

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 9: CONTROL SYSTEMS

STRUCTURE AND FUNCTION OF THE MAMMALIAN NERVOUS SYSTEM

SCORE

/63

PERCENTAGE

%

STEMUP

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Q1. There are various ways of investigating brain structure and function.

(a) Compare the use of computed tomography (CT) with magnetic resonance imaging (MRI) for studying brain structure.

(3)

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(b) Suggest why functional magnetic resonance imaging (fMRI) is considered better than CT for studying brain function.

(2)

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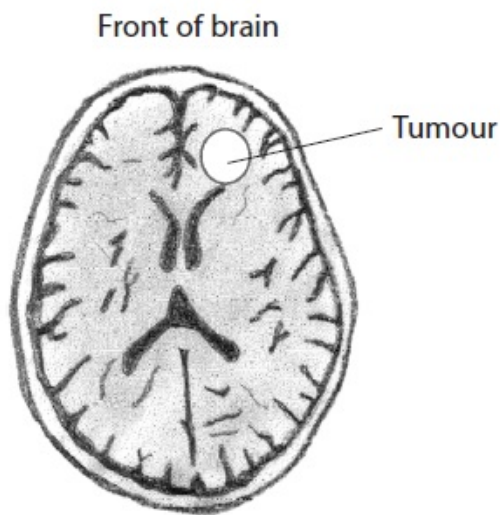
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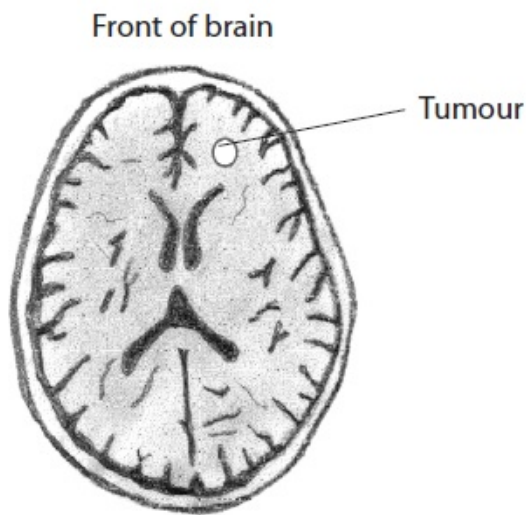
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(c) The diagrams below show two MRI scans of the brain of a patient with a tumour. Scan 1 was taken before treatment was carried out, and scan 2 after treatment.



Scan 1 before treatment



Scan 2 after treatment

(i) Suggest why the tumour appeared white in the scans.

(2)

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(ii) Using the information in the diagrams, describe the effect of the treatment on this tumour.

(2)

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(iii) Using the information in the diagrams, suggest **two** brain functions that may have improved after treatment. Give a reason for your answer.

(3)

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(Total for Question = 12 marks)

Q2. There are various ways of investigating brain structure and function.

(a) Describe how scans from magnetic resonance imaging (MRI) may be used to investigate brain tumours.

(2)

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(b) An investigation was carried out to study brain activity when eating chocolate.

Functional magnetic resonance imaging (fMRI) was used to study the brain activity of people eating chocolate.

It was found that certain areas in their brains became more active when they ate chocolate.

(i) Suggest **two** variables that should be taken into account when selecting the people for this investigation.

(1)

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(ii) Suggest how fMRI was able to show that certain areas in the brain became more active when people ate chocolate.

(3)

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(iii) Some of these more active areas were in the cerebral hemispheres of the brain. The cerebral hemispheres have a number of functions.

State **two** functions associated with the cerebral hemispheres.

(2)

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(Total for Question = 8 marks)

Q3.

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)

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(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)

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(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)

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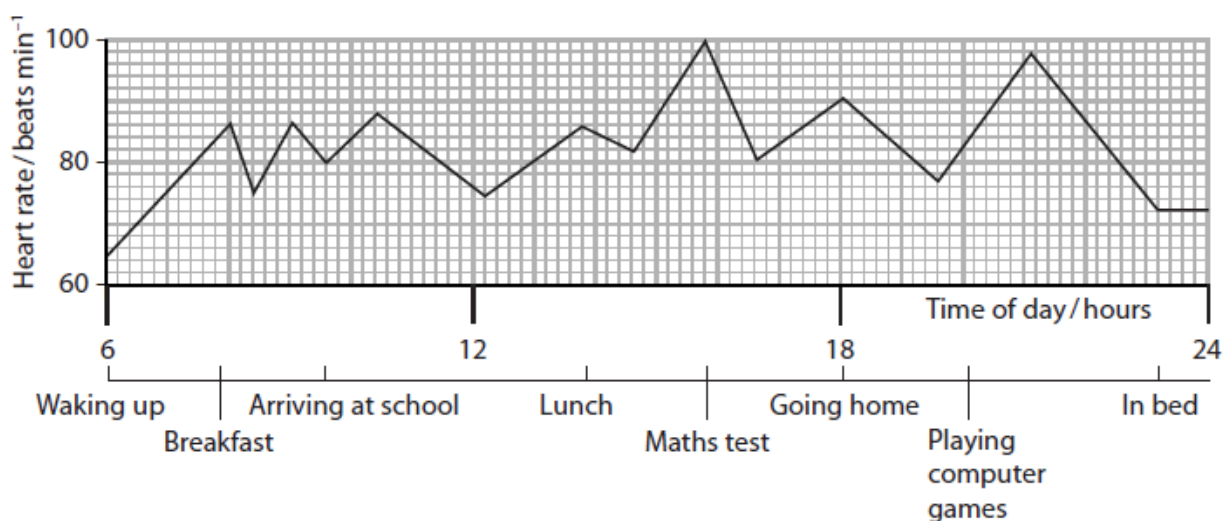
(Total for question = 10 marks)

Q4.

A student was interested to find out how his heart rate would vary throughout the day.

He wore a heart rate monitor from the time he woke up until the time he went to bed.

The graph shows the data collected and some of the student's activities during the day.



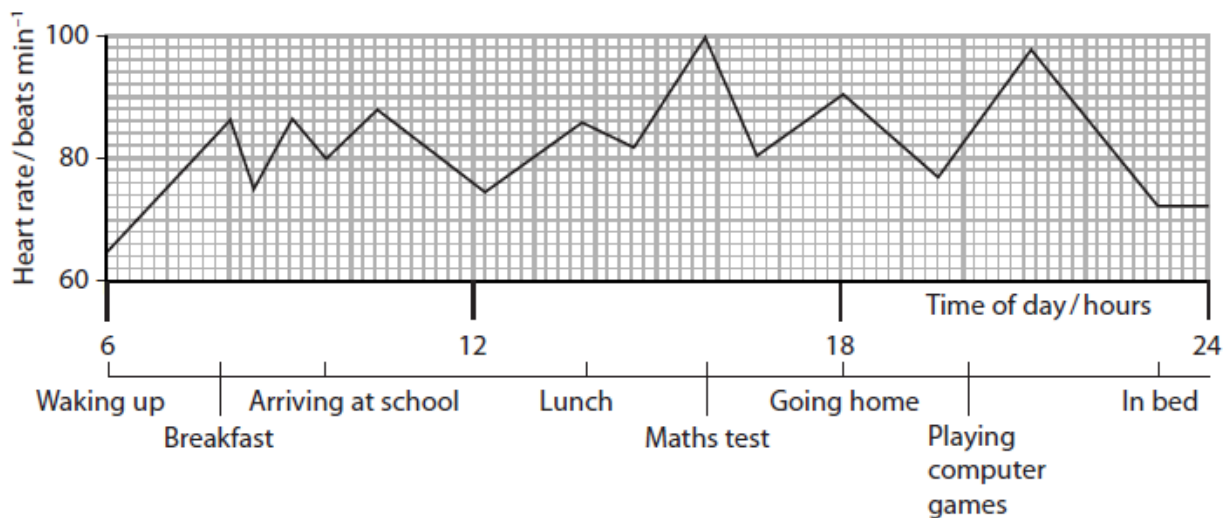
Calculate the rate of increase in the student's heart rate between 6 am and 8 am.

(2)

Answer

Q5.

A student was interested to find out how his heart rate would vary throughout the day. He wore a heart rate monitor from the time he woke up until the time he went to bed. The graph shows the data collected and some of the student's activities during the day.



Explain why the student's heart rate changed at the time of his maths test.

(5)

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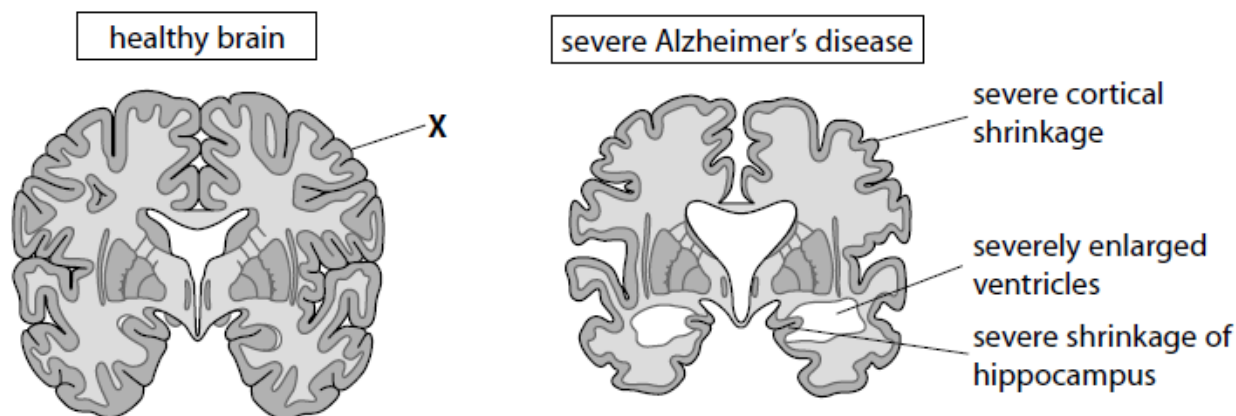
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Q6.

The diagrams below show a horizontal cross section of a healthy human brain and a brain from a person with severe Alzheimer's disease.



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Explain why a person with Alzheimer's disease may show a change in behaviour.

(2)

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(Total for question = 2 marks)

Q7.

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

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.

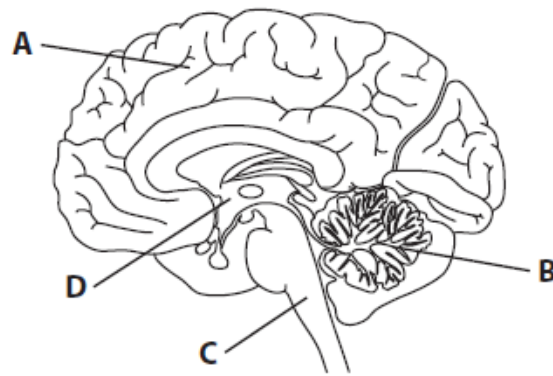
(i) Suggest the scanning technique required to study the brain in this investigation. Give reasons for your choice.

(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

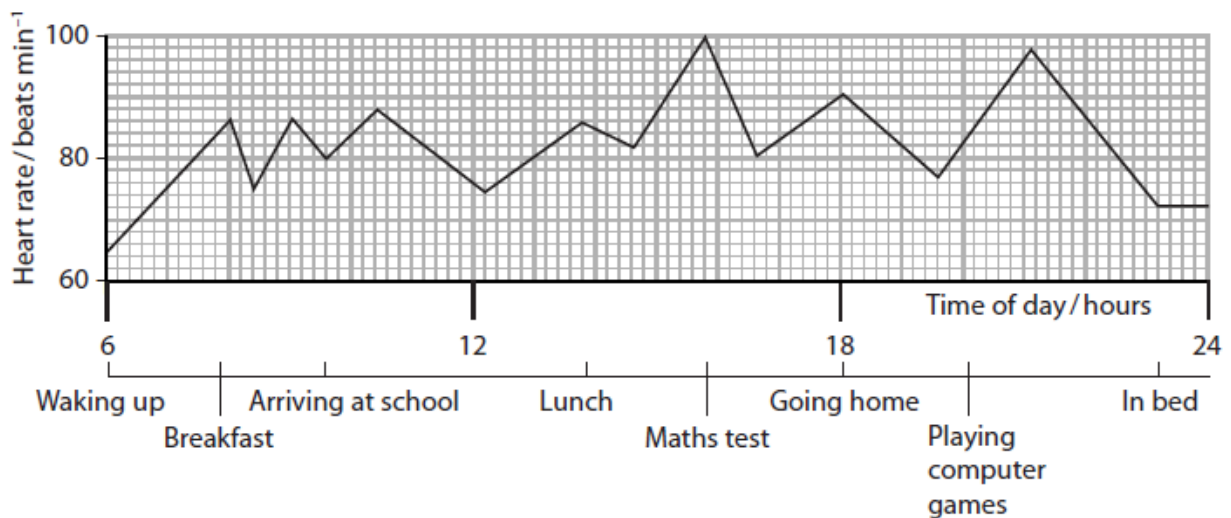
☐ D

Q8.

A student was interested to find out how his heart rate would vary throughout the day.

He wore a heart rate monitor from the time he woke up until the time he went to bed.

The graph shows the data collected and some of the student's activities during the day.



The student noticed that the graph showed a change in his heart rate while he was playing computer games.

He designed an investigation to find out how different computer games affect heart rate.

The student played one computer game and recorded the increase in his heart rate.

He then played four other different computer games and again recorded the increase in his heart rate.

He repeated this on six different occasions throughout the week.

(i) Explain how the design of the student's investigation could be improved.

(4)

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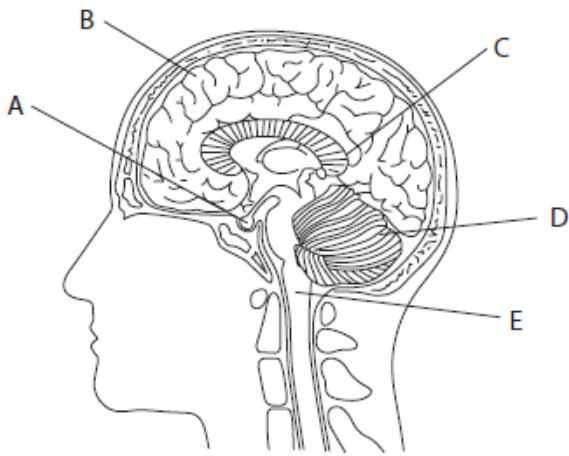
(ii) Sketch a suitable graph that the student could use to present the results of his investigation.

(2)

Q9.

The human brain controls many functions.

The diagram shows a section through a human brain with parts labelled A to E.



Which letter labels the part of the brain that controls heart rate?

(1)

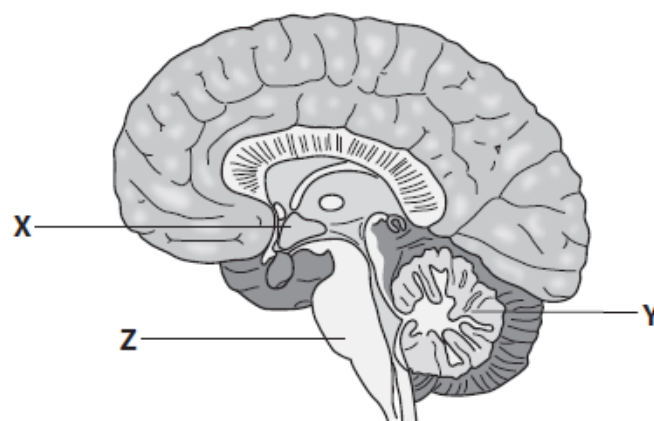
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(Total for question = 1 mark)

Q10.

The brain is involved in many homeostatic mechanisms.

The diagram shows a vertical section through a human brain.



Which row of the table correctly matches the regions **X**, **Y** and **Z** with their functions?

(1)

	Control of breathing rate	Control of balance	Temperature regulation
☐ A	X	Y	Z
☐ B	Y	Z	X
☐ C	Z	X	Y
☐ D	Z	Y	X

(Total for question = 1 mark)

Q11.

Humans have a nervous system that has a variety of neurones.

The human brain is made up of a number of areas containing many millions of neurones.

Place a cross in the box ☐ that identifies the areas of the brain associated with riding a bicycle uphill.

(i) the decision to ride the bicycle

(1)

- ☐ **A** cerebrum
- ☐ **B** cerebellum
- ☐ **C** hypothalamus
- ☐ **D** medulla

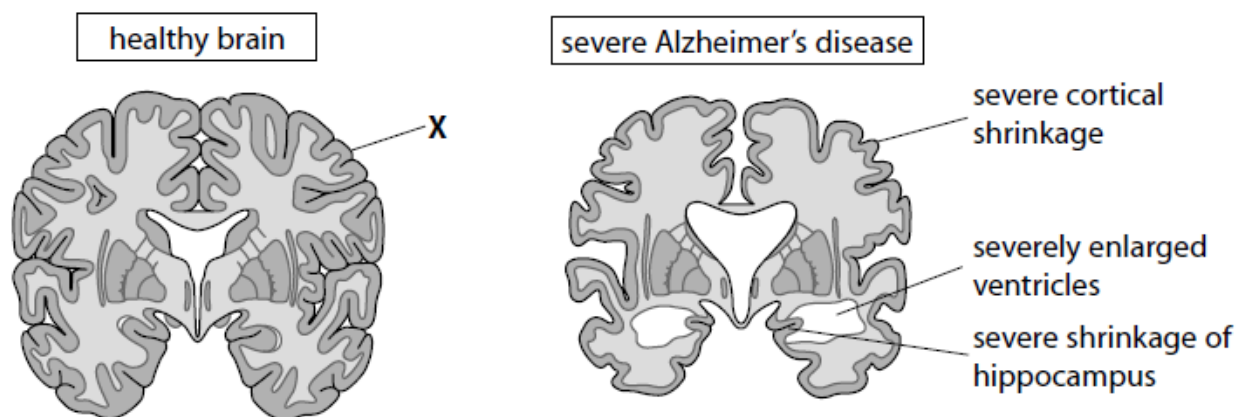
(ii) initiating an increase in sweating during the ride

(1)

- ☐ **A** cerebrum
- ☐ **B** cerebellum
- ☐ **C** hypothalamus
- ☐ **D** medulla

Q12.

The diagrams below show a horizontal cross section of a healthy human brain and a brain from a person with severe Alzheimer's disease.



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Name the part of the brain which is labelled **X**.

(1)

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(Total for question = 1 mark)

Q13.

Compare and contrast the central nervous system and the peripheral nervous system.

(3)

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(Total for question = 3 marks)

Q14.

During the First World War, some soldiers received head wounds that damaged one side of the cerebellum.

One soldier said

'The movements of my left hand are done subconsciously but I have to think out each movement of my right arm.'

(i) State one function of the cerebellum.

(1)

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(ii) State the part of the brain the soldier used to think about moving his right arm.

(1)

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(iii) Explain why this soldier had problems moving his right arm.

(2)

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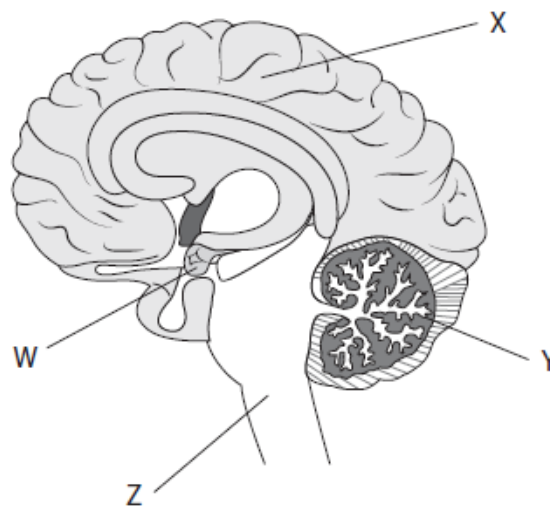
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Q15.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The autonomic nervous system controls the heart rate.

The diagram shows a human brain.



(i) Which region of the brain controls the heart rate?

(1)

☒ **A** W

☐ **B** X

☐ **C** Y

☐ **D** Z

(ii) Which one of the following would lead to an increase in heart rate?

(1)

☒ **A** release of acetylcholine by the sympathetic nervous system

☐ **B** release of acetylcholine by the parasympathetic nervous system

☐ **C** release of noradrenaline by the sympathetic nervous system

- ☒ **D** release of noradrenaline by the parasympathetic nervous system

(Total for question = 2 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
(a)	1. idea of comparative image clarity ; 2. CT therefore can only identify {larger / main} structures / MRI can identify smaller structures / eq ; 3. Reference to tissue identified / eq ; 4. MRI uses {radio waves / magnetic field}, CT uses X-rays / eq ; 5. Idea of both give {2D / 3D} images ; 6. limitation of MRI or CT ; 7. idea of images for both are at one point in time ; 8. ref to comparative cost of use ;	ACCEPT 1 - image resolution {higher in MRI / lower in CT} / MRI offers more detail ACCEPT 6 – MRI-noisy, need to keep still, not so good for people with metal implants, pacemakers CT ref to safety aspects of X-rays ACCEPT 8 - MRI more expensive than CT	(3)

Question Number	Answer	Additional guidance	Mark
(b)	1. view brain activity directly / eq ; 2. idea of see brain activity over a period of time ; 3. safer as does not use X rays ; 4. no need to use special dyes ;	ACCEPT 1 – MRI identifies active areas by greater blood flow, greater oxygen uptake, presence of more oxyhaemoglobin in these areas ACCEPT 2 – see in real time, quotes figures such as fMRI takes up to 4 images a second or moving image, CT is still image	(2)

Question Number	Answer	Additional guidance	Mark
(c)(i)	1. idea that tumour tissue differs from brain tissue ; 2. detail of effect on scan e.g. {energy source / magnetic field / radio waves / eq} {absorbed / blocked / eq}} ; 3. Ref to difference in blood supply ;	ACCEPT 1 - ref to relative densities, tumour growing / dividing / mutated cells	(2)

Question Number	Answer	Additional guidance	Mark
(c)(ii)	1. Idea that (treatment) has been partially successful ; 2. tumour reduced / eq ; 3. reduction qualified e.g. in contact with less brain tissue or size reduction quoted ;	ACCEPT 3 - affecting less brain tissue Halved in size	(2)

Question Number	Answer	Additional guidance	Mark
(c)(iii)	1&2. two appropriate functions given e.g. think, learn, show emotions, memory, personality, reasoning, eq ; ; 3. Because tumour is situated in the frontal lobe / cerebral hemispheres / cerebrum ;	ACCEPT 1&2 – decision making, problem solving, planning, intelligence, controls voluntary behaviour, forming associations (combining information from rest of cortex) ACCEPT 3 – frontal cortex	(3)

Q2.

Question Number	Answer	Additional Comments	Mark
(a)	1. identification of location / eq ; 2. size of tumour / eq ; 3. type of tumour / eq ; 4. reference to {blood vessels / eq} ; 5. idea of monitoring treatment or growth of tumour ;	NB question asks about the use of the scan not MRI 4. Accept oxygen supply	(2)

Question Number	Answer	Additional Comments	Mark
(b) (i)	Two from gender, age, physiological state, {BMI/eq}, not dieting, previous chocolate intake ;		(1)

Question Number	Answer	Additional Comments	Mark
(b) (ii)	1. idea that fMRI can allow brain activity to be seen in real time ; 2. idea that fMRI uses {radio waves / magnetic field} ; 3. increase supply of oxygenated blood in active areas / eq ; 4. that {reflects/does not absorb} fMRI signals / eq ; 5. idea of seen as a white area ; 6. idea of comparison with and without chocolate ;	1. Accept observe whilst eating chocolate 3. Accept active areas {use more oxygen / more de-oxygenated blood produced} 4. Accept less signal absorbed Accept if de-oxygenated then more signal absorbed, less reflected 5. Accept area lights up or is a different colour	(3)

Question Number	Answer	Additional Comments	Mark
(b)(iii)	Two from Think, learn, feel emotions, personality, ability to see, memory, initiate motor activity ;	Accept Speech, decision making, problem solving intelligence, controls voluntary behaviour, forming associations, ability to carry out different movement, Ignore control / co-ordinates movement	(2)

Q3.

Question Number	Answer		Mark
(a)			(2)
	Region of the brain	One role while she is on the beam	
	Cerebellum	maintaining balance / coordination of movement / muscle control / eq ;	
	Medulla oblongata	regulation of {breathing / heart beat} / eq ;	

Question Number	Answer	Mark
(b)	1. idea more blood flows near the skin surface / eq ; 2. due to {vasodilation / dilation of arterioles / eq} ; 3. {vasoconstriction / eq} of shunt vessels / eq ; 4. more blood to capillaries / eq ; 5. idea of more heat lost ; 6. via radiation ;	(4)

Question Number	Answer	Mark
(c)(i)	1. {in the knee / behind the knee cap} / {cross- shaped / two ligaments} ; 2. (connective tissue that) connects bone to bone / eq ;	(2)

Question Number	Answer	Mark
(c)(ii)	1. idea of smaller incision reduces chance of infection / eq ; 2. idea of smaller incision reduces recovery time ; 3. idea of smaller incision reduces likelihood of osteoarthritis / knee joint replacement later / eq ; 4. idea of smaller incision so less scar tissue / eq ; 5. idea of smaller incision so less blood loss / eq ; 6. idea of smaller incision so less pain / eq ; 7. use of local anaesthetic means less (associated) risk / eq ; 8. idea of cheaper related to fewer staff needed ;	(2)

Q4.

Question Number	Acceptable Answer	Additional Guidance	Mark
	- correct numerical calculation (1) - correct units (1)	<u>Example of Calculation:</u> $22 \div 120 = 0.183$ beats per minute per minute / beats minutes ⁻²	(2)

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: { stress / fear } causes the adrenal glands to release adrenaline into the bloodstream (1) - because of impulses along sympathetic nerve (1) - from the { cardiac control centre / medulla (oblongata) } in the brain (1) - increase in heart rate caused by increased rate of depolarisation of SAN (1) - due to release of noradrenaline at SAN (1) ATP than other cells		(5)

Q6.

Question Number	Correct Answer	Additional guidance	Mark
	An explanation that makes reference to one of the following pairs: • less cerebral cortex (1) • so individual has inability to do everyday tasks (1) or • smaller hippocampus (1) • so loss of memory / incapacity or inability to perform everyday tasks (1)	control movement	(2)

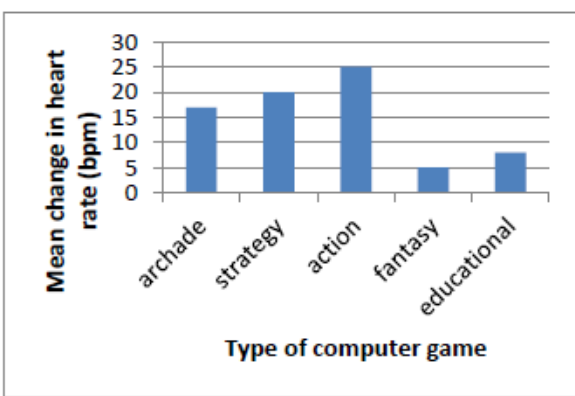
Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	1. fMRI ; and any two from: 2. (fMRI) operates in real time / eq ; 3. as experience will be short lived / eq ; 4. Active areas will {light up / be coloured / eq} (on the image) / eq ; 5. high resolution (as areas involved may be small) / eq ; 6. Safer / eq ;	2 ACCEPT live images, 4 images per second 4. ACCEPT idea of active areas require more oxygen/ oxygenated blood 5 ACCEPT more pixels, image is more detailed 6. ACCEPT ref. to not using X rays, etc	(3)

Question Number	Answer	Mark
(ii)	D ;	(1)

Q8.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to four of the following: - all games must be played for the same length of time to make a valid comparison (1) - a recovery period is needed for the heart rate to return to normal before each subsequent game (1) - repeats should be { at the same time of day / under the same conditions } to avoid effect of other variables (1) - games should be tested in a different sequence each time, to account for effects of fatigue (1) - more individuals should be tested, other than the student himself, to obtain valid results (1)		(4)

Question Number	Acceptable Answer	Additional Guidance	Mark												
(ii)	• bar chart (1) • x-axis: type of computer game and y-axis: mean change in heart rate (1)	 <table><caption>Mean change in heart rate (bpm) by Type of computer game</caption><thead><tr><th>Type of computer game</th><th>Mean change in heart rate (bpm)</th></tr></thead><tbody><tr><td>arcade</td><td>18</td></tr><tr><td>strategy</td><td>20</td></tr><tr><td>action</td><td>25</td></tr><tr><td>fantasy</td><td>5</td></tr><tr><td>educational</td><td>10</td></tr></tbody></table>	Type of computer game	Mean change in heart rate (bpm)	arcade	18	strategy	20	action	25	fantasy	5	educational	10	(2)
Type of computer game	Mean change in heart rate (bpm)														
arcade	18														
strategy	20														
action	25														
fantasy	5														
educational	10														

Question Number	Answer	Additional Guidance	Mark
	• E		(1)

Q10.

Question Number	Answer	Additional Guidance	Mark
	The only correct answer is D (Z,Y,X) A is not correct because X regulates temperature and Z controls breathing rate B is not correct because Y controls balance and Z controls breathing rate C is not correct because X regulates temperature and Y controls balance		(1)

Q11.

Question Number	Answer	Mark
(i)	A ; cerebrum	(1)

Question Number	Answer	Mark
(ii)	C ; hypothalamus	(1)

Q12.

Question Number	Correct Answer	Additional guidance	Mark
	cerebrum (1)		(1)

Q13.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to at least one similarity and one difference: Similarities - both contain {nerve cells / neurones} (1) - both contain synapses (1) Differences - PNS is divided into somatic and autonomic systems, but CNS is not (1) - only the PNS has sensory input and motor output (1) - only the CNS carries out processing of information (1)	Allow both carry nerve impulses Allow both use neurotransmitters Allow PNS contains sympathetic and parasympathetic systems, but CNS does not	(3)

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: (the cerebellum is for) {balance / coordination (of muscles) / posture} (1)	Allow {motor memory / learning complex motor skills}	(1)
(ii)	An answer that makes reference to the following: cerebrum (1)	Allow {cerebral cortex / motor cortex / cerebral hemisphere}	(1)
(iii)	An explanation that makes reference to two of the following: - the damage is to the left side of the cerebellum (1) - so movement of the right arm is no longer automatic / co-ordinated (1) - therefore the soldier compensates by having to think about it (1)	Allow no impulses from cerebellum to (right) arm Allow impulses pass from cerebrum to right arm (to move arm)	(2)

Q15.

Question Number	Answer	Additional Guidance	Mark
(i)	The only correct answer is: D <i>A is incorrect because W is the hypothalamus</i> <i>B is incorrect because X is the cerebrum</i> <i>C is incorrect because Y is the cerebellum</i>		1 comp

Question Number	Answer	Additional Guidance	Mark
(ii)	The only correct answer is: C release of noradrenaline by the sympathetic nervous system <i>A is incorrect because acetylcholine decreases the rate</i> <i>B is incorrect because acetylcholine decreases the rate</i> <i>D is incorrect because noradrenaline is released by the sympathetic nervous system</i>		1 comp