1.21 The Nervous System and Reflexes: 1-hour Pack

AQA 8464 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A student measures their own reaction time five times using a computer-based reaction time test. Table 4 shows the results.

Table 4
Attempt: 1, 2, 3, 4, 5
Reaction time (s): 0.28, 0.25, 0.51, 0.24, 0.27

(a) Identify the anomalous result in Table 4. **(1)**

(b) Calculate the mean reaction time, excluding the anomalous result. Give your answer to 3 significant figures. **(3)**

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(Total for Question 1 is 4 marks)

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2 Table 1 describes three types of neurone found in the nervous system, labelled P, Q and R.

Neurone	Description
P	Carries impulses from receptors to the CNS
Q	Found inside the CNS; connects sensory neurones to motor neurones
R	Carries impulses from the CNS to effectors

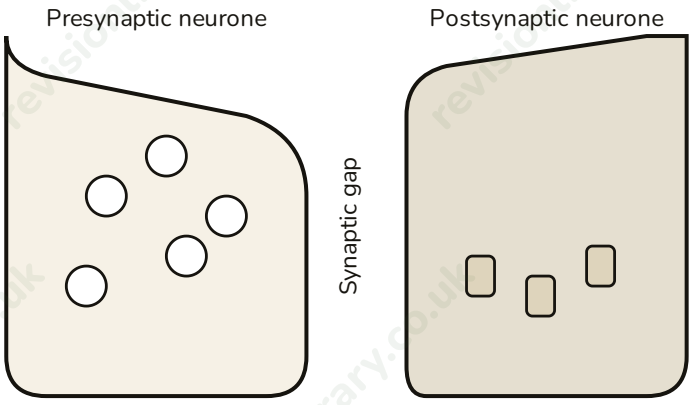
(a) Identify neurones P, Q and R as sensory, relay or motor neurones. **(3)**

(b) State where in the body relay neurones (neurone Q) are mainly found. **(1)**

(Total for Question 2 is 4 marks)

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3 Figure 2 shows a synapse: the gap between the end of one neurone and the start of the next.



(a) Define the term 'synapse'. **(1)**

(b) Describe how an electrical impulse in one neurone is transmitted across the synapse shown in Figure 2, to trigger an impulse in the next neurone. **(4)**

(Total for Question 3 is 5 marks)

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4 Impulses can only cross a synapse in one direction: from the neurone that releases the neurotransmitter to the neurone that receives it.

(a) Explain why impulses can only cross a synapse in one direction. **(2)**

(b) Suggest why one-way transmission at synapses is important for a coordinated reflex response. **(1)**

(Total for Question 4 is 3 marks)

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5 Required practical: Kwame investigates his own reaction time using the ruler-drop method, with his partner Freya recording the results.

(a) Describe how Kwame and Freya could carry out this practical to measure Kwame's reaction time using a 30 cm ruler. **(4)**

(b) Identify one variable, other than the person catching the ruler, that should be kept the same each time to make this a fair test. **(1)**

(c) Explain why Kwame should repeat the test several times and calculate a mean falling distance. **(1)**

(Total for Question 5 is 6 marks)

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6 Kwame and Freya convert the falling distance into a reaction time using the equation $d = 0.5 * g * t^2$, where d is the distance fallen in metres, $g = 9.8\ m/s^2$, and t is the reaction time in seconds.

(a) On Kwame's first attempt, the ruler fell a distance of 24.5 cm before he caught it. Rearrange the equation to make t the subject, then calculate Kwame's reaction time. Give your answer to 3 significant figures. **(3)**

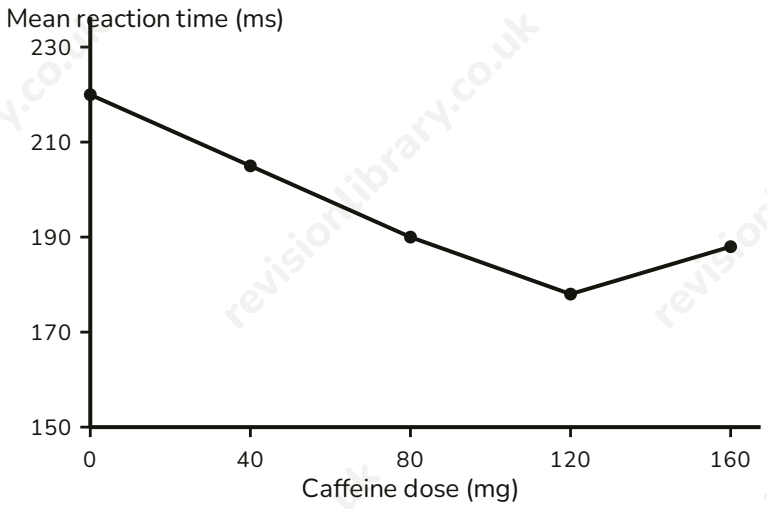
(b) On a second attempt, the ruler fell only 12.25 cm before Kwame caught it. State which of the two attempts shows the faster reaction time, and explain your answer. **(1)**

(Total for Question 6 is 4 marks)

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7 Olamide investigates the effect of caffeine dose on her own mean reaction time, using a computer-based reaction time test. Figure 3 shows her results as a line graph, with the data also given in Table 2.

Table 2
Caffeine dose (mg): 0, 40, 80, 120, 160
Mean reaction time (ms): 220, 205, 190, 178, 188



(a) Describe the pattern shown by the data for caffeine doses between 0 mg and 120 mg. **(2)**

(b) One result does not fit this pattern. Identify this result and suggest an explanation for it. **(2)**

(c) Calculate the percentage decrease in mean reaction time from 0 mg to 120 mg of caffeine. Give your answer to 3 significant figures. **(2)**

(Total for Question 7 is 6 marks)

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8 A teacher suggests that a computer-based reaction time test may give more valid results than the ruler-drop method used by Kwame and Freya.

(a) Suggest two reasons why a computer-based test might give more valid results than the ruler-drop method. **(2)**

(b) Suggest two ways the ruler-drop method could be made more reliable. **(2)**

(Total for Question 8 is 4 marks)

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9 Higher tier only. Accommodation allows the eye to focus on objects at different distances by changing the shape of the lens.

(a) Describe how the ciliary muscles, suspensory ligaments and lens change when the eye focuses on a near object. **(3)**

(b) Explain why a thicker, more curved lens is needed to focus on a near object rather than a distant one. **(1)**

(Total for Question 9 is 4 marks)

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10 Explain how myelination and axon diameter affect the speed of nerve impulse conduction. In your answer include the cellular mechanisms responsible and the likely magnitude of the effect. (6 marks)

(Total for Question 10 is 6 marks)

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Mark scheme · 1.21 The Nervous System and Reflexes: 1-hour Pack

Question 1

(a) 0.51 s (attempt 3) cao **B1**

(a) Answer: 0.51 s (attempt 3).

(b) excludes the anomalous result identified in (a) from the calculation (allow ft from candidate's own answer to (a)) **M1**

(b) correct sum of the remaining four readings: 0.28 + 0.25 + 0.24 + 0.27 = 1.04 (s), dependent on M1 **dM1**

(b) 0.260 s awrt cao **A1**

(b) Answer: 0.260 s.

Question 2

(a) P: sensory neurone **B1**

(a) Q: relay neurone **B1**

(a) R: motor neurone **B1**

(a) Answer: P: sensory neurone. Q: relay neurone. R: motor neurone.

(b) in the CNS (the brain and/or spinal cord), oe **B1**

(b) Answer: In the central nervous system (brain and spinal cord).

Question 3

(a) the junction/gap between two neurones, oe **B1**

(a) Answer: The gap (junction) between two neurones.

(b) the electrical impulse reaches the end of the first (presynaptic) neurone, oe **B1**

(b) this triggers the release of a chemical called a neurotransmitter (e.g. into the synaptic gap), oe **B1**

(b) the neurotransmitter diffuses across the gap/cleft, oe **B1**

(b) the neurotransmitter binds to (complementary) receptor molecules on the membrane of the second (postsynaptic) neurone, which triggers a new electrical impulse in that neurone, oe **B1**

(b) Answer: The impulse reaches the end of the first neurone and triggers release of a neurotransmitter, which diffuses across the gap and binds to receptor molecules on the next neurone, triggering a new impulse there.

Question 4

(a) the neurotransmitter is only released from (vesicles at the end of) the first (presynaptic) neurone, oe **B1**

(a) the (complementary) receptor molecules for the neurotransmitter are only found on the membrane of the second (postsynaptic) neurone, so an impulse cannot be triggered in the reverse direction, oe **B1**

(a) Answer: Neurotransmitter is only released from the first neurone, and the receptor molecules it binds to are only found on the second neurone, so transmission cannot happen in reverse.

(b) it ensures nerve impulses travel in the correct sequence along the reflex arc, from receptor to sensory neurone to relay neurone to motor neurone to effector, producing an appropriate, coordinated response, oe **B1**

(b) Answer: It ensures impulses travel in the correct sequence through the reflex arc (receptor to effector), so the response produced is appropriate and coordinated.

Question 5

(a) Freya holds the ruler vertically so that the 0 cm mark is level with the top of Kwame's open finger and thumb, without the ruler touching them, oe **B1**

(a) Freya releases the ruler without warning, at a random moment, oe **B1**

(a) Kwame catches the ruler between his finger and thumb as quickly as he can, oe **B1**

(a) the distance the ruler fell is read from the scale at the point where it is caught, and recorded (in cm), oe **B1**

(a) Answer: Freya holds the ruler vertically at the 0 cm mark level with Kwame's fingers, releases it without warning, and Kwame catches it as fast as possible; the distance it fell is read from the ruler's scale and recorded.

(b) any one of: the same ruler/ruler length used each time; the same person (Freya) releasing the ruler; the same starting position of the ruler; no warning given before release each time, oe **B1**

(b) Answer: E.g. the same ruler is used every time (or: the same person releases it, or: no warning is given before release).

(c) a single result could be an anomaly (e.g. Kwame anticipated the drop, or was briefly distracted), so repeating and finding a mean reduces the effect of random variation and gives a more reliable value for his reaction time, oe **B1**

(c) Answer: A single result could be anomalous (e.g. due to anticipation or distraction); repeating and finding a mean reduces the effect of this random variation, giving a more reliable reaction time.

Question 6

(a) correctly rearranges to $t = \sqrt{2*d/g}$, oe **M1**

(a) converts 24.5 cm to 0.245 m and substitutes correctly: $t = \sqrt{(2*0.245)/9.8}$, oe **M1**

(a) 0.224 s awrt cao **A1**

(a) Answer: 0.224 s

(b) the second attempt (12.25 cm) shows the faster reaction time, because a shorter falling distance means less time passed before the ruler was caught, oe (accept a correctly recalculated time, ft from a candidate's own value in part (a), used to make a consistent comparison) **B1**

(b) Answer: The second attempt (12.25 cm) is faster, as the ruler fell a shorter distance, so less time passed before it was caught.

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Question 7

(a) as caffeine dose increases from 0 mg to 120 mg, mean reaction time decreases, oe **B1**

(a) correct data quoted to support this, e.g. from 220 ms at 0 mg to 178 ms at 120 mg, oe **B1**

(a) Answer: As caffeine dose increases from 0 mg to 120 mg, mean reaction time decreases, from 220 ms to 178 ms.

(b) the result at 160 mg (188 ms) is anomalous, since reaction time increases here instead of continuing to fall, oe **B1**

(b) sensible explanation, e.g. too high a dose of caffeine may cause overstimulation/jitteriness/anxiety, which can slow reaction time; OR this could be a random measurement error, oe **B1**

(b) Answer: The 160 mg result (188 ms) is anomalous; a high caffeine dose may cause overstimulation/jitteriness that slows reaction time, rather than continuing to improve it.

(c) correct method: (220 - 178)/220*100, oe **M1**

(c) 19.1% awrt cao **A1**

(c) Answer: 19.1% decrease.

Question 8

(a) a computer test measures reaction time directly, in milliseconds, without relying on a calculation that assumes the ruler falls freely under gravity, oe **B1**

(a) it removes possible human error in reading the ruler's scale or in releasing/catching the ruler consistently, oe **B1**

(a) Answer: A computer test measures reaction time directly and precisely, without a calculation based on free fall, and removes human error in releasing or reading the ruler.

(b) increase the number of repeats for Kwame (e.g. from a few drops to at least ten) and calculate a mean, discarding any clear anomalies, oe **B1**

(b) OR test a larger sample of different people to check whether the same pattern of results is seen across the wider population, oe (any two distinct, valid suggestions) **B1**

(b) Answer: E.g. increase the number of repeats and calculate a mean, discarding anomalies; or test a larger sample of people to see if the pattern holds more widely.

Question 9

(a) the ciliary muscles contract, oe **B1**

(a) the suspensory ligaments loosen/slacken, oe **B1**

(a) the lens becomes thicker/more rounded (more curved), oe **B1**

(a) Answer: The ciliary muscles contract, the suspensory ligaments slacken, and the lens becomes thicker and more curved.

(b) light rays from a near object are diverging more strongly (spreading out more) as they reach the eye, so a more curved lens is needed to refract them more strongly, bringing them to a focus on the retina, oe **B1**

(b) Answer: Light from a near object diverges more strongly, so a more curved lens is needed to refract it more strongly and focus it on the retina.

Question 10

Level 3 A clear, detailed explanation of both myelination and axon diameter with correct cellular mechanisms and a statement about the magnitude of their effects; logical structure and clear link between cause and effect. **5-6**

Level 2 Good explanation of one factor and partial explanation of the other, or reasonable description of both without clear magnitude or mechanism links. **3-4**

Level 1 Simple statements e.g. myelin makes conduction faster, larger diameter increases speed, without explanation of mechanism. **1-2**

Indicative content:

- Myelination: myelin sheath insulates axon and forces saltatory conduction so action potentials jump between nodes of Ranvier; fewer ion channels open per unit length so conduction is faster and more energy efficient
- Effect magnitude: myelinated axons conduct much faster than unmyelinated of same diameter (tens of m/s up to 100 m/s compared with a few m/s for unmyelinated), gives idea of order of magnitude
- Axon diameter: larger diameter reduces internal resistance to ion flow, allowing faster local currents and faster propagation of the action potential
- Mechanistic link: reduced resistance and increased membrane resistance to current loss both increase length constant so depolarisation spreads further and threshold reached quicker at next node
- Any reasonable quantitative comment or example values and clear linking phrases

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