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BIOLOGY

GENETICS, POPULATIONS, EVOLUTION & ECOSYSTEMS

Level & Board	AQA (A-LEVEL)
TOPIC:	POPULATIONS
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	6
TOTAL MARKS	25

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Populations - 1

1.

One gene, comprising two codominant alleles, determines the color of the fur in one species of squirrel, *Sciurus carolinensis*. The gene for grey fur color is represented by C^G , whereas the allele for black fur color is represented by C^B .

The three potential phenotypes are displayed in the table below.

Genotype	Phenotype
$C^G C^G$	Grey fur
$C^G C^B$	Brown-black fur
$C^B C^B$	Black fur

(a) Two of the 34 *S. carolinensis* in the population had black fur.

Calculate the proportion of brown-black-furred squirrels in this population using the Hardy-Weinberg equation. Display your work. (2)

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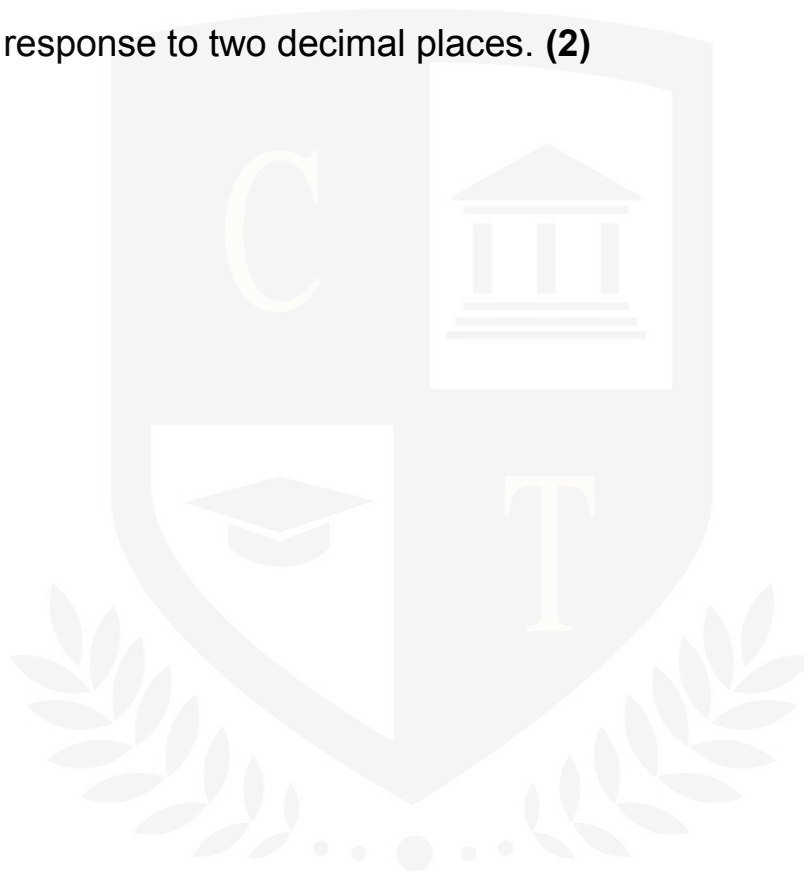
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(b) There were sixteen squirrels in this population who possessed brown-black fur.

Determine the true frequency of the CG allele using all available data.

In your computation, do not utilize the Hardy-Weinberg equation.

Round your response to two decimal places. **(2)**



2. CHEMISTRY ONLINE

Read the following passage: Complete achromatopsia is a type of complete color blindness that results from having only rods and no functioning cone cells. People with complete achromatopsia have trouble seeing details. Complete achromatopsia is caused by an autosomal recessive allele, and only one in 40 000 people are affected in most populations; however, 10% of people live on the Pacific 5 island of Pingelap.

More males than women are affected with a sex-linked recessive gene that causes one type of red-green color blindness. Individuals who suffer from

this red-green color blindness are unable to discriminate between other colors as well as between red and green. Although they contain ten photoreceptive pigments, their green-sensitive cones are inactive. They have green-sensitive cones but their photoreceptive pigment is non-functioning.

Researchers looked at using gene therapy to treat monkeys who were red-green color blind. The monkeys' eyes were immediately injected with viruses that carried the gene for the pigment that is sensitive to green. Even though the monkeys were able to see color for two years, there remains disagreement over the value of this type of gene therapy. There have been no human clinical studies for this treatment conducted. Induced pluripotent stem cells (iPS cells) are being used in studies to treat red-green color blindness.

Gene therapy may not always be superior to the usage of iPS cells. 20

Answer the following questions using the facts in the passage and your own understanding.

(a) Individuals suffering from total achromatopsia have trouble perceiving fine details (lines 2-3).

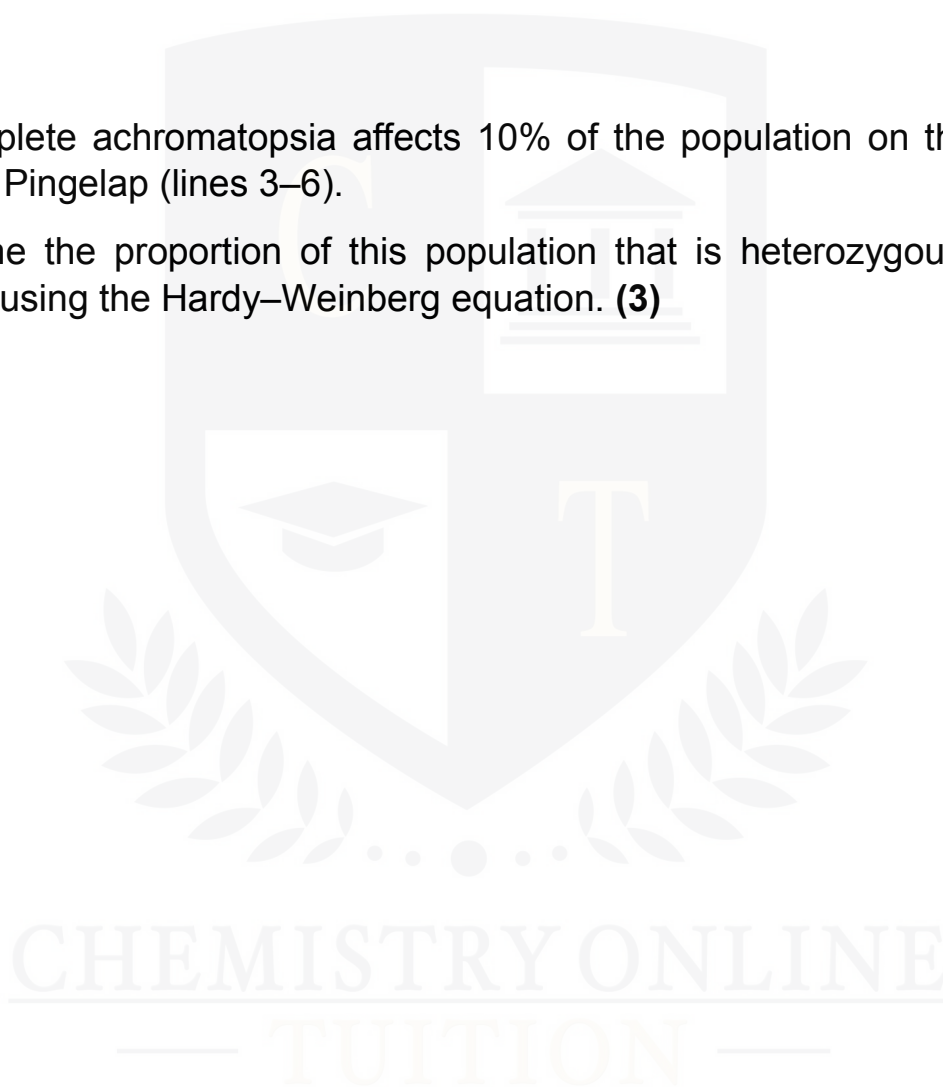
Describe your reasoning. **(3)**

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(b) Complete achromatopsia affects 10% of the population on the Pacific island of Pingelap (lines 3–6).

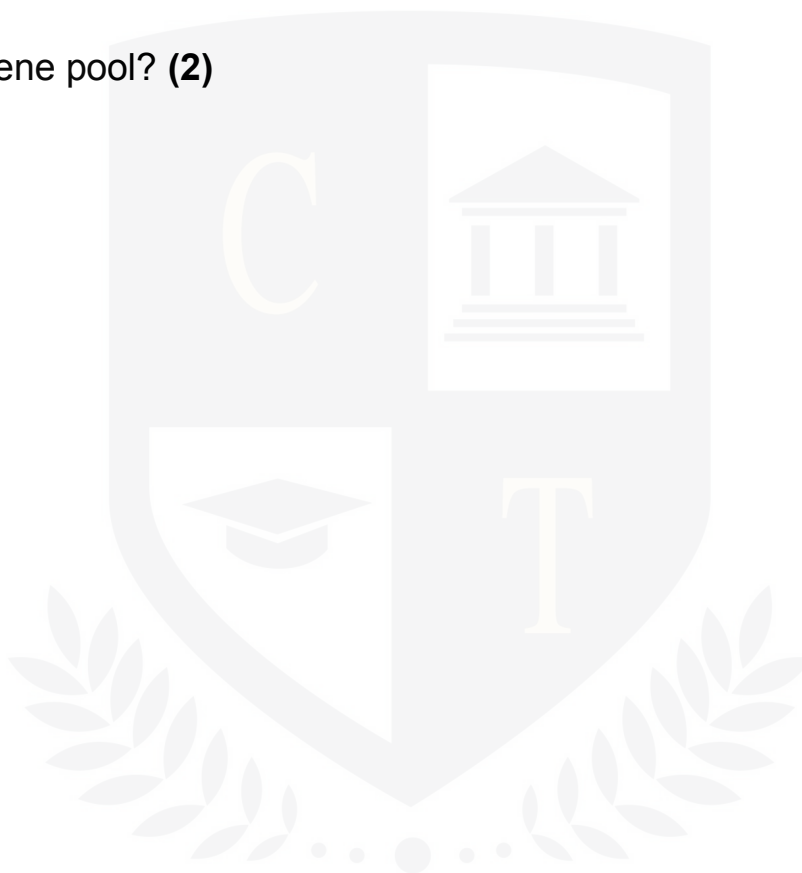
Determine the proportion of this population that is heterozygous for this disorder using the Hardy–Weinberg equation. **(3)**



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3.

(a) Define gene pool? (2)



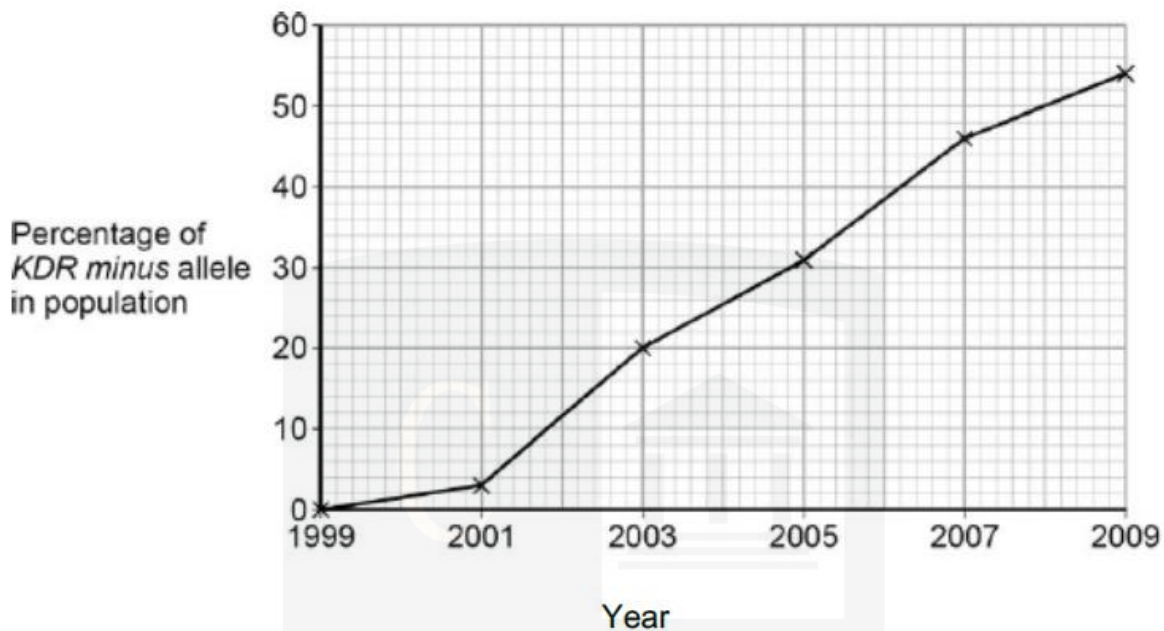
4.

Mosquitoes are the insects that carry the malaria virus. DDT is a chemical that is used in Africa to try and stop the spread of malaria by killing mosquitoes.

There is a gene in mosquitoes called KDR. Currently, some mosquitoes are resistant to DDT due to an allele of this gene called KDR minus. KDR +, the other allele, does not produce resistance.

Over a ten-year period, researchers looked into the prevalence of the KDR minus allele in a population of mosquitoes in an African nation.

The scientists' findings are depicted in the image below.



(a) Determine the percentage of mosquitoes in this population that are heterozygous for the *KDR* gene in 2003 using the Hardy–Weinberg equation.

Display your work. (2)

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(b) Provide a rationale for the outcomes seen in the preceding figure. **(4)**

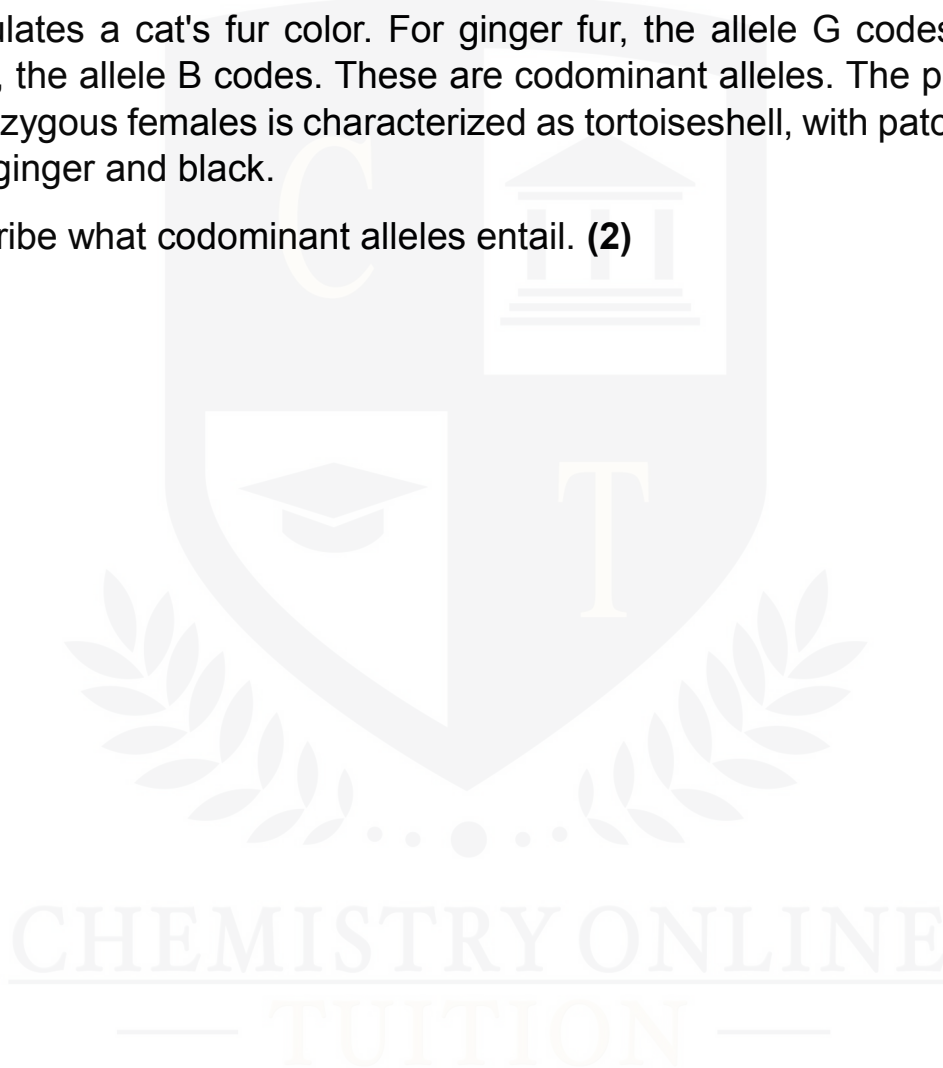


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5.

Men are XY and females are XX in cats. The X chromosome contains a gene that regulates a cat's fur color. For ginger fur, the allele G codes, and for black fur, the allele B codes. These are codominant alleles. The phenotypic of heterozygous females is characterized as tortoiseshell, with patches of fur that are ginger and black.

(a) Describe what codominant alleles entail. **(2)**



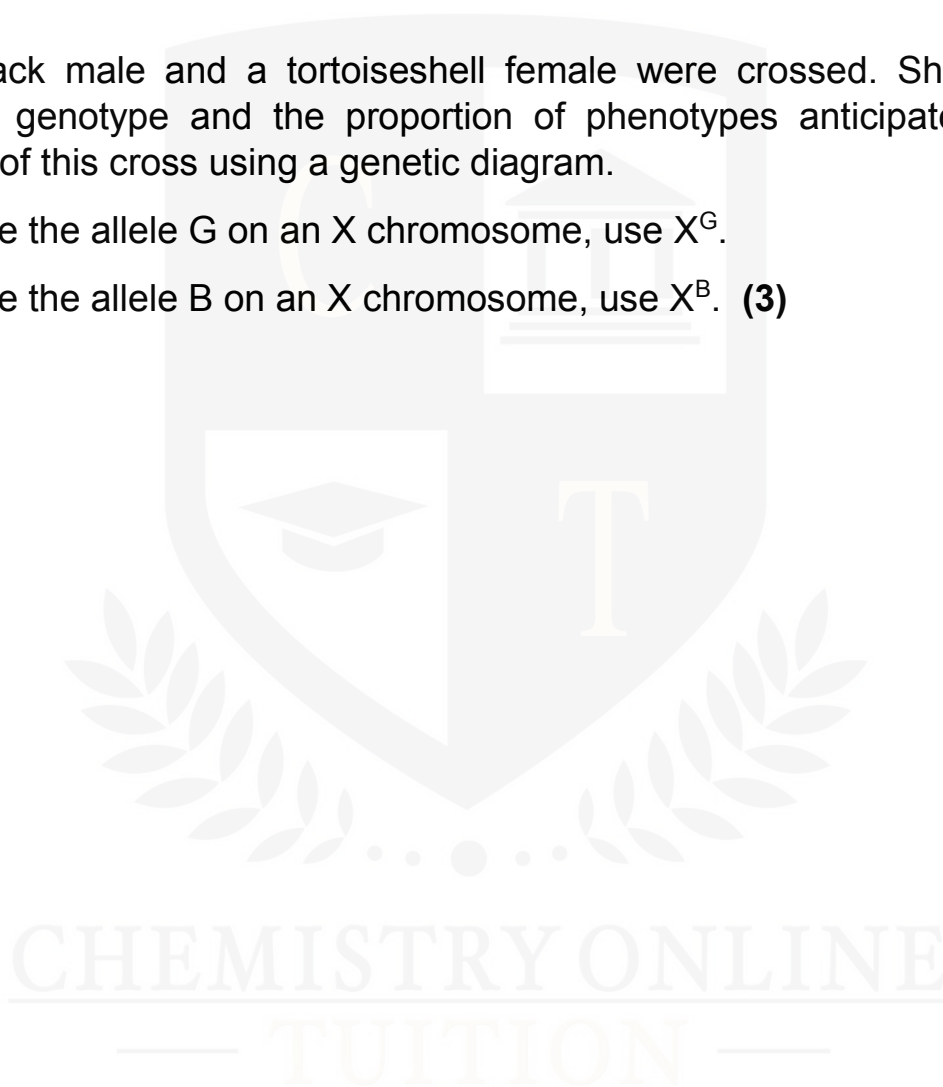
(b) Typically, male cats do not exhibit the tortoiseshell phenotypic. Describe your reasoning. **(2)**

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(c) A black male and a tortoiseshell female were crossed. Show every potential genotype and the proportion of phenotypes anticipated in the progeny of this cross using a genetic diagram.

To denote the allele G on an X chromosome, use X^G .

To denote the allele B on an X chromosome, use X^B . **(3)**



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6.

Cats with polydactyly, an inherited disorder, have additional toes. The polydactyly allele is dominant.

(a) Of a population of cats, 19% possessed an additional toe. Determine the frequency of the recessive allele for this gene in this population using the Hardy-Weinberg equation. Display your work. **(2)**



(b) Breeders of cats sometimes choose for polydactyly. Explain how this might impact the homozygous genotype frequencies of this gene in their breeding populations over time. **(2)**

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