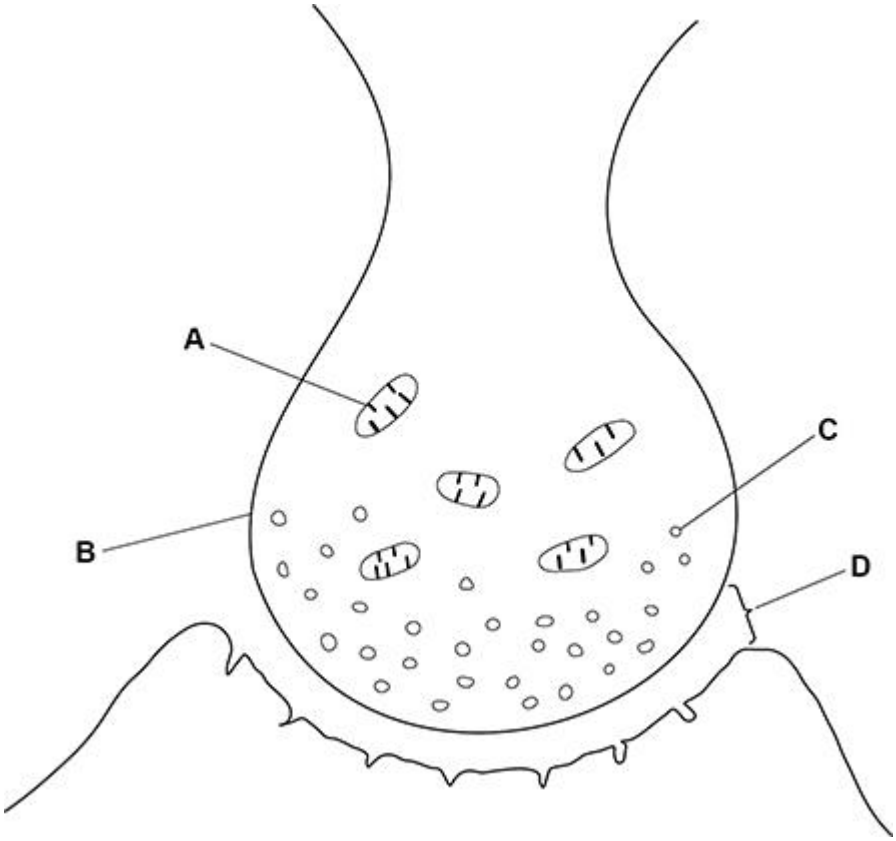
Q1.

The figure below shows a drawing of a neuromuscular junction.



(a) Name the parts labelled **A** to **D**.

A _____

B _____

C _____

D _____

(2)

(b) Following the release of acetylcholine into a neuromuscular junction, a muscle contraction occurs.

Describe the sequence of events, following the release of acetylcholine, that leads to stimulation of this contraction.

Do **not** include in your answer the events following the release of calcium ions in the myofibril.

(4)

(c) Inhibitory synapses cause hyperpolarisation in postsynaptic neurones.

Explain how this inhibits synaptic transmission.

(2)

(Total 8 marks)

Q2.

(a) Glutamate is a neurotransmitter involved in the transmission of nerve impulses from pain receptors to the brain. Ziconotide is a drug that can reduce severe, constant pain. Ziconotide blocks the calcium ion channels at some of the synapses which use glutamate.

The transmission of glutamate at synapses is similar to that of acetylcholine.

Explain how ziconotide reduces severe, constant pain.

(5)

Ziconotide is a polypeptide and acts on synapses in the spinal cord. Scientists investigated the effectiveness of ziconotide in reducing severe, constant pain.

Ziconotide was injected into each patient's cerebrospinal fluid that bathes the brain and spinal cord. Patients recorded the intensity of their pain using a statistically valid scale.

(b) Suggest **two** reasons why the patients had ziconotide injected into their cerebrospinal fluid rather than taking a pill containing the drug.

1

2

(2)

(c) Ziconotide was injected at 3 ng kg^{-1} h^{-1} for 8 days into each patient.

1 ng = 1 × 10^{-9} g

Calculate the total mass in grams of ziconotide injected after 8 days into a patient with a body mass of 82 kg

Show your working.

Answer _____ g

(2)

(d) When the patients recorded the intensity of pain, suggest **two** reasons why it was important to use a statistically valid scale.

1 _____

_____

2 _____

_____

(2)

(Total 11 marks)

Q3.

(a) Describe how stimulation of a Pacinian corpuscle produces a generator potential.

_____

_____

_____

_____

_____

_____

_____

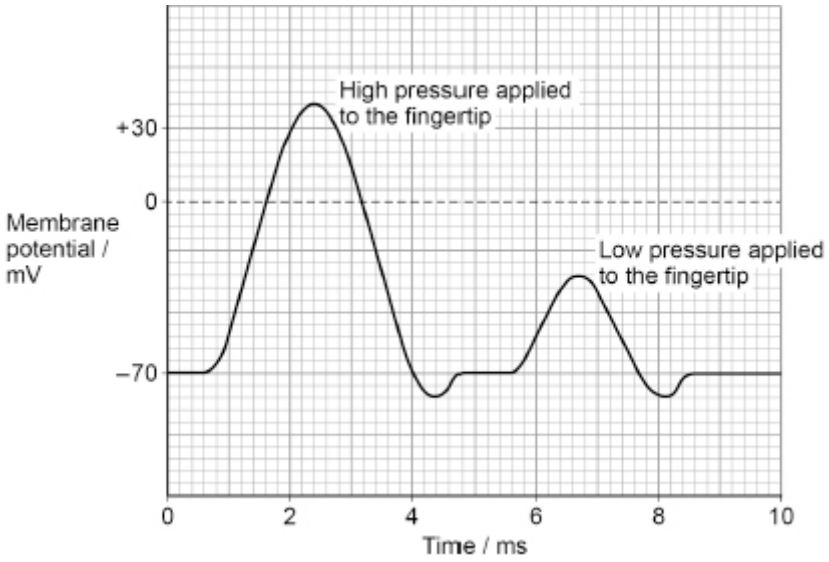
_____

_____

(3)

Scientists investigated the stimulation of a Pacinian corpuscle in the skin of a fingertip. The scientists applied two different pressures to the fingertip and recorded the changes in membrane potential of the Pacinian corpuscle's sensory neurone.

The graph below shows the scientists' results.



(b) Use the graph to describe what is meant by the all-or-nothing principle.

_____

_____

_____

_____

_____

_____

(2)

(c) On the graph above, from 0.6 ms to 4.0 ms, no new generator potential could be produced. What is this time period called?

_____

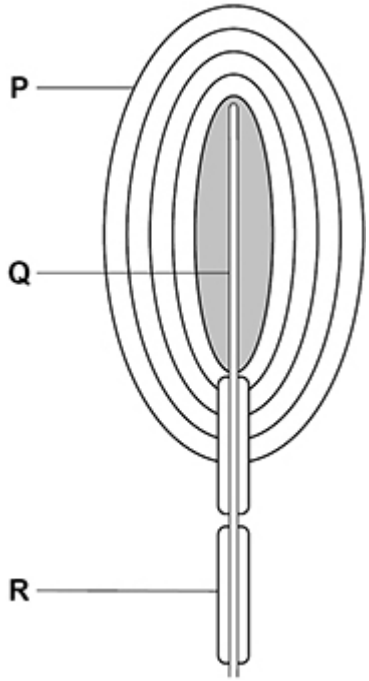
(1)

(Total 6 marks)

Q4.

Figure 1 shows a diagram of a Pacinian corpuscle.

Figure 1



(a) Name the structures labelled **P**, **Q** and **R** shown in **Figure 1**.

P _____

Q _____

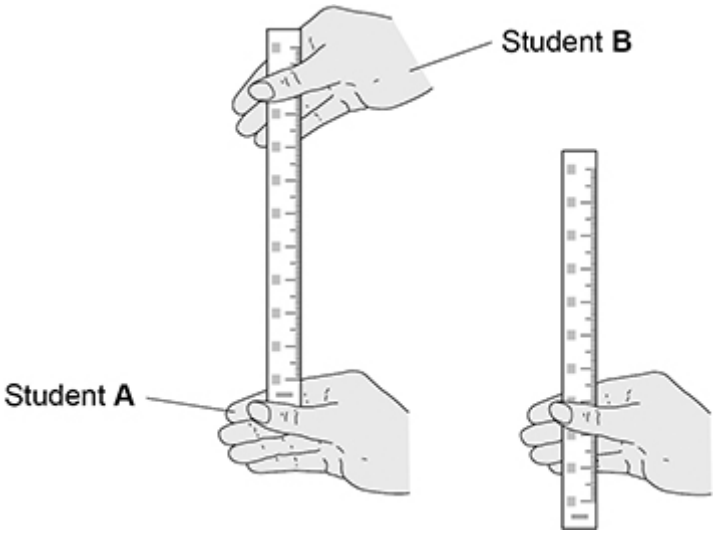
R _____

(2)

Two students (**A** and **B**) investigated reaction time in response to touch.

- Student **A** sat with her eyes shut and her forearm resting on a worktop so that her hand was over the edge.
- Student **B** held a ruler vertically between student **A**'s thumb and first finger, with the ruler at 0 mm lightly touching student **A**'s first finger.
- Student **B** released the ruler.
- As soon as student **A** felt the ruler fall, she closed her thumb and first finger to catch the ruler as shown in **Figure 2**.
- Student **B** measured the distance the ruler had fallen to the nearest mm

Figure 2



The test was repeated three more times using the same hand to catch the ruler. **Table 1** shows student **A**'s results.

Table 1

Trial	Distance the ruler has fallen / mm
1	79
2	97
3	10
4	94

The student was able to convert these distances into reaction times using **Table 2**.

Table 2

Distance the ruler fell / mm	Reaction time / ms
10	45
20	64
30	78
40	90
50	101
60	111
70	120
80	128
90	136

(b) Calculate the percentage uncertainty in the measurement of **Trial 1** in **Table 1**.

Put a Tick (✓) in the correct box below.

0.633% ☐

1.27% ☐

2.53% ☐

12.6% ☐

(1)

(c) In this investigation, it is not possible for a student to react in less than 45 ms

Suggest **one** explanation for the value recorded in **Trial 3** in **Table 1**.

_____

_____

_____

(1)

(d) Student **A** estimated that the length of the nerve pathway involved was 175 cm

Use **Table 1** and **Table 2** to calculate the mean speed of nerve impulse transmission.

Do **not** use the value for **Trial 3** in your calculation.

Answer _____ m s^{-1}

(2)

(e) In response to touch, nerve impulses can be transmitted at speeds of 76.2 m s^{-1}

Suggest **three** reasons why, in this investigation, the estimated speed of student **A**'s impulse transmission was less than 76.2 m s^{-1}

1 _____

_____

_____

2 _____

_____

_____

3 _____

_____

_____

(3)

(Total 9 marks)