1 An investigation was carried out to study the effect of positive and negative physical and emotional experiences on humans.

The positive physical experience was a warm object placed on the arm of a person for five seconds.

The negative physical experience was a hot object placed on the arm of a person for five seconds.

All other variables were kept constant.

Two groups of people were used in this investigation. In the first group, the warm object was used before the hot object. In the second group, the hot object was used before the warm object.

After each experience, the individuals were asked to rate their feelings using the scoring system below.

Feelings	Score
Very bad	1
Bad	2
Neutral	3
Good	4
Very good	5

(a) Suggest why one group had the warm object placed on their arm before the hot object and the other group had the hot object placed on their arm first.

(2)

(b) These two groups were then exposed to a positive emotional experience and a negative emotional experience.

The mean results for the investigation are shown in the table below.

Experience	**Mean score for feelings and standard deviation**	
	Physical	**Emotional**
Positive	4.5 ± 0.5	4.2 ± 0.4
Negative	1.9 ± 0.6	1.7 ± 0.4

A student concluded that the physical experiences and emotional experiences were similar.

Using information in the table, comment on the validity of this conclusion.

(4)

(c) This investigation then used a scanning technique to study whether the same areas of the brain were involved in both physical experiences and emotional experiences.

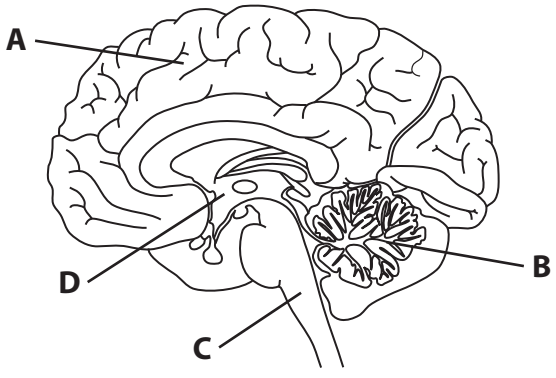
(i) Suggest the scanning technique required to study the brain in this investigation. Give reasons for your choice.

(3)

(ii) It was found that an area of the brain called the insula was involved in both physical experiences and emotional experiences. The insula is found just above the hypothalamus.

Using the diagram below, place a cross in the box ☒ that identifies the area of the insula.

(1)



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 1 = 10 marks)

2 The scientific article you have studied is adapted from several sources.

Use the information from the article and your own knowledge to answer the following questions.

(a) The sweet potato eaten by naked mole rats (paragraph 3) is very rich in cellulose and starch.

Give **two** structural differences between cellulose and starch.

(2)

(b) Naked mole rats show evidence of poikilothermy (paragraph 5) whilst other mammals, such as humans, maintain a nearly constant body temperature.

(i) Describe the role of the human nervous system in returning a slightly raised body temperature to its normal level.

(4)

(ii) Explain how shivering generates heat to return a slightly reduced body temperature to its normal level.

(2)

(c) Suggest how Buffenstein and Horsby introduced cancer-causing genes into cells from naked mole rats (paragraph 13).

(3)

*(d) If we had to breathe the 'rank air' found in the tunnels of naked mole rats, it would leave us 'gasping for air' (paragraph 33).

Describe how the mechanism involved in the control of breathing rate in humans would respond to this 'rank air'.

(5)

(e) Suggest how a study of the naked mole rat could help in the design of prosthetic limbs (paragraph 47).

(2)

(f) Using the information in paragraph 48, name **one** hormone and state its target organ.

(1)

Hormone .....

Target organ .....

(g) Suggest **two** reasons why the structure of the sperm may make it non-motile (paragraph 48).

(2)

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(h) The 'coefficient of band sharing' (paragraph 49) is a measure of the number of bands that different DNA samples have in common. The higher the coefficient the more bands the samples share. The maximum coefficient is 1.00.

Suggest why the coefficient of band sharing ranges from 0.93 to 0.99 within a colony of naked mole rats.

(3)

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(i) Suggest the importance of dispersers in naked mole rat colonies (paragraphs 50, 51 & 52).

(2)

(j) Describe and explain **two** ways in which naked mole rats are adapted to their environment.

(4)

(Total for Question 2 = 30 marks)

3 The photograph shows a female gymnast on a narrow beam.

(a) The table below refers to two regions of the brain.

Complete the table by describing **one** role of each region of the brain, while she is on the beam.

(2)

Region of the brain	One role while she is on the beam
Cerebellum	
Medulla oblongata	

(b) This gymnast will generate a lot of heat while she is on the beam.

Describe and explain how changes in blood flow in the skin will help her to control her body temperature.

(4)

(c) Gymnasts can damage their cruciate ligaments.
This is an injury that can be repaired using keyhole surgery.

(i) Explain what is meant by the term **cruciate ligament**.

(2)

(ii) A gymnast was offered keyhole surgery to repair her damaged cruciate ligament.

Suggest and explain **two** reasons why she might choose this type of surgery.

(2)

(Total for Question 3 = 10 marks)