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Tasmanian Certificate of Education

SCIENCE OF NATURAL RESOURCES

Senior Secondary

Subject Code: SNR5C

External Assessment

2008

Time: Two hours

On the basis of your performance in this examination, the examiners will provide a result on the following criteria taken from the syllabus statement:

Criterion 4 Develop and evaluate experiments.

Criterion 7 Demonstrate knowledge and understanding of scientific ideas relevant to the resource and its development.

Criterion 8 Analyse, interpret and draw conclusions.

Pages: 28
Questions: 8

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CANDIDATE INSTRUCTIONS

You **MUST** ensure that you have addressed **ALL** of the externally assessed criteria on this examination paper.

Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.

No other printed material is allowed into this examination.

You should make sure you answer all parts within each question so that the criteria can be assessed.

All written responses must be in English.

Section A – Criterion 4

For Marker Use Only

It is recommended that you spend approximately **45 minutes** on this section.

Question 1

Biological control strategies are used extensively in agriculture and forestry industries to reduce the impact of synthetic pesticides on non-target organisms, and to minimise the development of chemical resistance.

One of these new 'green chemistry' insecticides is called **Spinosad**. This chemical is derived from the naturally occurring soil bacterium *Saccharopolyspora spinosa*, and is used worldwide to control a very wide range of insect pests including fruit flies, caterpillars, leafminers, thrips, sawflies and leaf beetles.

To be effective in controlling insects the chemical Spinosad **must be eaten** by the target insect.

Forestry practices in Tasmania continue to use a variety of pest management strategies to control a number of leaf-eating beetles and in recent years has conducted several trials to evaluate the effectiveness of Spinosad in controlling the pest Eucalyptus leaf beetle *Chrysophtharta bimaculata*.

The forestry entomologist organized for three separate plantations of each of the native Tasmanian Blue gum *Eucalyptus globulus* and the introduced species Shining gum *Eucalyptus nitens* to be aerially sprayed with the insecticide at a concentration of 10g/L Spinosad in water. A wetting agent (or surfactant) was also added to the spray to help the insecticide stay on the waxy eucalypt leaves. After two days each plantation was sampled and the number of dead *C. bimaculata* beetles was calculated per hectare. The number of dead beetles was then converted to a percentage and the following results were obtained.

Plantation Site aerially sprayed with Spinosad 10g/L plus wetting agent	**Calculated % Mortality of the leaf eating *C. bimaculata* beetles per ha**
Eucalyptus globulus (Blue gum) at Geeveston	82.0
E. globulus at Wielangta	68.0
E. globulus at Scottsdale	73.0
Eucalyptus nitens (Shining gum) at Goulds Country block, St Helens	42.0
E. nitens at Kamena, Burnie	57.0
E. nitens at Geeveston	21.0

Question 1 continues opposite.

Question 1 (continued)

For Marker Use Only

(a) What is the independent variable? (1 mark)

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(b) What is the dependent variable? (1 mark)

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(c) Write a suitable hypothesis for this experiment? (3 marks)

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(d) What controls should the scientist have used for this experiment? Explain. (4 marks)

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Question 1 continues over the page.

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Question 1 (continued)

For Marker Use Only

(e) List **four** factors you would attempt to keep constant when applying the insecticide **by aircraft**. (2 marks)

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(f) Do the results enable you to confidently recommend the use of 'Spinosad' for reducing the numbers of leaf-eating beetles in Eucalypt plantations? Explain. (4 marks)

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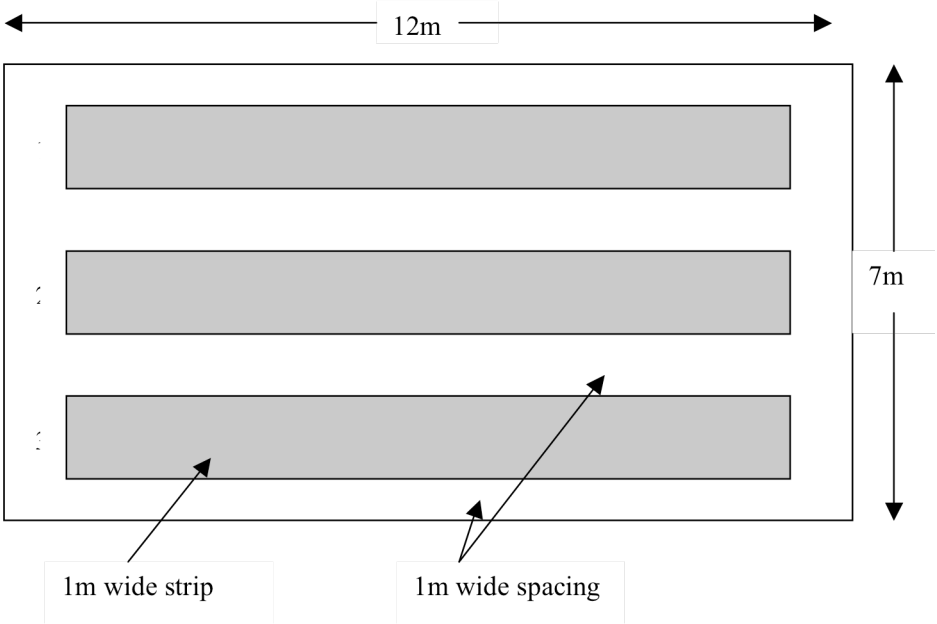
For Marker Use Only

Question 2

Part of a study of a grassland ecosystem for future grazing by cattle consisted of the following procedure. A 12m by 7m plot of land was selected and mown all over. Three strips, each 10m long and 1m wide were then marked out 1m apart as shown below.



Each strip was treated as shown in the table. After 10 days each strip was mown closely and the grass clippings collected, dried and weighed. The results are shown below:

Strip	Treatment on first day	Dry weight of grass clippings (gm)
1	Watered with 10L of distilled water	0.56
2	Watered with 10L of distilled water + a soluble fertilizer	0.59
3	Watered with 10L of distilled water + a soluble insecticide	0.65

(a) Give **two** reasons why the experimental strips were separated in this way. (2 marks)

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(b) State the significance of the treatment for strip 1. (1 mark)

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Question 2 continues opposite.

Question 2 (continued)

For Marker Use Only

(c) Suggest one reason for the similarity in the results obtained from strips 1 and 2. (1 mark)

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(d) State the most likely explanation for the different results obtained from strips 2 and 3. (1 mark)

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(e) Explain why the Dry Weight was used in the measurement of the grass clippings. (2 marks)

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(f) What assumption does the experimenter have to make about the treatment on strip 3? (1 mark)

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Question 3

For Marker Use Only

Lavender is a hardy, herbaceous, evergreen plant that can thrive under a wide range of soil and climatic conditions but it prefers a neutral to alkaline soil of pH 7.0 – 7.5. It will tolerate drought once the roots are established in the ground. Lavender is usually grown commercially from cuttings.

Bridestowe Lavender Estate near Lilydale in northern Tasmania is Australia's largest export supplier of high quality essential oil from the French lavender plant, *Lavandula angustifolia*.

Several new Lavender hybrids have been developed in New Zealand and you have been asked by the owners of Bridestowe Lavender Estate to test the NZ hybrid variety of *Lavandula stoechas,* called "Marshwood", to see if it can produce a similar quantity of quality oil per hectare when compared with the established species *L. angustifolia*.

It takes about four years for lavender plants to reach maturity producing approximately 5 tonnes of flowers per hectare and Bridestowe produces about 1200 kg of oil per annum from its 40 ha of *L. angustifolia*.

(a) Design an experiment that will allow you to compare the growth and oil production of *L. stoechas* "Marshwood" with the growth and oil production of the established lavender species, *L. angustifolia*. (10 marks)

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Question 3 continues opposite.

Question 3 (continued)

For Marker Use Only

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(b) Why would you use cuttings rather than seed? Give reasons. (2 marks)

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Question 4

For Marker Use Only

The Tasmanian oyster industry is based primarily on the Pacific oyster, *Crassostrea gigas*. It is commonly grown in intertidal oyster farms like those found at Pipeclay Lagoon in southern Tasmania. The majority of Tasmanian oysters are exported "live" so the quality of our marine waters surrounding Tasmania is critical to the ongoing survival of the oyster industry.

When an oil spill occurs at sea it is usual to get rid of the oil by applying a "dispersant" which causes the oil to mix with the sea water and disperse (break up into small droplets).

Now a new generation of "dispersants" are being trialled that use bacteria instead of chemicals. The bacteria are sprayed onto the water and they feed on oil and break it down. **Spillremed** is one such product. It contains bacteria that can clean up oil spills in marine environments. But are the bacteria toxic to oysters?

To find out toxicity trials were carried out in the laboratory. Each treatment consisted of placing 20 individuals of *C. gigas* in a bowl of seawater to which bacteria were added and left for 24 hours. After this time the number of dead oysters was counted.

Before recommendations could be made about the use of **Spillremed**, a further set of tests needed to be carried out in conditions more closely resembling a real oil spill.

(a) Identify **three** improvements that could be made in further experiments, and **explain** how they could improve the reliability of the results. (6 marks)

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Question 4 continues opposite.

Question 4 (continued)

For Marker Use Only

(b) Discuss the difficulties of carrying out the field tests compared to the laboratory tests. (4 marks)

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Section B – Criterion 8

For Marker Use Only

It is recommended that you spend approximately **40 minutes** on this section.

Question 5

Water is becoming a more highly valued natural resource and quality water for agriculture is very important for Tasmania's clean, green image. The smarter we are at the way we can utilise water the more sustainable our industries.

Irrigation practices vary considerably in the horticultural industries and over the last few years furrow irrigation methods have been largely replaced with pressurized systems. This change has led to uncertainty as to which pressurized irrigation system is appropriate for the districts soils.

Over a three year period three irrigation systems were compared on sandy clay loam soil – single line drip, double line drip and microjets on August Red nectarines. The objective was to compare the effect of three different irrigation systems on water useage, yield and fruit size distribution of nectarines grown on a sandy clay loam soil.

The results of the three year trial are shown in Table 1 below:

Table 1 – Total yield (tonnes per hectare) received from three irrigation systems*

		Fruit Count Category (diameter of fruit mm)							
Irrigation system	**Amt of water per tree /hour**	**20**	**23**	**25**	**28**	**30**	**54**	**57**	**Total Yield**
Microjet	40L	0.15	1.84	8.60	11.91	10.38	0.90	0.39	34.17
Double line drip	25L	0.63	5.59	16.90	13.34	3.88	0.44	1.10	41.88
Single line drip	13L	0.05	0.70	6.38	13.73	8.75	1.06	3.24	33.91

*Data adapted from a report published in 'Tree Fruits Tasmania' by Heather Cook 2001

(a) Which irrigation system had a significantly higher yield of fruit? (1 mark)

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Question 5 continues opposite.

Question 5 (continued)

For Marker Use Only

(b) What percentage of the total yield of fruit for each irrigation system had a diameter of 25mm or less? Show working. (3 marks)

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(c) The larger the fruit size the higher the price at market. On this basis, and using the data from the table, what type of irrigation system would you recommend to a farmer? Explain. (4 marks)

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(d) Identify the irrigation system that would be most suitable for very sandy soils? Give reasons **and** include in your answer why the other irrigation systems would be less appropriate. (3 marks)

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For Marker Use Only

Question 6

The release of pollutants into rivers, lakes and oceans from rural based industries using various chemicals can result in the death of aquatic life. It can also affect the health of people who drink or swim in the water or who eat contaminated organisms in the food chain of these environments.

One way to check the amount of pollution in a river is to measure the volume of oxygen dissolved in the water. Another way is to see what sort of animals are living in it. The table below shows the results of both methods when sampling the upper reaches of the Derwent River.

Use the information in the table below to help you answer the questions that follow:

Level of Pollution	**Types of Animals Present**		**Amount of dissolved Oxygen measured in ppm of Water**	
	Fish	**Others**	**at 5˚C**	**at 20˚C**
none	grayling salmon trout	mayfly nymph stonefly nymph	8	5
very low	dace roach	freshwater shrimp snail	6	4
moderate	gudgeon	bloodworm water louse	4	3
high	none	rat-tailed maggot sludge worm	2	1

(a) Which **two** animals would you expect to find in water with high levels of pollution?

(1 mark)

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(b) Outline **two** problems associated with the sampling of animals for such a study.

(2 marks)

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Question 6 continues opposite.

Question 6 (continued)

For Marker Use Only

(c) Describe the relationship between temperature, pollution and amount of dissolved oxygen. (2 marks)

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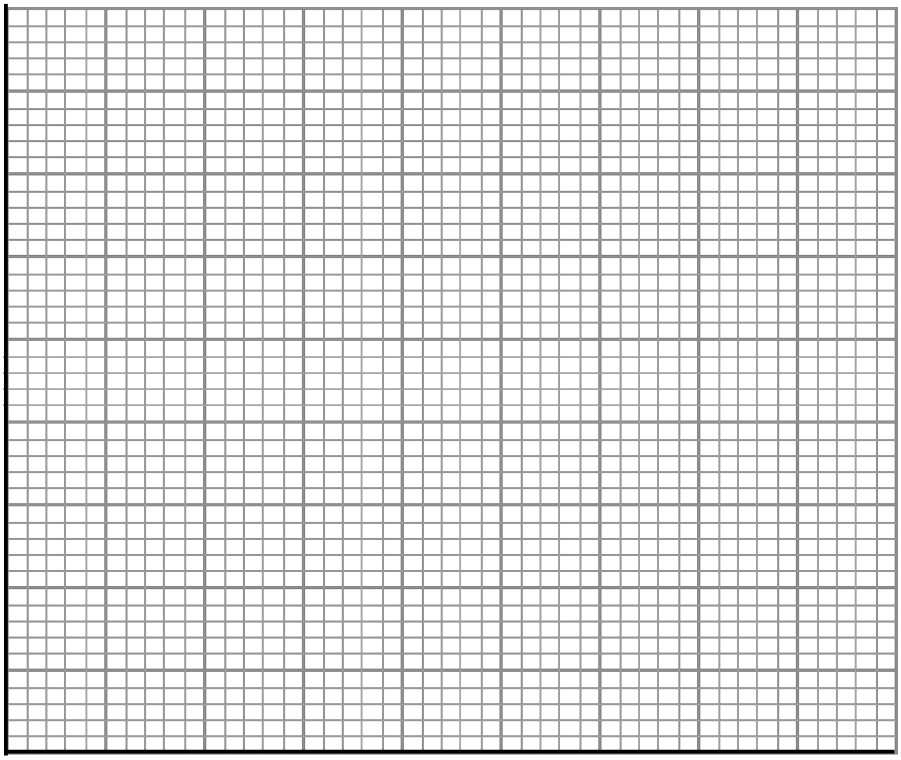
(d) Sketch a graph below to determine what volume of oxygen, measured in parts per million (ppm) of water, would you expect to find in a part of the river inhabited by trout when the water temperature is 10°C? (2 marks)



Your answer is: .....

(e) Some fish farmers raise trout. Explain what advice you would give to fish farmers about maintaining a water supply suitable for trout. (2 marks)

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For Marker Use Only

Question 7

A farmer wanted to know whether she should establish a forest plantation on a section of her property. To help her decide where to locate a tree plantation of *Eucalyptus globulus* she employed the services of a group of students studying Science of Natural Resources to collect samples, and analyse the data for her. After a day in the field the following observations and data were collected for the selected sites proposed for plantation timber. The data is given in Table 1.

Table 1 – Summary of characteristics associated with a 100ha parcel of land not previously used for agriculture

Area (ha)	Slope of Land	Native Plant type	Leaf litter depth (cm)	Soil type	Soil profile	Depth of soil horizon (cm)	Soil erodability	Estimate of worms and beetle larvae/ha
Site 1 70	3˚	Dry eucalypt forest	1.0	Sandy loam on Mathinna sandstone	Three horizons A1 A2 B	 10 30 60	 Low High Low	20 000
Site 2 30	10˚	Wet eucalypt forest	10.0	Sandy Loam on Mathinna sandstone	Two horizons A1 B	 40 80	 Low Low	600 000

(a) Which aspects of the data in the above table would you use to determine suitability of the site for a plantation of *E. globulus*?

Provide an explanation for each part below: (6 marks)

(i) Abiotic factors: .....

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Question 7 continues opposite.

Question 7 (continued)

For Marker Use Only

(ii) Biotic factors: .....

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(b) Forest management may use one or more of the following techniques to manage plantation timber:

- clear felling
- aerial seeding by aircraft
- variable retention
- selective logging
- controlled burning
- contour ploughing

Identify and **explain** which technique(s) you would choose for each of the two sites in Table 1. (6 marks)

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Question 7 continues over the page.

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Question 7 (continued)

For Marker Use Only

The farmer also has another parcel of land with similar characteristics to Site 1 in Table 1.

This second set of data is given in Table 2.

Table 2 – Summary of characteristics associated with a 300ha parcel of land not previously used for agriculture

Area (ha)	Slope of Land	Native Plant type	Leaf litter depth (cm)	Soil type	Soil profile	Depth of soil horizon (cm)	Soil erodability	Estimate of worms and beetle larvae/ha
70	7˚	Dry eucalypt forest	0.5	Sandy loam on granite rock	Three horizons A1 A2 B	 10 30 60	 Low High when exposed Low	5 000

(c) Based on the information in Table 2 explain why you would not use this land for growing plantation timber. (3 marks)

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Section C – Criterion 7

For Marker Use Only

You should spend approximately **35 minutes** on this question.

Question 8

In 2007 Federal and State approval was given for Gunns to build a pulp mill in Tasmania and for Protavia to build a pulp mill in South Australia. A comparison of the two pulp mills, at Bell Bay and Penola, is shown in Tables 1 and 2, respectively.

Table 1 – Gunns Bell Bay pulp mill on the Tamar River, Tasmania

Cost	$1.7 billion
Construction starts	Likely September 2007
Opening date	Late 2009
Process	Bleached kraft mill, chemical pulping process
Wood source	Public native forests and blue gum and pine plantations
Amount of wood used	4 million tones per annum
Amount of dry pulp produced	1 million tones per annum
Timber-to-processed-pulp conversion ratio	4:1
Water use	72 megalitres a day or 26,000MLs a year
Water source	Trevallyn dam, near Launceston
Power source	Wood-burning plant onsite; uses 500,000 tonnes woodchips per annum
Liquid effluent	64,000 tonnes of liquid effluent a day into Bass Strait
End product	Top-grade white pulp
Current value of pulp (world markets)	$US700/air-dried tonne of kraft pulp
Annual boost to Tasmanian economy	$413 million per annum
Pulp mill manufacturer	Andritz
Construction jobs	2500
Pulp mill operations employment	292
Nearest city	Launceston, population 100,000, 26km south of site

Question 8 continues over the page.

Question 8 (continued)

For Marker Use Only

Table 2 – Protavia pulp mill at Penola, South Australia

Cost	$1.5 billion
Construction starts	Early 2008
Opening date	Early 2010
Process	Mechanical pulping process
Wood source	Private plantation-grown blue gums only
Amount of wood used	1.6 million tones per annum
Amount of dry pulp produced	750,000 tonnes per annum
Timber-to-processed-pulp conversion ratio	2:1
Water use	7 megalitres a day or 2,600MLs a year
Water source	Underground aquifer
Power source	Natural gas from neighbouring power station or grid power
Liquid effluent	Closed loop system; none leaves the site
End product	Medium-grade pulp best suited to European and "green" paper market
Current value of pulp (world markets)	$US620/air-dried tonne of mechanical pulp
Annual boost to South Australian economy	$400 million per annum
Pulp mill manufacturer	Andritz
Construction jobs	1300
Pulp mill operations employment	120
Nearest city	Mt Gambier, population 24,000; 50km south of site

(Source: Adapted from an article published in *The Mercury*, 7 August 2007.)

(a) As a scientific consultant, you have been contracted to give advice to an international bank on the issues to consider before investing money in the development of a pulp mill in Australia. One of the key factors you have been asked to consider is the likely environmental impact. Based on the information provided in Tables 1 and 2 what advice would you give the bank? Give reasons. (6 marks)

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Question 8 continues opposite.

Question 8 (continued)

For Marker Use Only

(b) Outline **two** current significant management issues for the proposed Bell Bay pulp mill and discuss how these issues maybe overcome. (6 marks)

(i) Management Issue 1: .....

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(ii) Management Issue 2: .....

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(c) In what other ways can value be added to Forests (apart from pulp) to help improve the Tasmanian economy? Explain. (4 marks)

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Question 8 continues opposite.

Question 8 (continued)

For Marker Use Only

(d) What are the positive and negative impacts of a Pulp Mill on the management of **other** natural resources in the area? In your answer you should consider management, economic, environmental and social issues. (12 marks)

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