17.1 Variation

Question Paper

Course	CIE A Level Biology
Section	17. Selection & Evolution
Topic	17.1 Variation
Difficulty	Medium

Time allowed: 30

Score: /25

Percentage: /100

Question 1a

Cacti are plants that are adapted to live in arid conditions. They store water in thick stems which are protected from grazing by herbivores through the presence of multiple spines. The number of spines that are present on cacti may vary greatly, depending on the frequency of grazing that they experience.

Fig. 1 shows the number of spines present in a species of cacti.

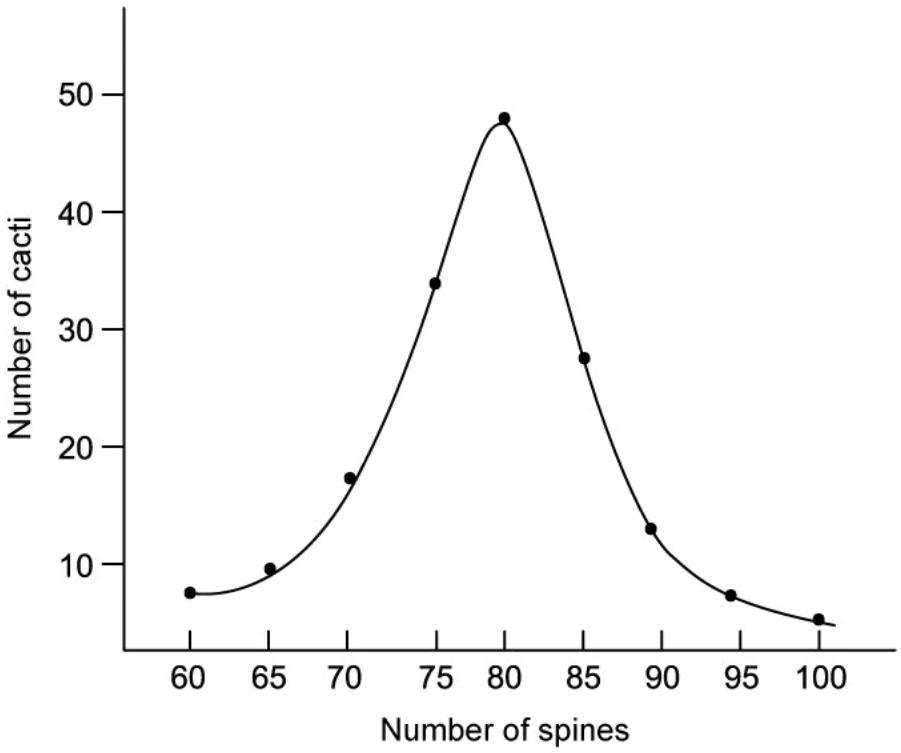

Fig. 1

State the type of variation that is represented by Fig. 1 **and** provide **two** reasons for your answer.

[3 marks]

Question 1b

Suggest the possible impact of environmental factors on the variation observed in Fig. 1, with regards to the number of spines on cacti.

[2 marks]

Question 1c

Contrast the genetic basis of continuous and discontinuous variation with each other.

[3 marks]

Question 2a

Students investigated the effect of light intensity on leaf length in the Mexican sword plant (*Echinodorus palaefolius*). They had two groups (**A** and **B**) consisting of ten plants each, with group **A** grown in a laboratory where the lights were kept on, while group **B** was grown under similar conditions to group **A** but kept under low light conditions. The plants were grown at these different light intensities for 14 days, and the average leaf length of each plant was calculated for each group.

The results of the investigation is shown in Table 1.

Table 1

Plant number	Leaf length of group A	Leaf length of group B
1	38	57
2	39	60
3	40	56
4	40	59
5	37	58
6	36	61
7	37	60
8	37	57
9	39	57
10	39	59
Mean	**38.2**	

Calculate the mean leaf length for group **B**.

Show your working.

[2 marks]

Question 2b

The students used the *t*-test to compare the means of groups **A** and **B**.

State **two** features of the data that allow for the use of the *t*-test.

[2 marks]

Question 2c

State a null hypothesis for this investigation.

[1 mark]

Question 2d

After performing the *t*-test, the students calculated a *t*-value of 29.7. Table 2 shows different *t*-values and the probability that the differences between the data sets are due to chance.

Table 2

Degrees of freedom	Significance level (p=)					
	(0.20)	(0.10)	(0.05)	(0.02)	(0.01)	(0.001)
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850

Using the information in Table 2, discuss the conclusions that the students can draw from their results.

[3 marks]

Question 3a

Scientists investigated the effect of light on the germination of begonia seeds. They had three groups consisting of 30 seeds each, for both light and dark conditions. The seeds were exposed to light or darkness for 72 hours before scientists calculated the mean number of seeds that germinated out of 30 seeds for each light condition. All other conditions were kept constant between the seeds.

Fig. 1 shows the results of this investigation.

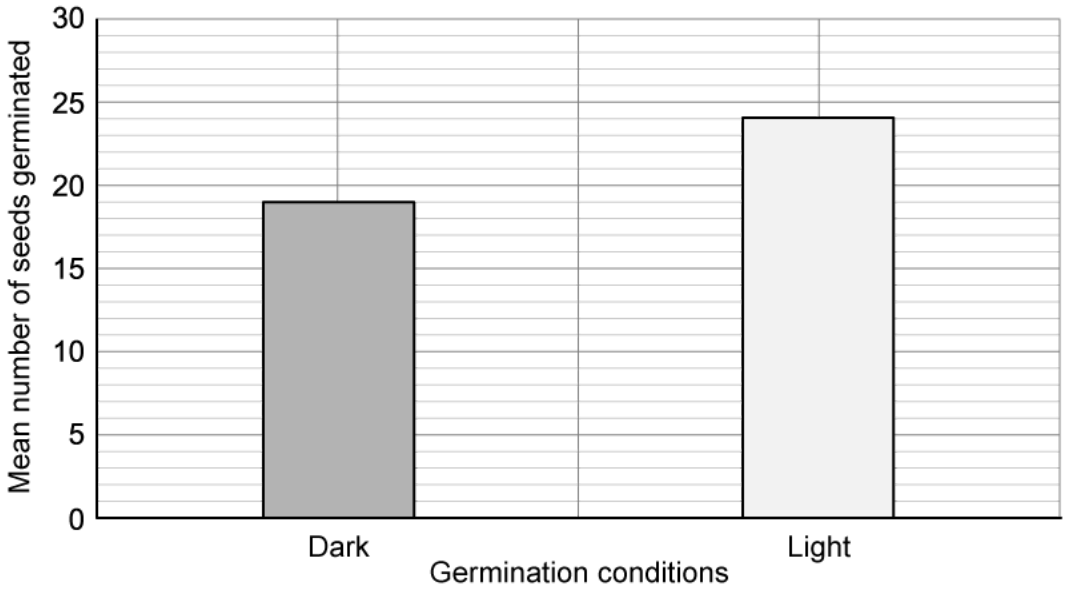

Fig. 1

Calculate the mean number of seeds germinating in dark conditions as a percentage of the mean number of seeds that germinated in light conditions.

Show your working and give your answer to one decimal place.

[2 marks]

Question 3b

Explain why the *t*-test would not be a suitable statistical test to use on the data represented in Fig.1.

[2 marks]

Question 3c

The house sparrow (*Passer domesticus*) is a small bird commonly found in most parts of the world. They feed mainly on seeds and they show variation in beak size. Two small populations of sparrows, consisting of 20 birds each, were studied to investigate the difference in beak size displayed by each population.

The biologists conducting the study calculated the mean beak size for each population, as well as the standard deviation for each. The results of these calculations are represented in Table 1

Table 1

	Population 1	Population 2
Mean	13	14
Standard deviation (S)	1.80	1.74

Fig. 2 represents the formula for calculating the *t*-value.

$$t = \frac{(\overline{x}_1 - \overline{x}_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$\overline{x}$ = mean of each population

s^2 = standard deviation of each population squared

n = number of measurements in each population

Fig. 2

Using the information in Table 1 and Fig. 2, calculate the *t*-value for this data set.

Show your working and give your answer to two decimal places.

[3 marks]

Question 3d

The null hypothesis for this investigation states that there is no significant difference between the beak sizes of the two populations. The *t*-value at a probability of 0.05 is 1.96 at 38 degrees of freedom.

With reference to the *t*-value calculated in part c), state the conclusion that can be made regarding the difference in beak size between the two populations.

[2 marks]