Pearson BTEC Level 3 Nationals Extended Certificate

Applied Science/Forensic and Criminal Investigation
Unit 3: Science Investigation Skills
Teacher / technician notes and guidance – confidential

Part P

January series 2020

Paper Reference
31619H

Instructions

- This document contains confidential information for centres on the preparation and administration of the **Part A** practical investigation.
- This document should be opened once it is received to allow centres to prepare for the **Part A** practical investigation.
- This document is confidential. It must be stored securely and must not be disclosed to learners.
- This document should not be returned to Pearson.

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Guidance for Teachers/Tutors

Set task

The set task requires learners to carry out a practical investigation in **Part A** and then complete a taskbook in **Part B**.

Both **Part A** and **B** of the task must be completed in the assessment period timetabled by Pearson.

The teacher/technician notes provided in this document give information on the method for the practical investigation. It is the responsibility of centres to resource and trial the practical investigation prior to it being undertaken by learners in the assessment period.

Any assessment material not required by learners for submission must be collected and held securely by the Exams Office until the RoMM deadline at which point they may be recycled or destroyed.

Part A Practical Investigation

Learners must not see the teacher/technician notes. A separate **Part A** will be available for the learners at the beginning of the assessment period.

The **Part A** task brief provides all the necessary information for learners to conduct the practical investigation and includes a notes page for the learner to record their results/observations.

Centres will be required to supervise learners when they carry out the investigation.

Teachers cannot provide guidance during the practical investigation. The practical investigation may take up to three hours depending on the nature of the investigation and it should be completed in the first section of the assessment period.

Learners may work in pairs to conduct the practical investigation, however they must record their set of results/observations independently.

Once learners have completed the practical investigation, teachers must keep the **Part A** taskbook containing learner results/observations secure.

This must be returned to learners when they start **Part B** in the second part of the assessment period.

Learners will need to refer to their results/observations obtained from **Part A** when they complete **Part B**.

Teacher/Technician Notes for the Practical Investigation

Learners must observe safe practice when carrying out practical scientific investigations.

It is the responsibility of centres to carry out risk assessments for all practical investigations.

Technician's list of equipment needed

- 1.0 M hydrochloric acid
- Agar powder
- 250 cm^3 beaker
- Magnetic hot plate with stirrer function
- Moulds of at least 2 cm depth
- 0.01 M sodium hydroxide solution
- Phenolphthalein
- Cork borer (used to cut agar cylinders to fit in boiling tubes e.g. size 6)
- Boiling tubes
- 10 cm^3 measuring cylinder with 0.1 cm^3 or 0.2 cm^3 increments
- Stopwatch / stop clock
- White tile / white paper
- Clamp stand and clamp
- Ice bath
- Hot water bath
- Spatula / spoon
- Thermometer

Method for technician

To make agar for at least fifteen size 6 cylinders:

1. Stir 2 g of plain (technical) agar powder into 100 cm^3 of 0.01 M NaOH with 5 cm^3 phenolphthalein.
2. Mix on a hot plate until boiling.
3. Pour the hot agar into moulds to a depth of 2 cm.
4. Allow the agar to cool and set.
5. Use a size 6 cork borer to cut identical size cylinders of agar.
6. Remove and store safely until required for use*.

The technician will need to make up at least 15 cylinders of agar for each learner/pair of learners working together.

* If the agar is to be made the night before, store sealed in a fridge. Remove the agar from the fridge no less than one hour before the experiment is due to take place.

Learner's list of equipment

Each learner/pair of learners will need:

- 1.0 M hydrochloric acid (200 cm^3)
- 15 × boiling tubes
- 5 × small beakers
- 10 cm^3 measuring cylinder with 0.1 cm^3 or 0.2 cm^3 increments
- 100 ml measuring cylinder
- Stopwatch / stop clock
- White tile / white paper
- 15 cylinders of agar
- Clamp stand and clamp
- Gloves
- Ice bath (large beaker with ice that will fit the small beaker)
- Hot water bath (large beaker with hot water or thermostatically-controlled water bath)
- Spatula / spoon
- Thermometer

Learners will:

1. Adjust the temperature of the acid with an ice bath or hot water bath.
2. Record the temperature of the acid.
3. Measure and record the time taken for the pink colour in the agar cylinders to disappear.
4. Record any other relevant observations.

Method for learners

1. Set up a clamp and a clamp stand.
2. Measure 40 cm^3 of 1.0 M hydrochloric acid into a small beaker.
3. Cool the hydrochloric acid to 10° C by placing the small beaker into an ice bath.
4. Use a thermometer to measure the temperature of the hydrochloric acid.
5. When the acid has reached the correct temperature, use a measuring cylinder to measure 10 cm^3 of the hydrochloric acid into a clean dry boiling tube.
6. Clamp the boiling tube on to a clamp stand in front of a white tile/sheet of white paper.
7. Using a spatula or spoon, place an agar cylinder into the boiling tube, making sure that the agar cylinder is covered by the hydrochloric acid.
8. Start the stopwatch/stop clock immediately.
9. Time how long it takes for the pink colour to disappear.
10. Repeat steps 4–9 so that you have three results for the hydrochloric acid at 10° C, using a clean dry boiling tube each time.
11. Cool or warm (as appropriate) a further 40 cm^3 of 1.0 M hydrochloric acid to 20° C by placing the acid into a small beaker in an ice/water bath.
12. Repeat steps 4–9 so that you have three results for the hydrochloric acid at 20° C, using a clean dry boiling tube each time.
13. Warm 40 cm^3 of 1.0 M hydrochloric acid to 30° C by placing the acid into a small beaker in a water bath.
14. Repeat steps 4–9 to get three results for the hydrochloric acid at 30° C, using a clean dry boiling tube each time.
15. Warm 40 cm^3 of 1.0 M hydrochloric acid to 40° C by placing the acid into a small beaker in a water bath.
16. Repeat steps 4–9 to get three results for the hydrochloric acid at 40° C, using a clean dry boiling tube each time.
17. Warm 40 cm^3 of 1.0 M hydrochloric acid to 50° C by placing the acid into a small beaker in a water bath.
18. Repeat steps 4–9 to get three results for the hydrochloric acid at 50° C, using a clean dry boiling tube each time.

Write your name here

Surname	Other names

Pearson BTEC Level 3 Nationals Extended Certificate

Applied Science / Forensic and Criminal Investigation

Unit 3: Science Investigation Skills

Part A

7 January 2020 – 17 January 2020	Paper Reference **31619H**

Instructions

- **Part A** contains material for the completion of the preparatory work for the set task.
- **Part A** should be undertaken over approximately 3 hours across the assessment period as timetabled by Pearson.
- **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 B** materials for the set task will be issued prior to the start of the supervised assessment period according to the guidance in the specification.
- This taskbook should not be returned to Pearson.

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Instructions for Teachers/Tutors

This paper must be read in conjunction with the teacher/technician notes and guidance, the unit information in the specification and the BTEC Nationals Instructions for Conducting External Assessments (ICEA) document. See the Pearson website for details.

This taskbook contains the instructions for learners and the set task brief and should be issued to learners at the start of the practical investigation. This taskbook must not be taken out of the classroom/laboratory.

The practical investigation outlined in the set task brief must be undertaken by learners over approximately three hours during the first section of the assessment period. The practical investigation must be undertaken in supervised conditions.

Centres are free to arrange the supervised assessment period how they wish provided the three hours for completing the practical investigation are under the level of supervision specified, in accordance with the conduct procedures.

Learners will be expected to conduct a practical investigation and record their results/observations in this taskbook.

Teachers/tutors cannot give any support to learners during the practical investigation and recording of results/observations.

Learners may work in pairs for the practical investigation, however they must record their own results and observations independently.

Once the practical investigation is completed and learners have recorded their results/observations in the spaces provided, teachers/tutors must keep the taskbooks secure until the start of **Part B**.

Any assessment materials not required by learners for submission must be collected and held securely by the Exams Office until the RoMM deadline at which point they may be recycled or destroyed.

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.

Instructions for Learners

Read the set task information carefully.

This contains **Part A** of the information you need to prepare for the set task. You will carry out a practical investigation over a period of up to three hours.

You may work in pairs, however you must record your set of results/observations independently in the spaces provided.

Your teacher/tutor may give guidance on when you can complete the practical investigation.

Your teacher/tutor cannot give you feedback during the practical investigation.

You must not take this taskbook out of the classroom/laboratory at any time and you must hand it in to your teacher/tutor on completion of the practical investigation and write up of any results/observations.

You will use your results recorded in this taskbook, and they will be given back to you when you begin the set task in **Part B**.

Set Task Brief

Please read the following brief carefully before completing the practical investigation.

You must observe safe practice when carrying out the practical investigation.

You have been asked to research how temperature affects the rate of diffusion of hydrochloric acid through an agar cylinder.

Diffusion is the process where molecules move from an area of high concentration to an area of low concentration.

When an agar cylinder is placed in hydrochloric acid, the hydrochloric acid will diffuse through the cylinder.

If the cylinder contains sodium hydroxide, the hydrochloric acid will react with it in a neutralisation reaction.

If phenolphthalein indicator is present, a colour change from pink to colourless is observed when neutralisation occurs so the rate of diffusion of the hydrochloric acid through the agar cylinder can be seen.

Safety Information

Hydrochloric acid and sodium hydroxide are irritants/corrosive.

Method

1. Set up a clamp and a clamp stand.
2. Measure 40 cm^3 of 1.0 M hydrochloric acid into a small beaker.
3. Cool the hydrochloric acid to 10° C by placing the small beaker into an ice bath.
4. Use a thermometer to measure the temperature of the hydrochloric acid.
5. When the acid has reached the correct temperature, use a measuring cylinder to measure 10 cm^3 of the hydrochloric acid into a clean dry boiling tube.
6. Clamp the boiling tube on to a clamp stand in front of a white tile/sheet of white paper.
7. Using a spatula or spoon, place an agar cylinder into the boiling tube, making sure that the agar cylinder is covered by the hydrochloric acid.
8. Start the stopwatch/stop clock immediately.
9. Time how long it takes for the pink colour to disappear.
10. Repeat steps 4–9 so that you have three results for the hydrochloric acid at 10° C, using a clean dry boiling tube each time.
11. Cool or warm (as appropriate) a further 40 cm^3 of 1.0 M hydrochloric acid to 20° C by placing the acid into a small beaker in an ice/water bath.
12. Repeat steps 4–9 so that you have three results for the hydrochloric acid at 20° C, using a clean dry boiling tube each time.
13. Warm 40 cm^3 of 1.0 M hydrochloric acid to 30° C by placing the acid into a small beaker in a water bath.
14. Repeat steps 4–9 to get three results for the hydrochloric acid at 30° C, using a clean dry boiling tube each time.
15. Warm 40 cm^3 of 1.0 M hydrochloric acid to 40° C by placing the acid into a small beaker in a water bath.
16. Repeat steps 4–9 to get three results for the hydrochloric acid at 40° C, using a clean dry boiling tube each time.
17. Warm 40 cm^3 of 1.0 M hydrochloric acid to 50° C by placing the acid into a small beaker in a water bath.
18. Repeat steps 4–9 to get three results for the hydrochloric acid at 50° C, using a clean dry boiling tube each time.

Record your results/observations in the space provided.

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Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson BTEC Level 3 Nationals Extended Certificate

Centre Number | | | | | | |

Learner Registration Number | | | | | | | | |

Monday 20 January 2020

Supervised hours: 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 your results/observations from the practical investigation in **Part A**.
- **Part B** contains material for the completion of the set task under supervised conditions.
- **Part B** must be undertaken in a single session of 1 hour and 30 minutes on the date timetabled by Pearson.
- **Part B** 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 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.

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Answer ALL questions in Section 1 and Section 2.

Write your answers in the spaces provided.

SECTION 1

1 (a) Record all your experimental results in a suitable table, using the space provided.

Your table must include an average time for the colour change at each temperature.

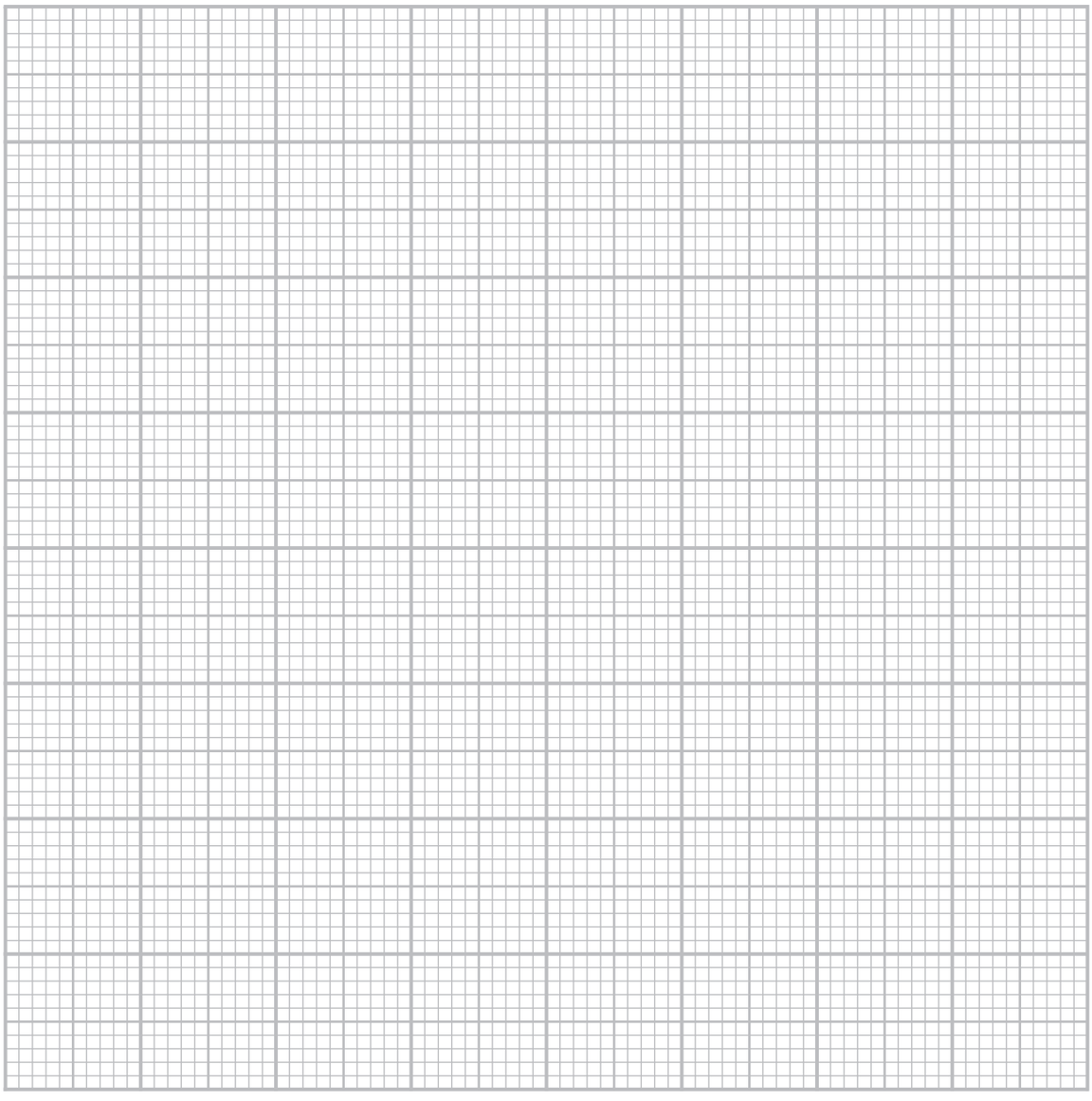
Circle any anomalous results.

(3)

(b) Plot a graph of the average time for the colour change against the temperature of the hydrochloric acid.

You should include a line of best fit.

(3)



(c) Describe, using the graph, the relationship between the average time for the colour change and the temperature.

(2)

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(d) Explain **one** risk in this investigation and how you minimised that risk.

(3)

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(e) In your investigation you used a measuring cylinder to measure 10cm^3 of the acid.

Other pieces of equipment could be used to measure the volume of acid more accurately than a measuring cylinder.

Identify and justify **one** different piece of equipment you could use to improve the accuracy of measuring volumes in your investigation.

(2)

identification .....

justification .....

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(Total for Question 1 = 13 marks)

2 Your colleague did a similar investigation.

Table 1 shows your colleague's data.

temperature (°C)	time (s)				
	trial 1	trial 2	trial 3	average	standard deviation
10	716.30	686.38	701.56	701.41	14.96
30	529.56	550.67	543.21	541.15	10.71
50	373.48	423.56	363.45	368.47	7.09
70	225.00	220.78	240.43	228.74	10.34
90	162.51	140.56	158.65	153.91	11.72

Table 1

(a) (i) Give a reason why your colleague did **not** use a temperature higher than 90 °C.

(1)

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(ii) Give a reason why your colleague did **not** use a temperature lower than 10 °C.

(1)

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(b) Your colleague has identified and circled an anomaly in Table 1.

Explain what might have caused the anomaly.

(2)

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(c) Figure 1 shows your colleague's data plotted on a graph.

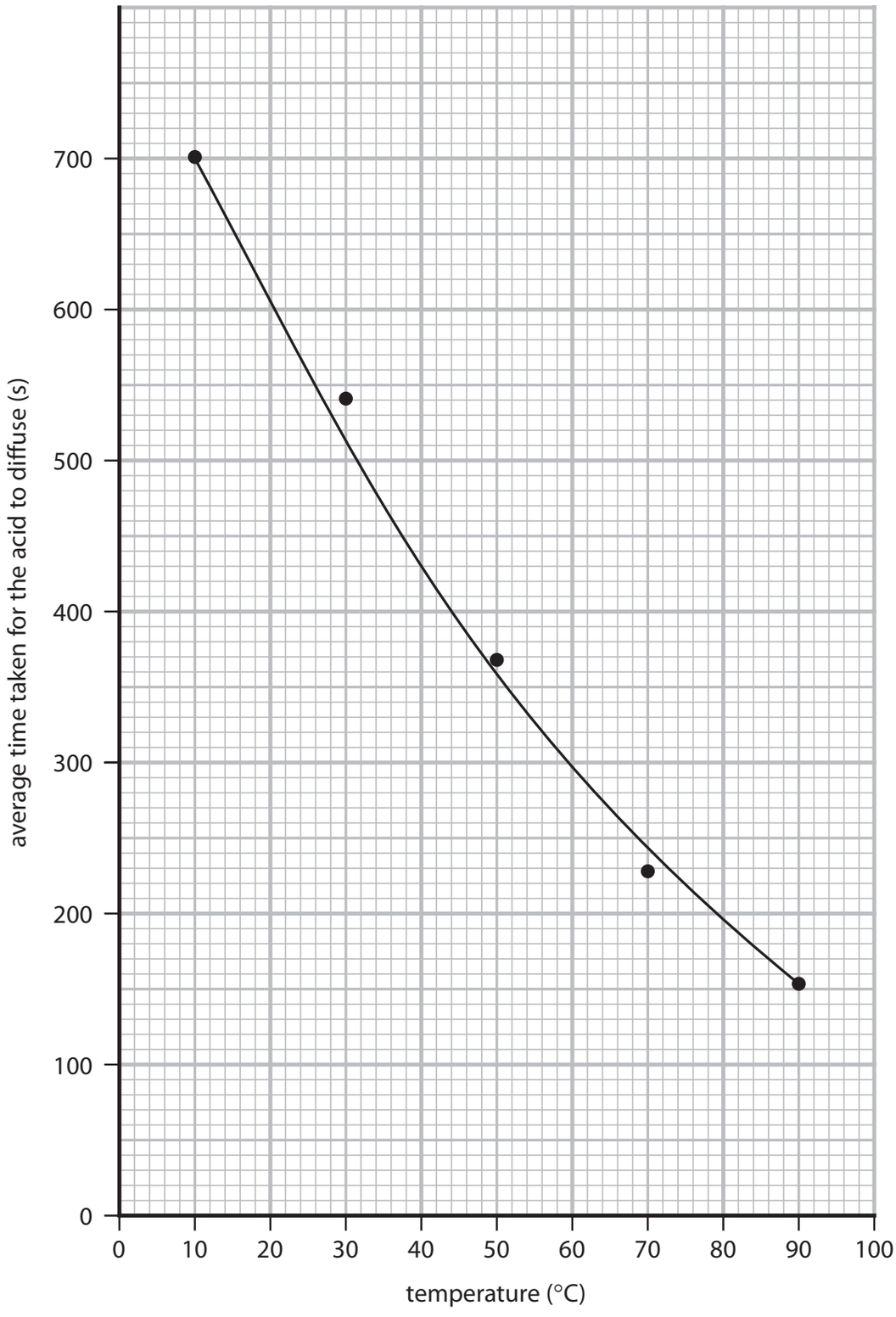

Figure 1

(i) Identify, using Figure 1, the average time taken for the acid to diffuse at 40 °C.

(1)

average time ..... s

(ii) The average rate of diffusion can be calculated using the equation

$$\text{average rate of diffusion } (s^{-1}) = \frac{1}{\text{average time (s)}}$$

Calculate the average rate of diffusion at 40 °C, using your value from 2(c)(i).

Give your answer in standard form.

(3)

average rate of diffusion ..... s^{-1}

(d) (i) Add error bars onto the graph in Figure 1 for each data point.

Use the standard deviations given in Table 1.

(2)

(ii) Explain which temperature in Figure 1 shows the **least** reliable set of results.

(2)

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(e) (i) Your colleague did a similar investigation but used sulfuric acid rather than hydrochloric acid.

Table 2 shows your colleague's results.

temperature (°C)	average time (s)	average rate of diffusion (s^{-1})
10	645.23	1.55×10^{-3}
30	482.12	2.07×10^{-3}
50	301.89	3.31×10^{-3}
70	184.54	5.42×10^{-3}
90		8.29×10^{-3}

Table 2

Calculate the average time the acid would take to diffuse at 90 °C.

Use the equation

$$\text{average rate of diffusion } (s^{-1}) = \frac{1}{\text{average time (s)}}$$

Show your working.

(3)

average time ..... s

(ii) State what effect using sulfuric acid instead of hydrochloric acid had on the average rate of diffusion.

(1)

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(Total for Question 2 = 16 marks)

3 In your investigation, the surface area of the agar cylinder was controlled.

(a) (i) State how the surface area of the agar cylinder was controlled.

(1)

(ii) Explain how the rate of diffusion would be affected if the surface area of the agar cylinder was increased.

(2)

(b) Explain how **two other** variables were controlled.

(4)

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(c) One way to extend your investigation would be to try different temperatures e.g. 15 °C and 25 °C.

Describe **two other** ways you could extend your investigation.

(4)

1 .....

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2 .....

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(Total for Question 3 = 11 marks)

TOTAL FOR SECTION 1 = 40 MARKS

SECTION 2

4 Potential difference

The relationship between potential difference (V) and resistance (R) of a resistance wire in a circuit is given by the following formula:

$$V = IR$$

where

V = potential difference
I = current in the circuit
R = resistance of the wire

The potential difference across a resistance wire in a circuit depends on the length of the wire.

You have been asked to write a plan for an investigation.

You need to investigate, using a circuit, how the potential difference across a resistance wire changes as the length of the wire changes.

You should include a circuit diagram to support your answer.

Your plan should include the following details:

- a hypothesis
- selection, and justification, of equipment, techniques or standard procedures
- health and safety 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 thermistor is one type of temperature dependent resistor.

A learner sets up a circuit to investigate how the resistance of the thermistor varies with the temperature of the thermistor.

Figure 2 shows the equipment used.

A hot plate is used to heat and control the temperature of the water in the beaker.

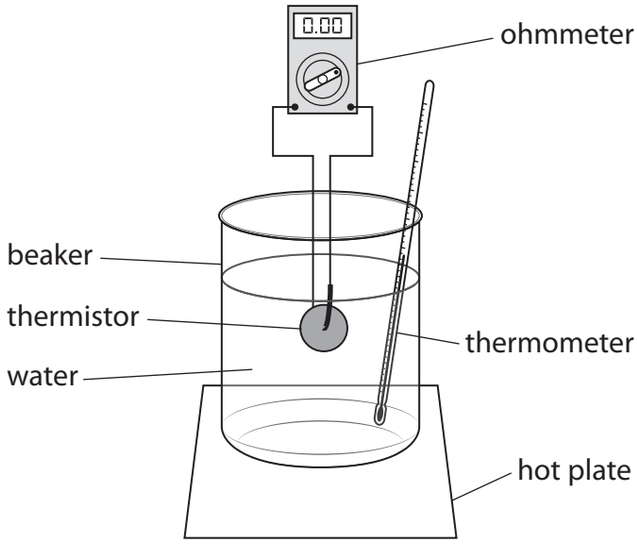

Figure 2

Here is the learner's method:

- put the thermistor into cold water
- measure the resistance with an ohmmeter
- switch on the hot plate
- measure the resistance at different temperatures.

The results of the learner's investigation are shown in Figure 3.

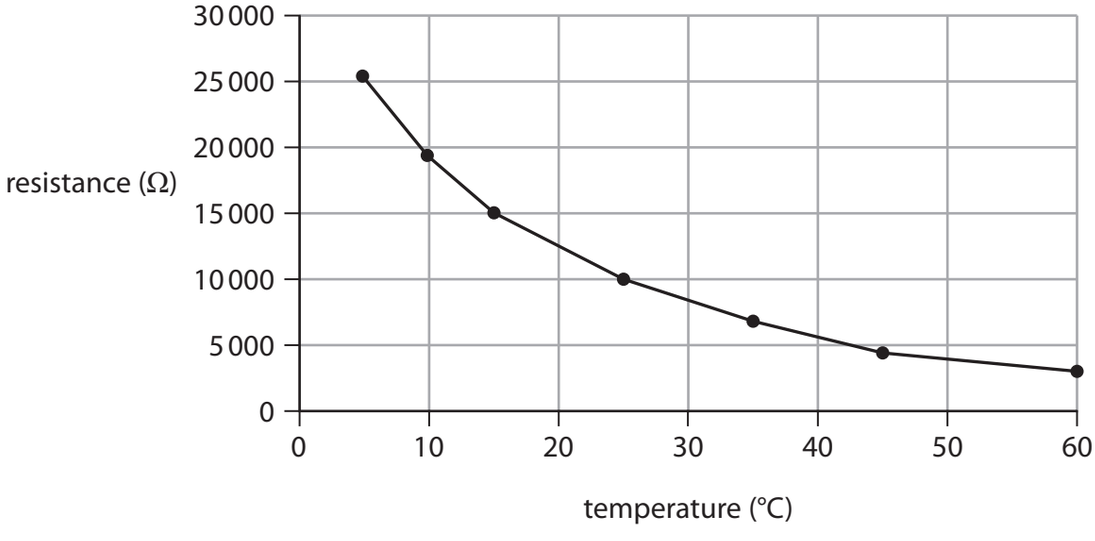

Figure 3

The learner concludes that:

'The resistance decreases at a greater rate when the temperature is high.'

Evaluate the learner's investigation.

Your answer should include reference to the:

- method of the experiment
- results collected
- conclusion made.

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(Total for Question 5 = 8 marks)

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

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