**Section A: Questions only**

 **This has a lot of pages so *please* remember to photocopy 4 pages onto one sheet by going A3→A4 and using back-to-back on the photocopier.**

This booklet contains a summary of every Section A exam question that has appeared on a leaving cert physics (higher and ordinary level) up to 2018

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# QUICK CHECK

For each experimentcheck that you can do can do each of the following:

1. Draw a fully labelled diagram which includes all essential apparatus (have you included the apparatus necessary to obtain values for both variables?)
2. Be able to state how the two sets of values were obtained (this is a very common question)
3. Describe what needs to be adjusted to give a new set of data
4. Write down the relevant equation if there is one associated with the experiment
5. Be able to state how the data in the table will need to be adjusted.
6. Be able to list three sources of error/precautions

***If the experiment involves a graph***

1. Know how the data provided will need to be adjusted
2. Know what goes on each axis
3. Know how to use the slope of the graph to obtain the desired answer

Note that all documents can be found on [www.thephysicsteacher.ie](http://www.thephysicsteacher.ie)

# LIST OF EXPERIMENTS

## MEASUREMENT OF THE FOCAL LENGTH OF A CONCAVE MIRROR

HL: 2013, 2007
OL: 2010, 2002

The following is part of a student’s report of an experiment to measure the focal length of a concave mirror.

 “I found the approximate focal length of the mirror to be \_\_ cm.

I then placed an object at different positions in front of the lens so that a real image was formed in each case.”

The table shows the measurements recorded by the student for the object distance *u* and the image distance *v*.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| u/cm | 15.0 | 20.0 | 25.0 | 30.0 | 35.0  | 40.0 |
| v/cm | 60.5 | 30.0 | 23.0 | 20.5 | 18.0 | 16.5 |

1. How was an approximate value for the focal length found?
2. What was the advantage of finding the approximate value for the focal length?
3. Draw a labelled diagram showing how the apparatus was arranged.
4. Mark the distances *u* and *v* on your diagram.
5. Describe how the student found the position of the image.
6. Calculate the value for the focal length *f* of the mirror using the data.
7. Give two precautions that should be taken when measuring the image distance.
8. Why did the student repeat the experiment?

## VERIFICATION OF SNELL’S LAW OF REFRACTION

***and***

**TO MEASURE THE REFRACTIVE INDEX OF A GLASS BLOCK**

HL: 2014, 2010, 2005
OL: 2013, 2012, 2008, 2006

In an experiment to measure the refractive index of a substance, a student used a rectangular block of the substance to measure the angle of incidence *i* and the corresponding angle of refraction *r* for a ray of light as it passed from air into the substance. The student repeated the procedure for a series of different values of the angle of incidence and recorded the following data.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *i* (degrees) | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
| *r* (degrees) | 13 | 20 | 27 | 23 | 36 | 40 | 43 |

1. What measurements were taken during the experiment?
2. Draw a labelled diagram of the apparatus that could be used in this experiment.
3. Indicate on the diagram the angles *i* and *r*.
4. Describe how the student found the path of the ray of light passing through the glass block.
5. Describe, with reference to the diagram, how the student found the angle of refraction.
6. Draw a suitable graph to illustrate the relationship between the angle of incidence and the angle of refraction.
7. Use your graph to find the refractive index of the material.
8. One of the recorded angles of refraction is inconsistent with the others. Which one?
9. Explain how your graph verifies Snell’s law.
10. The student did not record any values of *i* below 20°, why not?
11. Using a graph to calculate a value for the refractive index is a more accurate method than calculating the refractive index for each pair of angles and then finding the mean.
Give a reason for this.

## MEASUREMENT OF THE FOCAL LENGTH OF A CONVEX LENS

HL: 2012, 2009, 2003
OL: 2005

The following is part of a student’s report of an experiment to measure the focal length of a converging lens.

 “I found the approximate focal length of the lens to be 15 cm.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *u*/cm | 20.0 | 25.0 | 35.0 | 45.0 |
| *v*/cm | 66.4 | 40.6 | 27.6 | 23.2 |

I then placed an object at different positions in front of the lens so that a real image was formed in each case.”

The table shows the measurements recorded by the student for the object distance *u* and the image distance *v*.

1. How did the student find an approximate value for the focal length of the lens?
2. What was the advantage of finding the approximate value of the focal lens?
3. Draw a labelled diagram of the apparatus that you used in the experiment.
4. Describe, with reference to the diagram, how the student found the position of the image.
5. Why is it difficult to measure the image distance accurately?
6. Describe, with reference to the diagram, how the student obtained the data.
7. Using the data in the table, find an average value for the focal length of the lens.
8. Why is it difficult to measure the image distance when the object distance is less than 10 cm?
9. Give two sources of error in measuring the image distance and state how one of these errors can be reduced.

## MEASUREMENT OF VELOCITY AND ACCELERATION

OL: 2004, 2008, 2012

A student carried out an experiment to measure the acceleration of a moving trolley.

The student calculated the velocity of the trolley at different times and plotted a graph which was then used to find its acceleration. The table shows the data recorded.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Velocity/ m s-1 | 0.9 | 1.7 | 2.5 | 3.3 | 4.1 | 4.9 |
| Time/s | 0 | 2 | 4 | 6 | 8 | 10 |

1. Draw a diagram to show how the student got the trolley to accelerate.
2. Describe how the student measured the final velocity of the trolley.
3. What other measurement did the student take?
4. Using the data in the table, draw a graph on graph paper of the trolley’s velocity against time. Put time on the horizontal axis (X-axis).
5. Find the slope of your graph and hence determine the acceleration of the trolley.
6. Give a precaution the student took to ensure an accurate result.

## MEASUREMENT OF ACCELERATION DUE TO GRAVITY (g) USING THE FREEFALL METHOD

HL: 2009, 2004

OL: 2013, 2009, 2002

In an experiment to measure the acceleration due to gravity *g* by a free fall method, a student measured the time *t* for an object to fall from rest through a distance *s*.

This procedure was repeated for a series of values of the distance *s.*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *s*/cm | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
| *t*/ms | 244 | 291 | 325 | 342 | 371 | 409 | 420 |

The table shows the data recorded by the student.

1. Draw a labelled diagram of the apparatus used in the experiment.
2. Indicate the distance *s* on your diagram.
3. Describe how the time interval *t* was measured.
4. What did you need to do to get a new set of data?
5. Calculate a value for the acceleration due to gravity by drawing a suitable graph based on the recorded data.
6. Give two precautions that should be taken to ensure a more accurate result.

## TO SHOW THAT ACCELERATION IS PROPORTIONAL TO THE FORCE WHICH CAUSED IT

2010 HL

2010 OL, 2005 OL, 2003 OL

You carried out an experiment to investigate the relationship between the acceleration of a body and the force applied to it.

You did this by applying a force to a body and measuring the resulting acceleration.

The table shows the data recorded during the experiment.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Force / N | 0.20 | 0.25 | 0.30 | 0.35 | 0.40 | 0.45 | 0.50 |
| acceleration / m s−2 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |

1. Draw a labelled diagram of the apparatus you used.
2. How did you measure the applied force?
3. Describe the steps involved in measuring the acceleration of the body.
4. How did you minimise the effect of friction during the experiment?
5. Plot a graph on graph paper of the body’s acceleration against the force applied to it.
Put acceleration on the horizontal axis (X-axis).
6. What does your graph tell you about the relationship between the acceleration of the body and the force applied to it?
7. Calculate the slope of your graph and hence determine the mass of the body.
8. On a trial run of this experiment, a student found that the graph did not go through the origin.
Suggest a reason for this.
9. Describe how the apparatus should be adjusted so that the graph would go through the origin.

## TO VERIFY THE PRINCIPLE OF CONSERVATION OF MOMENTUM

HL: 2014, 2011, 2005

OL: 2006, 2011

A student carried out an experiment to verify the principle of conservation of momentum.

The student adjusted the apparatus till a body A was moving at a constant velocity *u*.

It was then allowed to collide with a second body B, which was initially at rest, and the two bodies moved off together with a common velocity *v*.

|  |  |
| --- | --- |
| mass of body A | 230 g |
| mass of body B | 160 g |
| velocity *u* | 0.53 m s–1 |
| velocity *v* | 0.32 m s–1 |

The following data were recorded:

1. Draw a labelled diagram of the apparatus used in the experiment.
2. How did the student measure the mass of the trolleys?
3. State what measurements the student took and how these measurements were used to calculate the velocities.
4. What adjustments did the student make to the apparatus so that body A would move at constant velocity?
5. How did the student know that body A was moving at constant velocity?
6. Describe how the student measured the velocity *v* of the bodies after the collision.
7. Using the recorded data, show how the experiment verifies the principle of conservation of momentum.
8. When carrying out this experiment the student ensures that there is no net external force acting on the bodies.
What are the two forces that the student needs to take account of to ensure this?
9. Describe how the student reduced the effects of these forces.

## VERIFICATION OF BOYLE’S LAW

HL: 2013, 2011, 2003

OL: 2004

During an experiment to verify Boyle’s law, the pressure of a fixed mass of gas was varied.

A series of measurements of the pressure *p* and the corresponding volume *V* of the gas was recorded as shown.

The temperature was kept constant.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *p*/kPa  | 325 | 300 | 275 | 250 | 200 | 175 | 150 | 125 |
| *V*/cm3  | 12.1 | 13.0 | 14.2 | 15.5 | 19.6 | 22.4 | 26.0 | 31.1 |

1. Draw a labelled diagram of the apparatus used in the experiment.
2. How was the pressure of the gas varied during the experiment?
3. Describe how the pressure and the volume of the gas were measured.
4. Why should there be a delay between adjusting the pressure of the gas and recording its value?
5. Draw a suitable graph to show the relationship between the pressure and the volume of a fixed mass of gas.
6. Explain how your graph verifies Boyle’s law.

## INVESTIGATION OF THE LAWS OF EQUILIBRIUM FOR A SET OF CO-PLANAR FORCES

HL: 2007, 2013, 2002

OL: 2014, 2007

A student investigated the laws of equilibrium for a set of co-planar forces acting on a metre stick.

The weight of the metre stick was 1 N and its centre of gravity was found to be at the 50.5 cm mark.

Two spring balances and a number of weights were attached to the metre stick.

Their positions were adjusted until the metre stick was in horizontal equilibrium, as indicated in the diagram.

The reading on the spring balance attached at the 20 cm mark was 2 N and the reading on the other spring balance was 4 N.

The other end of each spring balance was attached to a fixed support.

1. How did the student measure the upward forces?
2. Copy the diagram and show all the forces acting on the metre stick.
3. Find the total upward force acting on the metre stick.
4. Find the total downward force acting on the metre stick.
5. Explain how these values verify one of the laws of equilibrium.
6. Find the sum of the *anticlockwise moments* of the *upward* forces about an axis through the 10 cm mark on the metre stick.
7. Find the sum of the *clockwise moments* of the *downward* forces about an axis through the 10 cm mark on the metre stick.
8. Explain how these values verify the other law of equilibrium.
9. How did the student know the metre stick was in equilibrium?
10. How did the student find the weight, of the metre stick?
11. Why is the centre of gravity of the metre stick not at the 50.0 cm mark?
12. Describe how the centre of gravity of the metre stick was found.
13. Why was it important to have the spring balances hanging vertically?

## INVESTIGATION OF THE RELATIONSHIP BETWEEN PERIODIC TIME AND LENGTH FOR A SIMPLE PENDULUM AND HENCE CALCULATION OF g

HL: 2012, 2008, 2006

A student investigated the relationship between the period and the length of a simple pendulum. The student measured the length l of the pendulum.

The pendulum was then allowed to swing through a small angle and the time t for 30 oscillations was measured.

This procedure was repeated for different values of the length of the pendulum.

The student recorded the following data:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| l /cm  | 40.0  | 50.0  | 60.0  | 70.0  | 80.0  | 90.0  | 100.0  |
| t /s  | 38.4  | 42.6  | 47.4  | 51.6  | 54.6  | 57.9  | 60.0  |

1. Why did the student measure the time for 30 oscillations instead of measuring the time for one?
2. How did the student ensure that the length of the pendulum remained constant when the pendulum was swinging?
3. Describe how the student obtained a value for the length of the pendulum and its corresponding periodic time.
4. Using the recorded data draw a suitable graph to show the relationship between the period and the length of a simple pendulum.
5. What is this relationship?
6. Justify your answer.
7. Use your graph to calculate the acceleration due to gravity.
8. Give two factors that affect the accuracy of the measurement of the periodic time.
9. Explain why a small heavy bob was used.
10. Explain why the string was inextensible.

## TO CALIBRATE A THERMOMETER USING THE LABORATORY MERCURY THERMOMETER AS A STANDARD

OL: 2012, 2007

A student carried out an experiment to obtain the calibration curve of a thermometer.

The following is an extract from her report.

I placed the thermometer I was calibrating in a beaker of water along with a mercury thermometer which I used as the standard. I recorded the value of the thermometric property of my thermometer and the temperature of the water as shown on the mercury thermometer. I repeated this procedure at different temperatures. The following is the table of results that I obtained.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Temperature/°C | 0 | 20 | 40 | 60 | 80 | 100 |
| Value of thermometric property | 4 | 12 | 24 | 40 | 64 | 150 |

1. Draw a labelled diagram of the apparatus used in the experiment.
2. Describe, with the aid of a diagram, the procedure you used in the experiment.
3. Name the thermometric property of the thermometer you calibrated.
4. How was the value of this thermometric property measured?
5. Using the data in the table, draw a graph on graph paper of the value of the thermometric property against its temperature. Put temperature on the horizontal axis (X-axis).
6. Use your calibration curve to determine the temperature when the value of the thermometric property is 50.
7. Give an example of a thermometric property.

## MEASUREMENT OF THE SPECIFIC HEAT CAPACITY OF WATER

HL: 2007

OL: 2010, 2004

In a report of an experiment to measure the specific heat capacity of a substance (e.g. water *or* a metal), a student wrote the following.

“I assembled the apparatus needed for the experiment.

During the experiment I took a number of measurements of mass and temperature.

I used these measurements to calculate the specific heat capacity of the substance.”

1. Draw a labelled diagram of the apparatus used.
2. What measurements of mass did the student take during the experiment?
3. What temperature measurements did the student take during the experiment?
4. Give a formula used to calculate the specific heat capacity of the substance.
5. Give one precaution that the student took to get an accurate result.

The specific heat capacity of water was found by adding hot copper to water in a copper calorimeter.

|  |
| --- |
| mass of calorimeter 55.7 g |
| mass of calorimeter + water 101.2 g |
| mass of copper + calorimeter + water 131.4 g |
| initial temperature of water 16.5 oC |
| temperature of hot copper 99.5 oC |
| final temperature of water 21.0 oC |

*This was not the method most students would have used to carry out the experiment so there was much annoyance when it appeared on the paper. Nevertheless it does differentiate between those students who understand the underlying principles and those who have just learned off a formula.*

The following data was recorded:

1. Describe how the copper was heated and how its temperature was measured.
2. Using the data, calculate the energy lost by the hot copper
3. Using the data, calculate the specific heat capacity of water.
4. Give two precautions that were taken to minimise heat loss to the surroundings.
5. Explain why adding a larger mass of copper would improve the accuracy of the experiment.

## MEASUREMENT OF THE SPECIFIC LATENT HEAT OF FUSION OF ICE

HL: 2008, 2002

OL: 2014, 2013, 2009, 2003,

In an experiment to measure the specific latent heat of fusion of ice, warm water was placed in a copper calorimeter. Dried, melting ice was added to the warm water and the following data was recorded.

 Mass of calorimeter 60.5 g

 Mass of calorimeter + water 118.8 g

 Temperature of warm water 30.5 oC

 Mass of ice 15.1 g

 Temperature of water after adding ice 10.2 oC

1. Draw a labelled diagram of the apparatus used.
2. What measurements did the student take before adding the ice to the water?
3. What did the student do with the ice before adding it to the water?
4. How did the student know the ice was at 0 0C?
5. How was the ice crushed?
6. Why was the ice crushed?
7. Why was dried ice used?
8. Why was melting ice used?
9. Describe how the mass of the ice was found.
10. How did the student find the mass of the ice?
11. Why did the student use warm water in the experiment?
12. Give one precaution that the student took to get an accurate result.
13. Why was the experiment repeated?
14. Calculate the energy lost by the calorimeter and the warm water.
15. Calculate the specific latent heat of fusion of ice.
16. What should be the approximate room temperature to minimise experimental error?
17. What was the advantage of having the room temperature approximately halfway between the initial and final temperature of the water?
18. Calculate a value for the specific latent heat of fusion of ice
19. The accepted value for the specific latent heat of fusion of ice is 3.3 × 105 J kg-1; suggest two reasons why your answer is not this value.

## MEASUREMENT OF THE SPECIFIC LATENT HEAT OF VAPORISATION OF WATER

HL: 2010, 2005, 2003

OL: 2011, 2005

In an experiment to measure the specific latent heat of vaporisation of water, a student used a copper calorimeter containing water and a sensitive thermometer. The water was cooled below room temperature before adding dry steam to it. The following measurements were recorded.

Mass of calorimeter = 73.40 g

Mass of cold water = 67.50 g

Initial temperature of water + calorimeter = 10 0C

Temperature of steam = 100 0C

Mass of steam added = 1.03 g

Final temperature of water + calorimeter = 19 0C

1. Draw a labelled diagram of the apparatus used.
2. List two measurements that the student took before adding the steam to the water.
3. How did the student find the mass of steam that was added to the water?
4. How did the student make sure that only steam, and not hot water, was added to the calorimeter?
5. Why was dry steam used?
6. Give one precaution that the student took to prevent heat loss from the calorimeter.
7. Describe how the mass of the cold water was found.
8. How was the water cooled below room temperature?
9. Why was the water cooled below room temperature?
10. A thermometer with a low heat capacity was used to ensure accuracy. Explain why.
11. Give two ways of improving the accuracy of this value.
12. Calculate the heat gained by the water and the calorimeter
13. Calculate the heat lost by the condensed steam
14. Calculate the latent heat of vaporisation of water.

(specific heat capacity of copper = 390 J Kg−1 K−1 ; specific heat capacity of water = 4180 J Kg−1 K−1)

## TO MEASURE THE SPEED OF SOUND IN AIR

HL: 2014, 2006

OL: 2011, 2008, 2003

A student carried out an experiment to measure the speed of sound in air.

|  |  |  |  |
| --- | --- | --- | --- |
| f/Hz | 512 | 480 | 426 |
| l/cm | 16.0 | 17.2 | 19.4 |

The following data was recorded.

Diameter of column of air = 2.05 cm.

1. Draw a labelled diagram of the apparatus that you used.
2. Describe how the length of the column of air was adjusted.
3. Describe how the frequency of the column of air was measured.
4. How was the wavelength of the sound wave measured?
5. Describe how the diameter of the column of air was measured.
6. How was it known that the air column was vibrating at its first harmonic?
7. Using all of the data, calculate the speed of sound in air.
8. Why should you repeat the experiment?
9. Why was it necessary to measure the diameter of the air column?
10. Another student carried out the experiment. She measured the length of the column of air for each of the first two positions of resonance but she did not measure the diameter of the air column.
Explain how this second student would find the speed of sound in air.

## INVESTIGATION OF THE VARIATION OF FUNDAMENTAL FREQUENCY OF A STRETCHED STRING WITH LENGTH

HL: 2012

OL: 2014, 2009, 2006, 2002

In an experiment to investigate the variation of the fundamental frequency *f* of a stretched string with its length *l*, the following data were recorded.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| f/Hz | 95 | 102 | 114 | 126 | 141 | 165 | 194 | 232 |
| l/m | 0.603 | 0.553 | 0.503 | 0.453 | 0.403 | 0.353 | 0.303 | 0.253 |

1. Draw a labelled diagram of the apparatus used in the experiment.
2. Indicate on your diagram the length of the string that was measured.
3. Describe how the student set the string vibrating.
4. How was the length adjusted?
5. Why was the tension in the string kept constant during the experiment?
6. How did the student know that the string was vibrating at its fundamental frequency?
7. How was the frequency determined?
8. Using the data, draw a suitable graph on graph paper to show the relationship between the fundamental frequency of the stretched string and its length.
9. What conclusion can be drawn from yourgraph?
10. The fundamental frequency of a stretched string depends on factors other than its length

Name on these factors and give its relationship with the fundamental frequency.

1. If you were doing an experiment to establish the relationship between the fundamental frequency of a stretched string and this other factor, how would you obtain the relevant data?

## INVESTIGATION OF THE VARIATION OF FUNDAMENTAL FREQUENCY OF A STRETCHED STRING WITH TENSION

HL: 2009, 2004, 2002

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| T/N | 15 | 20 | 25 | 30 | 35 | 40 | 45 |
| f /Hz | 264 | 304 | 342 | 371 | 402 | 431 | 456 |

A student obtained the following data during an investigation of the variation of the fundamental frequency f of a stretched string with its tension T.

The length of the string was kept constant.

1. Describe, with the aid of a diagram, how the student obtained the data.
2. How did the student know that resonance occurred / how did the student know that the string was vibrating at its fundamental frequency?
3. Why was the length of the string kept constant during the investigation?
4. Plot a suitable graph on graph paper to show the relationship between fundamental frequency and tension for the stretched string.
5. State this relationship and explain how your graph verifies it.
6. Use your graph to estimate the fundamental frequency of the string when its tension is 11 N.
7. From your graph, estimate the tension in the string when its fundamental frequency is 380 Hz.
8. Use your graph to calculate the mass per unit length of the string.

## MEASUREMENT OF THE WAVELENGTH OF MONOCHROMATIC LIGHT

HL: 2011, 2008, 2006, 2004

OL: 2007, 2004

In an experiment to measure the wavelength of a monochromatic light source, a narrow beam of light was incident normally on a diffraction grating having 400 lines per mm.

A number of bright images were observed.

The angles *θ* between the central bright image and the first two images to the left and right of it were measured and recorded in a table, as shown.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 2nd image to leftof central image | 1st image to leftof central image | 1st image to rightof central image | 2nd image to rightof central image |
| *θ* / ° | 30.98 | 14.90 | 14.81 | 31.01 |

1. Name a source of monochromatic light.
2. Draw a labelled diagram of the apparatus you used.
3. What is the distance between each line on the diffraction grating?
4. Explain how the order of the images were identified.
5. Describe how the angle between the first order images was measured.
6. What formula did you use to calculate the wavelength of the light?
7. Using the data, calculate the wavelength of the monochromatic light.
8. Give one precaution that you took to get an accurate result.
9. Calculate the maximum number of images that are formed on the screen.
10. The light source is replaced with a source of white light and a series of spectra are formed on the screen.

Explain how the diffraction grating produces a spectrum.

1. Explain why a spectrum is not formed at the central (zero order) image.
2. The values for the angles on one side of the central image can sometimes *all* be smaller than the corresponding ones on the right. Suggest a possible reason for this.

What effect would each of the following changes have on the bright images formed:

1. using a monochromatic light source of longer wavelength
2. using a diffraction grating having 200 lines per mm
3. using a source of white light instead of monochromatic light?

2009 Section B

An interference pattern is formed on a screen when green light from a laser passes normally through a diffraction grating. The grating has 80 lines per mm and the distance from the grating to the screen is 90 cm. The distance between the third order images is 23.8 cm.

Calculate the wavelength of the green light.

## TO MEASURE THE RESISTIVITY OF THE MATERIAL OF A WIRE

HL: 2009, 2004

OL: 2010, 2005

In an experiment to measure the resistivity of nichrome, the resistance, the diameter and appropriate length of a sample of nichrome wire were measured.

The following data were recorded:

Resistance of wire = 7.9 Ω

Length of wire = 54.6 cm

Average diameter of wire = 0.31 mm

1. Describe how the student measured the resistance of the wire.
2. Describe the procedure used in measuring the length of the sample of wire.
3. Using the data, calculate the diameter of the wire.
4. Hence calculate the cross-sectional area of the wire.
5. What instrument did the student use to measure the diameter of the wire?
6. Why did the student measure the diameter of the wire at different places?
7. Describe the steps involved in finding the average diameter of the wire.
8. Use the data to calculate the resistivity of nichrome.
9. Give two precautions that the student took when measuring the length of the wire.
10. The experiment was repeated on a warmer day. What effect did this have on the measurements?

## TO INVESTIGATE THE VARIATION OF THE RESISTANCE OF A METALLIC CONDUCTOR WITH TEMPERATURE

HL: 2008

OL: 2006

A student investigated the variation of the resistance R of a metallic conductor with its temperature θ.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| θ/oC  | 20  | 30  | 40  | 50  | 60  | 70  | 80  |
| R/Ω  | 4.6  | 4.9  | 5.1  | 5.4  | 5.6  | 5.9  | 6.1  |

The student recorded the following data.

1. Describe, with the aid of a diagram, how the student measured the temperature of the wire.
2. How did the student vary the temperature of the wire?
3. How did the student measure the resistance of the wire?
4. Draw a suitable graph to show the relationship between the resistance of the metal conductor and its temperature.
5. Use your graph to estimate the resistance of the metal conductor at a temperature of –20 oC.
6. Use your graph to estimate the change in resistance for a temperature increase of 80 oC.
7. What does your graph tell you about the relationship between the resistance of a metallic conductor and its temperature?
8. Explain your answer

## TO INVESTIGATE THE VARIATION OF THE RESISTANCE OF A THERMISTOR WITH TEMPERATURE

HL: 2010

OL: 2009 OL, 2002 OL, 2013 OL

In an experiment to investigate the variation of the resistance *R* of a thermistor with its temperature *θ*, a student measured its resistance at different temperatures.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *θ* /°C | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
| *R*/Ω | 2000 | 1300 | 800 | 400 | 200 | 90 | 40 |

The table shows the measurements recorded.

1. Draw a labelled diagram of the apparatus used.
2. How did the student measure the temperature of the thermistor?
3. Explain, with the aid of a labelled diagram, how the student varied the temperature of the thermistor.
4. How was the resistance measured?
5. Using the recorded data, plot a graph to show the variation of the resistance of a thermistor with its temperature. Put θ on the X-axis

.

1. What does your graph tell you about the relationship between the resistance of a thermistor and its temperature?
2. Use your graph to estimate the temperature of the thermistor when its resistance is 1000 Ω.
3. Use your graph to estimate the average variation of resistance per Kelvin in the range 45 °C – 55 °C.
4. In this investigation, why is the thermistor usually immersed in oil rather than in water?

## TO INVESTIGATE THE VARIATION OF CURRENT (I) WITH POTENTIAL DIFFERENCE (V) FOR A THIN METALLIC CONDUCTOR

HL: 2013

A student was asked to investigate the variation of current with potential difference for a thin metallic conductor.

The student set up a circuit using appropriate equipment.

The student recorded the values of the current *I* passing through the conductor for the corresponding values of potential difference *V*.

The recorded data are shown in the table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *V*/V | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 |
| *I*/A | 0.17 | 0.34 | 0.50 | 0.64 | 0.77 | 0.88 |

1. Draw and label the circuit diagram used by the student.
2. Name the device in the circuit that is used to vary the potential difference across the conductor.
3. Explain how the student used this device to vary the potential difference.
4. Use the data in the table to draw a graph on graph paper to show the variation of current with potential difference.
5. Use your graph to find the value of the resistance of the conductor when the current is 0.7 A.
6. Explain the shape of your graph.

## TO INVESTIGATE THE VARIATION OF CURRENT (I) WITH POTENTIAL DIFFERENCE (V) FOR A FILAMENT BULB

HL: 2005

OL: 2011, 2003

A student investigated the variation of the current *I* flowing through a filament bulb for a range of different values of potential difference *V*.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Potential difference /V | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 |
| Current /A | 1.0 | 1.5 | 1.9 | 2.3 | 2.6 | 2.9 | 3.2 | 3.5 |

He recorded the following data.

1. Draw a suitable circuit diagram used by the student.
2. Describe how the student varied the potential difference.
3. Draw a graph, on graph paper, of the current against the potential difference.
4. What does your graph tell you about the variation of current with potential difference for a filament lamp?
5. Use your graph to find the resistance of the bulb when the current is 3 A.
6. With reference to the graph, explain why the current is not proportional to the potential difference.
7. With reference to the graph, calculate the change in resistance of the filament bulb as the potential difference increases from 1 V to 5 V.
8. Give a reason why the resistance of the filament bulb changes.

## TO INVESTIGATE THE VARIATION OF CURRENT (I) WITH POTENTIAL DIFFERENCE (V) FOR COPPER ELECTRODES IN A COPPER-SULPHATE SOLUTION

HL: 2011, 2002

OL: 2012, 2004

A student investigated the variation of the current *I* through an electrolyte as the potential difference *V* across the electrolyte was changed. The electrolyte used was a solution of copper sulfate.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *V*/V  | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| *I*/mA  | 0 | 30 | 64 | 93 | 122 | 160 | 195 |

The electrodes used were made of copper.

The student recorded the following data:

1. Draw a diagram of the apparatus used in this experiment, identifying the anode and the cathode.
2. How was the potential difference changed during the investigation?
3. Draw a suitable graph to show the relationship between the current and the potential difference in this investigation.
4. Calculate the slope of your graph.
5. Use your graph to calculate the resistance of the electrolyte.
6. What was observed at the electrodes as current flowed through the electrolyte?
7. Draw a sketch of the graph that would be obtained if inactive electrodes were used in this experiment.

## TO INVESTIGATE THE VARIATION OF CURRENT (I) WITH POTENTIAL DIFFERENCE (V) FOR A SEMICONDUCTOR DIODE

HL: 2012, 2007

OL: 2014, 2008

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *V*/V  | 0 | 0.50 | 0.59 | 0.65 | 0.68 | 0.70 | 0.72 |
| *I*/mA  | 0 | 3.0 | 5.4 | 11.7 | 17.4 | 27.3 | 36.5 |

A student investigated the variation of the current *I* flowing through a for a semiconductor diode for a range of different values of potential difference *V*.

He recorded the following data.

1. Draw a circuit diagram used by the student.
2. How did the student vary and measure the potential difference?
3. What is the function of the 330 Ω resistor in this circuit?
4. Using the data, draw a graph to show how the current varies with the potential difference for the semiconductor diode. Put potential difference on the horizontal axis (X-axis).
5. What does the graph tell you about the variation of current with potential difference for a semiconductor diode?
6. Does the resistance of the diode remain constant during the investigation?

Justify your answer.

1. Estimate from your graph the junction voltage of the diode.
2. The student then put the diode in reverse bias and repeated the experiment.

How would a student connect the diode in reverse bias?

1. Draw a sketch of the graph obtained for the diode in reverse bias.

## TO VERIFY JOULE’S LAW

HL: 2014, 2006, 2003

OL: 2007

In an experiment to verify Joule’s law, a fixed mass of water was heated in an insulated cup. ϴ*,* the highest temperature reached*,* was recorded for different values of current, *I*. In each case the current flowed for 4 minutes and the initial temperature of the water was 20.0 °C. The recorded data is shown in the table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| I (A) | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 |
| ϴ (°C) | 22.0 | 24.5 | 28.5 | 34.0 | 38.5 | 45.5 |

1. Draw a labelled diagram of the apparatus used in the experiment.
2. How was the current changed during the experiment?
3. Draw a suitable graph to verify Joule’s law.
4. Explain how the graph verifies Joule’s law.
5. Use your graph to estimate the highest temperature of the water when a current of 1.6 A flows through the coil for 4 minutes.
6. Explain why the current was allowed to flow for a fixed length of time in each case.
7. Explain why a fixed mass of water was used.
8. Apart from using insulation, give one other way of reducing heat losses in the experiment.
9. Given that the mass of water in the calorimeter was 90 g in each case, and assuming that all of the electrical energy supplied was absorbed by the water, use the graph to determine the resistance of the heating coil.

The specific heat capacity of water is 4200 J kg–1 K–1.