Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Biology

Advanced Subsidiary

Unit 3: Practical Biology and Research Skills

Tuesday 6 May 2014 – Morning
Time: 1 hour 30 minutes

Paper Reference
WBI03/01

You must have:
Ruler, Calculator, HB pencil

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 40.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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PEARSON

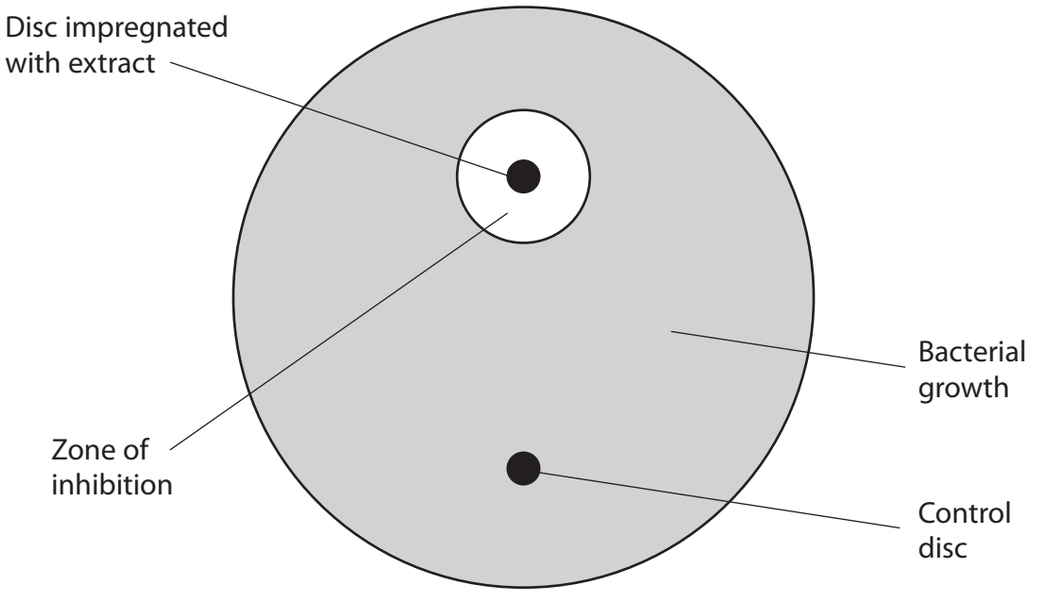
Answer ALL questions.

1 Chinese Senna (*Senna obtusifolia*) is a common plant found in many parts of the world. It is traditionally used to treat a number of bacterial infections.

Some scientists decided to investigate the antimicrobial properties of extracts from *S. obtusifolia* leaves.

The following method was used.

- Dried leaves were crushed in sterile water, to produce an extract.
- The extract was pipetted onto discs of filter paper.
- Other discs of filter paper were soaked in sterile water to use as controls.
- All of the discs were then dried.
- Plates were prepared using agar containing the bacterium *Salmonella typhi*.
- A disc containing the extract *and* a control disc were placed on each of three agar plates.
- The agar plates were incubated for 48 hours.
- The diameter of the zone of inhibition was then measured for each disc as shown in the diagram.



This method was repeated using three organic solvents, A, B and C, to obtain extracts from the leaves, instead of using sterile water.

(a) (i) Name the independent variable in this investigation.

(1)

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(ii) Name the dependent variable in this investigation.

Suggest how this variable was measured.

(2)

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(iii) Name **one** variable that should have been controlled in this investigation.

Describe how this variable could be controlled.

(2)

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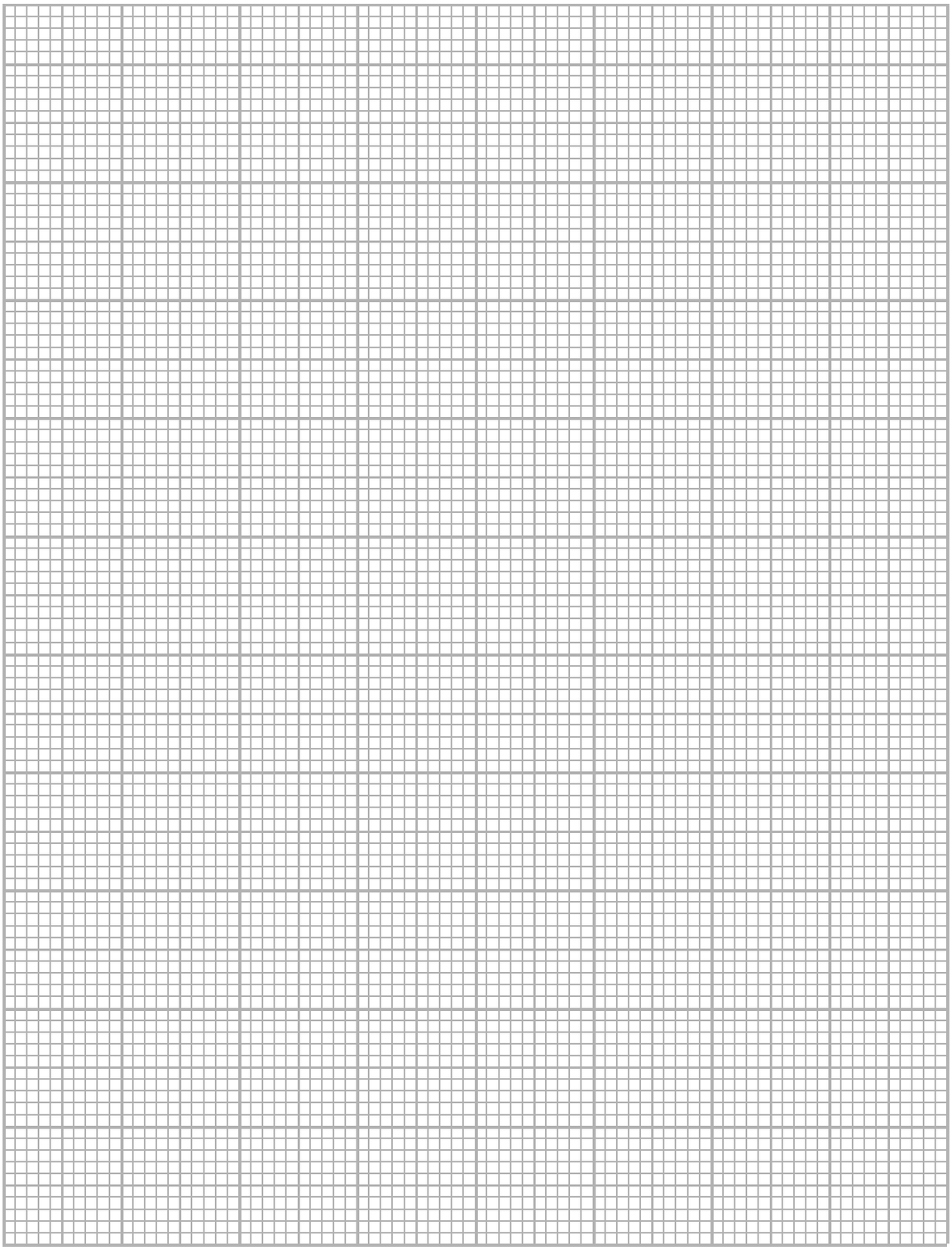
(b) The table below shows the results of the investigation.

Solvent used to prepare extract	Mean diameter of zone of inhibition / mm	Standard deviation
Water	2.1	0.10
Solvent A	11.9	0.51
Solvent B	2.1	0.09
Solvent C	5.8	0.29
None of the control discs had zones of inhibition.		

(i) Plot the information about the solvent used to prepare the extract and the mean diameter of the zone of inhibition in a suitable graphical form.

(4)



(ii) Comment on the reliability of these data.

(2)

(iii) Explain which solvent produces the most effective antimicrobial extract.

(3)

(c) The scientists then studied the effect of **extracts** of *S. obtusifolia* on three more species of bacteria. The table below shows some of their results.

Species of bacterium	Mean diameter of zone of inhibition / mm			
	Water	Solvent A	Solvent B	Solvent C
Streptococcus aeruginosa	2.1	8.1	5.8	5.8
Escherichia coli	5.0	10.0	4.1	6.9
Staphylococcus aureus	5.8	6.2	4.9	4.1

Suggest how these data support the validity of the investigation using *Salmonella typhi*.

(2)

(d) Traditional cures may again be useful as bacteria become resistant to antibiotics. Some antibiotics are expensive and difficult to obtain.

The scientists used the antibiotic Ofloxacin and found that it produces a mean zone of inhibition of 12.0 mm for *Escherichia coli*.

Suggest the advantages and disadvantages of using Senna extract instead of Ofloxacin to treat infections caused by *Escherichia coli.*

(4)

(Total for Question 1 = 20 marks)

2 Read the following extract from a student's **unfinished** report on the topic of parasitic mites on bees.

1. The European honeybee, *Apis mellifera*, is important in agriculture, being the main pollinator of numerous vegetables and fruits. Recently, colony collapse disorder has devastated the honeybee population. One cause of this disorder is the mite *Varroa destructor*, an ectoparasite of the honeybee. It attaches itself to the body of a honeybee, and feeds on its blood. This weakens and shortens the lifespan of the honeybee. The mites also act as vectors for many pathogens. It has been estimated that between 30–50% of honeybee colonies in Britain were destroyed by *Varroa* infestation when the mite first arrived in the UK.

2. The life cycle of the mite is synchronised with that of the honeybee: an adult female mite enters a brood cell in the beehive, where the bee larvae develop. Once there, it feeds on the honeybee and lays eggs. The offspring from these eggs breed in the sealed cell, continuing to feed off the honeybee, until the bee emerges. When this happens, only the mature female mites leave, the male and immature female mites being unable to live outside the brood cell.

3. The *Varroa* mite originates from Asia and it is not known how it arrived in the UK in around 1992, but a possible cause is unintentional transportation of honeybees from infected areas, such as in imported goods.

4. Loss of honeybee colonies through mite infestation can bring economic losses for beekeepers. Those people with a few hives lose a large percentage of their honeybees should a hive be lost.

5. At present, there is no method successful enough to completely remove mites from a colony of honeybees. Instead, biologists are working on ways to keep the mite populations under control. The main method is to use varroacide, which kills the mites. There are many different types of chemical commonly available for this purpose, each affecting the mites in a different way, but with the same end result – death of the *Varroa*.

6. Two of the most effective, and hence frequently used, were Apistan®, and Bayvarol®, both of which contain synthetically produced pyrethroids as the active chemicals. Pyrethroids are synthetically altered pyrethrins, originally found in the chrysanthemum family. This group of chemicals functions as an effective varroacide by preventing the sodium channels in neurones from closing.

7. Another commonly used varroacide is Apiguard®, which contains thymol, extracted from thyme plants. Thymol is less specific in its effects on the mites, but mainly denatures proteins in the cell membrane. This disrupts numerous aspects of the cell's functioning.

8. A third example of a widely used varroacide is oxalic acid. The treatment relies on the acid's corrosive properties. It damages the proboscis of the mites so they cannot suck the blood of the honeybees.

9. All of the above treatments, when used in the correct concentration, kill the mites, but do not damage the honeybees. Bayvarol® and Apistan® kill 95% of mites. Apiguard® is slightly less effective, whilst still achieving an average of 93% effectiveness. Oxalic acid can also kill up to 90% of mites in a hive.

10. A population of over 1000 mites can cause serious damage to the honeybee colony, so numbers should be kept below this level. The varroacide method of controlling the problem of *Varroa* mites is usually highly effective, whichever method is used. Only a few treatments are required per year.

11. Varroacide treatments cost about £4 to £5 per hive. For those who make a business of selling honey, wax and other hive products with many beehives the cost of varroacides can be quite large.

12. It must be noted that humans eat the honey produced, so misuse of the varroacides could lead to high levels of the chemicals in the honey. Oxalic acid is one example, as it will dissolve in honey, and is also poisonous to humans. Thymol residues in honey, however, have proven to be relatively safe. But thymol accumulation in the honey can have the effect of altering the quality of the honey, in particular the taste.

13. A major risk of using chemicals to control the population growth of *Varroa* mites is that resistance could develop in a few mites, and the advantageous allele would then be passed on until the whole population is resistant to that form of treatment. This has already been shown to have happened with Bayvarol® and Apistan®.

14. For this reason, beekeepers generally rotate treatment by using alternating varroacides, which have different active chemicals. This reduces the likelihood of resistant mites developing. This rotation of varroacides can increase the cost.

15. Some methods rely on purely physical means of removing the mites. Sugar dusting of the mites works because the individual grains of sugar prevent the mites from gripping to honeybees. These methods are often inexpensive, but require more work than varroacides; they also have lower and more variable efficacies than chemical methods.

16. A possible solution for the future is biological control, using one organism to control another. Fungi, native to Britain, can kill the mites inside the hive, and will not have an adverse effect on the honeybees. For these reasons, it appears that this would be a safe method of *Varroa* control. One advantage of using the fungus is that it is found in Britain and so shouldn't have any unknown effects on the environment.

(a) A visit or issue report requires a problem to be identified.

State the problem identified in this extract.

(1)

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(b) (i) In the space below, present the information in paragraph 9 in a visual form.

Give your visual a suitable title.

(3)

Title .....

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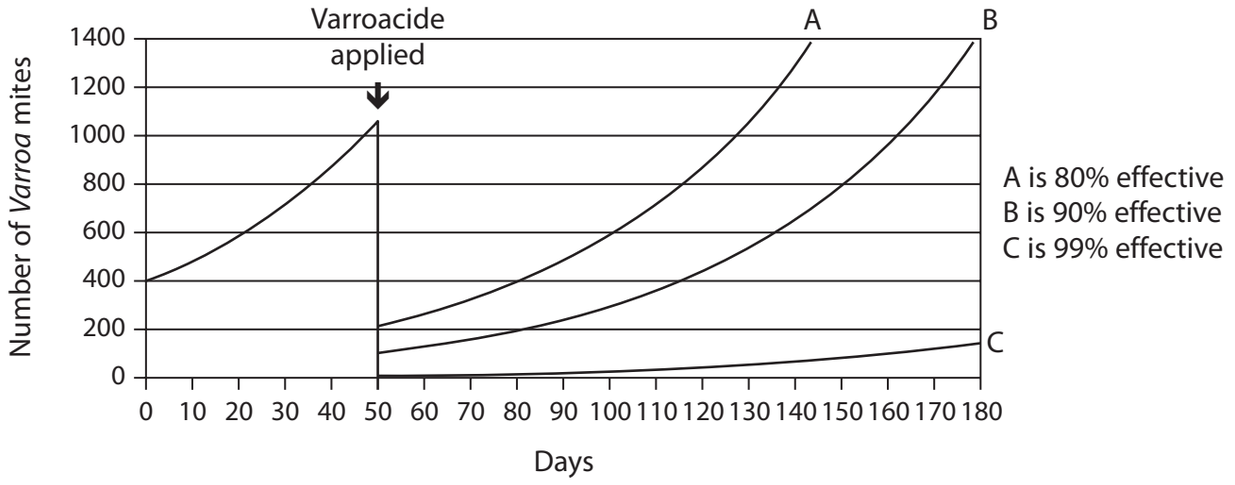
(ii) The student found the following graph in a government leaflet.

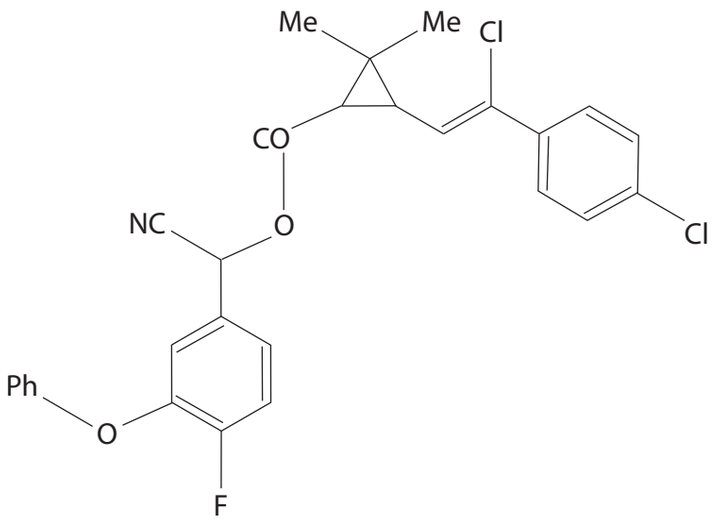


Paragraph 10 states that *"Only a few treatments are required per year."*

Explain how the information in this graph and paragraphs 9 and 10 support this statement.

(3)

(iii) The student found the following illustration.



Chemical structure of a pyrethroid

Suggest a suitable paragraph for this illustration.

(1)

Paragraph .....

(c) The boxes below show how reference 30 was given in the report and some information from the cover of the book it was taken from.

30) Michael Schacker, 2008, 'A Spring without Bees – How colony collapse disorder has endangered our food supply' – appendix 9 list of foods pollinated by bees

Use these two pieces of information to write a complete reference for this book.

(2)

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(d) The student's report includes discussion of the risks and implications for humans and other organisms.

It also includes some alternative solutions to the problem.

(i) Give **one** economic implication and **one** risk for humans of using varroacides, identified in this report.

(2)

Economic implication.....

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Risk for humans.....

.....

(ii) Using information from the report, explain why an alternative solution to the use of varroacides to control the mites might be needed.

(3)

(iii) Identify and explain **one** alternative solution to the use of varroacides discussed in this report.

(3)

(e) Some information about two of the references quoted in this report is given below.

- Ref 12, from the website of Dadant who make the thymol-based Apiguard®, saying that pyrethroid resistance is widespread.
- Ref 23, which is a government agency website saying that pyrethroid resistance is widespread in the UK.

Comment on the validity of these references.

(2)

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(Total for Question 2 = 20 marks)

TOTAL FOR PAPER = 40 MARKS