

# Mark Scheme (Results)

## Summer 2025

Pearson Edexcel A Level GCE
In Biology A Salters - Nuffield (9BN0)
Paper 2: Energy, Exercise and Co-ordination

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**General Marking Guidance**

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1 (a)(i)** | • unit conversion correct (1)<br>• correct answer derived by dividing by actual size (1) | <u>Example of calculation</u><br>width on image is 5mm =<br>is 5 x $10^6$ nm / 5 000 000 nm<br>or width of cisterna as 20 x$10^{-6}$ mm<br>5 000 000 ÷ 20 =<br>(x) 250 000<br>ECF – 1 mark for x 25 000<br>Correct answer with no working gains full marks | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1 (a)(ii)** | An answer that makes reference to two of the following:<br>• two pairs of centrioles (1)<br>• centrioles at the poles of the cell (1)<br>• no {nucleus / nuclear envelope} is present (1) | IGNORE reference to other organelles<br>ALLOW a pair of centrioles on each side of the cell gains the first two marking points<br>ALLOW nuclear membrane has broken down | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1 (b)** | A description that makes reference to four of the following:<br><br>• (the polypeptide) { is folded / forms 3D shape / folds into globular shape / tertiary structure is formed } in the rER (lumen) (1)<br><br>• transported to Golgi apparatus in vesicles (from rER) / vesicles fuse with Golgi apparatus (1)<br><br>• addition of carbohydrate in Golgi apparatus (1)<br><br>• packaged into (secretory) vesicles by Golgi apparatus (1)<br><br>• exocytosis (1) | Do not allow reference to this happening at or on the rER<br><br>ALLOW sugar, glucose, disaccharide for carbohydrate<br>IGNORE glycogen<br><br>ALLOW description of exocytosis as fusing of membranes of vesicle with cell surface membrane | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2 (a)** | An explanation that makes reference to three of the following:<br>• depth of breathing increases / tidal volume would increase (1)<br>• breathing rate would increase (1)<br>• as carbon dioxide is not removed / carbon dioxide in air increases (1)<br>• so {more carbon dioxide / reduced pH} in blood (1) | ALLOW as carbon dioxide in spirometer increases<br>ALLOW: inhaling more carbon dioxide | **(3)** |

| Question Number | Answer | Mark |
|---|---|---|
| **2 (b) (i)** | The only correct answer is C (14)<br>A *is not correct because 6 breaths per minute is not the resting breathing rate shown on the spirometer*<br>*B is not correct because 7 breaths per minute is not the resting breathing rate shown on the spirometer*<br>*D is not correct because 16 breaths per minute in not the resting breathing rate shown on the spirometer* | **(1)** |

| Question Number | Answer | Mark |
|---|---|---|
| **2 (b) (ii)** | The only correct answer is A (0.5)<br><br>B *is not correct because this is the tidal volume during exercise*<br><br>*C is not correct because this is twice the number of troughs to 30 second point at rest*<br><br>*D is not correct because this is one minute in seconds* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2 (b)(iii)** | An answer that makes reference to three of the following:<br><br>• take measurements during rest and during exercise (1)<br><br>• repeat when collecting {rest / exercise} data to calculate a mean (1)<br><br>• calculate decrease in volume (1)<br><br>• work out the change in rate of oxygen uptake (1) | | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3 (a)** | A description that makes reference to the following:<br><br>• hydrophilic component by phosphate heads (1)<br><br>• hydrophobic component in {fatty acid tails / hydrocarbon chains } (1) | ALLOW marks from an annotated diagram<br><br>ALLOW phospholipid heads for phosphate heads<br>ALLOW hydrophilic part faces the outside (of the phospholipid bilayer)<br><br>ALLOW hydrophobic part faces the inside (of the phospholipid bilayer) | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3 (b)** | An explanation that makes reference to four of the following:<br><br>• protein S (1)<br><br>• (protein S) is a {carrier protein / pump } (1)<br><br>• (as) oxygen concentration increases more {(aerobic) respiration occurs / ATP is formed } (1)<br><br>• (so) active transport increases (1)<br><br>• (therefore) more of ion P can be taken up (1) | ALLOW more rapid changing of shape | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4 (a)** | A description that makes reference to three of the following:<br>• {rods / cones} in the retina (1)<br>• (impulse conducted by) {bipolar cell / ganglion cell} (1)<br>• (nerve impulses sent from the eye along) optic nerve (1)<br>• to {occipital lobe / ocular dominance columns / visual cortex} (1) | ALLOW neurone instead of cell | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4 (b)** | • maximum density (1)<br>• area of fovea (1)<br>• maximum number of photosensitive cells to three significant figures (1) | <u>Example of calculation</u><br>188 000 ($mm^{-2}$)<br>2.01 ($mm^2$)<br>ALLOW 2.0106 ($mm^2$)<br>378 000<br>ALLOW 2 marks for values from 377 804 to 377 996<br>Correct answer with no working gains full marks | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4 (c)** | An explanation that makes reference to the following:<br><br>• { pupil diameter decreases / pupil constricts } as light intensity increases (1)<br><br>• circular muscles contracting (1)<br><br>• radial muscles relaxing (1)<br><br>• to reduce chance of damage to the retina (1) | ALLOW converse for marking points 2 and 3 if describing pupil dilation for lower light intensities<br><br>ALLOW converse<br>ALLOW negative correlation<br><br>DO NOT ALLOW circular muscles constrict<br><br>ALLOW rods / cones for retina<br>IGNORE eye for retina | **(4)** |

| Question Number | Answer | Mark |
|---|---|---|
| **5 (a)(i)** | The only correct answer is A (6)<br><br>B *is not correct because 7 is not the number of different codons on the mRNA transcribed*<br><br>*C is not correct because 10 is not the number of different codons on the mRNA transcribed*<br><br>*D is not correct because 21 is not the number of different codons on the mRNA transcribed* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5 (a)(ii)** | An answer that makes reference to the following:<br><br>• total number of hydrogen bonds in this part of the gene (1)<br><br>• number of hydrogen bonds in { deleted part of gene / remaining part of gene } (1)<br><br>• correct percentage change calculated and given to one decimal place (1) | <u>Example of calculation</u><br><br>(12 x 2) + (9 x 3) = 24 + 27 = 51<br><br>(6 x 2) + (5 x 3) = 12 + 15 = 27<br>OR<br>(6 x 2) + (4 x 3) = 12 + 12 = 24<br><br>(24÷51) x 100 = 47.1%<br>OR<br>(27÷51) x 100 = 52.9%<br><br>Correct answer with no working gains full marks | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5 (b)** | An explanation that makes reference to the following:<br>• change in { primary structure / amino acid sequence} (1)<br>• so change in {bonding / R-groups } (1)<br>• so change in {tertiary structure/3D shape / folding } (1) | ALLOW shorter chain / fewer amino acids / different amino acids<br>IGNORE active site changes shape | **(3)** |

| Question Number | Answer | Mark |
|---|---|---|
| **5 (c)** | The only correct answer is B<br>A *is not correct because cell repair is not a function of mitosis*<br>*C is not correct because asexual reproduction is a function of mitosis but cell repair is not*<br>*D is not correct because asexual reproduction is a function of mitosis* | **(1)** |

| Question Number | Answer | Mark |
|---|---|---|
| **5 (d)** | The only correct answer is A (it contains cytoplasm in which organelles may be present)<br><br>*B is not correct because animal cells do not have cell walls containing actin*<br><br>C *is not correct because the nucleus does not disappear in interphase*<br><br>*D is not correct because viruses can also have genetic material but are not cells* | **(1)** |

| Question Number | Answer | Mark |
|---|---|---|
| **6 (a)** | An answer that makes reference to<br><br>• extensor (muscle) (1) | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6 (b)** | An explanation that makes reference to two of the following:<br>• calculated value is greater than critical value / the p value is less than 0.05 (1)<br>• the null hypothesis (of no difference) can be rejected / the alternative hypothesis can be accepted (1)<br>• (the difference) is (probably) not due to chance (1) | | **(2)** |

| Question Number | Answer | Mark |
|---|---|---|
| **6 (c)** | The only correct answer is B (linear)<br>A *is not correct because the relationship is not exponential*<br>*C is not correct because the relationship is not logarithmic*<br>*D is not correct because the relationship is not proportional* | **(1)** |

| Question Number | Indicative content |
|---|---|
| ***6(d)** | Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.<br>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.<br><br>Basic statement<br>• the greater the contraction of the muscle the longer it took for it to be relaxed<br>• reference to delay of 200 - 340 ms depending on degree of muscle contraction<br>Stimulus effect on the eye<br>• light stimulus causes rhodopsin to break down to opsin and retinal / cis to trans retinal change<br>• effect on membrane of rod cells / hyperpolarisation<br>• neurotransmitter not released from rod cell<br>• bipolar neurone depolarises / action potential achieved<br>• ganglion cell depolarises / action potential achieved<br>Nerve pathways involved<br>• nerve impulse travels along ganglion cell (from retina/eye) / optic nerve to brain<br>• processing in visual cortex / occipital lobe<br>• nerve impulse from motor cortex of brain to muscle<br>• nerve impulse sent via motor neurones<br>• no further impulses from brain to flexor muscle /impulses to neuromuscular junction stop<br>Processes in the muscle (ALLOW: converse for contraction of extensor muscle)<br>• energy released from ATP breakdown<br>• myosin head released from actin /actin slides across myosin<br>• calcium ions taken up by sarcoplasmic reticulum<br>• troponin releases calcium and changes shape / moves tropomyosin on actin / binding site on actin blocked<br>• myosin head cannot bind to actin<br>• no cross bridges / muscle relax<br><br>**(6)** |

| | | Level Descriptors | Additional guidance |
|---|---|---|---|
| Level 0 | Marks | No awardable content | |
| Level 1 | 1-2 | Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made.<br><br>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. | Reference to data – the greater the contraction of the muscle the longer it took for it to be relaxed / data 200- 340 ms delay<br><br>Detail of location of delay: eye / neurones / muscle |
| Level 2 | 3-4 | Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented.<br><br>Lines of argument occasionally supported through the application of relevant evidence (scientific ideas, processes, techniques and procedures).<br><br>The explanation shows some linkages and lines of reasoning with some structure. | Details from the indicative content such as:<br><br>• basic nerve pathway described<br>• eye response e.g. time for rod cell to stop releasing neurotransmitter<br>• nerve pathway response e.g. time for neurotransmitter to diffuse across synapse<br>• muscle response e.g. actin and myosin sliding apart |
| Level 3 | 5-6 | Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented.<br><br>Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures).<br><br>The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured. | All three processes described, with details from the indicative content list. |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7 (a)** | An answer that makes reference to three of the following:<br><br>• inner mitochondrial membrane drawn with infoldings and labelled (1)<br><br>• crista / cristae labelled (1)<br><br>• DNA loop drawn and labelled (1)<br><br>• stalked particles drawn and labelled (1) | IGNORE inter-membrane space<br><br>ALLOW labelled as plasmid<br><br>ALLOW ribosomes drawn and labelled | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7 (b)** | A description that makes reference to four of the following:<br>• { catalyses / lowers the activation energy } (1)<br>• to remove {carbon / carbon dioxide} / decarboxylation (1)<br>• to remove hydrogen (atoms) / reduction of NAD (1)<br>• add {coenzyme A / CoA} (1)<br>• to synthesise acetyl CoA (1) | ALLOW speeds up reaction<br>IGNORE production of carbon dioxide<br>IGNORE reference to ions | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7 (c)** | An explanation that makes reference to five of the following:<br><br>• chemiosmosis (1)<br><br>• so protons (from the matrix) are moved into the inter-membrane space (1)<br><br>• creating an electrochemical gradient (1)<br><br>• so protons can diffuse (down the gradient) (1)<br><br>• through {the stalked particle / ATP synthase} (1)<br><br>• so ATP can be synthesised (in the mitochondrion) (1) | ALLOW { $H^+$ / hydrogen ions} for protons<br><br>NB: space between the inner and out membranes = inter-membrane space<br><br>ALLOW concentration gradient, proton gradient<br><br>ALLOW protons move back into the matrix down the gradient<br><br>ALLOW ATP generated during oxidative phosphorylation | **(5)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8 (a)(i)** | An answer that makes reference to the following:<br>• exposing (the $P_{FR}$ form) to far red light (1)<br>• in the dark / during the night (1) | ALLOW absorption of far red light<br>ALLOW in the absence of light | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8 (a)(ii)** | An explanation that makes reference to three of the following:<br>• long days allow { $P_{FR}$ to be made / $P_{FR}$ to $P_R$ ratio increases / $P_R$ to be converted to $P_{FR}$ } (1)<br>• short nights mean less time for {conversion of $P_{FR}$ to $P_R$ / loss of $P_{FR}$} (1)<br>• $P_{FR}$ stimulates flowering (1)<br>• $P_{FR}$ activates transcription factors for genes associated with flowering (1) | ALLOW active phytochrome for $P_{FR}$, and inactive phytochrome for $P_R$<br>ALLOW 16 hours is long enough to accumulate enough $P_{FR}$<br>ALLOW gene activation or protein synthesis if linked to flowering | **(3)** |

| Question Number | Answer | Mark |
|---|---|---|
| **8 (b)(i)** | The only correct answer is A (amino acid)<br><br>*B is not correct because molecule Q is not a nucleic acid*<br><br>*C is not correct because molecule Q is not a nucleotide*<br><br>D *is not correct because molecule Q is not a protein* | **(1)** |

| Question Number | Indicative content | Mark |
|---|---|---|
| ***8(b)(ii)** | Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.<br>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.<br><br>Phytochrome<br>• Neighbouring plants block the light, therefore less conversion of $P_R$ to $P_{FR}$ / reduced level of $P_{FR}$<br>Transcription factors<br>• bind to promoter region<br>• so {DNA to be unzipped / gene to be activated}<br>• activate RNA polymerase /RNA polymerase unzips the DNA<br>• allowing transcription of genes<br>Enzymes TAA and YUC - how produced<br>• mRNA formed and leaves nucleus<br>• mRNA read at ribosome and tRNA brings in amino acids<br>• details of translation<br>• so more TAA and YUC made<br>Height increase – caused by auxin<br>• TUC and YUC enzymes involved in making auxin<br>• more auxin produced by tip of *Arabidopsis*<br>• which diffuses down shoot (to zone of elongation)<br>• leading to cell elongation<br>• water enters cells by osmosis to bring about elongation<br>• details of auxin action e.g. vacuole formation / increasing cell wall plasticity | **(6)** |

| | | | Additional guidance |
|---|---|---|---|
| Level 0 | Marks | No awardable content | |
| Level 1 | 1-2 | Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made.<br><br>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. | Basic information e.g.<br>• less $P_{FR}$ / less active phytochrome<br>• allowing transcription of genes<br>• so more TAA and YUC made<br>• TUC and YUC enzymes involved in making auxin / IAA<br>• auxin / IAA causes stem / cell elongation |
| Level 2 | 3-4 | Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented.<br><br>Lines of argument occasionally supported through the application of relevant evidence (scientific ideas, processes, techniques and procedures).<br><br>The explanation shows some linkages and lines of reasoning with some structure. | Basic information and some additional details relating to one of the following:<br><br>• transcription factor process<br>• protein synthesis<br>• auxin / IAA induced elongation mechanism |
| Level 3 | 5-6 | Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented.<br>Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures).<br>The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured. | Information and comprehensive knowledge relating to the following:<br>• transcription factor process<br>• protein synthesis<br>• auxin / IAA induced elongation mechanism |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9 (a)(i)** | A description that makes reference to four of the following:<br>• differential gene expression (1)<br>• a chemical {signal / stimulus} activates specific genes (in the stem cells) (1)<br>• activated genes {transcribed / produce mRNA} (1)<br>• translation of mRNA produces { polypeptides / proteins } (1)<br>• proteins determine the {structure / function} of the cell (to produce specialised cells) (1) | ALLOW transcription factor for {chemical signal / stimulus}<br>ALLOW 'switched on' for activated<br>ALLOW polypeptide for protein | **(4)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9 (a)(ii)** | An explanation that makes reference to two of the following:<br><br>• stem cells can {give rise to / differentiate} into {all/many} cell types (1)<br><br>• many genes in common (1)<br><br>• fewer gene edits needed (1)<br><br>• (stem cells from closely related animals needed) because the thylacine is extinct (1) | IGNORE reference to rejection<br><br>ALLOW {genome / gene pool} more similar, more likely to have similar genes<br>IGNORE similar DNA<br><br>ALLOW less genetic modification needed | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9 (a)(iii)** | An explanation that makes reference to the following:<br><br>• genetic diversity / genetic variation (1)<br><br>• so more likely to adapt / to reduce likelihood of a genetic condition being perpetuated (1)<br><br>OR<br>• so can have males and females (1)<br><br>• to keep the species going (1) | ALLOW increase the gene pool<br>ALLOW increases heterozygosity<br><br>ALLOW surviving a selection pressure<br>ALLOW reduce chance in inbreeding depression | **(2)** |

| Question Number | Answer | Mark |
|---|---|---|
| **9 (b) (i)** | The only correct answer is D (phosphodiester)<br><br>A *is not correct because ester bonds are not hydrolysed by restriction enzymes*<br><br>*B is not correct because hydrogen bonds are not hydrolysed by restriction enzymes*<br><br>*C is not correct because peptide bonds are not hydrolysed by restriction enzymes* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9 (b)(ii)** | An explanation that makes reference to three of the following:<br>• four (1)<br>• phosphodiester bonds (1)<br>• two per DNA strand (1)<br>• (and) DNA is double-stranded (1) | ALLOW each end of gene/plasmid/DNA would need two bonds | **(3)** |

| Question Number | Answer | Mark |
|---|---|---|
| **10 (a) (i)** | The only correct answer is A (aorta)<br><br>*B is not correct because the left atrium supplies blood to the left ventricle*<br><br>*C is not correct because the pulmonary artery supplies blood to the lungs*<br><br>*D is not correct because the right ventricle supplies blood to the pulmonary artery* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **10 (a)(ii)** | An explanation that makes reference to three of the following:<br><br>• (during exercise) heart muscle {respiring more / requires more oxygen} (1)<br><br>• insufficient {oxygen / oxygenated blood} supplied (for additional demand) (1)<br><br>• due to {blockage / narrowing} of coronary artery (1)<br><br>• so (cardiac muscle) {starts to carry out anaerobic respiration / lactate is produced} (1) | ALLOW heart rate increases during exercise<br><br>ALLOW reduced oxygen supply to heart muscle<br>ALLOW converse – at rest sufficient {oxygen /oxygenated blood} supplied for aerobic respiration<br><br>ALLOW reference to partial blockage allows enough oxygenated blood to flow through when at rest | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **10 (a)(iii)** | A description that makes reference to three of the following:<br>• endothelium damaged (1)<br>• inflammatory response (1)<br>• build-up of {cholesterol / fatty deposits} (1)<br>• white blood cells enter / calcification (1) | IGNORE inflammation for inflammatory response<br>ALLOW calcium ions / salts accumulate | **(3)** |

| Question Number | Answer | Mark |
|---|---|---|
| **10 (b) (i)** | The only correct answer is C (to allow a valid comparison between humans)<br>A *is not correct because 15mg kg$^{-1}$ does not give each person the same mass of substance*<br>*B is not correct because 15mg kg$^{-1}$ does not make the data more precise*<br>*D is not correct as 15mg kg$^{-1}$ is not the dependent variable* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **10 (b)(ii)** | An answer that makes reference to five of the following:<br>• measure mass of individual *Daphnia* (1)<br>• range of substance given below 15mg $kg^{-1}$ (body mass) (1)<br>• count number of heart beats in a set time (1)<br>• control of a relevant biotic variable (1)<br>• control of a relevant abiotic variable (1)<br>• use several *Daphnia* at each concentration to find the mean (1) | ALLOW measure for count, or a correct description for finding heart rate<br>IGNORE heart rate for heart beats e.g. count the heart rate<br>e.g. {species/age/sex} of *Daphnia*<br>e.g. temperature<br>ALLOW repeats to find a mean | **(5)** |

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