Cambridge International AS & A Level

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CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

3060741898

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

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1 **(a)** Some students were asked to use leaf discs to investigate photosynthesis in leaves of different types.

The students decided to compare the rate of photosynthesis in four different types of leaf in a room kept at a temperature of 20 °C.

The leaves were taken from:

- ivy, which has a thick waxy cuticle on the upper surface
- geranium, which has a thin cuticle on the upper surface
- spiderwort, which has purple and green stripes and a thin cuticle
- sorghum, which has a thick waxy cuticle on the upper surface.

The students prepared leaf discs of the same diameter from all four types of leaf and placed them onto damp paper in Petri dishes. Each Petri dish was covered by a lid.

When first placed in a solution, the leaf discs sink. As photosynthesis occurs oxygen is released and the discs rise to the surface. The time taken for the discs to reach the surface allows the rate of photosynthesis to be determined.

Fig. 1.1 shows leaf discs rising to the surface after being placed in a solution of sodium hydrogencarbonate.

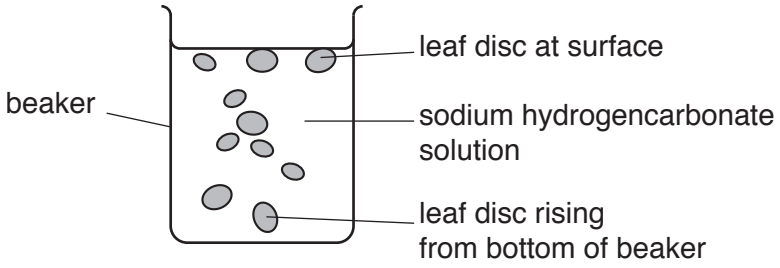


Fig. 1.1

(i) State the independent variable **and** the dependent variable in this investigation.

independent variable .....

.....

dependent variable .....

..... [2]

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(ii) Use the information provided to describe a method by which the students could compare the rate of photosynthesis in discs cut from the four types of leaf.

Your method should be set out in a logical order and be detailed enough to let another person follow it.

Details of the preparation of the leaf discs are **not** required.

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(b) The students' results are shown in Table 1.1.

Table 1.1

type of leaf	ivy	geranium	spiderwort	sorghum
mean time for leaf discs to reach the surface / s	130	75	95	100

(i) Describe how the students could calculate the rate of photosynthesis from their results.

.....

..... [1]

(ii) The students made three conclusions.

conclusion 1
Leaves with a thick cuticle absorb less light and photosynthesise more slowly than leaves with a thin cuticle.

conclusion 2
Leaves of spiderwort have a slower rate of photosynthesis because they have less chlorophyll than other plants.

conclusion 3
Sorghum is a C4 plant and so its leaves photosynthesise faster than those of ivy which is a C3 plant.

Each of these conclusions is supported by the evidence, but may **not** be valid.

Explain why each conclusion may **not** be valid, using the information in **(a)** about the leaves and the method used to determine the rate of photosynthesis.

conclusion 1 .....

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conclusion 2 .....

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conclusion 3 .....

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[3]

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(c) A colorimeter passes a beam of light through a coloured filter into a solution and measures the light absorbance of that solution.

A standard solution is used to set the colorimeter scale to zero (0) before taking any measurements.

Chlorophyll absorbs red light, so the chlorophyll concentration of a leaf extract can be measured using a colorimeter.

(i) Outline how the students could use a colorimeter to obtain further evidence to support the conclusion that leaf discs of spiderwort have a lower chlorophyll content than the leaf discs from the other types of leaf investigated.

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..... [3]

(ii) Suggest a standard solution that could be used in the colorimeter to ensure that light absorbance is due **only** to the chlorophyll in a leaf extract.

..... [1]

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(d) Table 1.2 shows the students' results from the colorimeter measurements made on 10 samples of each of the four types of leaf.

Table 1.2

type of leaf	ivy	geranium	spiderwort	sorghum
mean absorbance ± *s*	0.28 ± 0.08	0.32 ± 0.1	0.43 ± 0.18	0.39 ± 0.21

The students decided to use the *t*-test to test the hypothesis that:

The difference in the chlorophyll concentration between spiderwort and each of the other plants is significant.

The formula for the *t*-test is shown in Fig. 1.2.

$$t = \frac{\left|\bar{x}_1 - \bar{x}_2\right|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}} \qquad \nu = n_1 + n_2 - 2$$

ν = degrees of freedom
s = standard deviation
n = sample size (number of observations)
$\bar{x}$ = mean

Fig. 1.2

Comment on the use of the *t*-test by:

stating how many values of *t* the students should calculate **and** explaining your answer

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explaining how the students would find out if the results of their *t*-tests were significant.

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[4]

[Total: 21]

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2 The red squirrel is a tree-living mammal native to woodlands in the United Kingdom. The population and distribution of the red squirrel have been decreasing since the introduction of a North American species of grey squirrel. The grey squirrel occupies an ecological niche that overlaps with that of the red squirrel, but the grey squirrel is a better competitor.

One cause of the decline in red squirrels is the clearance of woodland for development. New areas of woodland have been planted, but the species of tree planted have changed over time.

Table 2.1 shows the changes in species composition of woodland in England and Scotland from 1980 to 1990 and the suitability of each species as habitats for red and grey squirrels.

Table 2.1

tree species		**suitability of tree species as a habitat for squirrels**	**percentage change in species composition**	
			England	**Scotland**
narrow-leaved trees	Sitka spruce	poor for both species	+14	+61
	Scots pine	poor for both species	−5	+8
	Norway spruce	good for both species	−21	−28
	Douglas fir	good for both species	+3	+1
	European larch	good for red squirrels	−34	−39
	Japanese larch	good for red squirrels	−3	+21
broad-leaved trees		good for grey squirrels	+36	+68

(a) (i) Use the information in Table 2.1 to summarise the effects on habitat for these species of squirrel as a result of the changes in the tree species composition in woodland.

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..... [3]

(ii) Suggest why the populations of red squirrels in England and Scotland have decreased.

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..... [2]

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[Turn over

(b) Squirrel parapoxvirus (SPPV) infects both red squirrels and grey squirrels.
Grey squirrels develop immunity to SPPV, but red squirrels are killed by this virus.

One method used to conserve red squirrels on an island involved culling all the grey squirrels.

During the cull, research was carried out to find the percentage of grey squirrels that were immune to SPPV. When the cull started the island had an estimated population of 40 red squirrels and 3000 to 4000 grey squirrels.

The research involved several steps.

- Traps were placed at a density of 1 per 0.01 km^2 in broad-leaved woodland and 2 per 0.01 km^2 in narrow-leaved woodland.
- Humane steel traps, all of the same size, were used. Non-target animals caught were released, any grey squirrel was killed.
- Blood samples were taken from grey squirrels trapped between January and August at randomly selected habitats.
- A standard test for antibodies to SPPV was used to screen the blood samples.
- A control sample of grey squirrels from the mainland was tested in 2010.
- The percentage testing positive for antibodies to SPPV was calculated for each sample.

Table 2.2 shows the results of this research.

Table 2.2

year	number of grey squirrels tested	percentage positive for SPPV antibodies
1999	23	52
2002	20	75
2003	99	40
2007	54	13
2010	28	4
2010 (control)	70	67

(i) State two variables that were controlled during the research.

1 .....

2 .....
[2]

(ii) The researchers concluded that culling could help to reduce the spread of SPPV.

State how the evidence in Table 2.2 supports this conclusion.

.....

..... [1]

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Culling of grey squirrels on the island successfully removed all of them by 2013. Subsequently the population of red squirrels has increased.

Culling of grey squirrels has also occurred on the mainland in areas occupied by both species. Within a few months of the end of a cull, the grey squirrel population returns to pre-cull level and the red squirrel population is unchanged.

(iii) Suggest why the cull on the mainland is less effective at removing grey squirrels than the cull on the island.

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..... [1]

[Total: 9]

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CANDIDATE NAME

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8490614715

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2018**

1 hour 15 minutes

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1 During the light dependent stage of photosynthesis, hydrogen ions and electrons are released by the photoactivation of chlorophyll and the photolysis of water. These are added to the carrier molecule, NADP, changing it from an oxidised state to a reduced state, as shown in Fig. 1.1.

$$2H^+ + 2e^- + \text{oxidised NADP} \longrightarrow \text{reduced NADP}$$

Fig. 1.1

DCPIP is a blue dye which becomes colourless when reduced by hydrogen ions and electrons, as shown in Fig. 1.2.

oxidised DCPIP (blue) ⟶ reduced DCPIP (colourless)

Fig. 1.2

A student used DCPIP to determine if the reactions in the light dependent stage had occurred in a suspension of chloroplasts.

- The suspension of chloroplasts was prepared by grinding, filtering and centrifuging a sample of leaves with ice-cold extraction medium.
- Four tubes covered in foil were set up containing the mixtures shown in Table 1.1.

Table 1.1

tube	contents
1	chloroplast suspension and DCPIP
2	chloroplast suspension and distilled water
3	DCPIP and extraction medium
4	chloroplast suspension and DCPIP

- The tubes were illuminated through a thin glass tank filled with water as shown in Fig. 1.3.

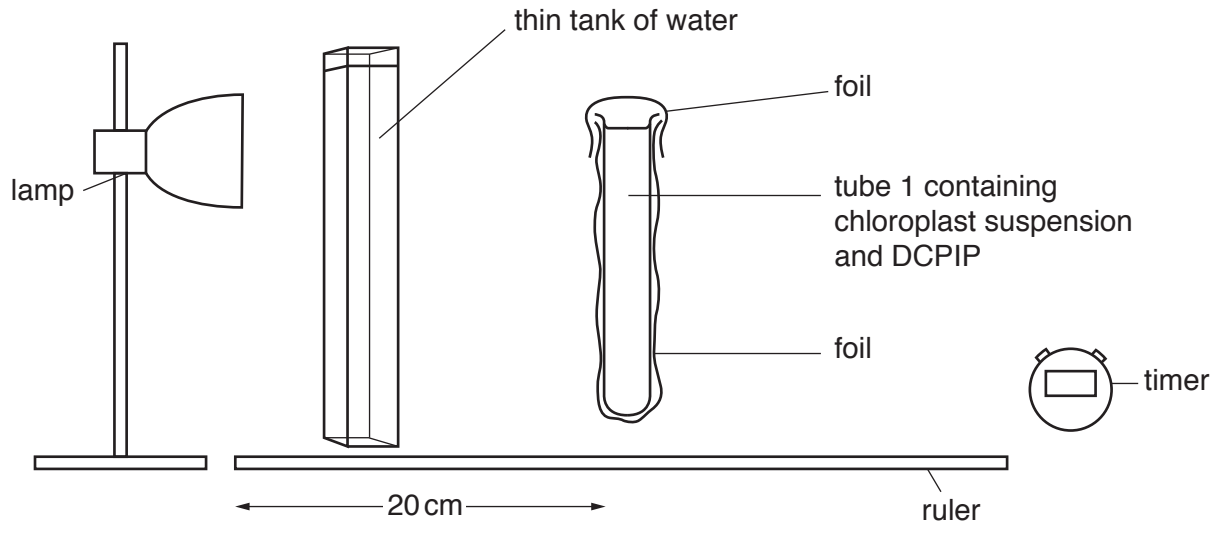


Fig. 1.3

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- The foil was removed from tubes 1, 2 and 3, but left on tube 4.
- A timer was started immediately.
- After 10 minutes the colour in each tube was observed and recorded.

Table 1.2 shows the student's results.

Table 1.2

tube	contents	foil	colour after 10 minutes
1	chloroplast suspension and DCPIP	removed	green
2	chloroplast suspension and distilled water	removed	green
3	DCPIP and extraction medium	removed	blue
4	chloroplast suspension and DCPIP	left in place	blue

(a) State why the results in Table 1.2 are qualitative.

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..... [1]

(b) Explain why tubes 2, 3 and 4 were included.

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..... [2]

(c) State the function of the thin tank of water.

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..... [1]

The student then modified the investigation to test the hypothesis:

As light intensity increases the rate of the light dependent stage of photosynthesis will increase.

(d) **(i)** Identify the independent variable **and** the dependent variable in this investigation.

independent .....

dependent .....

[2]

(ii) Using the apparatus shown in Fig. 1.3, describe a method the student could use to collect the data needed to test their hypothesis.

Your method should be set out in a logical way and be detailed enough to let another person follow it.

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(e) Light intensity (I) can be calculated using the formula shown in Fig. 1.4.

$$I = \frac{1}{\text{distance}^2}$$

Fig. 1.4

Use the formula shown in Fig. 1.4 to calculate the light intensity for the investigation shown in Fig. 1.3.

I = ... [1]

(f) The student prepared two tubes with the same contents as tube 1 (Table 1.1) from their original investigation. One tube was exposed to high light intensity and the other tube was exposed to low light intensity.

A colorimeter was used to measure the absorption values of samples taken from these tubes, at one minute intervals, over a period of 12 minutes.

Fig. 1.5 shows the absorption results at high light intensity.

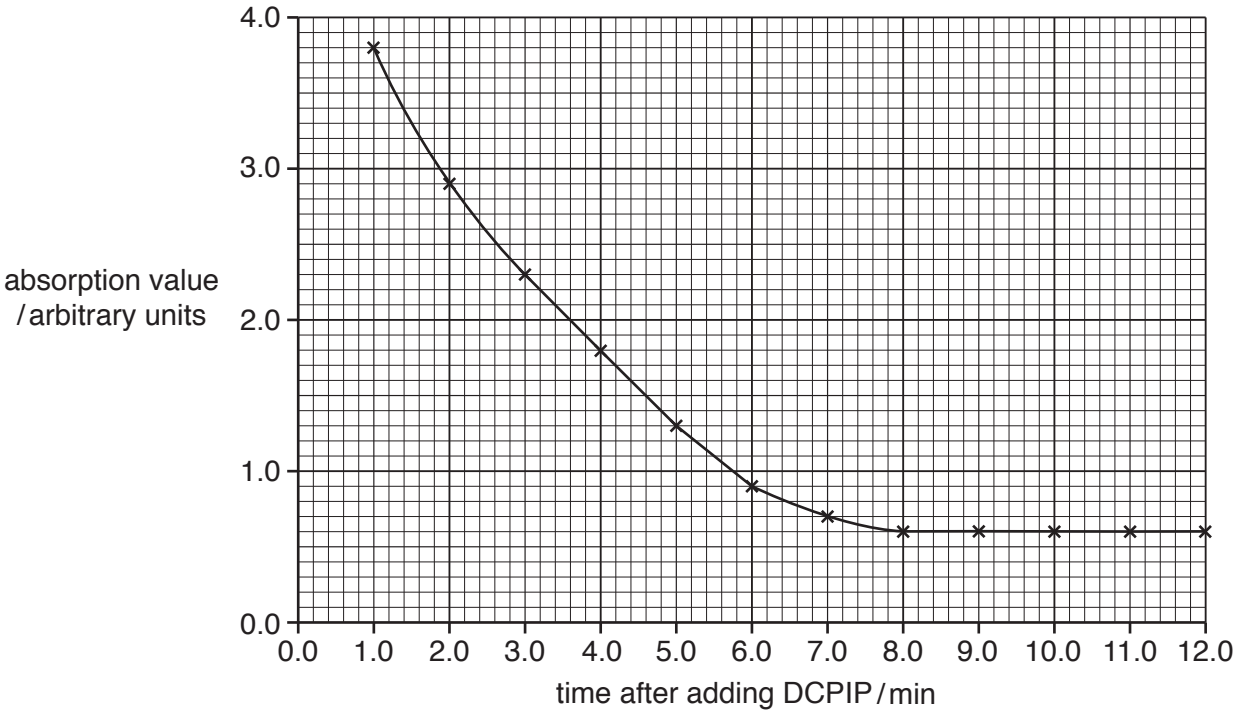


Fig. 1.5

(i) The student concluded that the reaction reached completion at 8 minutes.
State why the data in the graph do **not** support this conclusion.

.....

..... [1]

(ii) Draw a tangent on Fig. 1.5 **and** use it to calculate the rate of change at 6 minutes.

rate of change at 6 minutes = ... arbitrary units
[2]

(iii) On Fig. 1.5, sketch the curve that you would expect for the tube at low light intensity. [1]

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(g) The student then investigated the effect that three different weed killers had on the light dependent reaction.

- Four tubes covered in foil were set up containing the mixtures shown in Table 1.3.
- The volume of each component in the mixtures was standardised.

Table 1.3

tube	contents
1	chloroplast suspension, DCPIP and distilled water
2	chloroplast suspension, DCPIP and weed killer **X**
3	chloroplast suspension, DCPIP and weed killer **Y**
4	chloroplast suspension, DCPIP and weed killer **Z**

- The foil was removed and the tubes were illuminated as in the original investigation shown in Fig. 1.3.
- After 10 minutes the student used a colorimeter to measure the absorption value of the contents of each tube.
- The investigation was repeated a number of times and means were calculated.
- *t*-tests were used to compare the results for the tubes.

The results of all the *t*-tests are shown in Table 1.4.

Table 1.4

	$p < 0.05$		
contents of tube	**no weed killer added**	**weed killer X**	**weed killer Y**
no weed killer added			
weed killer **X**	not significant		
weed killer **Y**	significant	significant	
weed killer **Z**	significant	not significant	not significant

(i) Suggest a null hypothesis for the *t*-test used for tubes 1 and 2.

.....

..... [1]

(ii) The *t*-tests were used to compare the means.
State **one** feature of data that allows use of the *t*-test.

.....

..... [1]

(iii) The student calculated that there were 22 degrees of freedom in each of these *t*-tests. An equal number of replicates for each tube was carried out.

State the number of replicates of **each** tube that were carried out.

.....

..... [1]

(iv) The critical value for t at $p < 0.05$ in this investigation was 2.07.

State what the results in Table 1.4 tell you about the student's **calculated value** of t when comparing the effect between weed killers **X** and **Y**.

..... [1]

[Total: 22]

2 Red deer are herbivores common in the highlands of Scotland. They have no natural predators and in some areas culling of the deer is carried out in order to manage their numbers and maintain the species diversity of the ecosystem.

A group of scientists read a report which suggested that allowing sheep to graze alongside deer significantly reduces the need to cull the deer. They decided to carry out a survey to investigate the number of deer found grazing at 16 different sites.

- 8 sites contained deer **and** sheep.
- 8 sites contained deer but **no** sheep.
- Each site was visited during the first week of April and the first week of July in 2007 and again in 2009.
- Each site was 0.25 × 0.25 km.
- Within each site, three 10 × 10 m study plots were selected at random.
- The scientists used dung counts along a 1 × 10 m strip around each study plot to provide an estimate of the number of deer and sheep present. Dung is a pile of animal faeces.

Fig. 2.1 shows one study plot.

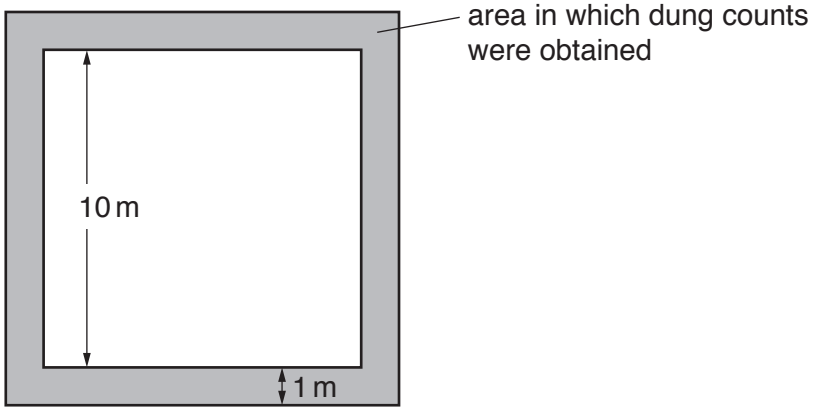


Fig. 2.1

(a) Describe a method that the scientists could have used to select the study plots randomly.

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..... [2]

(b) Suggest why counting the dung may **not** provide an accurate estimate of deer or sheep numbers.

.....

..... [1]

(c) State two variables that were standardised by the scientists.

1 .....

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2 .....

..... [2]

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(d) The scientists also counted the number of plant species present within each of the 16 sites.

Fig. 2.2 shows the mean deer dung count for each site and the number of plant species present within each site.

Fig. 2.3 shows the mean deer dung count for the sites containing deer **and** sheep and for the sites containing deer but **no** sheep. Range bars are also included.

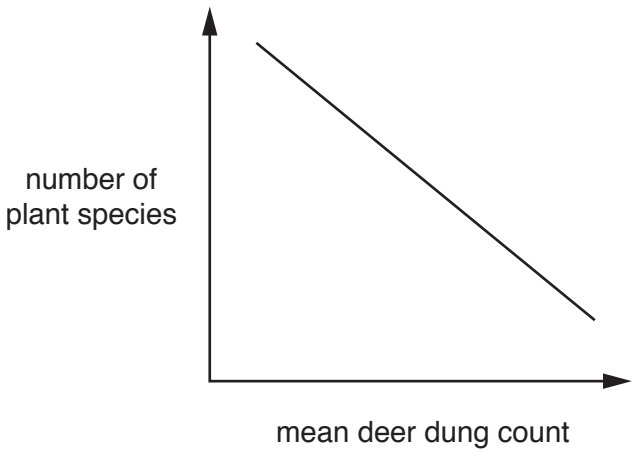


Fig. 2.2

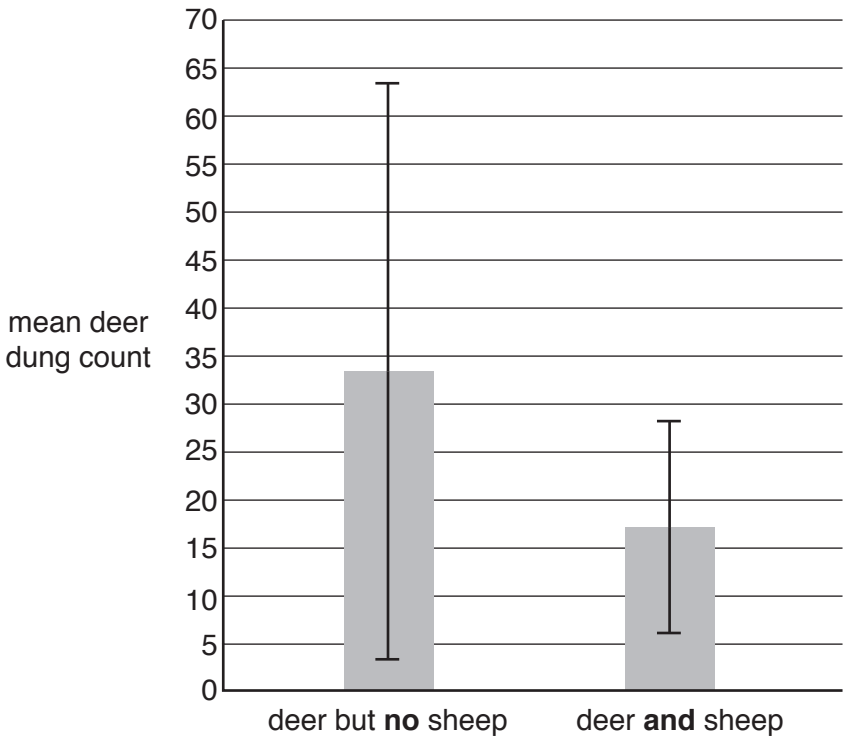


Fig. 2.3

The report that the scientists read suggested that allowing sheep to graze alongside the deer significantly reduces the need to cull the deer in order to maintain species diversity.

Explain why the results shown in Fig. 2.2 and Fig. 2.3 do **not** support this suggestion.

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..... [3]

[Total: 8]

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BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2018**

1 hour 15 minutes

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1 Sodium hydrogencarbonate indicator solution contains sodium hydrogencarbonate.

Some students found out on the internet that this indicator solution changes colour with pH. The students also discovered that this indicator is used to determine the concentration of carbon dioxide in a solution.

The students decided to use this indicator to measure the rate of photosynthesis in algal balls. Algal balls are unicellular algae that are immobilised in alginate.
The students assumed that the rate of carbon dioxide uptake was proportional to the rate of photosynthesis.

Fig. 1.1 shows the apparatus that the students used.

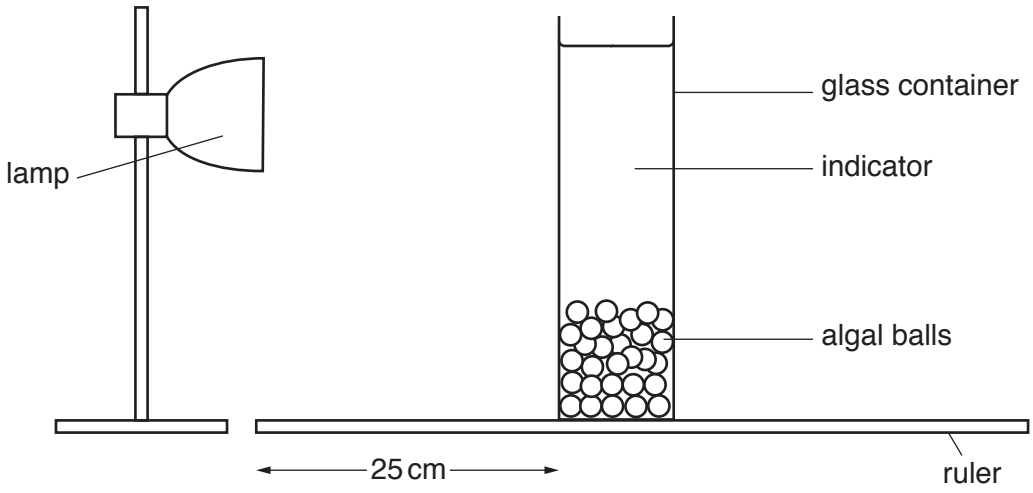


Fig. 1.1

A laboratory technician prepared a series of test-tubes containing hydrogencarbonate indicator solution from pH 7.6 to pH 9.2. The colour of the indicator solution in each test-tube is described in Table 1.1.

Table 1.1

← increasing CO_2 in indicator solution					decreasing CO_2 in indicator solution →			
pH 7.6	pH 7.7	pH 8.0	pH 8.2	pH 8.4	pH 8.6	pH 8.8	pH 9.0	pH 9.2
light yellow	dark yellow	light orange	dark orange	red	light magenta	dark magenta	light purple	dark purple

(a) Suggest what was added to each of the test-tubes to maintain the pH.

..... [1]

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(b) Unicellular algae can be immobilised using a technique that is similar to that used to immobilise enzymes.

Outline the method that the students would have used to immobilise the algae.

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(c) The students used the apparatus shown in Fig. 1.1 and the colours described in Table 1.1 to investigate the effect of light intensity on the rate of photosynthesis.

The students proposed the following hypothesis:

As light intensity increases the rate of photosynthesis increases.

(i) Identify the independent variable **and** the dependent variable in this investigation.

independent variable .....

dependent variable .....
[2]

(ii) Describe a method the students could use to collect the data needed to test their hypothesis.

Your method should be set out in a logical way and be detailed enough to let another person follow it.

You should **not** repeat any details from **(b)** about how to prepare immobilised algal balls.

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(iii) The students were concerned that the lamp may have increased the temperature of the solution in the container. Suggest how they could have attempted to control this variable.

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..... [1]

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(d) The light intensity (I) can be calculated using the formula shown in Fig. 1.2.

$$I = \frac{1}{\text{distance}^2}$$

Fig. 1.2

Use the formula in Fig. 1.2 to calculate the light intensity for the experiment shown in Fig. 1.1.

I = ... [1]

The students decided that using a pH probe would give them more accurate data. They decided to measure the pH change for **one** value of light intensity.

Fig. 1.3 shows their results.

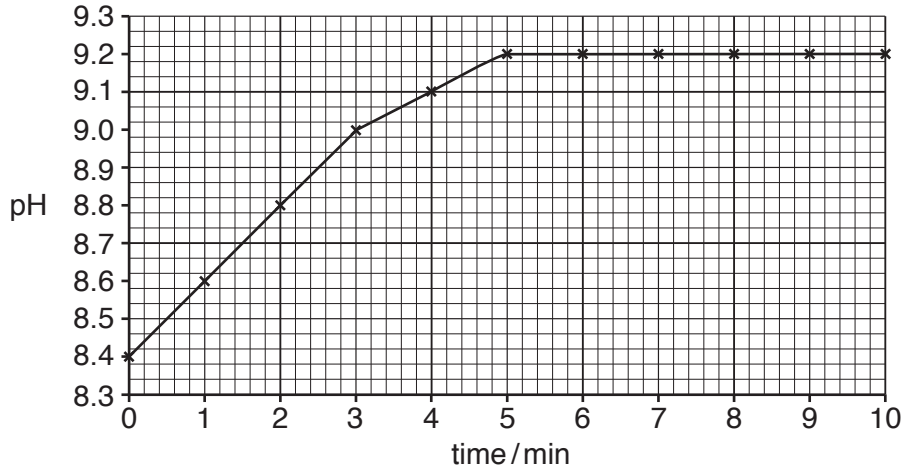


Fig. 1.3

(e) **(i)** State why the use of a pH probe provides more accurate data.

..... [1]

(ii) The data shown in Fig. 1.3 were for a high light intensity.

On Fig. 1.3, sketch the curve that you would expect for a low light intensity. [1]

(iii) State why carbon dioxide is **not** a limiting factor in this investigation.

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..... [1]

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(f) Certain weed killers work by reducing the rate of photosynthesis.

The students modified their method to investigate the effect of three different weed killers on algae at the same light intensity.

The investigation was replicated a number of times and the pH was recorded after 30 minutes. The students calculated the mean pH for each treatment, as shown in Table 1.2.

The students carried out *t*-tests to compare the mean pH for each of the treatments that used weed killers with the treatment that used no weed killer (treatment 1).
The students calculated the value of *t* for each of the tests.

Table 1.2 shows the results from their investigation.

Table 1.2

treatment	**contents**	**mean pH after 30 minutes**	***p* value**
1	algal balls, indicator and distilled water	9.2	
2	algal balls, indicator and weed killer **A**	8.5	< 0.001
3	algal balls, indicator and weed killer **B**	9.0	> 0.05
4	algal balls, indicator and weed killer **C**	8.7	< 0.05

(i) Suggest a null hypothesis for comparing the effect of treatment 2 with treatment 1.

.....

..... [1]

(ii) The *t*-tests were used to compare the means.

State **one** feature of data that allows use of the *t*-test.

.....

..... [1]

(iii) When calculating the effect of weed killer **A** on the rate of photosynthesis, 15 degrees of freedom was chosen. The students carried out 7 replicates of treatment 1.

State how many replicates were carried out for treatment 2.

.....

..... [1]

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(iv) The students concluded that the weed killers had a significant effect on the rate of photosynthesis.

Explain to what extent the *p* values in Table 1.2 support their conclusion.

.....

.....

.....

.....

.....

..... [3]

[Total: 22]

2 Lionfish are a type of fish native to the tropical waters of the Indian Ocean and Pacific Ocean.

Lionfish were first reported off the south east coast of the USA in the 1980s. Lionfish are an alien species to this area. Their lack of a natural predator in these waters resulted in their numbers increasing dramatically, allowing them to migrate to new areas. They have now become established across the Caribbean. Their numbers are so high that they are now a threat to many native species.

(a) In one year it was estimated that 5 million prey were consumed by 1000 lionfish.

Express these data as a ratio.

..... **: 1** [1]

(b) Surveys to assess the changes in lionfish abundance have been carried out every year since 2004. Divers have carried out visual transects at nine sites along a 15km stretch of continuous reef off the coast of one island in the Caribbean.

Visual transects involve swimming in a fixed direction across the reef for a set distance and counting the number of lionfish.

(i) State **one** variable which was standardised in these surveys.

.....

..... [1]

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The mean abundance of lionfish on the reef was calculated for each year. These values are shown in Fig. 2.1 using a log scale. The bars show 95% confidence intervals.

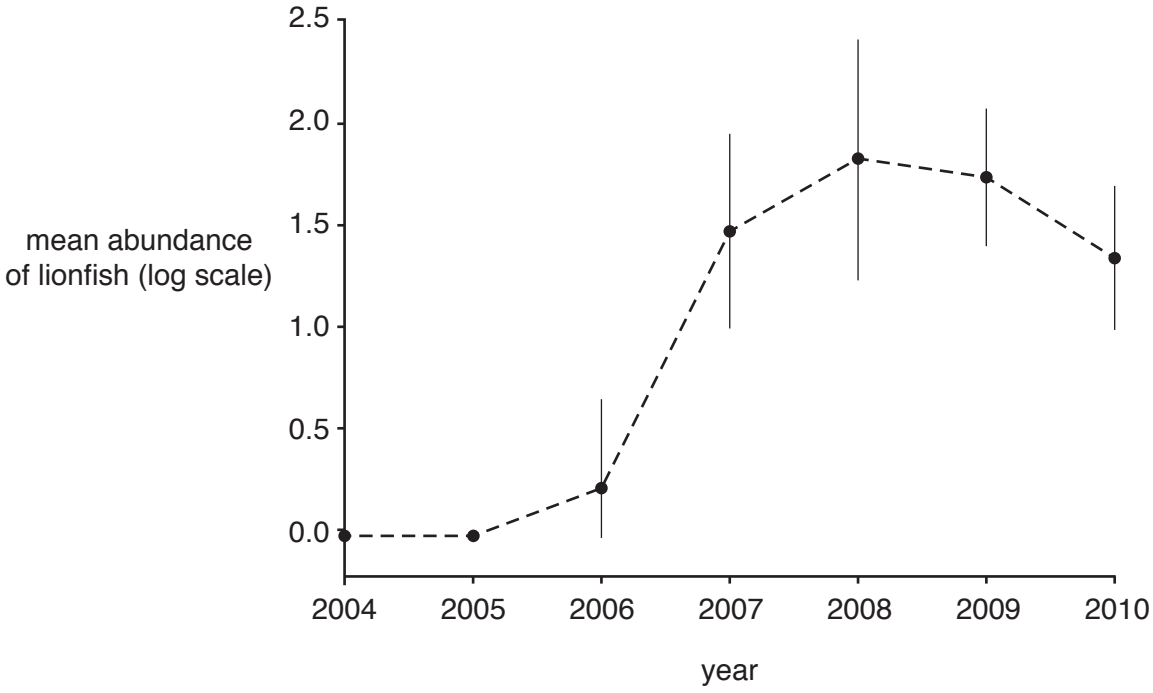


Fig. 2.1

(ii) A group of students read an article stating that local people were being encouraged to catch and eat lionfish in an attempt to reduce their numbers.

The students concluded that local people started catching and eating lionfish in 2008.

Explain to what extent the data in Fig. 2.1 supports their conclusion.

.....

.....

.....

.....

.....

..... [3]

(c) Some local communities hold annual fishing trips where they are encouraged to catch as many lionfish as possible.

In 2010 and 2011, 16 boats took part in these fishing trips. The mean number of lionfish per boat and the 95% confidence intervals were calculated.

Fig. 2.2 shows the results.

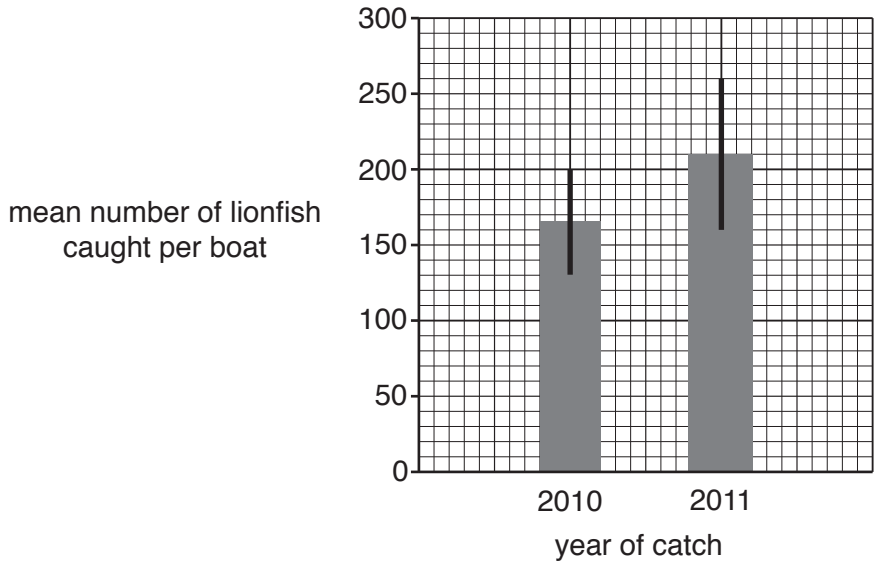


Fig. 2.2

The 95% confidence intervals are calculated from 2 × S_M.

Standard deviation can be calculated by rearranging the equation for standard error shown in Fig. 2.3.

$$S_M = \frac{s}{\sqrt{n}}$$

where S_M = standard error

s = standard deviation

n = number of boats

Fig. 2.3

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Use the data in Fig. 2.2 and the equation in Fig. 2.3 to calculate the standard deviation of the mean number of lionfish caught per boat in 2010.

standard deviation for 2010 = ... [3]

[Total: 8]

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