

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Learner Registration Number

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**Pearson BTEC Level 3 Nationals Extended Certificate,
Foundation Diploma, Diploma, Extended Diploma**

Time 45 minutes

**Paper
reference**

31619H

Applied Science/Forensic and Criminal Investigation

UNIT 3: Science Investigation Skills

Part A

You must have:

a calculator and a ruler.

Instructions

- **Part A** contains material for the completion of the preparatory work for the set task.
- **Part A** must be issued to learners 45 minutes before the start of **Part B**.
- **Part A** is specific to each series and this material must only be issued to learners who have been entered to undertake the task in the relevant series.
- **Part A** materials for the set task will be issued prior to the start of the supervised assessment period according to the guidance in the specification.
- **Part A** should not be returned to Pearson.

Turn over ►

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Instructions for Teachers/Tutors or Invigilators

This taskbook:

- contains the instructions for learners and the set task brief
- must be issued to learners 45 minutes before the start of **Part B**
- must not be taken out of the supervised assessment area.

Teachers/tutors or invigilators must not give any support to learners.

Learner notes will be retained securely by the centre after **Part B** has been undertaken and may be requested by Pearson if there is suspected malpractice.

Refer carefully to the instructions in this taskbook and the BTEC Nationals *Instructions for Conducting External Assessments (ICEA)* document to ensure that the preparatory period is conducted correctly and that learners have the opportunity to carry out the required activities independently.

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Instructions for Learners

You will be given 45 minutes to read **Part A** and make notes.

Part A contains the set task brief you need to prepare for **Part B, Section 1**.

Read the set task brief carefully.

You should use the space provided at the end of **Part A** to make notes.

You will use the set task brief in **Part A** and your notes to complete the set task in **Part B, Section 1**.

You must return **Part A** and **Part B** at the end of the examination.

The teacher/tutor or invigilator must not give you feedback during the time given to read and make notes for **Part A**.

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Set Task Brief for Part B, Section 1

A trainee technician is researching fuels. The technician is asked to find out if fuels containing more carbon atoms per molecule will release energy more quickly than fuels containing fewer carbon atoms per molecule.

The trainee technician decided to research how much energy is given out per minute when different alcohols are burned.

The trainee technician produces this draft report of their investigation.

Draft Report

Title

Investigation into the amount of energy that is released in one minute when alcohols are burned.

Aim

To measure the energy released in one minute when an alcohol burns and observe how the energy released changes as the number of carbon atoms per alcohol molecule changes.

Introduction

The combustion of an alcohol produces heat energy.

The heat energy released can be used to increase the temperature of a known volume of water.

The increase in the temperature of water can be used to find the amount of heat energy transferred to the water.

Equipment

- alcohol burners with caps
- alcohols: methanol, ethanol, propan-1-ol, butan-1-ol and pentan-1-ol
- conical flask
- thermometer
- retort stand, boss and clamp
- 100 cm³ measuring cylinder (with 1 cm³ graduation marks)
- glass stirring rod
- ruler
- heatproof mat
- stopwatch.

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Method

Figure 1 shows some of the equipment used in the investigation.

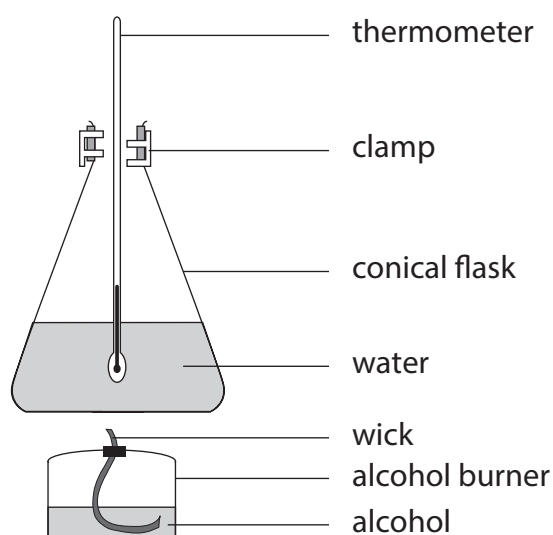


Figure 1

1. Set up a clamp and a retort stand.
2. Measure 80 cm^3 of water using a measuring cylinder and pour water into a conical flask.
3. Place the alcohol burner on a heatproof mat.
4. Clamp the conical flask so that its base is about 1.5 cm above the wick of the alcohol burner.
5. Note the initial temperature of the water.
6. Light the wick of the alcohol burner and start the stopwatch.
7. Stir the water in the conical flask with the stirring rod at regular intervals.
8. When the stopwatch reads 1 minute, replace the cap on the alcohol burner to extinguish the flame.
9. Note the final temperature of the water and any other observations.
10. Calculate and record the temperature change of the water.
11. Repeat steps 1 to 10 so that you have three results for the first alcohol.
12. Repeat steps 1 to 11 to get three results for each alcohol.



Raw data

Alcohol: butan-1-ol, C_4H_9OH

Temp change of water: 6.0, 7.0, 6.5

Observations: orange flame, large black circle on bottom of conical flask

Alcohol: ethanol, C_2H_5OH

Temperature change of water: 9.0, 9.5, 9.0

Observations: blue/orange flame, slight mark on bottom of conical flask

Alcohol: methanol, CH_3OH

Temperature change of water ($^{\circ}C$): 12.5, 11.5, 12.0

Observations: blue flame

Alcohol: pentan-1-ol, $C_5H_{11}OH$

Temp change of water: 5.0, 4.5, 4.0

Observations: orange flame, large black circle on bottom of conical flask

Alcohol: propan-1-ol, C_3H_7OH

Temperature change of water: 7.0, 7.5, 7.0

Observations: orange flame, black circle on bottom of conical flask

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Notes

Use this space to make notes about the trainee technician's draft report.

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Notes

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**Pearson BTEC Level 3 Nationals Extended Certificate,
Foundation Diploma, Diploma, Extended Diploma**

Time 1 hour 30 minutes

**Paper
reference**

31619H

**Applied Science/Forensic and
Criminal Investigation**
UNIT 3: Science Investigation Skills

Part B

You must have:

A calculator and a ruler.

Total Marks

Instructions

- You will need **Part A** to complete **Part B Section 1**.
- **Part A** and **Part B** contains material for the completion of the set task under supervised conditions.
- **Part A** and **Part B** must be undertaken in a single session of 2 hours and 15 minutes on the date timetabled by Pearson.
- **Part A** should be given to learners at the start of the examination.
- **Part B** should be given to learners after 45 minutes has passed.
- **Part A** and **Part B** are specific to each series and this material must only be issued to learners who have been entered to undertake the task in the relevant series.
- **Part B** should be kept securely until the start of the 1 hour and 30 minute supervised assessment period.
- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and learner registration 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 60.
- 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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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Answer ALL questions in Section 1 and Section 2.

Write your answers in the spaces provided.

SECTION 1

You should use the trainee technician's draft report and your notes from Part A to complete Section 1.

- 1 (a) Record the trainee technician's raw data in a suitable table, using the space provided.

Your table must include an average temperature change for the water for each alcohol used.

(3)

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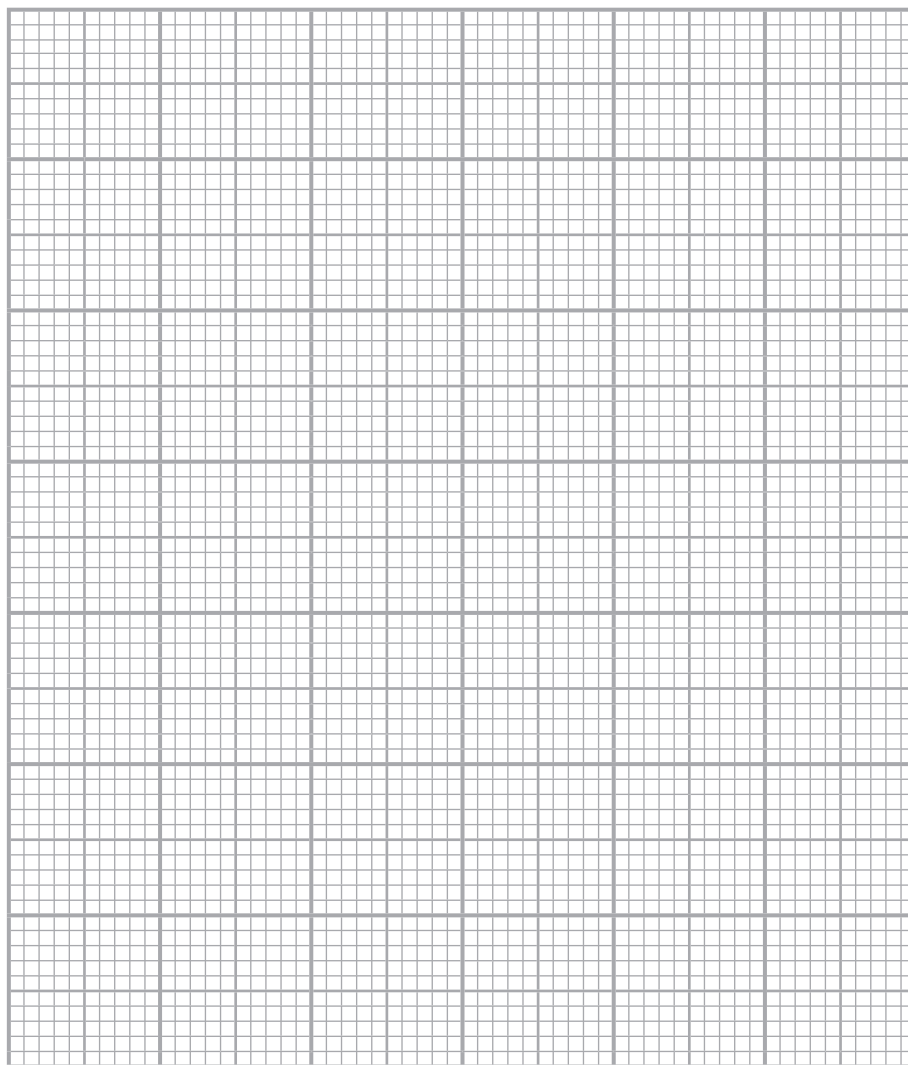
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(b) Draw a bar chart of the average temperature change against the number of carbon atoms in each type of alcohol molecule.

(3)



(c) Describe the relationship shown in your bar chart.

(1)

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- (d) The bar chart displays the average temperature change against the number of carbon atoms per molecule in each alcohol.

State why a bar chart is more appropriate than a line graph to show this relationship.

(1)

- (e) The trainee technician used alcohol burners in the investigation.

Each alcohol burner displays a hazard symbol showing that the contents are flammable.

- (i) State the risk to the trainee technician when using an alcohol burner.

(1)

- (ii) Give **one** precaution that the trainee technician should take to reduce this risk.

(1)

- (f) The trainee technician made the following observation after the combustion of pentan-1-ol.

'large black circle on bottom of conical flask'

Explain why the conical flask had a black mark on the bottom after burning the pentan-1-ol.

(2)

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(g) The trainee technician used a measuring cylinder to measure out 80 cm³ of water.

(i) The measuring cylinder had graduation marks of 1 cm³.

Calculate the percentage error of the volume of water measured using the measuring cylinder.

Show your working.

(2)

percentage error of measuring cylinder =

(ii) Name a piece of equipment that would measure the water more accurately than a measuring cylinder.

(1)

(iii) State why the trainee technician stirred the water during heating.

(1)

(iv) Describe how the trainee technician calculated the temperature change of the water.

(1)

(Total for Question 1 = 17 marks)





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2 (a) The trainee technician's supervisor carried out a similar investigation.

The supervisor used 50 cm³ of water in a metal calorimeter rather than 80 cm³ of water in a conical flask.

Figure 1 shows the equipment that the supervisor used.

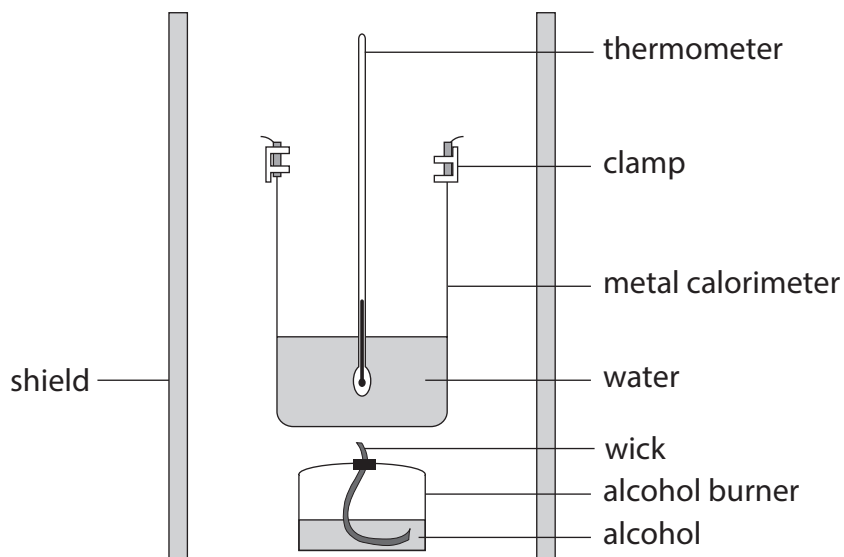


Figure 1

(i) Explain why the supervisor placed a shield on each side of the experiment.

(2)

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(ii) Explain why the supervisor used a metal calorimeter rather than a glass conical flask.

(2)

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(b) Table 1 shows the supervisor's results.

alcohol	volume of water (cm ³)	temperature change (°C)				
		attempt 1	attempt 2	attempt 3	average	standard deviation
methanol	50	20.5	21.0	21.5	21.0	0.50
ethanol	50	18.5	10.5	19.0	18.8	0.36
propan-1-ol	50	15.0	14.5	16.0	15.2	0.76
butan-1-ol	50	11.0	13.5	12.5	12.3	1.26
pentan-1-ol	50	8.0	7.5	8.0	7.8	

Table 1

- (i) Calculate the heat energy released by burning methanol using the results in Table 1.

Use the equation:

$$\text{heat energy} = \text{mass of water (g)} \times 4.2 \text{ (J g}^{-1} \text{ °C}^{-1}) \times \text{average temperature change (°C)}$$

Assume 1 cm³ of water has a mass of 1 g.

You should include the unit for heat energy in your answer.

(3)

heat energy =

unit =

- (ii) The supervisor has circled an anomaly in their results shown in Table 1.

They realised that the result was much lower than the others.

Explain **one** possible reason for this anomaly.

(2)

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(iii) Identify which alcohol has the least reliable results, based on the standard deviations in Table 1.

(1)

- A methanol
- B ethanol
- C propan-1-ol
- D butan-1-ol

(iv) Calculate the standard deviation for the temperature change for pentan-1-ol.

Use the equation.

Show your working.

(5)

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{N - 1}}$$

standard deviation for pentan-1-ol =

(Total for Question 2 = 15 marks)



3 (a) The trainee technician used a stopwatch to control the amount of time the water was heated for.

Explain how **two** other variables were controlled.

(4)

1

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(b) One way to extend the trainee technician's investigation would be to change the type of fuel from alcohols to hydrocarbons.

Explain **two** other ways the trainee technician could extend their investigation.

(4)

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(Total for Question 3 = 8 marks)

TOTAL FOR SECTION 1 = 40 MARKS

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SECTION 2

4 Estimating population numbers through sampling.

Random sampling would allow you to estimate the number of dandelion plants in an area without having to count all of the plants.

You have been asked to write a plan for an investigation to determine if there are more dandelion plants in a north facing field compared with in a south facing field.

Your plan should include the following details:

- a hypothesis
- selection and justification of equipment, techniques or standard procedures
- health and safety issues associated with the investigation
- a step-by-step method for data collection and analysis to test the hypothesis including:
 - quantities to be measured
 - number and range of measurements to be taken
 - how equipment may be used
 - control variables
 - brief method for data collection analysis.

(12)

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(Total for Question 4 = 12 marks)



- 5 A learner wanted to investigate how the number of daisy plants changes along a transect.

Figure 2 shows the cross section of the area where the learner carried out their investigation.

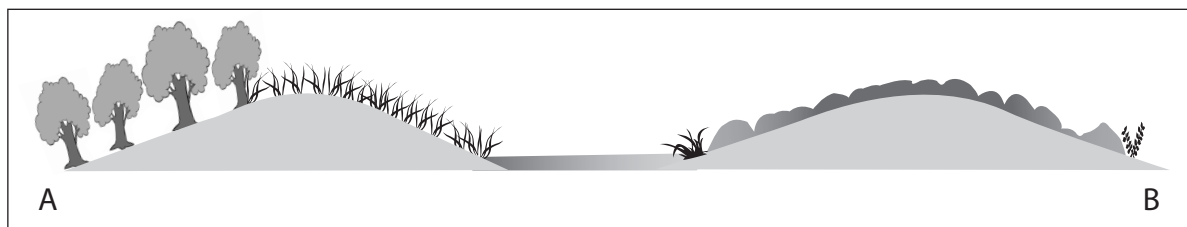


Figure 2

Here is the learner's method:

- drop the quadrat at A
- count the daisy plants that are inside the quadrat
- slide the quadrat along the transect line
- repeat until you reach B.

Table 2 shows the results of the learner's investigation.

distance from A	number of daisy plants
1	14
2	22
3	16
4	28
5	36

Table 2

The learner concludes that:

'The number of daisies increases as you get further from A and shows a positive correlation.'

Evaluate the learner's investigation.

Your answer should make reference to the:

- method of the experiment and equipment used
- results collected
- conclusion made.

(8)



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(Total for Question 5 = 8 marks)

TOTAL FOR SECTION 2 = 20 MARKS
TOTAL FOR PAPER = 60 MARKS

