

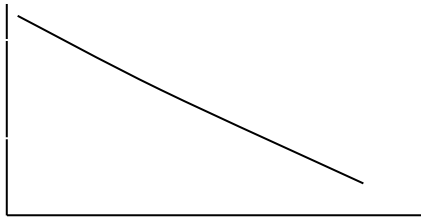
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Question	Answer	Marks
1(a)	*independent variable*: concentration of, copper (II) sulfate **;** *dependent variable*: volume of, oxygen **;**	**2**
1(b)(i)	1 minimum of five stated dilutions and correct units **;** 2 method of serial dilution for a minimum of 2 intermediate (concentrations) **;**	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(b)(ii)</td><td>
any six from:

1 maintaining a constant temperature and a suitable method ;
2 maintaining a constant pH and use a buffer ;
mp 3 and 4 and 5: if ‘amount’ rather than ‘volume’, penalise only once and ecf the following ones
3 same / stated, volume of catalase / enzyme
or
same / stated, concentration of catalase / enzyme ;
4 same / stated, volume of each copper sulfate / inhibitor solution ;
5 measure / record, volume of oxygen / gas collected, in set time / set intervals or time taken to reach a set volume ;
6 state a suitable control ;
7 use new / fresh (named) solutions for each replicate / experiment ;
8 repeat at least twice / three replicates, and finding mean for at least one concentration ;
9 named hazard and risk and precaution ;
e.g.
<table>
<tr><th>hazard</th><th>risk</th><th>precaution</th></tr>
<tr><td rowspan="2">catalase / enzyme</td><td>irritant / allergy</td><td rowspan="7">wear gloves / goggles / mask
PPA</td></tr>
<tr><td>moderate / medium, hazard</td></tr>
<tr><td rowspan="3">hydrogen peroxide</td><td>irritant / allergy</td></tr>
<tr><td>moderate / medium, hazard</td></tr>
<tr><td>oxidising agent</td></tr>
<tr><td rowspan="3">copper(II) sulfate</td><td>irritant / allergy</td></tr>
<tr><td>moderate / medium, hazard</td></tr>
<tr><td>corrosive</td></tr>
<tr><td></td><td>toxic</td><td>do not pour down sink</td></tr>
</table>
10 AVP ;
</td><td>6</td></tr>
</table>

Question	Answer	Marks
1(b)(iii)	1 axes correctly orientated with labels ; 2 axes labels have correct units ; 3 line shows downward trend as concentration of copper(II) sulfate increases ; e.g. volume of oxygen / mm^3 or cm^3  concentration of copper sulfate / mol dm^{-3}	**3**
1(c)(i)	All three lines correctly drawn / indicated ; V_{max} **or** $\frac{1}{2}$ V_{max} correctly labelled for lines drawn ; K_m correctly labelled (on correct line) ;	**3**
1(c)(ii)	plateaus below V_{max} / does not reach V_{max} / V_{max} is lower (than without inhibitor) ; same / almost same / similar, K_m ;	**2**

Question	Answer	Marks
2(a)(i)	remove / cover, anthers (from plant **B**) ;	**1**
2(a)(ii)	method of transferring pollen (from anther) to stigma ; **or** shake anthers, on / over, stigmas ;	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(b)</td><td>any three from:

light, intensity / duration / amount / strength / wavelength / colour ;
temperature ;
frequency of watering / amount of water ;
humidity ;
CO_2 / O_2 concentration ;
growing medium / soil composition ;
planting density ;</td><td>3</td></tr>
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long pollen grains</td><td>102</td><td>62</td><td>25.81</td></tr>
<tr><td>red petals
round pollen grains</td><td>112</td><td>62</td><td>40.32</td></tr>
<tr><td>purple petals
round pollen grains</td><td>14</td><td>62</td><td>37.16</td></tr>
<tr><td>red petals
long pollen grains</td><td>20</td><td>62</td><td>28.45 ;</td></tr>
<tr><td colspan="3">χ^2 =</td><td>131.74 ;</td></tr>
</table>
</td><td>2</td></tr>
</table>

Question	Answer	Marks
2(c)(ii)	1 reject and state that their calculated value / χ^2, is higher than 7.82 / critical value **;** *any **two** from:* 2 (if the null hypothesis is rejected) There is a significant difference between the expected and observed values **or** there is a **less** than 5% / 0.05 probability that the difference has occurred due to chance **;** 3 genes, are on the same chromosome / are not on different chromosomes / are linked / do not assort independently **or** autosomal linkage **or** alleles (likely to be) inherited together **;** 4 the two genes are close together (on the same chromosome) **or** small number of recombinants **;**	**3**
2(d)	1 yes in copper sensitive plants and no in copper tolerant plants / only in copper sensitive plants **;** 2 decrease, in percentage / %, viability, in sensitive plants / ora **or** slight increase, in percentage / %, viability, in tolerant plants **;** 3 in sensitive plants, there is no overlap of (error) bars, which means the difference may be significant **or** in tolerant plants, there is an overlap of (error) bars, which means difference is not significant **;** 4 no statistical test was carried out (in copper-sensitive plants) **;** 5 growth of pollen tube does not indicate pollen grain is viable **;** 6 no reference to concentration of copper ions used in the investigation **;**	**2**

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Examples of how to apply the list rule

State **three** reasons…. [3]

A

1. Correct	✓	**2**
2. Correct	✓	
3. Wrong	×	

B (4 responses)

1. Correct, Correct	✓, ✓	**3**
2. Correct	✓	
3. Wrong	ignore	

C (4 responses)

1. Correct	✓	**2**
2. Correct, Wrong	✓, ×	
3. Correct	ignore	

D (4 responses)

1. Correct	✓	**2**
2. Correct, CON (of 2.)	×, (discount 2)	
3. Correct	✓	

E (4 responses)

1. Correct	✓	**3**
2. Correct	✓	
3. Correct, Wrong	✓	

F (4 responses)

1. Correct	✓	**2**
2. Correct	✓	
3. Correct CON (of 3.)	× (discount 3)	

G (5 responses)

1. Correct	✓	**3**
2. Correct	✓	
3. Correct Correct CON (of 4.)	✓ ignore ignore	

H (4 responses)

1. Correct	✓	**2**
2. Correct	×	
3. CON (of 2.) Correct	(discount 2) ✓	

I (4 responses)

1. Correct	✓	**2**
2. Correct	×	
3. Correct CON (of 2.)	✓ (discount 2)	

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore

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Question	Answer	Marks
1(a)	*idea of:* *grinding with sand* to break open the cells / release enzyme **;** *filtering through cloth* to remove, sand / debris / AW **;**	**2**
1(b)(i)	(*idea that* result / it, is) quantitative / AW **;**	**1**
1(b)(ii)	*independent variable:* concentration of catechol / substrate **;** *dependent variable :* absorbance (on colorimeter) **;**	**2**

Question	Answer	Marks
1(c)(i)	*any* ***eight*** *from:* 1 *ref. to* preparing / using, at least five dilutions concentrations of catechol **;** 2 stated range of at least five concentrations from 1% downwards with % units **;** 3 method of keeping catechol oxidase / enzyme solution / banana extract cold **;** 4 *idea of* bringing enzyme and substrate to temperature / equilibrating, before mixing **;** 5 method of keeping reactants / reaction mixture, at, constant / controlled / stated / standardised, temperature **;** 6 same / constant / stated / standardised / known, volume / concentration / mass of, **Y** / inhibitor **;** 7 same / constant / stated / standardised / known, volume of, catechol / substrate **;** 8 same / constant / stated / standardised / known, volume / concentration, of catechol oxidase / enzyme / banana extract **;** 9 *ref. to* measuring absorbance / intensity of colour (on colorimeter) after one set time **;** 10 additional detail of use of colorimeter **;** 11 repeat at least twice / three replicates, and calculate mean **;** 12 *idea of* repeating, whole experiment / range of concentrations, without, **Y** / inhibitor **;** 13 named hazard and risk and precaution **;**	**8**
1(c)(ii)	curve should be to the right of the original curve **;** curve should plateau below the original curve **;**	**2**
1(c)(iii)	correct placement of V_{max} and K_m **;**	**2**
1(c)(iv)	(reaction with non-competitive inhibitor) has same K_m value than with no inhibitor **;**	**1**

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Question	Answer	Marks
1(d)	*any **three** from:* 1 combination of drugs gives a larger reduction in blood pressure **;** 2 no error bars **;** 3 no, statistical test / *t*-test, done to compare groups **;** 4 no data on long term results **;** 5 AVP **; ;** *any **two** from:* • no information on blood pressure prior to trial • no information on type of blood pressure • no information on number of patients in each group • no data on side effects • *ref. to* reduction in blood pressure brought about by the placebo alone • no data on, age / gender	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(i)</td><td>any one from:
idea of compare / AW, observed and expected (data / results / ratios / phenotypes) ;
or
data is, categoric / discrete / discontinuous / nominal ;</td><td>1</td></tr>
<tr><td>2(a)(ii)</td><td>idea of no (significant) difference between the observed and the expected (results) ;
or
idea of difference between observed and expected (results) is due to chance ;</td><td>1</td></tr>
<tr><td>2(a)(iii)</td><td>
<table>
<tr><th>offspring phenotype</th><th>O</th><th>E</th><th>$\frac{(O-E)^2}{E}$</th></tr>
<tr><td>wrinkled wings
rosy eyes</td><td>44</td><td>36
(36.000)</td><td>1.78
(1.77778)</td></tr>
<tr><td>wrinkled wings
red eyes</td><td>2</td><td>12
(12.000)</td><td>8.33
(8.33333)</td></tr>
<tr><td>normal wings
rosy eyes</td><td>2</td><td>12
(12.000)</td><td>8.33
(8.33333)</td></tr>
<tr><td>normal wings
red eyes</td><td>16</td><td>4 ;
(4.000)</td><td>36.00 ;
(36.00000)</td></tr>
<tr><td colspan="3">χ^2 =</td><td>54.44 ;
(54.44444)</td></tr>
</table>
apply ecf as needed</td><td>3</td></tr>
<tr><td>2(a)(iv)</td><td>n–1 <u>and</u> probability of 0.05 / one less degree of freedom than number of categories <u>and</u> probability of 0.05 ;</td><td>1</td></tr>
</table>

Question	Answer	Marks
2(a)(v)	*apply ecf as needed* **1** reject (null hypothesis) **and** state that, the calculated value / χ^2, is higher than, 7.82 / the critical value **;** **2** *If null hypothesis rejected:* (between O and E): there is a significant difference / the difference **is not** due to chance *idea that* there is a **less** than 5 % probability that the difference **is** due to chance / there is a **more** than 95% probability that the difference is **not** due to chance **;** **3** *From mp1 If null hypothesis rejected or mp2 If there **is a** significant difference / AW, stated* *idea that:* genes, are on the same chromosome / are not on different chromosomes / are linked / show autosomal linkage / do not assort independently **;** ***A** idea of, 'may be / can be', throughout mp3*	**3**