

OCR GCSE GATEWAY BIOLOGY A • J247

BIOLOGY



EXAM QUESTION PACK

B3.1 COORDINATION AND CONTROL: THE NERVOUS SYSTEM

SCORE

/141

PERCENTAGE

%

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Gateway Biology A (9-1)

Coordination and control - the nervous system

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	
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Centre number						Candidate number				
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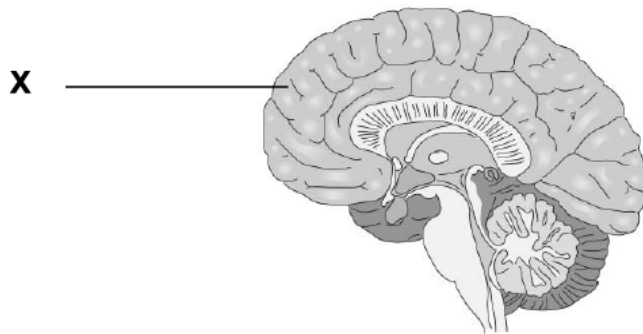
INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **141**.
- The total number of marks may take into account some 'either/or' question choices.

- 1 The diagram shows the brain.
What is the name of part X?

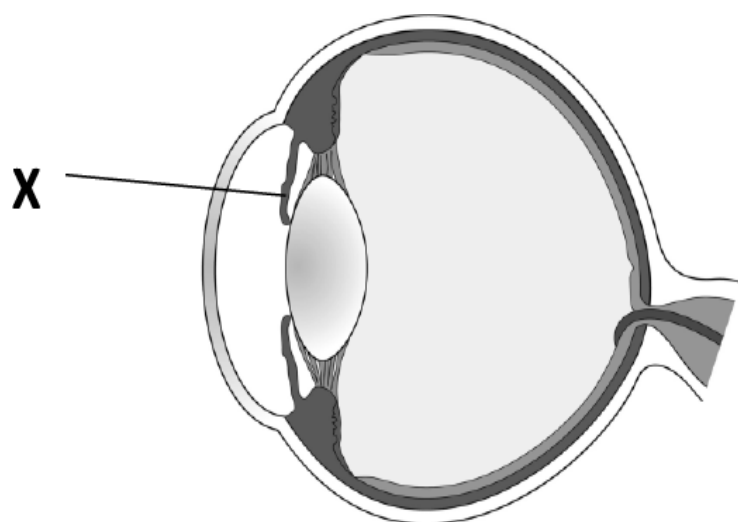


- A cerebellum
- B cerebrum
- C hypothalamus
- D medulla

Your answer

[1]

- 2 The diagram shows the eye.
What is the name of part X?



- A cornea
- B iris
- C lens
- D pupil

Your answer

[1]

5 Which eye defect can be overcome by using spectacles containing concave lenses?

- A colour blindness
- B eye ball too short
- C long sight
- D short sight

Your answer

[1]

6(a) A boy picks up a hot plate and quickly drops it.

This is a reflex action.

Describe the sequence of events that happens in his nervous system during this reflex action.

[5]

(b) The table shows information about different types of neurons.

Type of neurone	Diameter ($\times 10^{-3}$ mm)	Is myelin sheath present?	Speed of impulse (m/s)
A	13-20	yes	80-120
B	6-12	yes	33-75
C	5-8	yes	4-24
D	1-5	yes	3-15
E	0.2-1.5	no	0.5-20

(i) Discuss the effect of diameter on the speed of impulse.

-----[2]

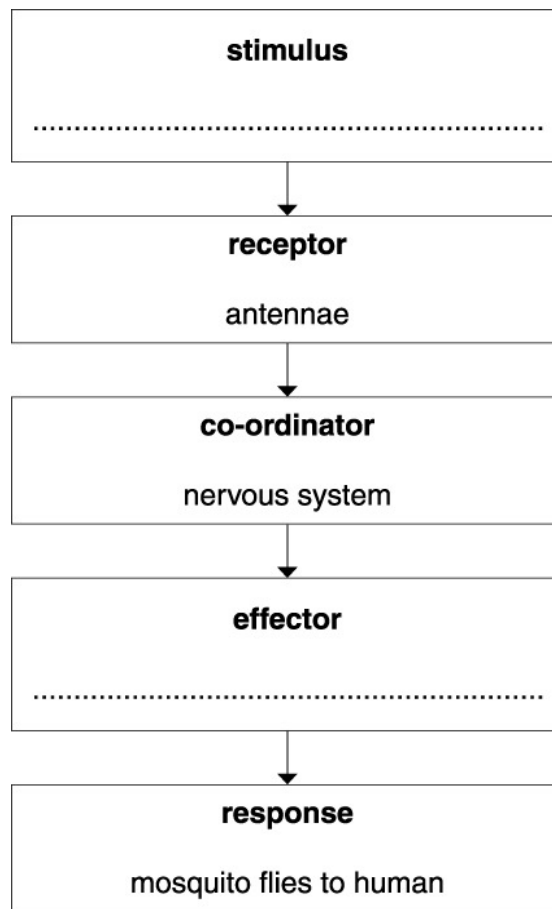
(ii) Explain how strong a conclusion, if any, you can make from the data about the effect of the myelin sheath on the speed of impulse.

-----[2]

7 Mosquitoes use their sense of smell to detect humans.

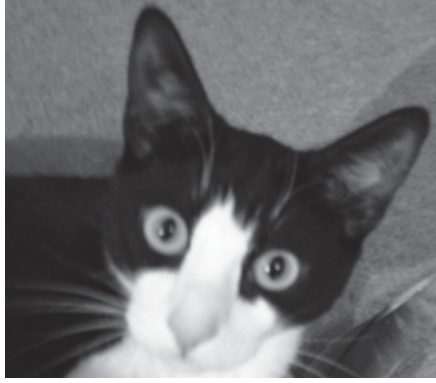
Mosquitoes detect the smell with receptors on their antennae.

Complete the flow chart to show how a mosquito detects, and responds to, the smell of a human.



[2]

8 Look at the picture of a cat.



The cat has a blink reflex. Reflex actions protect the body from harm.

Write down **two other** features of reflex actions.

----- [2]

Doctors concerned about spread of disease

Zika is a disease that is caused by a virus.

It is spread by mosquitoes.

In most people the disease is quite mild.

However, there is evidence that in pregnant women it can slow the growth of the baby's brain.

The disease cannot be treated by antibiotics.

Scientists are trying to develop a vaccine for the zika virus.

The article says that the virus can cause damage to the brain of unborn babies.

Which part of the baby includes the brain?

Put a tick (3) next to the correct answer.

peripheral nervous system

☐

sense organs

☐

central nervous system

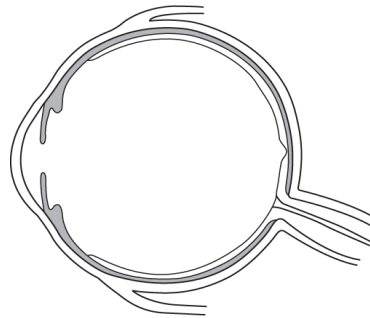
☐

circulatory system

☐

[1]

10 The diagram shows a section through the human eye.



Complete the diagram by drawing the **lens** in its correct place.

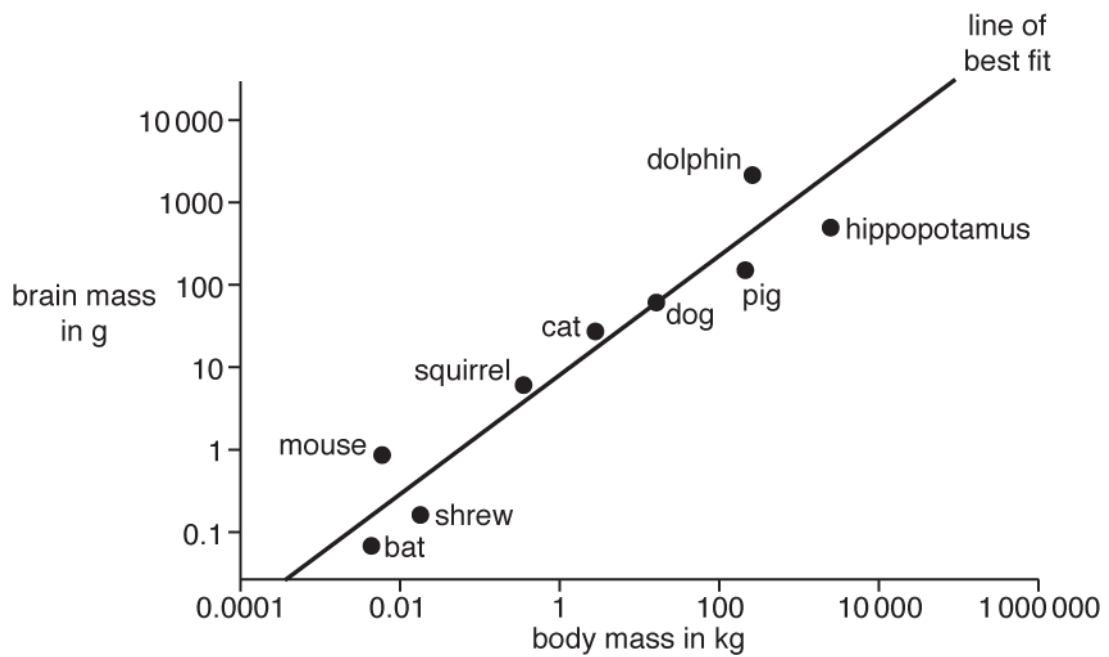
[1]

11(a)

Look at the graph.

It shows the brain mass and body mass of some different animals.

A student has drawn a line of best fit on the graph.



(i) Which animal has the smallest brain mass?

(ii) Which animal has the largest body mass?

[1]

(iii) Has the student drawn a correct line of best fit?

Explain your answer.

[2]

(b) Look at the table about some different animals.

It shows the mean (average) body mass, brain mass and **relative** brain mass.

The **relative** brain mass is the percentage (%) that the brain mass is of the body mass.

Animal	Body mass in g	Brain mass in g	Relative brain mass (% of body mass)
marmoset monkey	320		2.5
rhesus monkey	7 750	93	1.2
chimpanzee	48 750	390	0.8
gorilla	100 000	500	0.5
elephant	4 148 000	4148	0.1

(i) For the marmoset monkey, its brain mass is 2.5% of its body mass.

Calculate its brain mass.

Use information from the table.

You should show your working.

answer = ----- g

(ii) Look at the information in the table.

What patterns can you see between body mass, brain mass and **relative** brain mass?

[2]

(iii) The mean (average) body mass, brain mass and **relative** brain mass of a human is shown in this table.

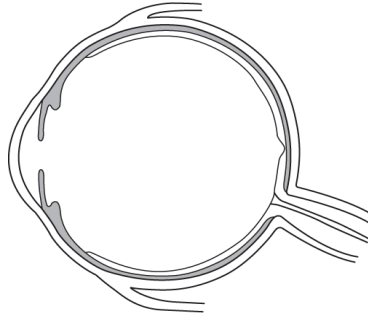
Animal	Body mass in g	Brain mass in g	Relative brain mass (% of body mass)
human	66 500	1330	2.0

Do humans fit the patterns shown by the other animals?

Explain your answer.

[2]

12 The diagram shows a section through the human eye.



Some humans and animals have an inherited condition called cornea plana.

It causes the cornea to be less curved than normal. This can lead to long-sight in humans.

(i) Label the diagram with an X to show the position of the cornea.

[1]

(ii) What are the symptoms of long-sight in humans?

[2]

13(a) Look at the table about some different animals.

It shows the mean (average) body mass, brain mass and **relative** brain mass.

The **relative** brain mass is the percentage (%) that the brain mass is of the body mass.

Animal	Body mass in g	Brain mass in g	Relative brain mass (% of body mass)
marmoset monkey	320	8	2.5
rhesus monkey	7750	93	1.2
chimpanzee	48 750	390	0.8
gorilla	100 000	500	0.5
elephant	4 148 000	4148	0.1

(i) Look at the information in the table.

What patterns can you see between body mass, brain mass and **relative** brain mass?

[2]

(ii) The mean (average) body mass, brain mass and **relative** brain mass of a human is shown below.

Animal	Body mass in g	Brain mass in g	Relative brain mass (% of body mass)
human	66 500	1330	2.0

Do humans fit the patterns shown by the other animals?

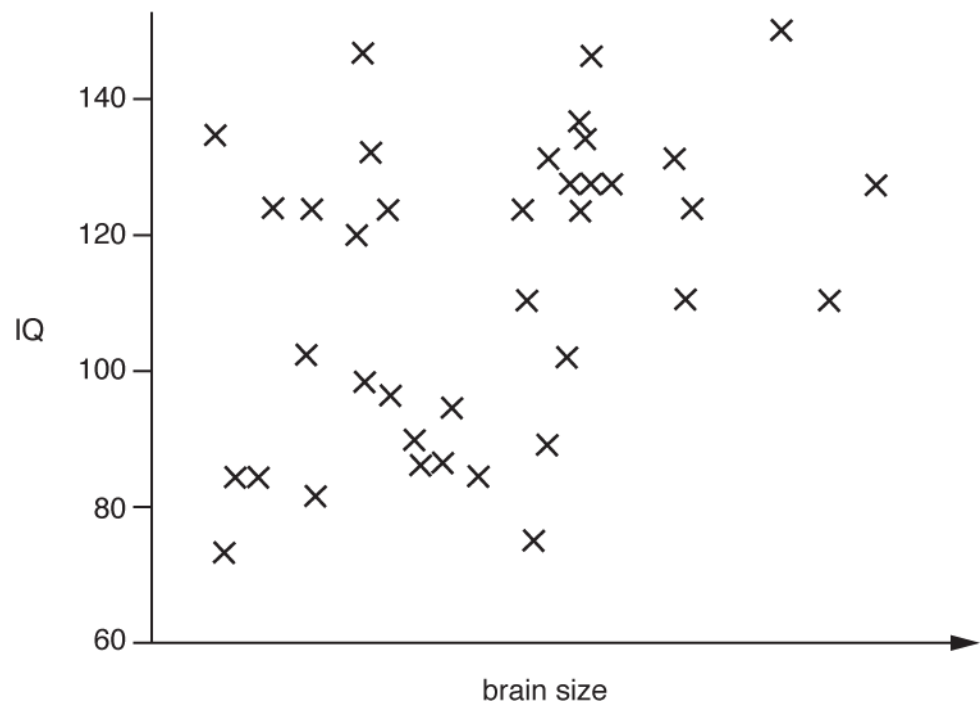
Explain your answer.

----- [2]

(b) IQ is one way of measuring intelligence.

Scientists investigated whether there is a link between brain size and IQ for university students.

The scatter graph shows their results.

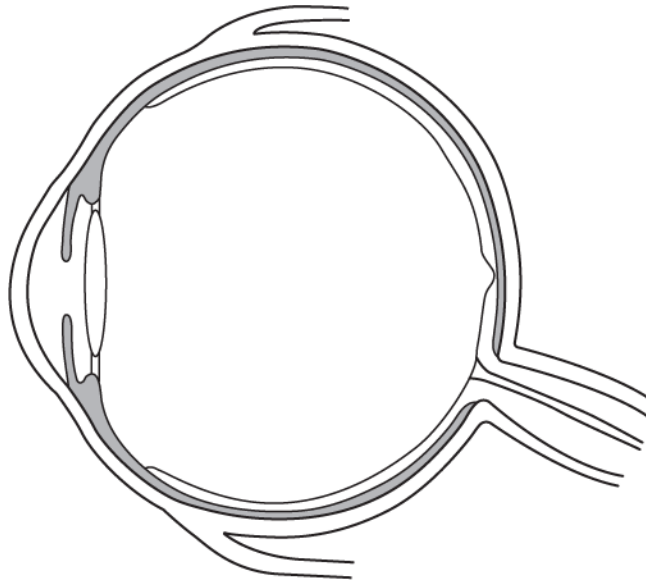


Does the graph show a link between brain size and IQ?

Explain your answer.

[2]

14(a) The diagram shows a section through the human eye.



Label the diagram with an X to show the part of the eye that controls how much light enters the eye.

[1]

(b) Some humans and animals have an inherited condition called cornea plana.

It causes the cornea to be less curved than normal.

This can lead to long-sight in humans.

Explain why cornea plana causes long-sight in humans.

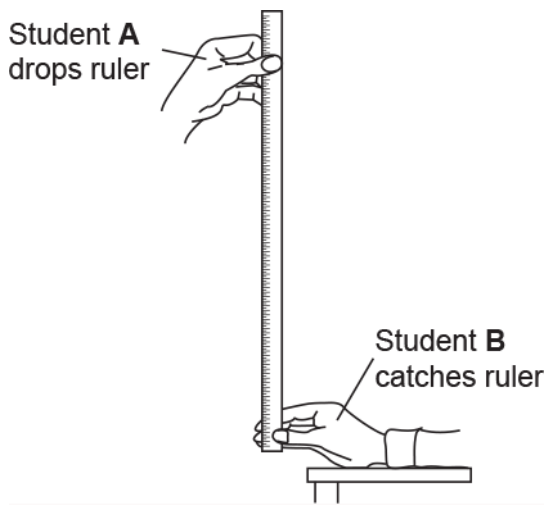
[2]

15(a) A class of students investigate reaction time.

Student A drops a ruler while student B catches it.

They then measure the position of student B's thumb on the ruler, this is the drop distance.

The diagram shows how the measurements were taken.



The drop distance is converted into a reaction time. The reaction time in seconds for each hand is recorded.

The table shows the results for ten **right-handed** students in the class.

Reaction time(s)	
Left non-dominant hand	Right dominant hand
0.22	0.28
0.23	0.25
0.27	0.23
0.24	0.24
0.25	0.24
0.25	0.25
0.25	0.26
0.25	0.26
0.25	0.26
0.27	0.23
Mean = 0.25	Mean = 0.25

(i) Calculate the **mode** for the right dominant hand.

Answer = ... seconds [1]

(ii) The mean and mode for the left non-dominant hand are identical.

What **other** conclusions can be made about reaction times in these ten students?

.....

.....

..... [2]

(b) How could these students improve the recording of their results?

.....

.....

..... [2]

(c) The students want to investigate reaction times to see if left-handed people are faster than right-handed people.

How could they develop the experiment to test this?

[3]

(d) The reaction in the experiment involves a **stimulus**.

What is the stimulus in the reaction involving catching the ruler?

[1]

(e) Complete the sequence of a reflex arc.

Stimulus →		Sensory neurone→	CNS→		Effector→	Response
	-----			-----		

[2]

Finish these sentences to explain what is happening in the body of a female during the menstrual cycle.

The pituitary gland in the ----- releases the hormone FSH.

FSH causes an ----- releases the hormone FSH.

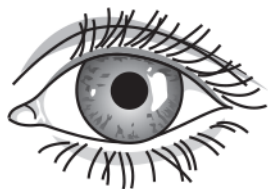
FSH also causes the follicle to release the hormone ----- .

After ovulation, the empty follicle releases another hormone called ----- .

[4]

17(a) A girl walks from a sunny beach into a dark café

Diagram A shows the girl's left eye on the beach.



A



B

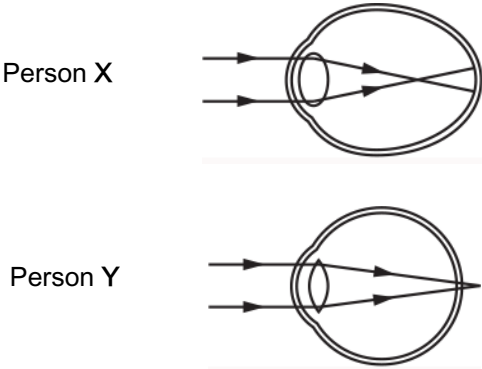
Diagram B shows the girl's left eye after she enters the café.

Explain how you can tell this and how this change happens.

[3]

(b) Look at the diagrams.

They show how light is focused in people with different eye defects.



(i) Name the eye defect in each person.

Person X -----

Person Y -----

----- [2]

(ii) Identify the type of corrective lens needed by person X and Y and explain how the lenses work.

----- [3]

18 Retinitis pigmentosa is a genetic condition.

It is caused by a mutation to a gene. This mutation produces a recessive allele.

If people have retinitis pigmentosa then the cells in their retina are damaged.

If a person has two alleles for retinitis pigmentosa, they will not be able to see properly.

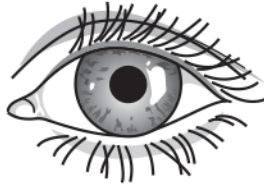
(i) Why does a person need two affected alleles to have the condition?

-----[1]

(ii) Why does the condition affect the ability to see properly?

-----[1]

19(a) Diagram A shows the girl's left eye on the beach.



A



B

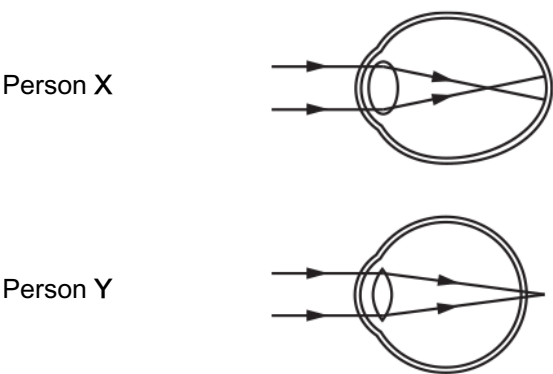
Diagram **B** shows the girl's left eye after she enters the café.

Explain how you can tell this and how this change happens.

[3]

(b) Look at the diagrams.

They show how light is focused in people with different eye defects.



(i) Name the eye defect in each person.

Person X

Person Y

[2]

(ii) Identify the type of corrective lens needed by person X and Y and explain how the lenses work.

.....

.....

.....

.....

.....

[3]

20(a) A class of students investigate if right handed people are faster with their dominant right hand.

Student A drops a ruler while student B catches it.

They then measure the position of student B's thumb on the ruler, this is the drop distance.

The diagram shows how the measurements were taken.

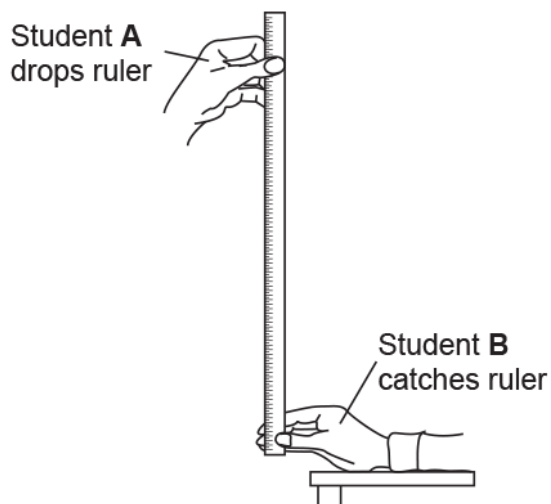


Fig. 19.1

The drop distance is converted into a reaction time. The reaction time in seconds for each hand is recorded in a table.

(i) Identify **two** possible sources of error in this method of measuring reaction time.

1 -----

2 -----

[2]

(ii) A second method of measuring reaction time involves a computer reaction time program shown in Fig. 19.2.

Each student is asked to click the “Start” button. After a 3-second delay a number randomly flashes up. The student moves the mouse to click on the flashing number.

Left hand is used first then the right hand.

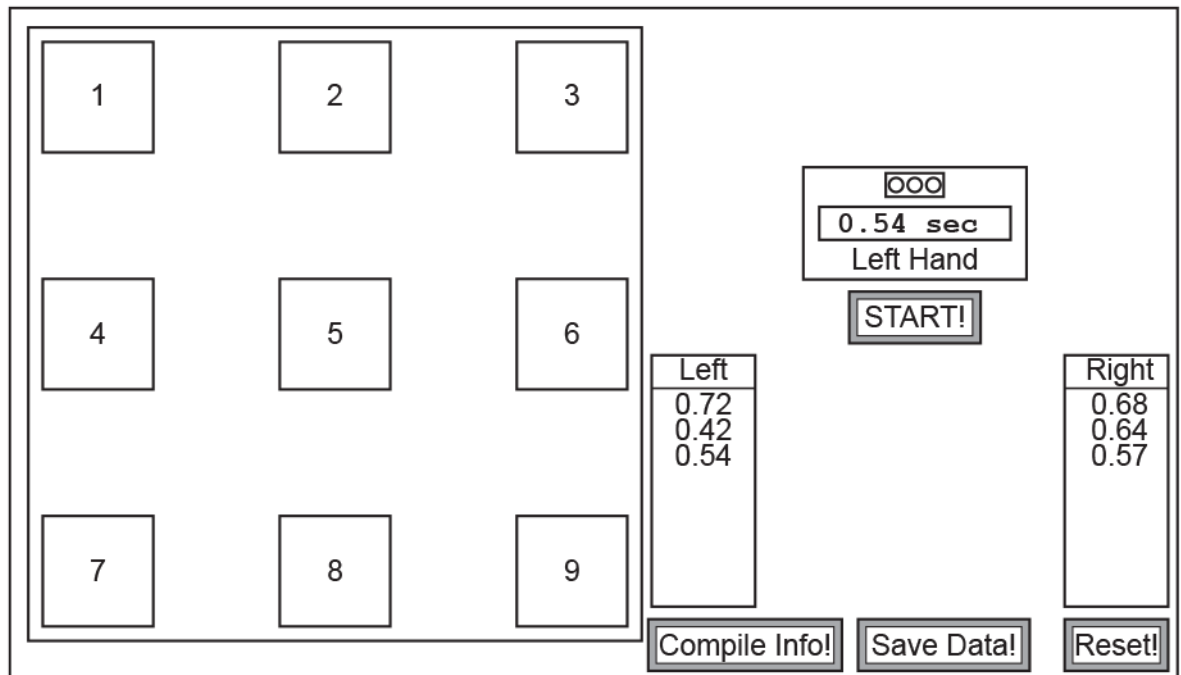


Fig. 19.2

This second method is a better design than the first method but it could still be improved.

Explain why it is a better designed experiment than the first method and suggest how this second method could be improved.

[3]

(b) The table shows the results for ten **right handed** students in the class.

Reaction time (seconds)	
Left non-dominant hand	Right dominant hand
0.22	0.21
0.23	0.25
0.27	0.23
0.24	0.24
0.25	0.24
0.25	0.25
0.25	0.26
0.25	0.26
0.25	0.26
0.25	0.26
0.27	0.28
Mean = 0.25	Mean = 0.25

(i) Calculate the **median** for the right dominant hand.

Answer = -----mg [2]

(ii) The mean and median for the left non-dominant hand are identical.

What **other** conclusions can be made about reaction times in these ten students?

-----[2]

(c)

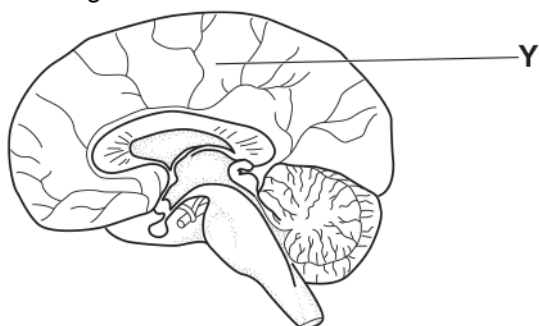
- (i) Motor neurone disease (MND) is a condition that affects reaction times. MND affects the speed of nerve impulse in motor neurones.

Stem cells taken from the skin of people with MND are used in research. The stem cells can be grown in the lab and used to measure the speed of the nerve impulse.

Which special feature of stem cells makes this possible?

----- [1]

- (ii) The diagram shows the brain.



Name part Y and explain why it is an important area of the brain in the research of MND.

Part Y: -----

Explanation: ----- [2]

- (iii) Measuring the speed of the nerve impulse in the brain is more difficult than using stem cells.

Suggest **two** reasons why.

----- [2]

21 Retinitis pigmentosa is a genetic condition that affects the eyes.

It is caused by a mutation to a gene. This mutation produces a recessive allele.

The condition causes rod cells in the retina to break down.

(i) Two people who are heterozygous for retinitis pigmentosa are expecting a baby.

Draw a genetic diagram to calculate the probability that the baby will have the condition.

Use R for the normal allele and r for the allele for retinitis pigmentosa.

Answer = ... [3]

(ii) If the baby has retinitis pigmentosa, it will have normal colour vision but will not be able to see well in dim light.

Explain why.

.....

.....

.....

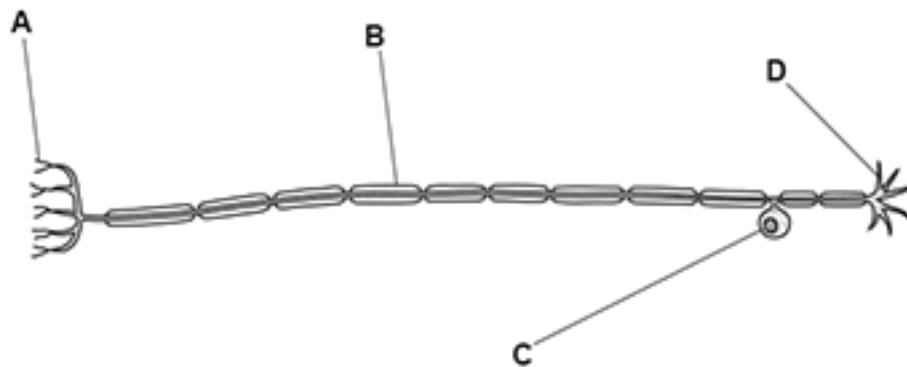
22 Which part of the eye does not function correctly in colour blindness?

- A Cornea
- B Iris
- C Lens
- D Retina

Your answer

[1]

23 Which label is pointing to the myelin sheath in a motor neurone?



Your answer

[1]

24 What is the name of the gap between two neurones?

- A Axon
- B Dendrite
- C Lumen
- D Synapse

Your answer

[1]

25 Light travels through different parts to reach the back of the eye.

Which structure does light pass through first when it enters the eye?

- A Cornea
- B Lens
- C Pupil
- D Retina

Your answer

[1]

26 Which part of the brain controls the heartbeat and breathing?

- A Cerebrum
- B Hypothalamus
- C Medulla
- D Pituitary

Your answer

[1]

27 Which condition can be caused by a lens in the eye that is too thick?

- A Long-sightedness
- B Colour blindness
- C Diabetes
- D Short-sightedness

Your answer

[1]

28 The eye switches from focusing on a distant television to focusing on a close up newspaper.

Which change happens to the suspensory ligaments and to the lens during this switch?

	Suspensory ligaments	Lens
A	slack to tight	thicker
B	slack to tight	thinner
C	tight to slack	thicker
D	tight to slack	thinner

Your answer

[1]

29(a) Investigating brain function may involve the following techniques:

- External recording of the brain using EEG.
- Scanning techniques such as CAT and MRI.
- Case studies of humans with accidental damage.
- Deliberate damage in animal experimentation.

(i) Understanding of brain function has increased in recent years. However, there are still problems that scientists face that are preventing a complete understanding.

Evaluate the reasons why understanding has increased but also why problems still exist.

[4]

(ii) When scientists complete their research they usually publish it in journals or online.

Give **two** reasons why scientists publish their results.

1 -----

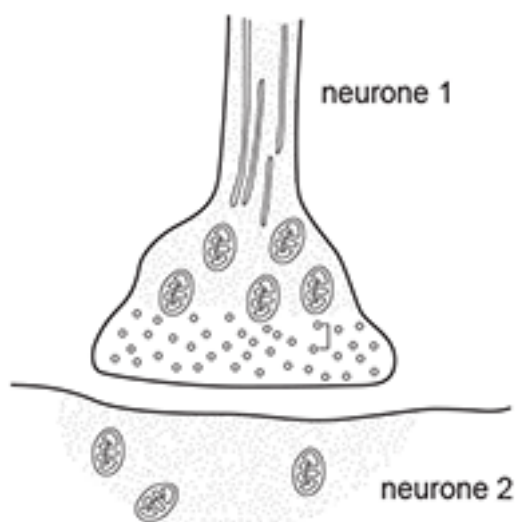
2 -----

[2]

(b) Alzheimer's disease involves damage to nerve transmission.

Symptoms include difficulties in judging distance, concentrating and making decisions.

The diagram shows a synapse between two neurones in the brain.



Acetylcholine is a neurotransmitter in the brain. It diffuses across the 32 nanometre synaptic gap.

In a brain from a person with Alzheimer's disease, the time for acetylcholine to diffuse between neurones is 6.4×10^{-7} s.

1 metre = 10^9 nanometres

(i) Calculate the speed of diffusion in a person with Alzheimer's disease.

Use this formula: speed = distance $\div$ time

Give your answer in metres per second.

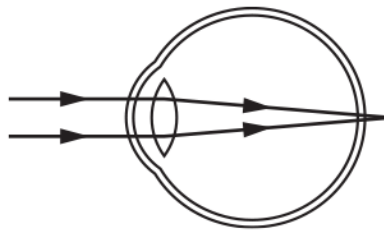
Speed of diffusion = ... metres per second [3]

(ii) In the brain of a healthy person the speed of diffusion is 0.2 metres per second.

How does the result obtained in part (i) account for the symptoms of Alzheimer's disease?

[2]

30 Look at the diagram showing an eye defect.



What is the defect and which lens could be used to correct it?

- A Long-sightedness, corrected with a concave lens
- B Long-sightedness, corrected with a convex lens
- C Short-sightedness, corrected with a concave lens
- D Short-sightedness, corrected with a convex lens

Your answer

[1]

31 Anaesthetics used during operations slow down breathing and heart rate.

Which part of the brain do anaesthetics act on to do this?

- A Cerebrum
- B Cerebellum
- C Medulla
- D Pituitary

Your answer

[1]

32 Fig. 20.1 shows a section through the skin on the back of the hand.

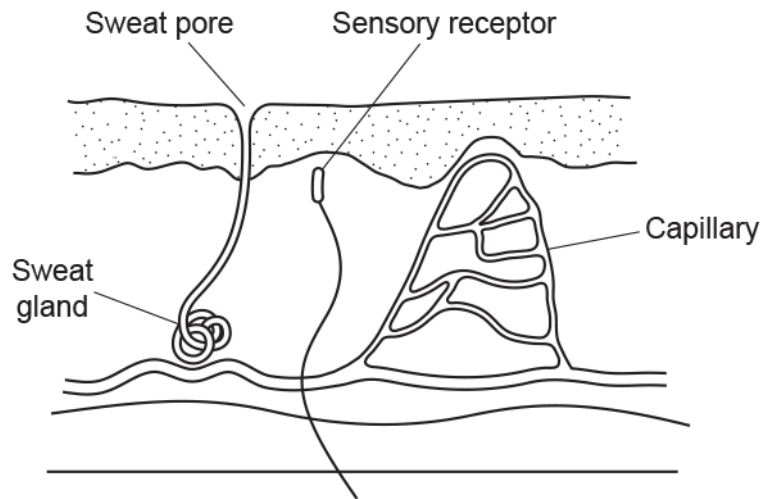


Fig. 20.1

- (i) Which part of the skin detects something touching the back of the hand?

----- [1]

- (ii) The body responds when something touches the back of the hand.

Complete the sentences to explain how this happens.

The receives impulses from the skin along sensory neurones.

These impulses are processed and other impulses are sent along

..... neurones to bring about responses.

[2]

33 Anaesthetics used during operations slow down breathing and heart rate.

Which part of the brain do anaesthetics act on to do this?

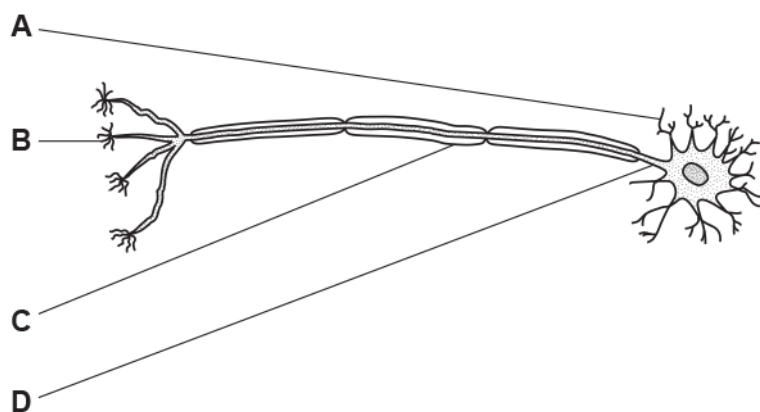
- A Cerebrum
- B Cerebellum
- C Medulla
- D Pituitary

Your answer

[1]

34 A motor neurone is usually stimulated by a relay neurone.

Which part of the motor neurone is first stimulated by a relay neurone?



Your answer

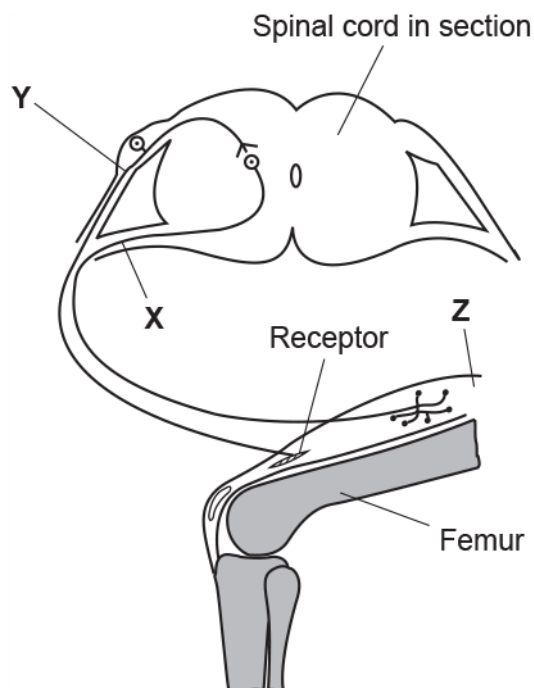
[1]

35 Which row in the table represents the eye when a person is in a dark room?

	Front view of iris and pupil	Circular iris muscles
A		contracted
B		relaxed
C		relaxed
D		contracted

Your answer

[1]



A patient needs treatment for a leg injury.

An anaesthetic is injected to block nerve impulses to prevent pain but still allow movement of the leg.

Where was the anaesthetic injected in this patient?

- A At X
- B At Y
- C At Z
- D At X, Y and Z

Your answer

[1]

37(a) This question is about coordination.

Parts of the body, such as the fingers, are moved by the contraction of muscles.

In a voluntary movement the brain sends nerve impulses to muscle fibres along motor neurones.

Name the part of the brain that controls voluntary movement.

-----[1]

(b) A nerve to a muscle contains many motor neurones.

Fig. 21.1 shows two motor neurones supplying a muscle that moves the fingers. Fig. 21.2 shows the force of contraction of the muscle when the neurones are stimulated separately or both together.

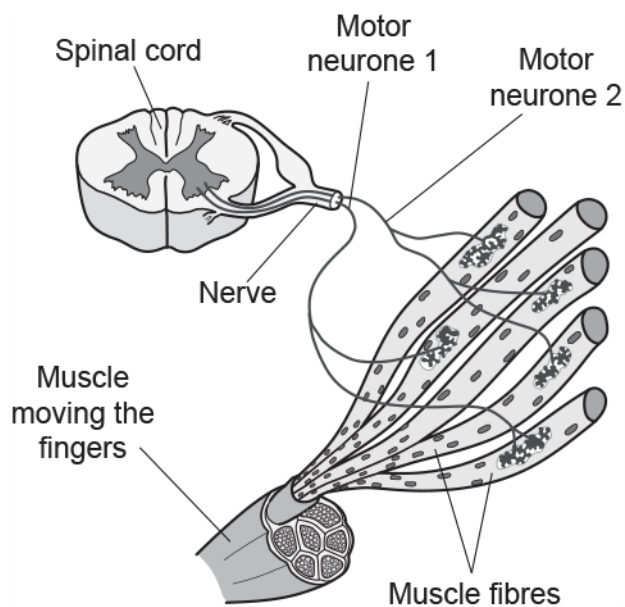


Fig. 21.1

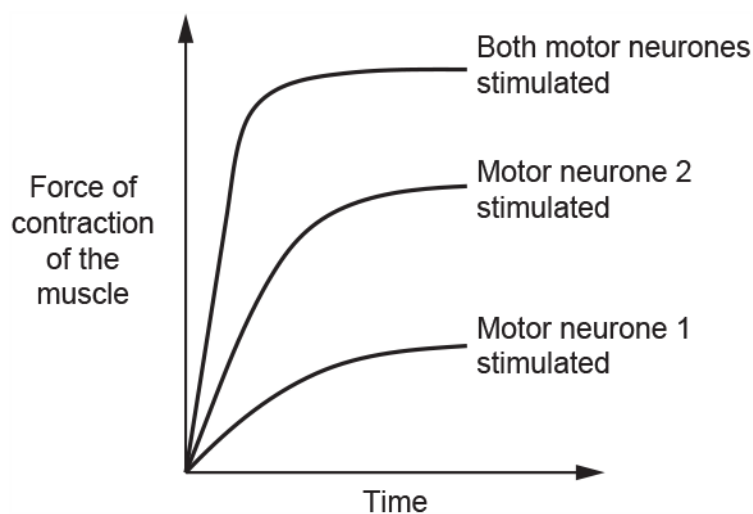


Fig. 21.2

(i) Suggest how the brain can finely control the force of contraction in the muscles controlling the fingers.

[2]

(ii) Fig. 21.3 shows a motor neurone supplying a muscle that moves the leg.

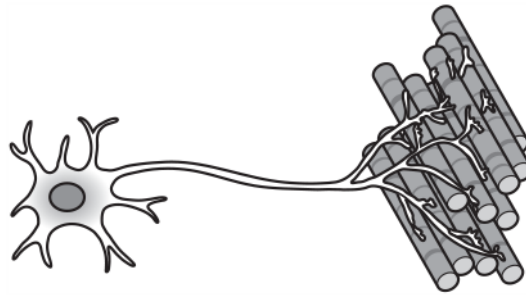


Fig. 21.3

Explain the reason for the difference in the neurone supplying this muscle compared to the neurones supplying the muscle that moves the fingers.

[3]

(c) * Dart players use their fingers to throw darts at a dart board.

Dart players **A** and **B** have different throwing styles. Fig. 21.4 shows the throwing styles of the two players.

The release window is the area where the dart is released.

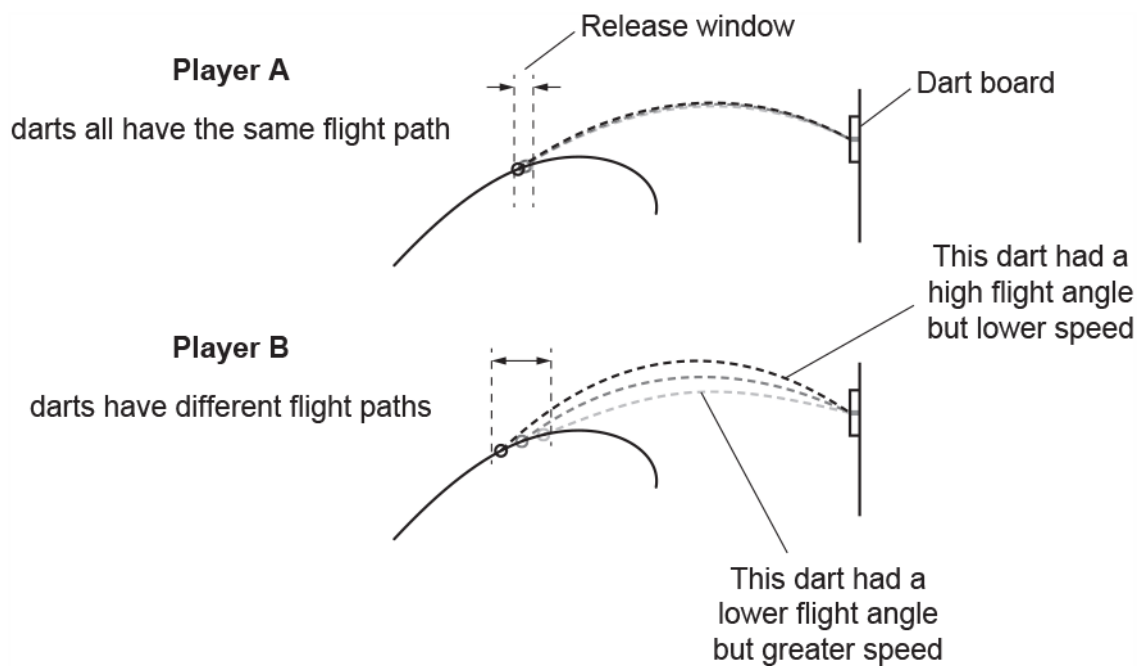


Fig. 21.4

To throw a dart accurately at the centre of a dart board involves coordination. The brain needs to coordinate the actions of sense organs and muscles.

Explain the function of the nervous system and muscles in the throwing of a dart at the centre of the dart board and why this process is more complicated in **Player B** than in **Player A**.

----- [6]

END OF QUESTION PAPER

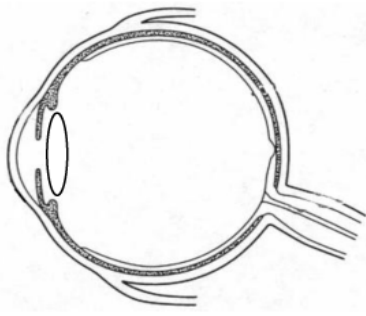
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			B	1	
			Total	1	
2			B	1	
			Total	1	
3	a		detected by receptors in skin (1)	1	To gain marks these need to be in correct sequence ignore brain
			impulse sent along sensory neurone (1)	1	
			to spinal cord / CNS (1)	1	
			impulse sent along motor neurone (1)	1	
			to (hand / arm) muscles / effectors (1)	1	
	b		to avoid (further) damage (1)	1	allow ora
			the reaction needs to be rapid (1)	1	
			the brain would slow down the reaction time (1)	1	
			Total	8	
4			D	1	
			Total	1	
5			D	1	
			Total	1	
6	a		detected by receptors in skin (1)	1	to gain marks these need to be in the correct sequence ignore brain
			impulse sent along sensory neurone (1)	1	
			to spinal cord / CNS (1)	1	
			impulse sent along motor neurone (1)	1	
			to (hand / arm) muscles / effectors (1)	1	
	b	i	conclusion: as diameter increases so does speed of impulse (1)	1	must include example, but allow other valid examples from data
		i	but there are exceptions e.g. all speeds for B are greater than for C even though the diameters overlap (1)	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	cannot make a (valid) conclusion (1)	1	
		ii	although D has lowest speeds it also has the smallest diameter (and the results might be due to this) (1)	1	
			Total	9	
7			smell (of person) (1) wings / wing muscles (1)	2	allow scent ignore muscles unless correctly qualified Examiner's Comments Generally well answered. Where candidates gave generic muscle / gland responses they didn't score. These needed to be linked to the wings to gain credit. The stimulus was more often correct, but common errors were nose, humans and blood.
			Total	2	

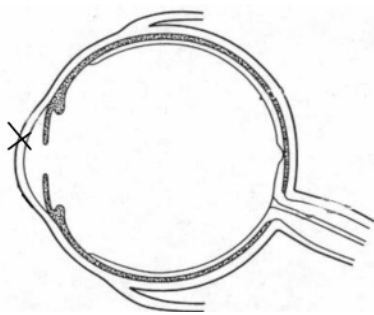
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance								
8			fast (1) automatic (1)	2	allow quick / rapid allow unlearned allow you do it without thinking / unconsciously ignore 'it just happens' allow the response is always the same (1) Examiner's Comments Some candidates misread the question and described examples of other reflexes or explained the benefits of reflexes. Those who did correctly explain that reflexes are fast and automatic usually only gave one of these ideas, the former being the most common.								
			Total	2									
9			<table><tr><td>peripheral nervous system</td><td></td></tr><tr><td>sense organs</td><td></td></tr><tr><td>central nervous system</td><td>✓</td></tr><tr><td>circulatory system</td><td></td></tr></table>	peripheral nervous system		sense organs		central nervous system	✓	circulatory system		1	more than one answer =0
peripheral nervous system													
sense organs													
central nervous system	✓												
circulatory system													
			Total	1									
10				1	Needs to be in the correct position but not necessarily an ovoid shape								
			Total	1									

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11	a	i	bat (1)	1	
		ii	hippopotamus (1)	1	
		iii	(yes – no mark) any two from the line does show the trend / the line does show that as body mass increases, brain mass increases (1) the trend does seem to go in a straight line (1) there are the same number of points / four points above and below the line (1)	2	no = award no marks for answer
	b	i	8 (g) (2) But $\frac{2.5 \times 320}{100} \quad (1)$	2	correct answer but no working = 2
		ii	any two from as body mass increases, brain mass increases / ORA (1) as body mass increases, relative brain mass decreases / ORA (1)	2	ignore high or low must be comparative ignore references to 'larger' body mass and brain mass increases as relative brain mass decreases = 2

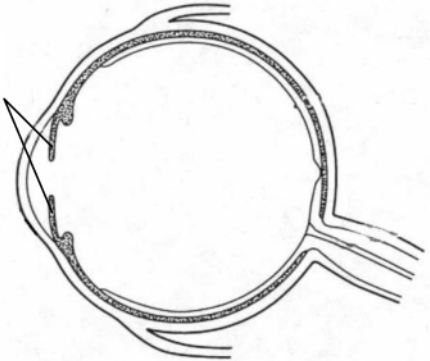
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	(no) idea that brain mass is higher than expected (1) idea that relative brain mass is higher than expected (1)	2	if yes answer then award zero marks allow have an abnormally high brain mass (1) allow comparison e.g. have a lower body mass than gorilla / elephant but higher brain mass (1) allow ratio of brain mass to body mass is higher (1) allow ratio of body mass to brain mass is lower (1) ignore just 'humans have a high(er) brain mass' allow have an abnormally high relative brain mass (1) allow comparison e.g. have a lower body mass than gorilla / elephant but higher relative brain mass (1) ignore just 'humans have a high(er) relative brain mass' ignore just 'they don't fit the pattern'
			Total	10	
12		i		1	The centre of the X must be on the cornea allow label line that touches cornea
		ii	a person can see / focus on objects that are distant to them (1) but cannot see / focus on close objects (1)	2	allow a person can only see / focus on objects that are distant to them = (2) ignore see things in longer distance
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13	a	i	any two from as body mass increases, brain mass increases / ORA (1) as body mass increases, relative brain mass decreases / ORA (1)	2	ignore high or low must be comparative ignore references to 'larger' body mass and brain mass increases as relative brain mass decreases = 2
		ii	(no) idea that brain mass is higher than expected (1) idea that relative brain mass is higher than expected (1)	2	if yes answer then award zero marks allow have an abnormally high brain mass (1) allow comparison e.g. have a lower body mass than gorilla / elephant but higher brain mass (1) allow ratio of brain mass to body mass is higher (1) allow ratio of body mass to brain mass is lower (1) ignore just 'humans have a high(er) brain mass' allow have an abnormally high relative brain mass (1) allow comparison e.g. has a higher body mass than chimpanzee but higher relative brain mass (1) ignore just 'humans have a high(er) relative brain mass' ignore just 'they don't fit the pattern'

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		(no) the points are scattered (1) (no) at any particular brain size there are people with a range of IQs / ora (1) (yes) lots of anomalies (1)	2	allow (no) as no pattern / no correlation (1) allow (yes) there is a (slight) positive correlation (1) allow (yes) the higher the brain size the higher the IQ / ora (1) allow (no) some people with small brains have higher IQ (than those with large brains) (1) allow (no) some brains are larger but IQ isn't as high (as expected) (1) allow the higher the brain size the higher the IQ for large brain sizes only (2)
			Total	6	
14	a		X 	1	allow X drawn over part of iris, centre of X must be on the iris allow only one side correctly labelled
	b		it bends / refracts / focuses the light less (1) light focused behind the retina / only light from distant objects is focused on the retina (1)	2	allow can't focus on near objects as this requires more refraction
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a	i	mode = 0.26 (seconds) ✓	1 (AO 2.2)	<u>Examiner's Comments</u> This question assessed AO2.2. Most had the correct response to this question. Occasionally candidates would forget the decimal point and put 26 or 0.25 as their answer.
		ii	(means are identical so) no difference between reaction time in each hand ✓ (mode shows) non-dominant hand most often faster reaction ✓	2 (AO 2 x 3.2b)	ALLOW they are very similar to each other ALLOW left side quicker/better to catch ruler <u>Examiner's Comments</u> This question assessed AO2.2. Most had the correct response to this question. Occasionally candidates would forget the decimal point and put 26 or 0.25 as their answer.
	b		include the units ✓ record results in rank order ✓	2 (AO 2 x 3.3b)	ALLOW put seconds in headings ALLOW sort the order <u>Examiner's Comments</u> This question set out to assess AO3, analyse information to improve experimental procedures, specifically related to recording data. Few candidates responded to the question in terms of improving the recording of their results. Most included experimental design elements to increase reliability or accuracy but not the actual recording of the data. Some candidates correctly identified that recording raw data of distance would be valuable (for peer review) and higher ability candidates did recognise that rank ordering the data would have improved the recording to help the mode calculation.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		use ten left (dominant) hand students / ten right (dominant) hand students✓ opposite non–dominant hand tested for left/right handedness✓ Any one from: similar sample sizes / similar aged groups✓ compare means for each group✓	3 (AO 3 x 3.3a)	ALLOW add another table where student is left handed ALLOW same reaction room ALLOW compare reaction times for each group ALLOW set amount of left/right handed people <u>Examiner's Comments</u> This question assessed AO3, analysis of information to improve experimental procedures. Very few candidates identified the need to keep the number of left/right (dominant) handed the same as in the experiment. Even fewer suggested testing the non-dominant hand. However, many candidates did gain marks for comparing the means.
	d		sight✓	1 (AO 2.2)	ALLOW visual ALLOW to see when it's coming ALLOW light IGNORE eyes <u>Examiner's Comments</u> The question assessed AO2.2. Very few candidates identified that sight/light was the stimulus, many referring to the distance the ruler dropped. This indicates a lack of understanding of what a stimulus is, linked to the receptors involved.
	e		receptor✓ motor neurone✓	2 (AO 2 x 1.1)	correct order needed <u>Examiner's Comments</u> The question assessed recall AO1.1 for the structure of a reflex arc. Where candidates gained marks, it was usually for the motor nerve. Some also got the receptor but, there were instances where candidates couldn't quite recall the correct name and words like reaction and reactor were seen.
			Total	11	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16			brain✓ egg✓ oestrogen✓ progesterone✓	4 (AO 4 x 1.1)	ALLOW estrogen <u>Examiner's Comments</u> Here AO1.1 recall was assessed for the role of hormones in the menstrual cycle. Most candidates gained one mark for the egg. Some also identified the brain and some got all four marks. However, occasionally candidates unfortunately got the two hormones the wrong way around.
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
17	a		pupil has dilated (in diagram B)✓ radial muscles contracted✓ to allow more light into the eye✓	3 (AO 2.1) (AO 1.1) (AO 1.1)	ALLOW pupil is larger IGNORE eyes / iris dilated ALLOW reflex action has occurred <u>Examiner's Comments</u> Candidates needed to recall details of how light entering the eye is controlled and apply this to the situation described in the question to be successful. Candidates often got mixed up in describing changes moving from the beach to the café. Although many could describe the change in size of the pupil few could explain how it happens. Radial muscles were not mentioned and where muscles were mentioned this was usually incorrect as they referred to ciliary muscles and suspensory ligaments. The understanding that this was a reflex action was rarely seen.
	b	i	person X is short-sighted✓ person Y is long-sighted✓	2 (AO 2 x 2.1)	ALLOW person X is myopic / has myopia ALLOW person Y is hypermetropic / has hypermetropia (hyperopia) <u>Examiner's Comments</u> The question assessed application of knowledge of eye defects. Most candidates referred to short sighted and long sighted with many identifying the correct person. However, some identified the defects but made the incorrect choice of person.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	person X concave/divergent lens and person Y convex/convergent lens✓ idea that concave lenses diverge light rays / person X needs a lens to diverge light rays (before they enter the eye)✓ idea that convex lenses converge light rays / person Y needs a lens to converge light rays (before they enter the eye)✓	3 (AO 1.1) (AO 2 x 2.1)	ALLOW minus powered lens ALLOW plus powered lens Allow diagram showing lens diverging light  Allow diagram showing lens converging light  Must be stated which diagram refers to which lens or person. Examiner's Comments Candidates needed to recall the appropriate lenses required to correct the eye defects and explain how these lenses work to gain maximum marks. The identification of the corrective lenses was achieved by higher ability candidates, but it was very rare to see anyone demonstrate an understanding of how these corrective lenses work. Both corrective lenses needed to be correctly identified to score the first marking point and some candidates only managed to identify one. Exemplar 3 <i>x concave lens bends the light outwards before it enters the eye. ✓</i> <i>✓ Y convex lens bends the light inwards. ✓</i> [3] This exemplar indicates that the candidate clearly understands what is happening to light rays after passing through the corrective lens. Although they have not used the correct terminology of diverging and converging, credit has been given to the descriptions of what is happening to the light rays. The marks awarded for an

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					explanation of how the lenses work could have been gained from a diagram, but this type of response was not seen.  This could be an area for candidates to develop their examination technique to recognise when diagrams could support an answer, if they find difficulty in writing down their ideas.
			Total	8	
18		i	(the allele) is recessive ✓	1 (AO 2.1)	ALLOW neither dominant <u>Examiner's Comments</u> Candidates need to apply their knowledge and understanding of genetics to achieve this mark. It differentiated well with the higher ability candidates' understanding that the allele is recessive. The majority of candidates referred to the number of eyes, and that they need two to become stronger / dominant, which did not gain credit.
		ii	The retina is damaged/doesn't function ✓	1 (AO 1.1)	ALLOW retina detects light / focuses the image / contains light receptors <u>Examiner's Comments</u> This was a well differentiated question. The majority of lower ability candidates did not gain the mark as common answers were too generalised such as 'it affects the eyes'.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19	a		pupil has dilated (in diagram B) ✓ radial muscles contracted ✓ to allow more light into the eye ✓	3 (AO 2.1) (AO 1.1) (AO 1.1)	ALLOW pupil is larger IGNORE eyes / iris dilated ALLOW reflex action has occurred <u>Examiner's Comments</u> Many candidates gained two marks here for the dilation of the pupil and the need to increase the ability of light to enter the eye. There were a significant number of candidates that tried to link this to the action of the ciliary muscles, rather than the radial muscles of the iris.
	b	i	person X is short-sighted ✓ person Y is long-sighted ✓	2 (AO 2 × 2.1)	ALLOW person X is myopic / has myopia ALLOW person Y is hypermetropic / has hypermetropia (hyperopia)

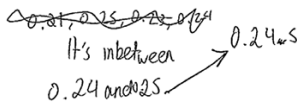
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	person X concave/divergent lens and person Y convex/convergent lens ✓ idea that concave lenses diverge light rays / person X needs a lens to diverge light rays (before they enter the eye) ✓ idea that convex lenses converge light rays / person Y needs a lens to converge light rays (before they enter the eye) ✓	3 (AO 1.1) (AO 2 × 2.1)	ALLOW minus powered lens ALLOW plus powered lens Allow diagram showing lens diverging light  Allow diagram showing lens converging light  Must be stated which diagram refers to which lens or person. Examiner's Comments Many candidates could correctly state the type of lens needed to correct each eye defect. For 'explain how the lens works', the most common error was to refer to the extent of bending or refraction of the light rather than the direction of the refraction. This is seen in exemplar 3, which would gain 1 mark. Exemplar 3 X, needs concave lenses, because the focus is before the retina. Concave lenses partially refract the light less, letting the focus ^{be} on the retina. Y, needs convex  because the focus is after the retina, so it refracts the light more. [3]
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
20	a	i	Any two from: idea that ruler release height is not standardised ✓ idea that release of ruler may cause uneven fall ✓ It (is the distance measured but time recorded) requires a calculation / may lead to conversion errors ✓ distance apart of fingers is not standardised ✓ fingers cover a range of different readings ✓ anticipation is possible / may learn to expect when it will be dropped ✓	2 (AO 2 × 3.3a)	eg may fall sideways IGNORE simply readings taken incorrectly ALLOW does not specify which part of finger is measured
		ii	stimulus is randomised ✓ time rather than distance measured / no calculation needed ✓ and any two from: improvements could include: randomising left and right hand ✓ making each target number same distance to move to / same distance from the start button ✓ randomising the delay time before the number flashes ✓ use a touch screen to avoid moving the mouse ✓	3 (AO 3.2a) (AO 2 × 3.3b)	IGNORE it uses a computer so its accurate <u>Examiner's Comments</u> A number of candidates could identify a reason why method two was better than method one. They often went on to state a problem with method two but did not suggest an improvement.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	First check answer on answer line If answer = 0.25 award 2 marks list in rank order / selects correct 5th and 6th values ✓ $\frac{0.25+0.25}{2} = 0.25$ ✓	2 (AO 2 × 2.1)	IGNORE decimal place for the list in rank order <u>Examiner's Comments</u> Most candidates appreciated that the median is the middle value but then a significant number did not put the figures in order first and so therefore calculated a value between 0.24 and 0.25. This error is seen in exemplar 5. Exemplar 5  Answer = <u>0.245</u> [2]
		ii	Any two from: there is no difference in reaction times between left (non-dominant) hand and right (dominant) hand ✓ mean and the median are the same for both hands / the same for the right (dominant) hand ✓ results from right (dominant) hand have a wider range (than left (non-dominant) hand) ✓	2 (AO 2 × 3.1a)	ALLOW ECF from b) ALLOW ORA Do not credit marks for reference to right and left handed students in each marking point. <u>Examiner's Comments</u> A small number of candidates incorrectly thought that the experiment was comparing right-handed and left-handed people and so lost marks here.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c	i	(skin stem cell) differentiates into (motor) neurone ✓	1 (AO 2.2)	ALLOW differentiates into MN (taken from abbreviation of motor neurone disease to MND in stem of question) <u>Examiner's Comments</u> This question was referring to the ability of stem cells to be able to produce nerve cells that could be used to measure the speed of impulses. Most candidates did not refer to nerve cells in their answers. This is shown in exemplar 6, which gained 1 mark. Exemplar 6 <i>Stem cells are undifferentiated</i> [1]
		ii	cerebru ✓ idea that area of brain controlling motor function / movement / conscious activities ✓	2 (AO 1.1) (AO 2.1)	ALLOW cerebral cortex / motor cortex IGNORE it is the area that coordinates reactions. DO NOT ALLOW a list of correct functions of the cerebrum without the importance of movement being highlighted <u>Examiner's Comments</u> The region labelled Y was correctly identified by many candidates, although there was some confusion with the cerebellum. The explanation did not always gain marks, as many candidates simply listed all the functions of the cerebrum.
		iii	Any two from: difficult to access brain (due to skull) ✓ large number of neurones / large number of nerve impulses in the brain/ difficult to follow a single neurone ✓ ethical issues of researching on brain / risk of damage ✓	1 (AO 2 × 2.2)	IGNORE difficult to take measurements in brain unless qualified <u>Examiner's Comments</u> There were many correct references to the difficulty of access to the brain and the risk of damage. Some candidates incorrectly referred to differences in conduction velocities in the two types of cell.
			Total	14	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance									
21		i	<table border="1"><tr><td></td><td>R</td><td>r</td></tr><tr><td>R</td><td>RR</td><td>Rr</td></tr><tr><td>r</td><td>Rr</td><td>rr</td></tr></table> correct gametes ✓ correct genotypes of offspring ✓ probability = 0.25 / ¼ / 25% / 1 in 4 / 1:3		R	r	R	RR	Rr	r	Rr	rr	4 (AO 2.2) (AO 2.2) (AO 3.2b)	ALLOW other forms of diagrams other than Punnett square <u>Examiner's Comments</u> This question assessed AO2.2 with the application of practical techniques in completing a genetic cross. This was particularly well done by most candidates, except some candidates did not choose the symbols recommended in the question and this caused them confusion in interpretation. The question also included an AO3 mark for interpreting and drawing a conclusion from the Punnett square. The most common error was to give 75% as the response. Some candidates also made an error by describing the ratio as 1 in 3 when they should have written 1 in 4 or 1:3. These errors could be minimised by improving examination technique, where candidates are made aware of common errors in interpreting genetic diagrams.
	R	r												
R	RR	Rr												
r	Rr	rr												
		ii	rod cells are do not work / damaged ✓ rod cells can work in dim light ✓ but cannot detect colour ✓	3 (AO 2.1) (AO 2.1) (AO 1.1)	ALLOW rods cells broken down / cones are not broken down IGNORErod cells broken down (as in stem of question) ALLOW converse for cones ALLOW converse for cones ALLOW rods only see in black and white <u>Examiner's Comments</u> This question covered AO1.1 and AO2.1. Candidates often did not identify that rod cells were damaged. They frequently just put rod cells break down, missing out it was 'only' the rod cells, and hence were just repeating what was in the stem of the question. Good responses also discussed cones cells so got the reverse argument.									
			Total	6										

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
22			D	1 (AO 1.1)	
			Total	1	
23			B	1 (AO 1.1)	
			Total	1	
24			D	1 (AO 1.1)	
			Total	1	
25			A	1 (AO 1.1)	Examiner's Comments  Misconception This is an AO1.1 question testing recall of the structure of the eye and its functions. Many candidates chose either C or B. Only candidates who performed well overall chose the correct answer A. Candidates seem to have the misconception that light enters the eye first through either the pupil or lens and very few were aware of the function of the cornea.
			Total	1	
26			C	1 (AO 1.1)	
			Total	1	
27			D	1 (AO 1.1)	
			Total	1	
28			C	1 (AO 2.1)	Examiner's Comments This proved to be a difficult question with no real pattern to the choices for incorrect answers.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
29	a	i	<u>understanding has increased because:</u> wider range of recording/scanning techniques / technology has developed ✓ improved accuracy of measurement ✓ maximum three from: <u>problems existing:</u> difficulties in getting individuals for case studies ✓ may cause harm to patients ✓ interpreting data from case studies is very complex ✓ ethical issues with experimenting on (live) animals / killing/harming animals for experimentation ✓	4 (AO 3.1b)	ALLOW named examples eg CAT, EEG / description of the techniques ALLOW map brain function with more accuracy ALLOW people reluctant to give consent / need many cases to draw reliable conclusions IGNORE consent is needed ALLOW may cause cancer in patients ALLOW Interpreting brain function/information is difficult / several areas may be involved in a specific function. IGNORE unethical to study the brain <u>Examiner's Comments</u> Many answers referred to improvements in technology leading to advancements. The most common problem stated was ethical issues with animal experimentation. Some candidates understood that human subjects may be reluctant to give consent but many simply stated that they were incapable of giving consent.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	Any two from: to inform other scientists (who might be working on the topic) ✓ to see if other scientists can replicate the work/ to have it peer reviewed✓ to allow recognition for their work✓	2 (AO 1.1)	ALLOW communicate scientific rationale/methodology for investigations / share ideas with other scientists / allow other scientists to develop work ALLOW check/prove/reproduce results IGNORE to let people know / to spread it more widely / to make it be accepted as fact <u>Examiner's Comments</u> Peer review, other scientists using the results in their research and publishing to gain recognition were often given as correct reasons. There were a number of vague references to 'letting other people know', which did not gain credit.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.05 (metres per second) award 3 marks Conversion of 32(nm) to 3.2×10^{-8} (metres) ✓ $3.2 \times 10^{-8} \div 6.4 \times 10^{-7}$ ✓ = 0.05 (metres per second) ✓	3 (AO 1.2) (AO 2.2 x2)	ALLOW ECF from first making point ALLOW 5×10^{-2} Examiner's Comments Many candidates could handle the conversion from nanometres to metres, divide by the time and give the correct answer in standard form. Credit was given for dividing by the time even if the initial conversion was incorrect. Exemplar 7 shows an example of this. It only scores one mark because the conversion is incorrect and the final calculation also contains an error. Exemplar 7 (i) Calculate the speed of diffusion in a person with Alzheimer's disease. Use this formula: speed = distance ÷ time Give your answer in metres per second. 32×10^9 = 32000000000 $t = 6.4 \times 10^{-7}$ $d = 32000000000$ $\frac{32 \times 10^9}{6.4 \times 10^{-7}}$ = 5×10^{15} Speed of diffusion = 5 x 10¹⁵ metres per second [3]
		ii	(in Alzheimer's,) neurotransmitter/it takes longer to diffuse/move (across the synaptic gap) ✓ communication between areas of the brain takes longer / idea that brain function less co-ordinated / idea that making decisions takes longer / idea that reactions are slower / takes longer to comprehend / lack of concentration ✓	2 (AO 2.1) (AO 3.2a)	ALLOW in healthy people the speed (of diffusion) is faster / in Alzheimer's the speed (of diffusion) is slower need to score first marking point to score this marking point Examiner's Comments Most answers commented on the reduced speed of diffusion in people with Alzheimer's disease, but some did not follow this up by relating this to the symptoms.
			Total	11	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
30			B ✓	1 (AO1.1)	
			Total	1	
31			C ✓	1 (AO2.1)	
			Total	1	
32		i	(sensory) receptor ✓	1 (AO2.1)	IGNORE neurone
		ii	brain ✓ motor ✓	2 (AO1.1)	ALLOW CNS IGNORE relay
			Total	3	
33			C ✓	1 (AO2.1)	
			Total	1	
34			A ✓	1 (AO2.1)	
			Total	1	
35			B ✓	1 (AO2.1)	
			Total	1	
36			B ✓	1 (AO2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
37	a		cerebral cortex / cerebrum ✓	1 (AO1.1)	ALLOW motor cortex
	b	i	can send impulses along a different number of neurones ✓ the more neurones that are stimulated then the greater the force of contraction ✓ Or could stimulate motor neurone 1 or motor neurone 2 ✓ motor neurone 2 gives a stronger contraction / because motor neurone 2 supplies more muscle fibres ✓	2 (AO2.1)	answer must specifically refer to changes in the number of motor neurones stimulated to score marks (not just the order of motor neurones)
		ii	idea that the neurone supplying the leg muscle connects to many muscle fibres ORA ✓ this means that the contraction of the leg muscles can be less finely controlled ORA ✓ idea leg does not need such fine control for its function ORA ✓	3 (AO2.1) (AO3.2a) (AO3.2a)	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	c	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed explanation of how the body coordinates this specific response, including a detailed outline of the correct pathway, in the correct order. AND Explains why coordination in B is more complicated. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Attempts to explain how the body coordinates this specific response, including an outline of the correct pathway, in the correct order. AND Gives a reason why coordination in B is more complicated. OR Detailed explanation of how the body coordinates this specific response, including a detailed outline of the correct pathway, in the correct order. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Attempts to explain how the body coordinates a response. OR Gives a reason why coordination in B is more complicated. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i>	6 (AO2 x 1.1) (AO2 x 2.1) (AO2 x 3.2a)	AO1.1 Demonstrates knowledge and understanding of scientific ideas to identify the correct pathway - receptors detect the stimulus and send impulse via a sensory neurone - CNS coordinates the response - CNS sends impulse to motor neurone - motor neurone causes muscles or effectors to respond AO2.1 Applies knowledge and understanding of scientific ideas to explain how the body coordinates the response - image dart board detected by retina/eye - cerebrum coordinates the response by sending impulses down spinal cord - motor neurone takes impulse from spinal cord to the muscles of the arm/hand - muscles in the arm/hand bring about the throwing response AO3.2a Analyse information and ideas to make judgements about the differences between A and B - coordination in B is more complicated because darts have different flight paths/ different positions of release - therefore, B needs to adjust the speed of the hand/force of the throw to match the throw angle

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			0 marks <i>No response or no response worthy of credit.</i>		
			Total	12	