

**WJEC (Wales) Biology A-level**  
**Topic 4.3: Inheritance**  
**Questions by Topic - Mark**  
**Scheme**

1.	Question	Marking details	Marks Available
1	(a)	(i) NnGg for both; NG Ng nG ng for both; correct completion of punnet square; correct ratio 9:3:3:1; correct phenotypes matched to ratio;	5
		(ii) Correct expected number column 72 : 24 : 24 : 8;	1
	(b)	(i) 0.667/0.67/2/3;	1
		(ii) 7.82 circled;	1
		(iii) Accept because $\chi^2$ value is to left of {critical value/7.82}/ Accept because $\chi^2$ value has probability higher than {0.05/5%}/ Accept because $\chi^2$ value falls between {0.9/90%} and {0.8/80%} probability/ Accept because the probability lies between 80-90% that it is due to chance alone; <i>If not circled any answer for (ii) must refer to 7.82 in (iii)</i> ECF from chi squared table	1
	(c)	{Common phenotypes/red grey and scarlet ebony} are due to linkage/ description of linkage; {Rare phenotypes/red ebony and scarlet grey} due to {crossing over/recombinants};	2
<b>Question 1 Total</b>			<b>[11]</b>

2.

Question			Marking details	Marks Available
2	(a)	(i)	Correct parental genotypes: BbRr BbRr; Correct gametes: BR Br bR br; Correct headings on punnet square: BR Br bR br; Correct completion of genotypes in punnet square;(ecf)	4
		(ii)	Chocolate $\frac{3}{16}$ / 18.75% and yellow $\frac{4}{16}$ / $\frac{1}{4}$ / 25%; <b>both</b> for 1(ecf)	1
		(iii)	$\frac{1}{4}$ /25%;	1
		(iv)	All the noses should be brown; Accept fur is black and skin is brown	1
	(b)	(i)	BBrr;	1
		(ii)	Cross with {yellow, brown nose dog / homozygous recessive / bbr} / back cross / test cross;	1
		(iii)	Yellow with a brown nose;	1
<b>Question 2 Total</b>				<b>[10]</b>

3.

Question			Marking details	Marks Available																						
				AO1	AO2	AO3	Total	Maths	Prac																	
3	(a)	(i)	Purple White and Aa aa (1) Aa Aa aa aa (1) correct completion of punnett square		2		2																			
		(ii)	Null hypothesis: There is no <u>significant</u> difference between the observed and expected numbers/ratios (1) <table border="1"> <thead> <tr> <th>Phenotype</th> <th>O</th> <th>E (1)</th> <th>O-E</th> <th>(O-E)<sup>2</sup></th> <th><math>\frac{(O-E)^2}{E}</math> (1)</th> </tr> </thead> <tbody> <tr> <td>white</td> <td>32</td> <td>25</td> <td>7</td> <td>49</td> <td>1.96</td> </tr> <tr> <td>purple</td> <td>18</td> <td>25</td> <td>-7</td> <td>49</td> <td>1.96</td> </tr> </tbody> </table> Chi <sup>2</sup> = 3.92 (1)	Phenotype	O	E (1)	O-E	(O-E) <sup>2</sup>	$\frac{(O-E)^2}{E}$ (1)	white	32	25	7	49	1.96	purple	18	25	-7	49	1.96		4		4	4
	Phenotype	O	E (1)	O-E	(O-E) <sup>2</sup>	$\frac{(O-E)^2}{E}$ (1)																				
white	32	25	7	49	1.96																					
purple	18	25	-7	49	1.96																					
(iii)	Critical value is 3.84 (1) because chi <sup>2</sup> value {is greater than/to the right of critical value (at 0.05)} (1) reject null hypothesis (1) deviation is not due to chance/there is a significant difference between O and E(1) ECF from (ii)				4	4	4	4																		
	(b)	(i)	<table border="1"> <thead> <tr> <th></th> <th>AB</th> <th>Ab</th> <th>aB</th> <th>ab</th> </tr> </thead> <tbody> <tr> <th>aB</th> <td>AaBB</td> <td>AaBb</td> <td>aaBB</td> <td>aaBb</td> </tr> <tr> <th>ab</th> <td>AaBb</td> <td>Aabb</td> <td>aaBb</td> <td>aabb</td> </tr> </tbody> </table> Gametes (1) Correct completion (1) [from their gametes] Phenotype ratio 3 purple : 5 white (1) [from table]		AB	Ab	aB	ab	aB	AaBB	AaBb	aaBB	aaBb	ab	AaBb	Aabb	aaBb	aabb		3		3				
	AB	Ab	aB	ab																						
aB	AaBB	AaBb	aaBB	aaBb																						
ab	AaBb	Aabb	aaBb	aabb																						
		(ii)	Hypothesis 2 and The chi squared value is {to the left/less than} the critical value/no <u>significant</u> difference between O and E/probability is between {0.8-0.9/above 0.8/above 5%}/due to chance alone			1	1	1																		
	(c)		Hypothesis 1 white x white could only produce white offspring/hypothesis 2 white x white could give purple/or description with genotypes			1	1		1																	
<b>Question 3 total</b>				<b>0</b>	<b>9</b>	<b>6</b>	<b>15</b>	<b>9</b>	<b>9</b>																	

4.

Question		Marking details	Marks Available																				
4.	(a)	(i) (Genes) on the {X/ Y} chromosomes; Reject sex chromosomes Accept (genes) on sex chromosomes not on the autosomes	1																				
		(ii) <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td>Parents</td> <td colspan="2"><math>X^H Y</math></td> <td colspan="2"><math>X^H X^h</math> ;</td> </tr> <tr> <td>Gametes</td> <td><math>X^H</math></td> <td>Y</td> <td><math>X^H</math></td> <td><math>X^h</math> ;</td> </tr> <tr> <td>Offspring</td> <td><math>X^H X^H</math></td> <td><math>X^H X^h</math></td> <td><math>X^H Y</math></td> <td><math>X^h Y</math> ;</td> </tr> <tr> <td></td> <td>Normal female</td> <td>Normal/ Carrier female</td> <td>Normal male</td> <td>Haemophiliac/ sufferer/ affected} male;</td> </tr> </table> <p>Suitable symbols with key eg. <math>X^N X^n</math> max 3 Suitable symbols with no key max 2 Reject crosses not involving X and Y chromosomes If wrong genotypes ecf apart from phenotype of offspring which must correctly identify a haemophiliac son</p>	Parents	$X^H Y$		$X^H X^h$ ;		Gametes	$X^H$	Y	$X^H$	$X^h$ ;	Offspring	$X^H X^H$	$X^H X^h$	$X^H Y$	$X^h Y$ ;		Normal female	Normal/ Carrier female	Normal male	Haemophiliac/ sufferer/ affected} male;	4
		Parents	$X^H Y$		$X^H X^h$ ;																		
		Gametes	$X^H$	Y	$X^H$	$X^h$ ;																	
Offspring	$X^H X^H$	$X^H X^h$	$X^H Y$	$X^h Y$ ;																			
	Normal female	Normal/ Carrier female	Normal male	Haemophiliac/ sufferer/ affected} male;																			
(iii) None;	1																						
(iv) 0.25 / 25%; Accept 1 in 4/ ¼ Reject 1:3	1																						
(b)	<table style="width: 100%; border: none;"> <tr> <td style="padding-right: 20px;">AB</td> <td style="padding-right: 20px;">ab</td> <td style="padding-right: 20px;">AB</td> <td>ab ;</td> </tr> <tr> <td>AABB</td> <td>AaBb</td> <td>AaBb</td> <td>aabb ;</td> </tr> </table> <p>3:1 ; Genotypes must show some correct indication of linkage between a and b for ecf Award 0 if dihybrid cross is completed</p>	AB	ab	AB	ab ;	AABB	AaBb	AaBb	aabb ;	3													
AB	ab	AB	ab ;																				
AABB	AaBb	AaBb	aabb ;																				

Question		Marking details	Marks Available
	(c)	Incomplete linkage; Genes {further/ far} apart on same chromosome; {Crossing over/ chiasmata} can occur; Four types of gametes produced( but not in equal numbers); Small numbers of recombinants / large numbers parental types; Recombinants equal in numbers / parental equal in numbers;	Max 2
Question 4 Total			[12]

5.

Question	Marking details	Marks Available
5	(a) (i) CGC is replaced by TGC/ C is replaced by T; Amino acid cys has replaced arg;	2
	(ii) Change in {protein/tertiary} structure/ different protein is made; MC1R will not be stimulated (by the hormone); {Less/no} eumelanin will be produced;	Max 2
<b>Question 6 Total</b>		<b>[4]</b>

6. (a) (i)

Gametes	HW	HR	<u>hW</u>	<u>hR</u>
HW	HW HW	HR HW	<u>hW</u> HW	<u>hR</u> HW
HR	HW HR	HR HR	<u>hW</u> HR	<u>hR</u> HR
<u>hW</u>	HW <u>hW</u>	HR <u>hW</u>	<u>hW</u> <u>hW</u>	<u>hR</u> <u>hW</u>
<u>hR</u>	HW <u>hR</u>	HR <u>hR</u>	<u>hW</u> <u>hR</u>	<u>hR</u> <u>hR</u>

1 mark per column; if wrong- gametes-1, letters -1;

4

(ii) Phenotypes

Horn less roan 6

Horn less red 3

Horn less white 3

Horned roan 2

Horned red 1

Horned white 1

3 marks all phenotypes + 3 for all correct matching ratio  
-1 per error, no ecf from (i)

6