Question			Answer	Marks	Guidance
1	(a)		cell signalling **;**	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
1	(b)	(i)	syn<u>a</u>ptic (cleft / space / gap) **;**	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ALLOW** syn<u>a</u>pse **DO NOT CREDIT** synoptic / synopse / synapsis

Question			Answer	Marks	Guidance
1	(b)	(ii)			**DO NOT CREDIT a mark point** if stated that complete *vesicles* (even if containing neurotransmitter) are involved
			1 (named) **neurotransmitter** / **acetylcholine** , released from **pre-synaptic** / first , cell / membrane ;		***1*** *release of neurotransmitter* must be clearly stated
			2 **diffuse**s across , gap / cleft / **synaptic cleft** ***or*** reaches second , neurone / cell / membrane , by diffusion ;		***2*** **IGNORE** synapse
			3 attaches to , **receptors** / binding sites of sodium channels , on **post-synaptic** membrane / membrane of second cell ;		***3*** **DO NOT CREDIT** post-synaptic knob / bulb ***Note*** *that a statement reading:* *'Diffuses across and attaches to receptors on the post-synaptic membrane'* **= 2 marks** (mps 2 & 3)
			4 neurotransmitter / acetylcholine , broken down (in cleft) ;	2 max	***4*** **CREDIT** ref to action of cholinesterase
			QWC – technical terms used appropriately and spelt correctly ;	1	Use of **three** terms from: **neurotransmitter**, **acetylcholine**, **pre-synaptic / presynaptic**, **diffuse / diffusion**, **synaptic cleft**, **receptor**, **post-synaptic / postsynaptic** Please insert a QWC symbol next to the pencil icon, followed by a tick (✓) if QWC has been awarded or a cross (×) if QWC has not been awarded You should use the green dot to identify the QWC terms that you are crediting.

Question			Answer	Marks	Guidance
1	(b)	(iii)	**1** ensures movement of **,** impulse / action potential **,** in one direction (only) **;** **2** integration **or** one neurone can **,** connect to / receive impulses from / transmit impulses to **,** many neurones **;** **3** allows summation **;** **4** *idea* that filters out **,** 'background' / low level **,** stimuli **or** ensures that only stimulation that is strong enough will be passed on**;** **5** AVP **;**	3 max	**IGNORE** ref to 'signals' / 'messages' / coordination ***1*** **ACCEPT** description eg ACh only released from presynaptic and receptors only on postsynaptic ***3*** **ACCEPT** description eg enough action potentials arrive to trigger depolarisation in next neurone ***5*** eg • permits **,** memory / learning • acclimatisation (or described) • prevents continuous stimulation of neurones • synapses are of two types – excitatory and inhibitory
1	(c)	(i)	endotherm(s) **;**	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **CREDIT** homoiothermic

Question			Answer	Marks	Guidance
1	(c)	(ii)	(vaso)dilation ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** 'arteriole' **DO NOT CREDIT** 'arterial dilation'
1	(d)	(i)	thyroxine / adrenaline;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** adrenalin / thyroxin / epinephrin(e)
1	(d)	(ii)	hypothalamus ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			Total	**12**	

Question	Expected Answer	Mark	Additional Guidance
2 (a)		3	**Award 1 mark for each correct side by side comparison.** Comparative statements **must** be made on the same row. **ALLOW two valid comparisons in the same pair of boxes, e.g** Cell body at end of neurone in the CNS | Cell body in middle and in the PNS **= 2 marks** mps 2, 3 and 4 can be taken from a labelled diagram All mps can be taken from annotated diagrams

	motor neurone	*sensory neurone*	
1	cell body in CNS	cell body , not in CNS / in PNS	;
2	cell body at end (of neurone)	cell body , not at end / in middle (of neurone)	;
3	dendrites connect directly to cell body	dendrites do not connect directly to cell body **or** dendrites at the end(s) of , dendron / axon	;
4	long(er) axon	short(er) axon	;
5	dendron absent / no dendron	dendron present	;
6	ends at motor end plate	starts at / connects to , (sensory) receptor	;

Question			Expected Answer	Mark	Additional Guidance
2	(b)				**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			1 - 60 to -70 ;		*1* **ACCEPT** any single figure or range (within this range) Must be a negative number
			2 depolarisation ;		
			3 threshold potential / threshold value ;		
			4 all or nothing ;		*4* **ALLOW** all or none
			5 size / magnitude ;		*5* **ALLOW** amplitude **DO NOT CREDIT** intensity / strength / value / potential difference / voltage
			6 frequency ;	6	
			Total	**9**	

Question			Expected Answers		Marks	Additional Guidance	
3	(a)	(i)	1	structure A / Schwann cell / it , produces **myelin** ;		*1*	Needs the idea of production rather than simply stating 'it is a myelin sheath'
			2	(electrical) insulation / insulates ;		*2*	**CREDIT** insulate or derived term. **IGNORE** impermeable **DO NOT CREDIT** *idea of* thermal insulation
			3	prevents movement of ions , into / out of , neurone / axon ***or*** prevents **depolarisation** ;		*3*	**CREDIT** 'across membrane' instead of , in / out, of axon **IGNORE** ion exchange **IGNORE** impermeable **DO NOT CREDIT** ions moving , into / out of , membrane **DO NOT CREDIT** movement of ions without qualification
			4	speeds up , **conduction** / transmission / passage , of , **impulse** / action potential ;		*4*	Statement must be comparative eg faster **DO NOT CREDIT** message / signal / wave of depolarisation
			5	**action potentials** / **local circuits** / depolarisation / only occur at , gaps / **nodes** (of Ranvier) ;		*5*	**ACCEPT** longer local circuits **ACCEPT** 'local currents' instead of local circuits
			6	**saltatory** conduction / described ;	**3 max**	*6*	eg • impulse jumps from , node to node / gap to gap **Note:** 'saltatory conduction' = 2 QWC terms
			QWC – technical terms used appropriately with correct spelling ;		**1**	Correct use and spelling of 3 terms from: **myelin, depolarisation (or other derived term), impulse, conduct (or other derived term), action potential, local circuit, node, saltatory** **You should use the GREEN DOT to identify the QWC terms that you are crediting.** **Please insert a QWC symbol next to the PENCIL ICON, followed by a tick (✓) if QWC has been awarded or a cross (×) if QWC has not been awarded**	

Question			Expected Answers	Marks	Additional Guidance
3	(a)	(ii)	exocytosis ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** bulk transport
3	(a)	(iii)	diffusion ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **DO NOT CREDIT** facilitated diffusion
3	(a)	(iv)	**1** *idea that only* the presynaptic neurone , produces / releases / contains , acetylcholine / ACh / (neuro)transmitter ; **2** only the presynaptic membrane has , $Ca^{(2+)}$ / calcium (ion) , channels ; **3** *idea that only* the postsynaptic , membrane / neurone , has (ACh) receptors ; **4** ACh broken down at postsynaptic membrane ;	1 max	**IGNORE** ref to refractory period (as not a feature of synapse) **ACCEPT** ACH / ach throughout ***1*** **CREDIT** knob / terminal bouton / bulb (instead of neurone) ***2*** ***3*** **DO NOT CREDIT** ref to bouton / bulb / etc ***4*** **IGNORE** ref to (acetyl)cholinesterase without ref to action at postsynaptic membrane

Question			Expected Answers		Marks	Additional Guidance	
3	(b)	(i)				**IGNORE** ref to atropine and ACh having similar shapes (as given in Q) **ACCEPT** ACH / ach throughout **Only credit ORA for the mark points if candidate clearly states that these events do <u>NOT</u> take place with atropine.**	
			1	*idea that* atropine **,** binds to / occupies / competes for **,** (ACh) <u>receptor</u> on postsynaptic **,** membrane / neurone **;**		***1***	**IGNORE** ref inhibition **DO NOT CREDIT** active site **DO NOT CREDIT** ref to bouton / bulb / etc
			2	*idea that* prevents ACh binding / blocks binding site / blocks receptor **;**		***2***	
			3	ion gates / ion channels / sodium channels / protein channels **,** do not open / remain closed **;**		***3***	**CREDIT** fewer ion channels open
			4	Na^+ cannot enter / K^+ cannot leave **,** neurone / (nerve) cell **;**		***4***	**CREDIT** sodium ions / potassium ions **DO NOT CREDIT** Na / K **DO NOT CREDIT** ions entering the membrane
			5	no / insufficient **,** depolarisation / postsynaptic potential / excitatory postsynaptic potential / epsp / generator potential **;**		***5***	**IGNORE** action potential (as given in Q)
			6	(so) does not reach threshold (value / potential) **;**	**3 max**	***6***	

Question			Expected Answers	Marks	Additional Guidance
3	(b)	(ii)			**ACCEPT** ACH / ach throughout
			1 *idea that* will , bind to / occupy / compete for / block , (some of ACh) receptors ;		***1*** **DO NOT CREDIT** ref to active site
			2 *so* acetylcholine / ACh , cannot bind / less likely to bind (to receptor / to postsynaptic membrane) ;		***2*** **ACCEPT** *idea that* ACh remains in synaptic cleft
			3 prevents / reduces , constant stimulation / overstimulation / constant depolarisation , of postsynaptic neurone **or** prevents / reduces , constant firing of action potentials / tetanus / (muscle) spasm ;		***3***
			4 AVP ;		***4*** eg • effective if administered soon after exposure • cannot counteract inhibition of acetylcholinesterase
				2 max	
			TOTAL	**12**	

Question			Expected Answer	Mark	Additional Guidance
4	(a)	(i)	**E ;**	**1**	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
4	(a)	(ii)	**A** and **F ;**	**1**	**Mark the first two answers for one mark.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
4	(a)	(iii)	**D ;**	**1**	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
4	(a)	(iv)	**B ;**	**1**	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
4	(b)	(i)	**B ;**	**1**	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
4	(b)	(ii)	channel / receptor / ion **,** is different **;** AVP **;**	**1 max**	**IGNORE** has enzyme to break it down (as Q states that it is stored in body) **DO NOT CREDIT** ref to active site e.g. • *idea that* toxin confined to **,** organelle / organ / part of the body • toxin not **,** in general circulation / (circulated) in blood • toxin stored in inactive form • contains a compound that neutralises toxin [S & C x 1]

Question			Expected Answer		Mark	Additional Guidance
4	(c)	(i)	1	attacked by the body's (own) immune system ;	2 max	*1* Named parts of the immune system are credited in mp 3 – not in this mp
			2	(immune system) mistakes / treats / recognises , body cells / neurones / myelin , as , 'foreign' / non self ;		
			3	correct ref. to , antibodies / (named) phagocytes / (named) B lymphocytes / (named) T lymphocytes ;		
4	(c)	(ii)	1	(damage to) myelin / sheath / Schwann cell(s) ;	2 max	*1* **IGNORE** damaged neurone (as given in Q) **IGNORE** damaged axon
			2	removes / has less , insulation ;		
			3	interferes with / slows / stops , conduction of , (nerve) impulse / action potential **or** slows / stops / prevents , saltatory conduction / described ;		*3* e.g. • more gaps where depolarisation needs to take place • shorter local , circuits / currents
			4	occurs , in sensory neurones / towards brain / towards CNS / from sensory organ / from receptor ;		
				Total	**[10]**	

Question			Expected Answers		Marks	Additional Guidance
5	(a)		1 2 3	myelin / myelinated / lipid / fatty (sheath) ; (Schwann) <u>cell</u>, wrapped around / surrounds / AW, <u>axon</u> ; except at nodes of Ranvier / (sheath) not continuous / presence of gaps (in the sheath) ;	2 max	1 **DO NOT CREDIT** fatty acids 3 must be in the context of structure rather than function (as many refer to it in context of saltatory conduction)
	(b)	(i)	1 2 3	(myelination produces) greater speeds ; unmyelinated needs larger diameter to produce same speed ; comparative figs, **all** with units, to support either the general trend or the exception to the trend with the mollusc ;	2 max	1 **IGNORE** ref to axon diameter for this mp 3 1 speed for myelinated (25 / 30 / 35 , **m s^{-1}**) **and** 1 speed for unmyelinated (3 / 30 , **m s^{-1}**) (allow m/s) **or** calculated difference in speed between myelinated and unmyelinated (**with units unless** a multiple e.g. approx. x12)
	(b)	(ii)	1 2	larger axon diameter produces greater speeds ; **ora** comparative figs, **all** with units, to support ;	2 max	1 needs to be a general statement 2 2 diameters & speeds (**both with units**) for ***myelinated*** **or** calculated difference in diameter for 2 stated speeds (**both with units unless** diameter is a multiple e.g. around x 1.4 / around 140%)

type of neurone	diameter (µm)	speed (m s^{-1})	animal taxon
myelinated		25	mammal
myelinated		30	amphibian
myelinated		35	amphibian

or
2 diameters & speeds (**both with units**) for ***unmyelinated***
or
calculated difference in diameter for 2 stated speeds (**both with units unless** diameter is a multiple e.g. about x10)

type of neurone	diameter (µm)	speed (m s^{-1})	animal taxon
unmyelinated	15		mammal
unmyelinated	1 000		mollusc

Question			Expected Answers	Marks	Additional Guidance
(c)	(i)	1	increased <u>kinetic energy</u> / <u>KE</u> so, • ions <u>diffuse</u>, across (axon) membrane / into neurone / into cell / between nodes / along neurone**,** more quickly ***or*** • faster movement of (neurotransmitter) vesicles / exocytosis (of neurotransmitter) ***or*** • neurotransmitter diffuses more quickly across, synapse / synaptic cleft ***or*** • neurotransmitter (ACh) broken down by enzyme (acetylcholinesterase) more quickly **;**	**S & C** **1 max**	description of ion movement must be correct (e.g. Na^+ in for depolarisation / Ca^{2+} into presynaptic knob)
		2	faster <u>diffusion</u> of ions leads to, • faster depolarisation ***or*** • shorter duration of action potential ***or*** • shorter refractory period ***or*** • faster repolarisation **;**		
(c)	(ii)	1	ion, channels / pumps, disrupted / denatured / no longer function **;**	**1 max**	**DO NOT CREDIT** general denaturation of proteins / enzymes
		2	fluidity of, membrane / phospholipid / bilayer, disrupted **;**		**2** **IGNORE** leaky membrane unless qualified
		3	(named) synaptic enzymes denatured **;**		

Question	Expected Answers	Marks	Additional Guidance
(d)			**IGNORE** ref to influx of Na^+ and events when action potential arrives at the synaptic knob – start when the Ca^{2+} channels open
	1 calcium **channel**s open ;		
	2 Ca^{2+} / Ca^{++} / calcium ions , enter / diffuse into,		**2** **DO NOT CREDIT** 'calcium' alone **DO NOT CREDIT** Ca^+ **DO NOT CREDIT** 'enter membrane' – must cross it
	3 acetylcholine / ACh / **neurotransmitter**, in **vesicle**(s) ;		
	4 (synaptic) vesicles move towards **presynaptic** membrane ;		**4** **CREDIT pre-synaptic**
	5 vesicles fuse with membrane ;		**5** **DO NOT CREDIT** attach / bind / join
	6 release acetylcholine, by **exocytosis** , into synaptic **cleft** ;		'vesicles move and fuse with presynaptic membrane' = mps 4 & 5
		3 max	'vesicles move and fuse with membrane' = mp 5 only
	QWC – technical terms used appropriately and spelt correctly ;	**1**	Use of **three** terms from: **channel**(s), **vesicle**(s), **neurotransmitter**, **presynaptic / pre-synaptic**, **exocytosis**, **cleft**,
	Total	**12**	

Question			Answer	Marks	Guidance
6	(a)		**1** receptors **;** **2** intensity **;** **3** chemical **;** **4** potential / value **;** **5** impulse **;**	**5**	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **1 ACCEPT** receptor cells **DO NOT CREDIT** neurones / organs **2 IGNORE** brightness **DO NOT CREDIT** frequency **3 IGNORE** volatile / soluble **4 ACCEPT** 'level' / '(needed) for depolarisation' **IGNORE** numerical value quoted / 'receptor' **DO NOT CREDIT** action potential **5 ACCEPT** action potential **DO NOT CREDIT** message / signal / information / stimulus

Question			Answer	Marks	Guidance
6	(b)	(i)	*the motor neurone - structure* the cell body is at (one) end of the **,** neurone / cell **or** the cell body is in **,** brain / spinal cord / CNS **or** dendrites connected (directly) to cell body **or** long(er) axon **or** no dendron **or** axon **,** connects to / ends at **,** effector / motor end plate **;**	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** ref to cell size / myelin(ation) **DO NOT CREDIT** at end of axon / nerve **IGNORE** reference to dendrite length **CREDIT ora for sensory** i.e. cell body is at centre of cell **or** cell body is in PNS **or** dendrites at the end(s) of **,** axon / dendron **or** short(er) axon **or** dendron present **or** connects to / starts at **,** receptor

Question			answer	Marks	Guidance
6	(b)	(ii)	*the motor* neurone - *function* carries , impulse(s) / action potential(s) , from , brain / spinal cord / CNS / relay neurone **or** carries , impulse(s) / action potential(s) , to , effector / muscle / gland ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** refs to 'connects …' **DO NOT CREDIT** message / signal / information / stimulus **DO NOT CREDIT** message / signal / information / stimulus **CREDIT ora for sensory** i.e. carries , impulse(s) / action potential(s) , to , brain / spinal cord / CNS / relay neurone **or** carries , impulse(s) / action potential(s) , from receptor
			Total	7	