SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

Figures										Letter
Words										

Victorian Certificate of Education
1999

BIOLOGY

Common Assessment Task 3: Written examination

Monday 1 November 1999: 3.00 pm to 4.45 pm
Reading time: 3.00 pm to 3.15 pm
Writing time: 3.15 pm to 4.45 pm
Total writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Number of articles	*Number of questions in each article*	*Number of questions to be answered*
8	1	8

Directions to students

Materials
Question and answer book of 21 pages.

The task
Please ensure that you write your **student number** in the space provided on the cover of this book.
Answer **all** questions.
Write your answers in the spaces provided in this question and answer book.
The marks for each question give you an idea of how much time you should spend, and how much information you should provide. There is a total of 75 marks available for this task.
All responses should be in ink or ball point pen.
All written responses should be in English.

Students should attempt all parts of all questions

Article 1

Budgerigars and people

Scientists have discovered that there are many different genes controlling feather colour in budgerigars (budgies). One autosomal gene has alleles for yellow-green feather colour and pale blue feather colour. The phenotype yellow-green feathers is dominant to pale blue feathers.

Question 1

a. i. Assign allelic symbols for this gene.

Phenotype	Allele symbol

Several yellow-green budgies were mated with pale blue budgies. The offspring of these crosses had either yellow-green or pale blue feathers.

ii. What were the genotypes of the first generation offspring?

Offspring	Genotype
yellow-green feathers	
pale blue feathers	

iii. The yellow-green offspring were allowed to interbreed. Complete the table below for this second generation.

Possible genotypes of the second generation offspring	Expected proportion of each genotype	Corresponding phenotype of the offspring

1 + 2 + 3 = 6 marks

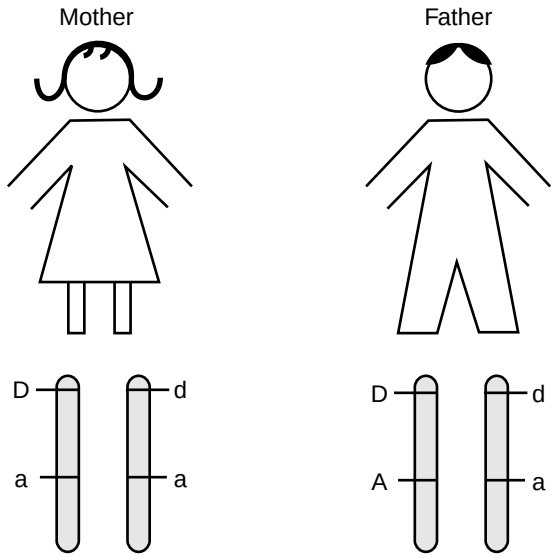
In humans, the gene controlling Rhesus blood group and the gene controlling the production of the enzyme amylase are both on chromosome 1.

The alleles for these genes are as follows.

Rhesus blood group	**D**	: Rhesus positive
	d	: Rhesus negative
Enzyme production	**A**	: Amylase produced
	a	: No amylase produced

A couple, with their genotypes, are shown in Figure 1.

Figure 1



The couple had nine children.

b. **i.** What is the mode of inheritance of the Rhesus positive phenotype?

_____

ii. What is the chance that a child of this couple will be able to produce the amylase enzyme?

_____

iii. What is the chance that a child of this couple will be homozygous at the Rhesus blood group locus?

_____

1 + 1 + 1 = 3 marks

A student claimed that, with respect to the genes for Rhesus blood group and amylase production, the father would only produce two different kinds of gametes.

c. Explain whether you agree or disagree with the student.

2 marks

Total 11 marks

Article 2

Genetics and domesticated animals

Cattle

Before the 1950s, the Dexter or 'bulldog' phenotype was present in several cattle herds. These cattle have short legs, short faces and bulging foreheads. The Dexter phenotype has been studied under experimental conditions. No adult homozygous Dexter cattle have been identified and, when compared to other herds, Dexter cattle produce fewer offspring. Two crosses which have been performed a large number of times are shown in Table 1. The phenotypic ratios seen in the offspring are also shown in the table.

Table 1

	Parents	**Offspring**
Cross 1	Dexter X normal	1 Dexter : 1 normal
Cross 2	Dexter X Dexter	2 Dexter : 1 normal

Question 2

a. By showing **Cross 2** in detail, indicate how you can account for the phenotypic ratio seen in the offspring. Assign your own allelic symbols and state clearly their meaning.

3 marks

Dogs

Epilepsy is a disorder of another domesticated animal, the dog. One breed of dog in which epilepsy can have a genetic basis is the beagle. One of the gene loci involved in epilepsy in the beagle is X-linked recessive.

b. **i.** Explain to a dog owner how two unaffected beagles have produced puppies with the X-linked form of epilepsy. Show your explanation using the allelic symbols **E** for unaffected and **e** for epilepsy.

Epilepsy has also been seen in the offspring (pups) of females who experience a vitamin A or B deficiency while pregnant.

ii. You have a female dog with epilepsy. Describe how you would determine if this was the X-linked form or the form which is the result of a vitamin A or B deficiency.

2 + 2 = 4 marks

Chickens

A third domesticated species, the chicken, has a gene located on the Z chromosome which determines the colour of the feathers of certain breeds. Male chickens have two Z chromosomes and female chickens have only one Z chromosome and a smaller W chromosome. The W chromosome does not carry a gene for feather colour.

The gene for feather colour in certain breeds has two alleles.

G : silver feathers

g : gold feathers

c. **i.** How many alleles are there for feather colour in each somatic cell of the female chicken?

ii. A male, heterozygous with respect to this gene, is crossed to a female with gold feathers. What are the possible genotypes and corresponding phenotypes of the offspring? Show your working.

Another gene found on one of the autosomes of chickens has two alleles.

H : hard feathers

h : soft feathers

A cross between two chickens was carried out. The male had soft feathers.

Equal numbers of the following offspring were observed:

males with hard, silver feathers
males with soft, silver feathers
females with hard, gold feathers
females with soft, gold feathers

iii. What are the genotypes of the two parental chickens? Show your working.

1 + 2 + 2 = 5 marks

Total 12 marks

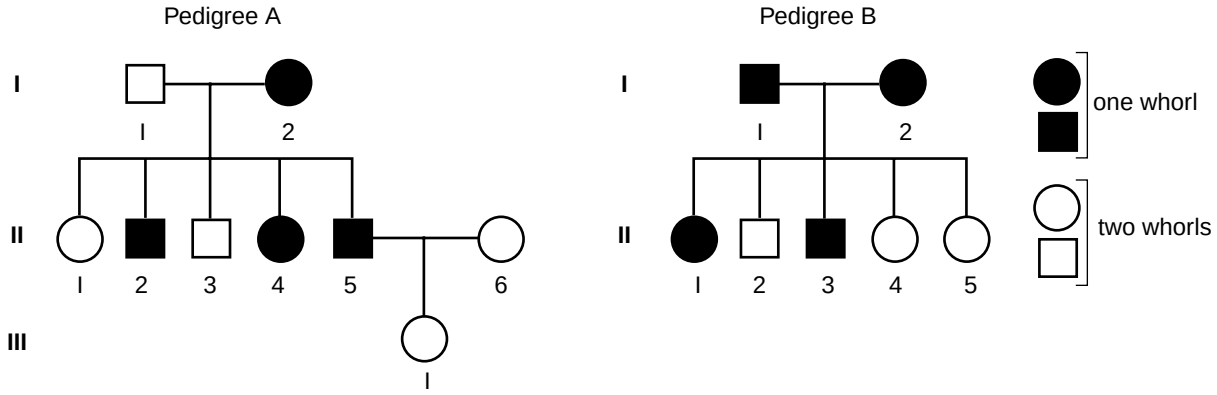
TURN OVER

Article 3

Human pedigrees

A survey of male and female Biology students found that some individuals have one whorl of hair at the crown of the head whereas others have two whorls. This was investigated further in two families, Family A and Family B. Data collected from these families were recorded in two pedigrees shown in Figure 2.

Figure 2



Question 3

a. **i.** Which of the pedigrees, A or B, will fit more than one pattern of inheritance for one whorl?

_____

ii. Explain how the pedigree chosen in **a.i.** fits more than one pattern of inheritance.

_____

_____

_____

_____

_____

_____

_____

1 + 2 = 3 marks

b. **i.** Consider the pedigree **not** chosen in part **a.i.** Explain what feature of this pedigree allows you to decide that the inheritance of a single whorl is dominant.

ii. Describe one feature of the pedigree considered in part **b.i.** which indicates that the inheritance of one whorl is **autosomal** dominant and not **X-linked** dominant.

2 + 1 = 3 marks

Total 6 marks

CONTINUED OVER PAGE

Article 4

Mutations and human disorders

A recent study of the *p53* gene in humans has suggested that a particular genotype represents a significant risk for the development of certain cancers. The allele encoding arginine at codon-72 when homozygous was shown to be present significantly more often in patients with cervical tumours and skin cancers.

Question 4

a. What is a codon?

2 marks

Table 2 Section of the genetic code (messenger RNA)

UCU Serine	UAU Tyrosine	UGU Cysteine
UCC Serine	UAC Tyrosine	UGC Cysteine
UCA Serine	UAA Stop	UGA Stop
UCG Serine	UAG Stop	UGG Tryptophan
CCU Proline	CAU Histidine	CGU Arginine
CCC Proline	CAC Histidine	CGC Arginine
CCA Proline	CAA Glycine	CGA Arginine
CCG Proline	CAG Glycine	CGG Arginine

b. Using the section of the genetic code shown in Table 2, name one of the sequences on the template strand of DNA which would result in the amino acid arginine.

1 mark

c. **i.** What term describes that part of the process of gene expression which occurs outside the nucleus?

ii. List the steps in the process you have named in **c.i.**

1 + 3 = 4 marks

Another allele at this locus produces **proline** at codon-72.

d. Using the information in Table 2, suggest what change has occurred in DNA which resulted in the production of proline instead of arginine at codon-72.

_____

_____

1 mark

Another inherited disorder in humans is Oculocutaneous Albinism Type 1 (OCA1) in which individuals do not produce the dark pigment melanin. As a result they have white hair and skin and reddish eyes. OCA1 results from mutation in the tyrosinase gene on chromosome 11. More than 70 different mutations which lead to OCA1 can occur in the nucleotide sequence of this gene. OCA1 occurs when both copies of the gene carry a mutation. The tyrosinase gene has 5 exons and a number of introns.

e. What is an exon?

_____

_____

1 mark

f. What is a nucleotide?

_____

_____

1 mark

One of the mutations in the tyrosinase gene is a deletion of a G at nucleotide position 53 in the DNA sequence of this gene.

g. **i.** What does the G represent in a molecule of DNA?

_____

ii. Describe the effect a single base deletion may have on the amino acid sequence of the polypeptide produced by a gene.

_____

_____

_____

_____

1 + 2 = 3 marks

Total 13 marks

TURN OVER

Article 5

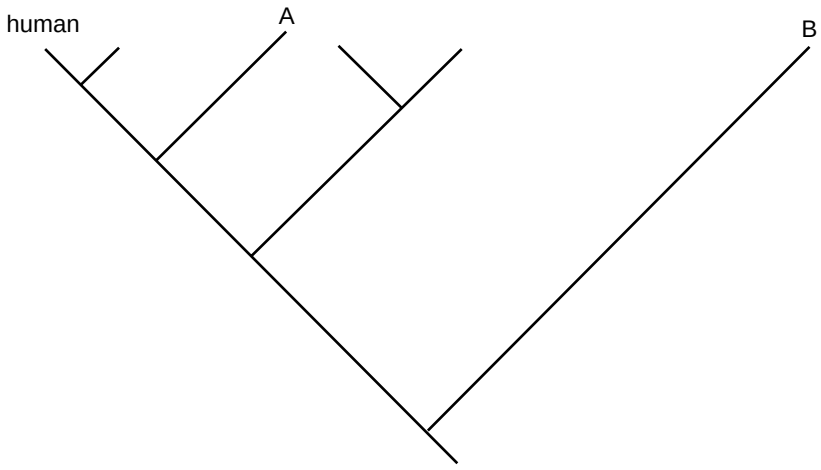
Evolutionary relationships

Cytochrome C is a protein which is involved in cellular respiration. Table 3 shows the number of amino acid differences in an homologous sequence of cytochrome C from 6 different species. The sequence consists of 104 amino acids.

Table 3

	human	penguin	rabbit	Rhesus monkey	duck
human					
penguin	14				
rabbit	9	8			
Rhesus monkey	1	13	8		
duck	11	3	6	10	
tuna	21	18	17	21	16

Figure 3



Question 5

Figure 3 shows the evolutionary relationships between the species in Table 3.

a. Using the information in Table 3, which of the 6 species are most likely represented by the letters **A** and **B** in Figure 3?

A _____

B _____

2 marks

The human and the Rhesus monkey differ in 1 of the 104 amino acids in cytochrome C. In human cytochrome C the amino acid at position 58 is isoleucine, whereas in the Rhesus monkey it is threonine.

b. Consider the 103 matching amino acids between these 2 species. Explain if it is correct to conclude that the DNA sequence coding for these matching amino acids in the human cytochrome C is exactly the same as the DNA sequence coding for them in the Rhesus monkey.

2 marks

As many different types of evidence as possible should be used when trying to determine evolutionary relationships.

c. Name **two** types of evidence, apart from protein, amino acid or DNA sequences, and discuss how they are used to help determine evolutionary relationships.

i.

ii.

2 + 2 = 4 marks

Planktonic graptolites are extinct animals that lived in colonies. The fossil record shows that the graptolites evolved into several distinct groups during the Ordovician period of the Palaeozoic era. Fossilised graptolite colonies appear as a series of branches, the number of branches in each colony gradually decreased during the Ordovician from thirty-two to sixteen to eight to four to two and finally to a single branch. A variety with four branches is shown in Figure 4.

The same change of branch reduction happened in three distinct and separate groups of graptolites.

Figure 4 Graptolite colony with 4 branches (× 1.5 approximately)

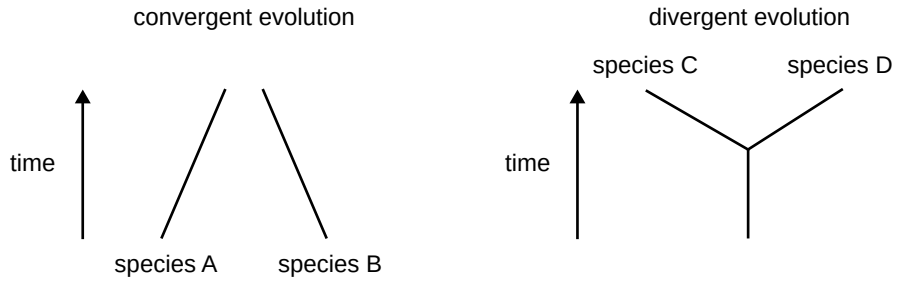
d. Explain how the same change could have occurred in three distinct groups of graptolites.

2 marks

Organ pipe cactus, *Lemaireocereus thurberi*, can be found growing in desert areas in New Mexico. These cacti have succulent stems with no leaves. The giant spurge, *Euphorbia pseudocactus*, with a very similar appearance to the organ pipe cactus, grows in the Namibian desert of South West Africa.

Two patterns of evolution are represented in Figure 5.

Figure 5



e. **i.** Using the information given above, and in Figure 5, what pattern of evolution best describes the evolution of the organ pipe cactus and the giant spurge?

_____

ii. Explain how you reached your conclusion in **e.i.**

_____

_____

_____

_____

1 + 1 = 2 marks

Ringtail possums and spider monkeys both have prehensile tails. Prehensile tails are used by these animals to grasp onto branches. A student stated that these tails are analogous but not homologous structures.

f. Explain the difference between analogous and homologous structures in animals.

_____

_____

_____

_____

_____

_____

2 marks

Total 14 marks

TURN OVER

Article 6

Beans

Question 6

Organisms whose somatic cells have more than two sets of chromosomes are called polyploids. Polyploidy is common in plants. A polyploid is classified on the basis of the number of sets of chromosomes in each somatic cell. For example:

Sets of chromosomes	Name
three	triploid
four	tetraploid
five	pentaploid
six	hexaploid
seven	septaploid
eight	octaploid

The diploid form of the field bean, *Vicia faba*, has 12 chromosomes in each somatic cell but polyploids are sometimes found. Figures 6 and 7 show the chromosomes from a leaf cell of *V. faba* and those from a leaf cell of one of the polyploid variants.

Figure 6 *V. faba*

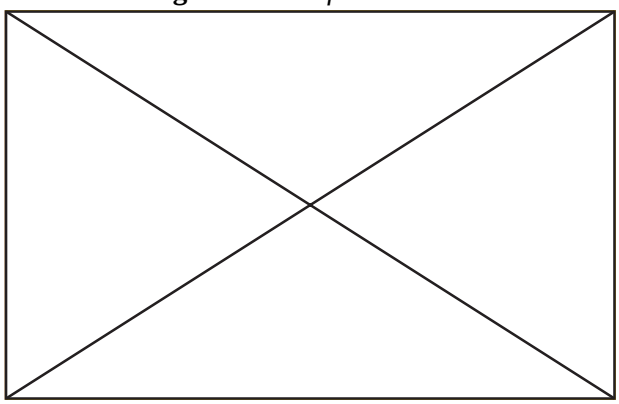
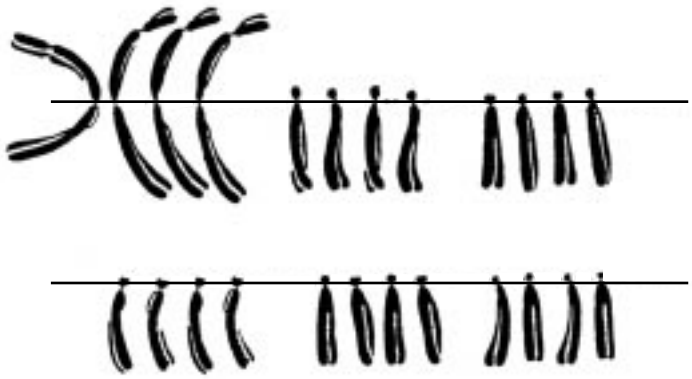


Figure 7 *V. faba* polyploid variant



a. **i.** How would you classify the polyploid variety in Figure 7 with respect to sets of chromosomes?

_____

ii. Suggest one way in which this polyploid of *V. faba* might have arisen.

_____

_____

_____

1 + 1 = 2 marks

b. What term is used to describe the pair of chromosomes labelled A in Figure 6?

_____

1 mark

When the *V. faba* with chromosomes as shown in Figure 6 is crossed with the polyploid variety shown in Figure 7, surviving offspring are produced. A student proposed that because a cross between the two parental plants is able to produce offspring, these offspring would be able to reproduce sexually.

c. Explain whether or not you support the student's proposal.

2 marks

Total 5 marks

CONTINUED OVER PAGE

Article 7

Little Foot

In 1998, a fossil that attracted worldwide attention was found in the walls of a South African cave. The fossil was a hominid of the genus *Australopithecus* and its estimated age was 3.2–3.6 million years. Most hominid fossils consist only of fragments of the original specimen but this South African fossil included an intact skull with jaw and teeth, and a well preserved leg and foot. The fossil was originally identified from four foot bones which lead to the title of 'Little Foot'. Scientists studying the fossil have suggested that the heel bone was adapted to take the strain of moving upright on two legs. They also suggested that the big toe retained the ability to grasp branches. Little Foot's skeleton is only about 1.2 m in length.

Question 7

a. Explain one reason why most fossilised hominid remains consist only of fragments of the original specimen.

1 mark

b. Based on the above description, which feature of the 'Little Foot' fossil would enable it to be characterised as a hominid?

1 mark

c. List **two** structural differences you would expect to find between Little Foot's skeleton and that of a modern human.

i.

ii.

1 + 1 = 2 marks

Evidence from the fossil record suggests that another species of hominid (*Australopithecus afarensis)* only existed from 4 million years ago until 3 million years ago.

d. Explain **two** reasons which may account for the complete disappearance of a particular hominid species.

i.

ii.

1 + 1 = 2 marks

Total 6 marks

Article 8

The woolly rhinoceros and relatives

Evidence of prehistoric rhinoceroses has been found on every continent except Australia and Antarctica. These animals varied in size. Some were larger than modern elephants. For one extinct genus, *Coelodonta* (the woolly rhinoceros), two proposals, shown below, have been made about its evolutionary history.

Question 8

a. In the table below, add the evidence that palaeontologists would need to support these proposals.

Proposals	Evidence
i. *Coelodonta* evolved somewhere in northeastern Asia from an earlier form, Dicerorhinus.	
ii. *Coelodonta* became extinct at the end of the most recent ice age, about 10 000 years ago.	

2 + 1 = 3 marks

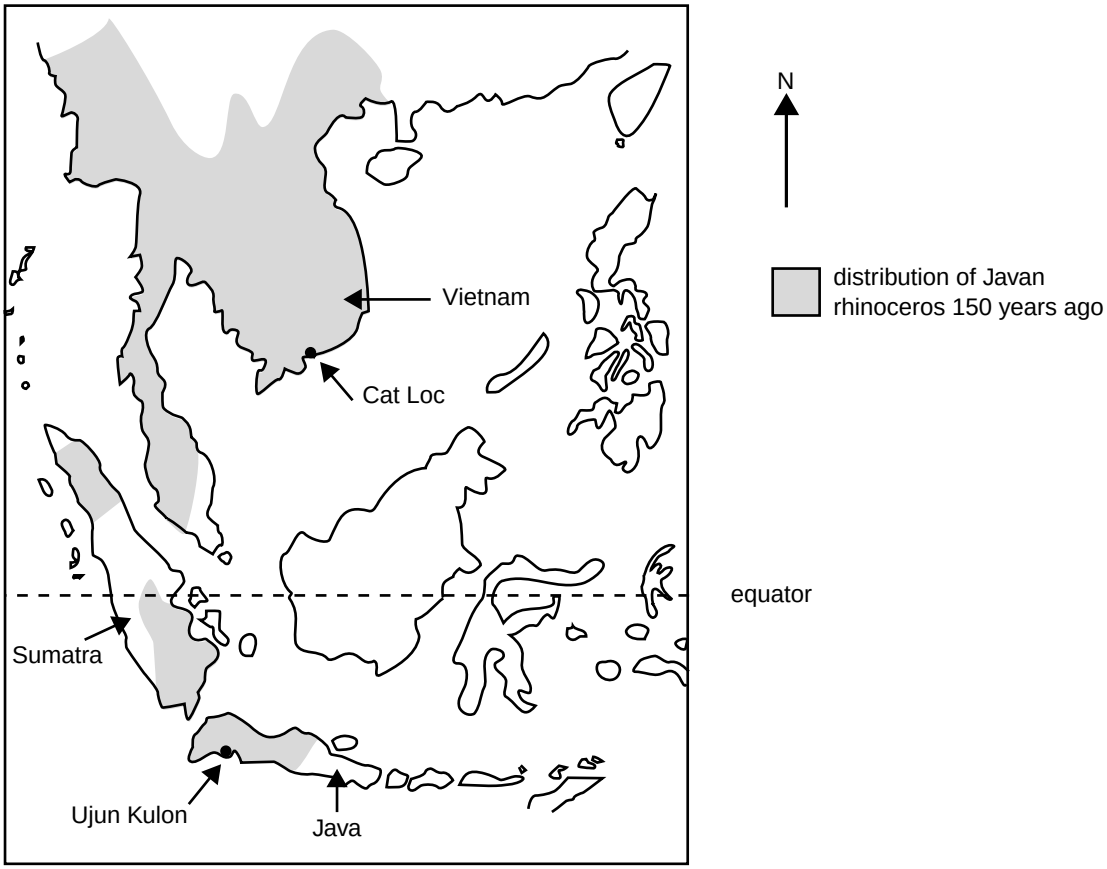
b. What procedure would be used to determine the age of the *Coelodonta* fossils?

_____

1 mark

Five species of rhinoceros survive today. Three of these species can be found in Asia. The Javan rhinoceros lives in dense, lowland tropical rainforest and was once widespread across southeast Asia. Figure 8 indicates the range of the Javan rhinoceros 150 years ago. Two isolated populations of the Javan rhinoceros remain: at the Cat Loc Wildlife Reserve in Vietnam and at Ujun Kulon in Java.

Figure 8



c. Assuming evidence is available to support proposal **a.i.** in the table on page 19, how could the dispersal of this species from northern Asia to Sumatra and Java be explained?

1 mark

All species of rhinoceros have been hunted for their horns and are now endangered.

d. Give one reason, other than hunting, to explain why there are only the two remaining populations of the Javan rhinoceros at Cat Loc and Ujun Kulon.

1 mark

A recent census at Cat Loc indicated that only five individuals remained. Captive breeding programs and protected habitats are used in attempts to rescue the endangered species from extinction. Problems are associated with these programs, and there is no guarantee of success.

e. Suggest **two** problems that might be encountered if a breeding program were to be established for the remaining Cat Loc population.

i. _____

_____

ii. _____

_____

1 + 1 = 2 marks

Total 8 marks

END OF QUESTION AND ANSWER BOOK