Arithmetic (Maths Skills MS0): Eduqas A Level Biology Exam Questions

20 questions · 41 marks · about 49 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · A level Component 2 · Autumn 2020 · Q5(c)(i) · 2 marks

(c) Research into the development of a male contraceptive has focussed on reducing the production of spermatozoa. One possible method has been to increase the blood concentration of testosterone by administering a drug called TU.

One study involved 898 Chinese men between 20 and 45 years of age. All men starting the trial had fathered a child in the previous two years. Following an initial dose of 1000 mg, the men were all given an injection of 500 mg of TU each month for 30 months.

(i) Calculate the total mass of TU given to each man during the period of the trial. **Give your answer in grams.** [2]

mass of TU = ... g

Question 2 · A level Component 1 · June 2017 · Q7(c)(i) · 2 marks

(c) Results from such a UK survey are shown below.

Woodland type: Scots pine
Total area sampled = 250 m^2
Cone cores collected over 84 days.
Total number of cone cores collected = 240
Average number of seeds per cone = 25
Average energy value per seed = 0.18 kJ

(i) Calculate the total energy consumed by the squirrels from the cones. [2]

Total energy consumed from the cones = ... kJ

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Question 3 · A level Component 1 · June 2017 · Q7(c)(ii) · 2 marks

(ii) Using your answer from (i) and the information above, calculate the total energy consumed in the area per hectare per day. (There are 10 000 m^2 in 1 hectare.) [2]

Total energy consumed = ... kJ ha^{-1} day^{-1}

Question 4 · A level Component 1 · June 2017 · Q7(c)(iii) · 1 mark

(iii) The average adult red squirrel consumes 550 kJ per day.
Calculate the estimated density of squirrels for the woodland. [1]

Squirrels per hectare = ...

Question 5 · A level Component 1 · Autumn 2021 · Q7(b)(i) · 2 marks

(b) In the past, sea otters were hunted by humans for their very thick, waterproof fur and by the 1900s were almost extinct.

(i) An adult male sea otter with a surface area of 7.2×10^3 cm^2 has approximately 8.64×10^8 hairs on its body surface.

Calculate the number of hairs per cm^2 of body surface. **Give your answer in standard form**. [2]

Number of hairs per cm^2 = ...

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Question 6 · AS Component 2 · June 2016 · Q3(d) · 2 marks

(d) Aphid stylectomy can also be used to estimate rates of translocation. In the experiment above over a six hour period, a total of 0.015 mm^3 of sap was collected from all 50 aphid stylets.

Calculate the rate at which sap flows out of a single stylet per hour. Express your answer in standard form. [2]

Rate = ... mm^3 per hour

Question 7 · AS Component 2 · June 2024 · Q2(b)(ii) · 3 marks

(ii) The rumen contains many types of micro-organism. An adult cow had a rumen capacity of $1.6 \times 10^4 cm^3$ of fluid. In a sample of the rumen fluid, micro-organisms made up 3.6% of the volume. The proportion of micro-organisms that were bacteria was $10^{10} cm^{-3}$.
Calculate the number of bacteria present in the rumen of this individual. **Give your answer in standard form**. [3]

Number of bacteria = ...

Question 8 · A level Component 2 · June 2023 · Q5(b)(i) · 3 marks

(b) The size of a DNA fragment can be measured using the kilobase (1 kilobase = 1000 base pairs).

The length of 1 kilobase is 0.34 µm.

The DNA in a nucleus of a cell from a male with DMD is 2.95×10^6 kilobases in total.

(i) Calculate the length of DNA in the nucleus of the cell from a male with DMD in millimetres (mm). **Give your answer in standard form**. Show your working. [3]

Length = ... mm

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5. Wading birds (waders) feed in shallow water. Areas of the Western Isles off the coast of Scotland are the most important breeding grounds for waders in Europe. The numbers of breeding pairs of lapwing, redshank, dunlin and snipe were monitored in the areas shown in **image 5.1** in 1983 and 2000. These waders are ground nesting birds.

Image 5.1



Area 1 is not colonised by hedgehogs.

Area 2 is where seven hedgehogs were introduced by a house owner to eat slugs in their garden. Since their introduction numbers have increased and they have established a large population.

Hedgehogs normally feed on worms, insects, slugs and snails but will also eat the eggs of ground nesting birds such as waders.

The results of the monitoring of the wading birds are shown in **table 5.2**.

Table 5.2

Species of wading bird	Percentage change in number of breeding pairs between 1983 and 2000	
	Area 1 (hedgehogs absent)	**Area 2** (hedgehogs present)
lapwing	+24	−31
redshank	+51	

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6. In the past, Red Kites *(Milvus milvus)* almost became extinct in the UK and by 1905 there were estimated to be only three breeding pairs in the UK, all of which were in West Wales.



It has taken a century for the UK Red Kite population to recover from the few remaining birds. In 1986 the recovery was helped by the re-introduction of some Red Kites from Wales to England and Scotland. Although they are still rare, between 2008 and 2011 they were found breeding in over 700 areas that were sampled across the UK.

The population recovery has involved keeping nest sites secret and round-the-clock protection by volunteers.

(a) In 1995 there were 284 Red Kites in the UK with numbers increasing to 1025 per cent of the original population between 1995 and 2017. Calculate the approximate **number of breeding pairs** of Red Kites present in 2017. [3]

..... breeding pairs

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4. A study was carried out to investigate the changes to the digestive system of snakes when not fed for extended periods.

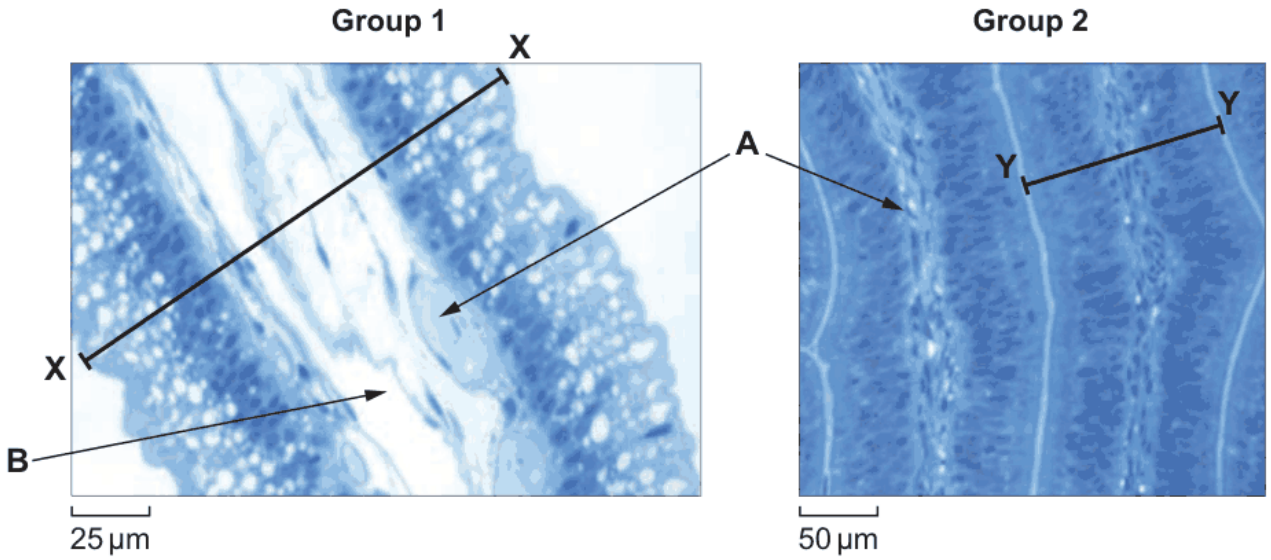
Burmese pythons *(Python molurus bivittatus)* are a species of snake that hide and wait for their prey to come close enough to catch and eat. Their prey is ingested whole and can weigh up to 25% of the snake's body mass. Digestion takes from 10 to 14 days. They can go without food for up to one year.

Two groups of snakes were fed for a four-week period as follows:

Group 1 fed every third day
Group 2 not fed during the period of the study

At the end of the study, snakes from each group were killed and the structure of the ileum examined using light and electron microscopy.

(a) The images below show sections through villi from the ileum of a snake from each group.

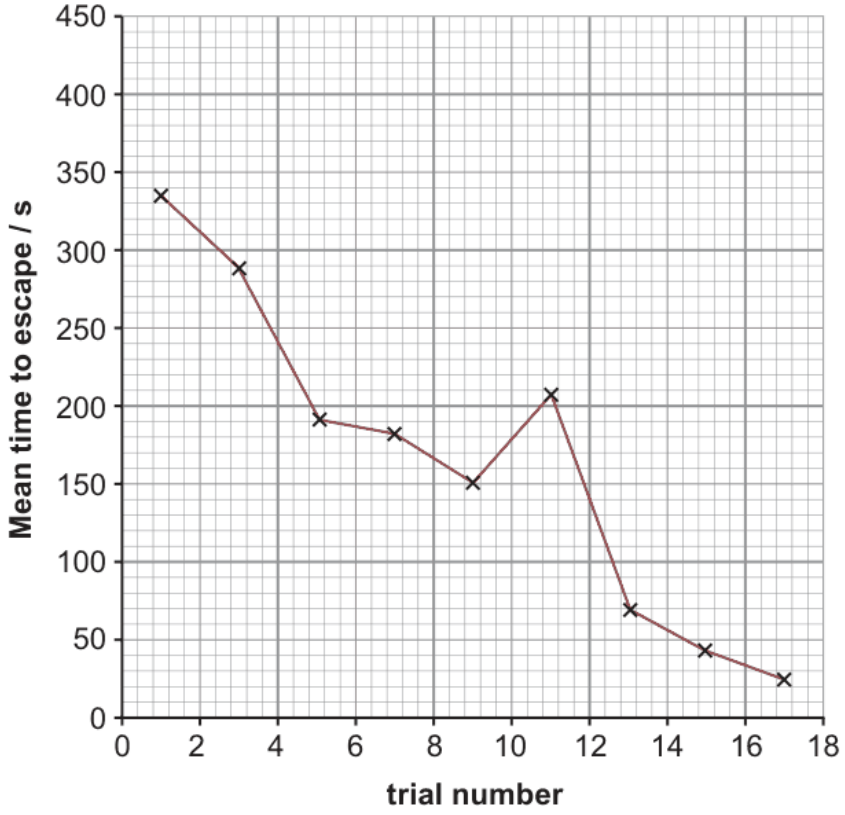


(i) The width of the villus shown by **X-X** in the Group **1** snake was 140 µm and the width of the villus in the Group **2** snake at **Y-Y** was 96 µm. Calculate the percentage decrease in the width of the villus when deprived of food. [2]

Percentage decrease in width = ...

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(c) In order to better understand learning in animals, researchers presented spotted hyenas *(Crocuta crocuta)* with a problem-solving task. Hyenas were placed in a puzzle box and were encouraged to escape to reach food placed outside. Researchers timed how long it took the hyenas to escape. The experiment was repeated several times.



(i) Calculate the percentage change in mean time to escape between the start and end of the trials. [2]

percentage change in mean time = ...

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4. Myoglobin is a type of protein that works in a similar way to haemoglobin. It is found inside muscle cells.

The table below shows both the myoglobin concentration and oxygen carrying capacity of skeletal muscle from a variety of terrestrial and marine mammals.

Habitat	Organism	Myoglobin concentration /g kg^{-1} muscle	O_2 carrying capacity /cm^3 kg^{-1} muscle
Terrestrial	Human	6.0	8.0
	Dog	6.7	9.0
	Rat	3.0	4.0
Marine	Harbour porpoise	41.0	56.0
	Harbour seal	52.1	69.8
	Weddell seal	44.6	59.8

(a) A Harbour seal is a marine mammal which lives and hunts for food (mostly fish) in the sea. It is very well suited to its environment and spends long periods of time under water when hunting.



(i) A Harbour seal has a muscle mass of 60% of its total body mass. Calculate the muscle mass of a 70 kg Harbour seal and use this to calculate the total oxygen carrying capacity of its myoglobin. [2]

Total oxygen carrying capacity = ... cm^3

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(c) Many damselfish species live between the branches of coral, where they feed on algae and obtain protection from predatory fish. They also feed on suspended plankton away from the coral but never swim far beyond it.

Image 1.4 shows a population of *Chromis viridis* around a colony of coral.

Image 1.4



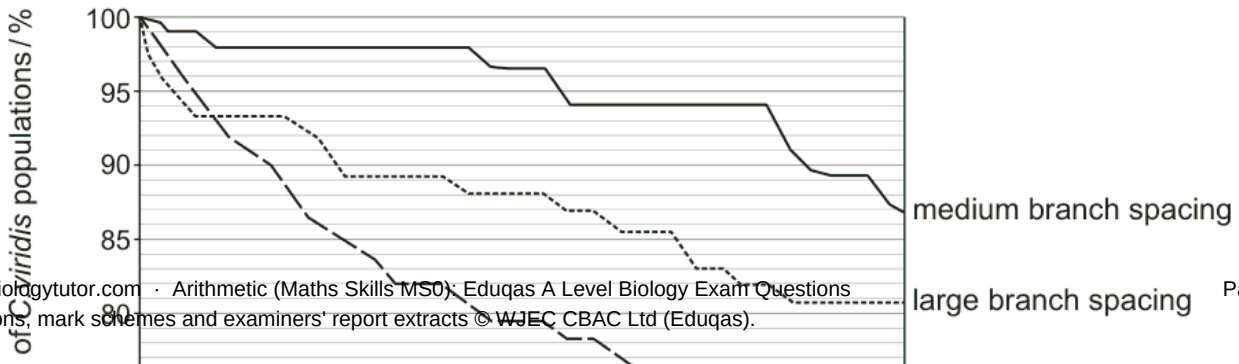
The spacing size between branches of host coral affects damselfish survival.

In an investigation:

- *S. hystrix* corals with the same diameter were monitored from the time of initial colonisation by a population of young *C. viridis*.
- Each coral was identified as having either large, medium or small branch spacing.
- The number of fish within each coral was counted every day for 30 days.
- The percentage of the initial population surviving after each day was calculated.

Graph 1.5 shows percentage survival for *C. viridis* populations within three sizes of coral branch spacing.

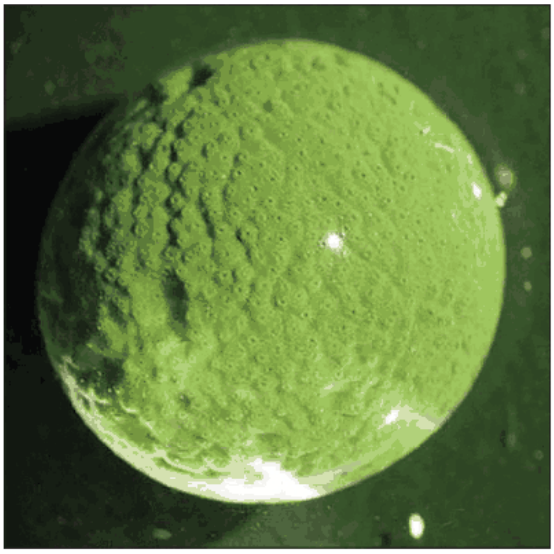
Graph 1.5



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2. *Gromia sphaerica* is a single-celled protoctist. Individuals have been discovered with a diameter of 40 mm in the Arabian Sea and others with a diameter of 30 mm in the sea in the Bahamas. **Image 2.1** shows one of these cells.

Image 2.1



(a) Individuals of *Gromia* are approximately spherical.

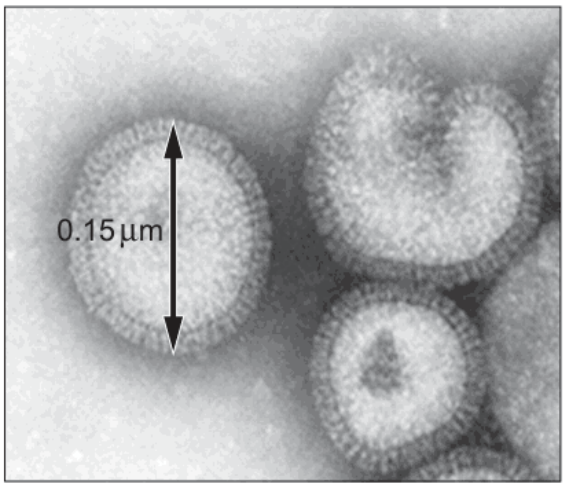
(i) The surface area of the *Gromia* from the Arabian sea was 20 096 mm^2 and the volume was 296 947 mm^3. Calculate the surface area to volume ratio for this organism. [2]

Surface area : volume ratio = ... : 1

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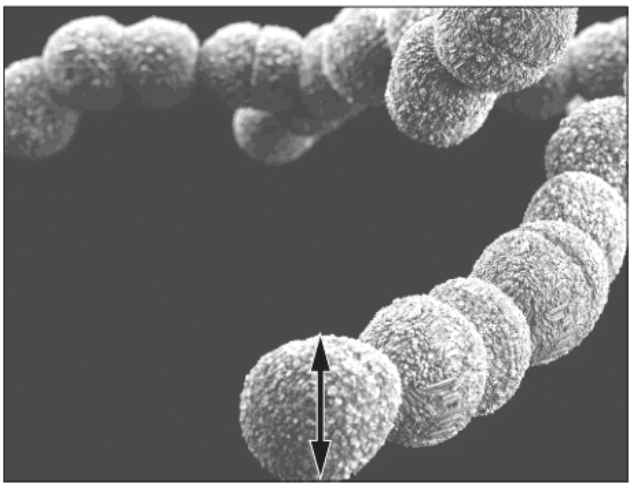
Images 7.5A and **7.5B** shows electron micrographs of flu viruses and *Streptococcus* bacteria. They have a similar shape although their size and structure are different.

Image 7.5A



Flu virus
Magnification = × 200 000

Image 7.5B



Streptoccocus bacteria
Magnification = × 20 000

(d) The diameter of the bacterium in **Image 7.5B** at the position of the arrow was calculated to be **0.75 µm**.
Calculate how many times larger the *Streptoccocus* bacterium is compared to the flu virus. [2]

Answer = ... times larger

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Question 17 · A level Component 2 · June 2018 · Q4(d) · 3 marks

(d) In the USA wheat prices are quoted per bushel, (a unit of volume). In Europe wheat prices are quoted per kg. Rex Ryder is a Kansas farmer who harvests his wheat into a truck that holds 998 bushels. During the harvest in 2015 he filled the truck 22 times. His farm covers 492 acres.

Estimate how many bushels of wheat he produced per acre to the nearest bushel and suggest **one** advantage and **one** disadvantage of using prices per kg rather than per bushel. [3]

Estimate

.....

.....

Advantage

.....

.....

Disadvantage

.....

.....

Question 18 · A level Component 1 · June 2022 · Q1(b)(ii) · 2 marks

(ii) For a culture in which cells divide every 20 minutes, calculate how many cells will be produced after eight hours from a single bacterium. **Express your answer in the form 2^n where n = the number of generations.** [2]

Number of bacteria after eight hours = ...

Question 19 · A level Component 2 · Autumn 2020 · Q2(b)(ii) · 1 mark

(ii) Estimate the **minimum number** of cell divisions needed to produce the 959 body cells (somatic cells) found in the adult hermaphrodite nematode. [1]

Minimum number of cell divisions = ...

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Classification of ferns was originally based on morphological features, but cross-fertilisation between unrelated species has produced hybrids that have often been classified as different species.

In recent years, analysis of the chloroplast genome has enabled botanists to identify hybrid forms as the chloroplast is inherited only from the female gamete.

Image 6.2 shows the gel electrophoresis of digested chloroplast DNA from four species of *Asplenium* fern. A DNA ladder was included to estimate the length of DNA fragments from the species of fern in number of base pairs.

Image 6.2

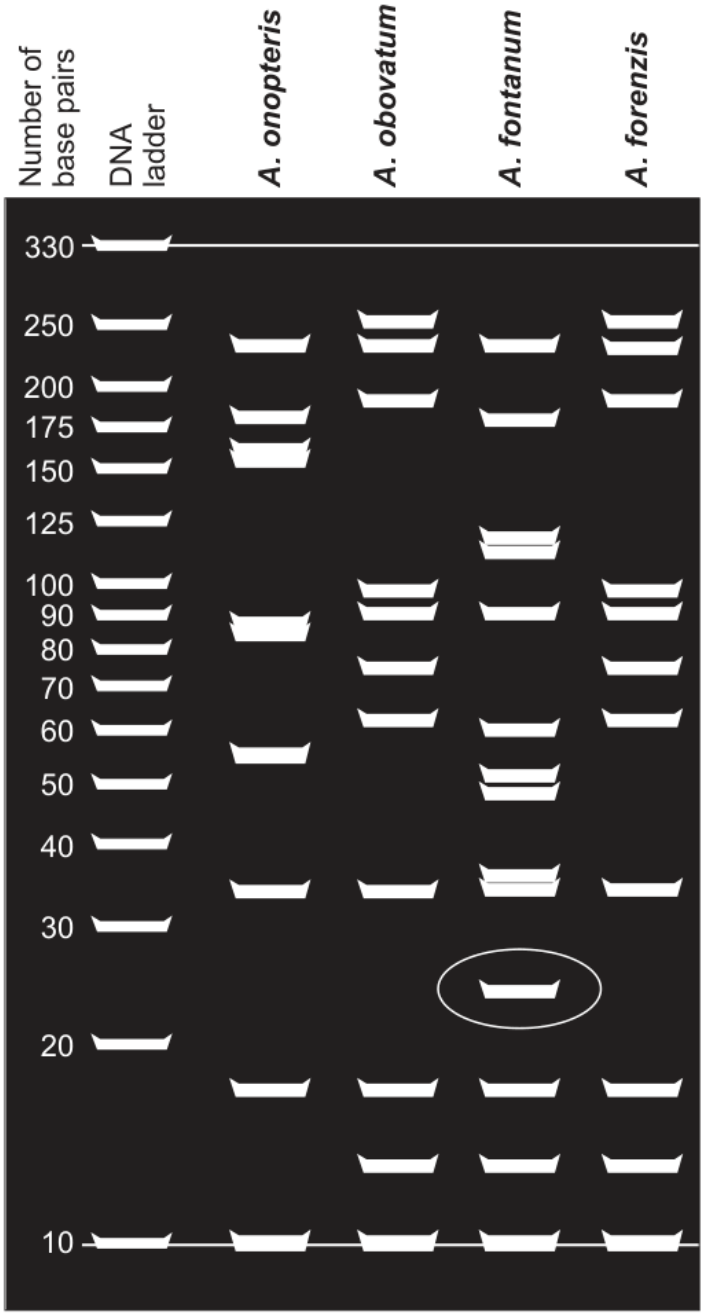


Table 6.3

number of base pairs	$\log_{10}$ number of base pairs	distance travelled / mm
10	1.00	128
20	1.30	103
30	1.47	88
40	1.60	78
50	1.70	70
60	1.78	63
70	1.85	57
80	1.90	53
90	1.95	48
100	2.00	44
125	2.10	36
150	.....	30
175	2.24	25
200	2.30	19
250	.....	10
330	2.52	0

(b) (i) **Complete table 6.3** by calculating the $\log_{10}$ value of the number of base pairs in the DNA fragments in the DNA ladder. [1]

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Mark schemes

Question 1 · A level Component 2 · Autumn 2020 · Q5(c)(i) · 2 marks

	(c)	(i)	16g (2) **if incorrect:** 16 000 (mg) (1) 1000 + (500 x 30) (1)	2	2	2	

Question 2 · A level Component 1 · June 2017 · Q7(c)(i) · 2 marks

	(c)	(i)	Total energy consumed = 240 x 25 x 0.18 (1) 2 = **1080 kJ** (1)	2	2	

Question 3 · A level Component 1 · June 2017 · Q7(c)(ii) · 2 marks

		(ii)	1080/84 x 10 000/250 = **514/514.3 kJ** per day per hectare ecf 2	2	2	

Question 4 · A level Component 1 · June 2017 · Q7(c)(iii) · 1 mark

	(iii)	514/550= **0.9/0.935/0.934/0.93/0.94/1** squirrels per hectare ecf 1	1	1	

Question 5 · A level Component 1 · Autumn 2021 · Q7(b)(i) · 2 marks

	(b)	(i)	1.2×10^5 [2] If incorrect award 1 mark for: 120000	2	2	2

Question 6 · AS Component 2 · June 2016 · Q3(d) · 2 marks

3	*(d)*	Volume exuded by 50 tubes in 6 hours = 0.015 mm^3 Volume exuded by 1 tube in 1 hour = $\frac{0.015}{6x50}$ (1) = 5×10^{-5} (1) 2 marks for correct answer in correct standard form If incorrect Award 1 mark for 0.00005 or Award 1 mark for sight of = $\frac{0.015}{6x50}$	2	2	2	

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Question 7 · AS Component 2 · June 2024 · Q2(b)(ii) · 3 marks

(ii)	5.76×10^{12} (3) **Award two marks for** 5,760,000,000,000 correct answer in incorrect standard form **If incorrect award one mark for any of:** 576 (cm^3) $\frac{16000}{100} \times 3.6$; or $\frac{1.6 \times 10^4}{10^2} \times 3.6$	3	3	3

Question 8 · A level Component 2 · June 2023 · Q5(b)(i) · 3 marks

(b)	(i)	1.003×10^3 mm or 1.00×10^3 mm (3 marks) If incorrect award 2 marks for 1 003 000 (µm) 1.003×10^6 (µm) 1003 (mm) If incorrect award 1 mark for $2.95 \times 10^6 \times 0.34$ = (length in µm)	3	3	3

Question 9 · A level Component 1 · Autumn 2021 · Q5(a)(i) · 3 marks

5	(a)	(i)	-41% [3] If incorrect award 2 marks for (-)40.99/ 41 If incorrect award 1 mark for (1288-760)/ 1288 x 100 528 Allow for doubling of numbers to allow for pairs	3	3	3

Question 10 · A level Component 1 · June 2019 · Q6(a) · 3 marks

6	(a)	1 455/ 1 456/ 1 455.5 = 3 marks If incorrect award 1 mark for each of any number divided by 2 (to show breeding pairs) any number multiplied by 1 025/100 or 10.25	3	3	3

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Question 11 · A level Component 3 · June 2018 · Q4(a)(i) · 2 marks

4	(a)	(i)	Accept range between (-) 31 to 31.43% = 2 marks If incorrect award 1 mark for (140µm – 96µm)/140µm x 100	1 1		2	2	

Question 12 · A level Component 3 · June 2017 · Q9(c)(i) · 2 marks

	(c)	(i)	335-25/335 x100 / 25-335/335 x 100 (1) 92.5%/ 93% / -92.5% / -93% (2)	2		2	2	

Question 13 · AS Component 2 · June 2017 · Q4(a)(i) · 2 marks

4	(a)	(i)	Total muscle mass = 70 x 60/100 = 42(kg) (1) O_2 capacity of muscle = 42 x 69.8 = 2931.6/ 2932/ 2930 cm^3 = 2 marks			2	2	2

Question 14 · AS Component 2 · June 2024 · Q1(c)(i) · 1 mark

	(c)	(i)	Different {group sizes / population sizes} would not be comparable / different numbers of fish in each coral at the start (1)			1	1	1

Question 15 · A level Component 3 · June 2022 · Q2(a)(i) · 2 marks

2	(a)	(i)	0.07 / 0.067675376 or correct rounding (: 1) = 2 marks Award 1 mark for $\frac{20096}{296947}$ 0.067675376 rounded incorrectly			2	2	2

Question 16 · A level Component 3 · June 2022 · Q7(d) · 2 marks

(d)	5 times larger (2) 0.75 (1) 0.15					2	2	2

Question 17 · A level Component 2 · June 2018 · Q4(d) · 3 marks

	(d)	Accept any value in range 40-45 (1) Advantage – more accurate/takes account of quality of grains/internationally understood unit/seeds settle over time decreasing volume (1) Disadvantage – need to weigh the grains/grains dry over time(1)	1	2	3	1		

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Question 18 · A level Component 1 · June 2022 · Q1(b)(ii) · 2 marks

	(ii)		2^{24} = 2 marks For 1 mark: sight of calculation of 24 generations/ 16777216	2	2	2		

Question 19 · A level Component 2 · Autumn 2020 · Q2(b)(ii) · 1 mark

		(ii)		10 (mitotic) divisions		1		1		

Question 20 · A level Component 2 · Autumn 2020 · Q6(b)(i) · 1 mark

	(b)	(i)		All correct (1) 150 2.18 250 2.40		1		1	1		

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