**2010 Ordinary Level**

1

[2010 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**

Labelled diagram to show:

Trolley / rider

Runway / air-track

Means of applying a force e.g. string over pulley to weight on pan

Means of measuring acceleration e.g. 2 photo-gates (and timer) // tickertape (and timer)

1. **How did you measure the applied force?**

Weighed the mass (and pan) / *mg* // from the (digital Newton) balance

1. **How did you minimise the effect of friction during the experiment?**

Slant/clean the runway // oil (the trolley) wheels / frictionless wheels

1. **Plot a graph on graph paper of the body’s acceleration against the force applied to it**



1. **What does your graph tell you about the relationship between the acceleration of the body and the force applied to it?**

They are proportional.

2

[2010 OL]

A student carried out an experiment to measure the specific heat capacity of a substance.

The following is an extract from her report.

“I set up the apparatus. I took a series of measurements before I heated the substance. I then took further measurements. I used these measurements to find the specific heat capacity of the substance.”

1. **Draw a labelled diagram of the apparatus used in the experiment.**

Labelled diagram to show:

Block of metal // calorimeter with liquid

Means of heating e.g. coil (and power supply)

Means of measuring energy supplied e.g. joulemeter

Insulation / (electronic) balance / stirrer /thermometer /other detail

Incorrect experiment, maximum mark

1. **Describe how the mass of the substance was determined.**

Mass of metal block obtained with an electronic balance //mass of calorimeter and warm water - mass of calorimeter

1. **What other measurements did the student take during the experiment?**

initial/minimum temperature

final/maximum temperature

joules supplied

mass of calorimeter

1. **Give the formula used to calculate the specific heat capacity of the substance.**

*E* = *mc*Δ*θ*

1. **Give a precaution that the student should have taken to get an accurate result.**

Initial temperature below room temperature (to help compensate for heat loss),repeat and get an average, insulate, etc.

3.

[2010 OL]

A student carried out an experiment to measure the focal length of a concave mirror.

The student placed an object in front of the mirror so that a real image was formed.

The student repeated the experiment by placing the object at different positions and each time recorded the object distance *u* and the image distance *v*.

|  |  |  |  |
| --- | --- | --- | --- |
| *u/*cm | 20 | 30 | 50 |
| *v/*cm | 65 | 32 | 23 |

The table shows the data recorded by the student.

1. **Draw a labelled diagram showing how the apparatus was arranged.**

Labelled diagram to showconcave mirror, object e.g. crosswire, image.

Correct arrangement

Detail e.g. optical bench, metre-stick, screen, ray-box, etc.

1. **Mark the distances *u* and *v* on your diagram.**

Distance from the object/crosswire to the mirror shown as *u.*

Distance from the image/screen to the mirror shown as *v.*

1. **How was the position of the real image located?**

Move the screen/object until a clear (inverted) image (is obtained) // by focussing

1. **Calculate the value for the focal length *f* of the mirror using the data.**

1/f = 1/u + 1/v

1/f = 1/20 + 1/65

1/f = 13/260 + 4/260

1/f = 17/260

f = 260/17

*f*1 = 15.29 cm

similarly

*f 2* = 15.48

*f 3* = 15.75

*favg* = 15.5 (cm)

1. **Why did the student repeat the experiment?**

Greater accuracy / more reliable result / minimise errors

4

[2010 OL]

In an experiment to determine the resistivity of the material of a wire, a student measured the length, diameter and resistance of a sample of nichrome wire.

|  |  |  |
| --- | --- | --- |
| *R*/Ω | 20.2 |  |
| *l*/cm | 48.8 |  |
| *d*/mm | 0.21 | 0.20 | 0.18 |

The table shows the data recorded by the student.

1. **Describe how the student measured the resistance of the wire.**

Ohmmeter / (digital) multimeter / measure *V* and *I* and hence determine *R*

1. **Describe how the length of the wire was measured.**

Ensure the wire is taut and measure the length between the crocodile clips using a metre-stick.

1. **What instrument did the student use to measure the diameter of the wire?**

Micrometer / digital callipers

1. **Why did the student measure the diameter of the wire at different places?**

To get average (diameter) as wire may not be uniform

1. **Using the data, calculate the cross-sectional area of the wire.**

Average diameter = 0.197 mm ⇒ r = 0.0001m

A = π(0.1 × 10-3)2

A = 3.03 – 3.14 × 10-8 m2

1. **Find the resistivity of nichrome.**

Ƿ = RA/l

Ƿ = (20.2)(3.14 × 10-8)/(0.488)

Ƿ = 1.25 – 1.29 × 10-6 Ω m)

5

[2010 OL]

1. **State Boyle’s law**

For a fixed mass of gas kept at a constant temperature) the pressure is inversely proportional to the volume

1. **A concrete mixer delivered 50 m3 of concrete to a building site, what was the mass of the concrete delivered?**

(Density of concrete = 2400 kg m−3)

m = 2400 × 50 = 120000 kg

1. **State Archimedes’ Principle**

When a body is immersed in a fluid/liquid it experiences an upthrust equalin size to the weight of the fluid displaced.

1. **Which of these scientists is associated with the law of refraction of light?**

**Rutherford Snell Joule Einstein**

Snell

1. **If the temperature of an object is 28 0C, what is its temperature in Kelvin?**

273.15 + 28 = 301.15 K

1. **Give one difference between a light wave and a sound wave**

Light waves travel faster than sound waves, light travels in transverse waves, sound in longitudinal waves



1. **Sketch the magnetic field surrounding a bar magnet**
2. **Give a common use of capacitors?**

Store charge, tune radio, flash guns, smoothing, filtering.

1. **In relation to semiconductors, what is meant by the term doping?**

Adding impurity/atoms and a relevant detail e.g. to change conductivity

[2010 OL]

1. **What type of nuclear reaction occurs in a nuclear power station?**

Fission.

6

[2010 OL]

1. **Define momentum**

*Momentum* = (mass)(velocity) // *p = mv*

1. **Define kinetic energy**

*Kinetic energy*: energy due to motion //

1. **State the principle of conservation of momentum.**

*m*1 *u*1 + *m*2 *u*2 = *m*1 *v*1 + *m*2 *v*2

1. **Explain how this principle applies in launching a spacecraft.**

Momentum before = momentum after // momentum of rocket equal but opposite to rocket exhaust

1. **An ice skater of mass 50 kg was moving with a speed of 6 m s−1 then she collides with another skater of mass 70 kg who was standing still. The two skaters then moved off together.**

**Calculate the momentum of each skater before the collision?**

50 × 6 = 300 kg m s−1

70 × 0 = 0 kg m s−1

1. **What is the momentum of the combined skaters after the collision?**

300 kg m s−1

1. **Calculate the speed of the two skaters after the collision.**

300 = (50 + 70) *v*

*v* = 2.5 m s−1

1. **Calculate the kinetic energy of each skater before the collision.**

*E*k *=* ½*mv*2

*E*k *=* ½ 50 × 62 = 900 J

*E*k = ½ 70 × 0 = 0 J

1. **Calculate the kinetic energy of the pair of skaters after the collision.**

*E*k *=* ½ 120 × (2.5)2 = 375 (J)

1. **Comment on the total kinetic energy values before and after the collision.**

Kinetic energy not conserved in collision because some of the energy was given off as heat and sound.

7

[2010 OL]

The diagram shows a waveform.



1. **What is the name given to the distance X and Y?**

X = Wavelength / λ

Y = Amplitude /height /depth

1. **What is meant by the frequency of a wave?**

Number of waves (passing a point) per second

1. **Explain the term natural frequency.**

Frequency objects tends to vibrate at (when set in motion) // resonance frequency

1. **If the natural frequency of a string is 250 Hz calculate the wavelength of the sound wave produced.**

v = f ***λ***

***λ*** = v/f

***λ*** = 340/250

= 1.36 m

1. **State the wave property on which the loudness, the pitch, of a musical note depends.**

Loudness depends on amplitude

Pitch depends on frequency.

1. **An opera singer, singing a high pitched note, can shatter a glass. Explain why.**

Resonance // transfer of energy

1. **Describe a laboratory experiment to demonstrate resonance**

*Apparatus*: Barton’s pendulums // tuning fork and adjustable length of air

*Procedure*: hang the pendulums (vertically) from a horizontal string //hold the vibrating tuning fork near air column.

Set one of the pendulums swinging // adjust the length of the air column

*observation*: the pendulum of the same length also swings //at a certain length the note emitted by the tuning fork gets louder.

*conclusion*: a transfer of energy occurs / resonance occurs

8

[2010 OL]

(a)

1. **What is heat?**

Heat is a form of energy

1. **Explain how heat transferred in a solid?**

Atoms are touching / in contact so the heat/energy gets transferred from one to the other by vibration (without the atoms moving along).

1. **Describe an experiment to compare the rates of heat transfer through different solids.**

*Apparatus*: bath of water containing different rods which protrude at the same height //four different metals bars arranged like spokes and touch in the middle.

Melt candle wax onto the outer end of each rod/metal and stick a matchstick/pin into the candle wax.

*Procedure*: heat the water-bath // heat the metals over a Bunsen.

*Observation // conclusion*: heat is conducted along the rods and the matchsticks fall off at different times // heat is transferred at different rates.

1. **Explain the term U-value**

measure of heat transmission / measure of insulation.

1. **How can the U-value of the walls of a house be reduced?**

Thicker insulation, double glazed windows, etc.

****

(b)

The diagram shows a solar heating system.

1. **How is the sun’s energy transferred to the solar collector?**

Radiation / rays

1. **Why is the solar collector normally painted black?**

(black surfaces are) better absorbers (of heat/radiation)

1. **How is the heat transferred from the solar panel to the hot water tank?**

By the water flowing/pumped (through the collector and the heating coil).

1. **The heating coil for the hot water tank are placed at the bottom, explain why.**

Water is heated by convection / hot water rises, etc.

1. **Give an advantage and a disadvantage of a solar heating system.**

Reduces costs, unlimited supply, no pollution, etc.

Needs sun, requires a back-up, costly to install, etc.

9

[2010 OL]

(a)

1. **State Coulomb’s law of force between electric charges.**

Force proportional product of charges inversely proportional to the square of the distance between them

1. **What is the unit of electric charge?**

The coulomb

1. **How does the lightning conductor prevent damage to the building?**

Provides (safe) path for flow of current if struck // it earths the building //allows easy path for discharge etc.

1. **Suggest a suitable material for a lightning conductor.**

Metal e.g. copper.



(b)

1. **State Ohm’s law**

*V*  *I* // *V* = *I R* (at a constant temperature)

1. **The diagram shows a number of resistors connected to a 12 V battery and a bulb whose resistance is 4 Ω.**

**Calculate the combined resistance of the 15 Ω and 30 Ω resistors in parallel.**

1/R15,30 = 1/15 + 1/30

R15,30 = 10 Ω

1. **Calculate the total resistance of the circuit**

T total = 10 + 10 + 4 = 24 Ω

1. **Calculate the current flowing in the circuit**

I = V/R = 12/24 = 0.5 A

10

[2010 OL]

1. **X-rays are produced when high speed electrons collide with a target in an X-ray tube as shown in the diagram.**

**What process occurs at the filament A?**

Thermionic emission / release of electrons // heating

1. **Name a substance commonly used as the target B**

tungsten / molybdenum

1. **Give three properties of X-rays**

Electromagnetic waves / have short wavelength, ionise, penetrate, no mass,no charge, effect photographic film, cause fluorescence, diffraction, etc.

1. **Give two uses of X-rays**

Specific medical use e.g. X-ray photo, photo organs, destroy cancerous cells

Specific industrial use e.g. detect cracks in metals, determine thickness of materials

1. **State the function of the part marked C**

protection / shielding

1. **The photoelectric effect can be regarded as the inverse of X-ray production.**

**What is meant by the photoelectric effect?**

Emission of electrons from the surface of a metal byelectromagnetic radiation / light of a suitable frequency.

1. **Describe an experiment to demonstrate the photoelectric effect**

*Apparatus*: (gold leaf) electroscope, UV lamp

*Procedure*: place a zinc plate on the cap of the electroscope / charge the electroscope

Negatively / shine the UV lamp on the zinc plate.

*Observation //conclusion*: the leaf collapses // electrons emitted

1. **Give two applications of the photoelectric effect**

Burglar alarms, automatic doors, central heating control, film sound track, etc.

11

[2010 OL]

Read this passage and answer the questions below.

In 1819 the Danish physicist Hans Christian Oersted discovered that an electric current flowing through a wire deflected a compass needle.

A year later the Frenchman François Arago found that a wire carrying an electric current acted as a magnet and could attract iron filings. Soon his compatriot André-Marie Ampère demonstrated that two parallel wires were attracted towards one another if each had a current flowing through it in the same direction. However, the wires repelled each other if the currents flowed in the opposite directions.

Intrigued by the fact that a flow of electricity could create magnetism, the great British experimentalist Michael Faraday decided to see if he could generate electricity using magnetism. He pushed a bar magnet in and out of a coil of wire and found an electric current being generated. The current stopped whenever the magnet was motionless within the coil.

(Adapted from ‘*Quantum' by Manjit Kumar, Icon Books 2008*)

1. **Who discovered that an electric current can deflect a compass needle?**

Hans Oersted

1. What did Arago discover?

A wire carrying an electric current acted as a magnet could attract iron filings.

1. **What happens when currents flows in the same direction in two parallel wires?**

The wires attract

1. **How could two parallel wires be made to repel each other?**

Reverse one of the currents / current in opposite directions

1. **Draw a sketch of the apparatus Michael Faraday used to generate electricity.**

correct diagram to include magnet, coil and meter

1. **What name is given to the generation of electricity discovered by Michael Faraday?**

Electromagnetic induction

1. **What energy conversions takes place in Faraday’s experiment**

Kinetic to electric

1. **How does Faraday’s experiment show that a changing magnetic field is required to generate electricity?**

Current stopped whenever the magnet was motionless // electricity is only generatedwhen the magnet or coil is moving.

12 (a)

[2010 OL]

A cyclist on a bike has a combined mass of 120 kg.

The cyclist starts from rest and by pedalling applies a net force of 60 N to move the bike along a horizontal road.

1. **Calculate the acceleration of the cyclist**

F = ma, a = 60/120

a = 0.5 m s–2

1. **Calculate the maximum velocity of the cyclist after 15 seconds.**

v = u + at.

v = u + (0.5)(15) = 7.5 m s–1

1. **Calculate the distance travelled by the cyclist during the first 15 seconds.**

s = ut + ½ at2

s = ut + ½ (0.5)(15)2 = 56.25 m.

1. **The cyclist stops peddling after 15 seconds and continues to freewheel for a further 80 m before coming to a stop. Why does the bike stop?**

Due to friction / air resistance.

1. **Calculate the time taken for the cyclist to travel the final 80 m?**

v2 = u2 + 2as

0 = (7.5)2 + 2a(80)

a = - (7.5)2/(2)(80)

a = - 0.35

Then use v = u + at

0 = 7.5 – (0.35)(t)

t = - 7.5/- 0.35 = 21.43s

Alternatively we could just have used s = (u +v)t/2

80 = (7.5 + 0)t/2

t = 21.33 s

12 (b)

[2010 OL]

1. **What is meant by dispersion of light?**

Breaking up of (white) light into different colours.

1. **Describe an experiment to demonstrate the dispersion of light.**

*Apparatus*: white light, prism, (diffraction) grating, CD

*Procedure*: shine a beam of light at the prism/CD/grating

*Observation //conclusion*: different colours / 3 named colours / spectrum

white light is dispersed // white light consists of different colours

1. **Give an example of the dispersion of light occurring in nature.**

Rainbow / oil film colours / soap bubble colours / CD colours

1. **Only red, green and blue lights are needed to create most lighting effects.**

**Explain why**

All colours can be made by mixing red, green and blue.

12 (c)

[2010 OL]

The diagram shows a plug which contains a fuse, an MCB and an RCD, all of which are used in domestic circuits.



1. **Explain how a fuse works**

Wire melts with too high a current, breaking circuit.

1. **How does the fuse improve safety?**

Prevents too high a current flowing / reduce fire risk

1. **What is an MCB?**

Miniature circuit breaker

1. **What is the function of an RCD?**

To protect against electrocution /shut off current in event of a fault /safety switch

1. **Why should an appliance be earthed?**

Provide path for current in event of a fault // to protect against electrocution.

1. **Give one other precaution that should be taken to improve safety when using electricity in the home.**

Do not use appliances near water / do not overload sockets, etc.

12 (d)

[2010 OL]

1. **What is radioactivity?**

Disintegration/decay of nuclei/atoms with emission of radiation/energy /α / β / γ

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1. **The diagram shows a shielded radioactive source emitting nuclear radiation.**

**How do you know that the source is emitting three types of radiation?**

One type stopped by the paper, 2nd by the aluminium and the 3rd by the concrete.

1. **Name the radiation blocked by each material**

paper blocks alpha / α,

aluminium blocks beta/ β,

concrete blocks gamma/ γ

1. **Give one danger associated with nuclear radiation**

Cancer, radiation sickness, ionises/kills/damages cells, etc.

1. **State two precautions that should be taken when handling radioactive substances.**

Use tongs, wear gloves, do not point at body, etc.

1. **Give two uses for radioactive substances**

medical / energy source / industrial.