**Successful experiments on film**

**Answers to the questions posed on screen**

Answers to the questions posed on screen for the following experiments are recorded below.

There is one page for each experiment even if there is only one question. The experiments which have questions are:

* P01E Basic Physics
* P02E Moments
* P03E Kinematics - Measurement of g by freefall
* P05E Young Modulus
* P07E Resistance
* P08E Resistivity of a wire
* P09E Variation of resistance with temperature
* P10E Determination of internal resistance of a cell
* P16E Determination of h using LEDs
* P20E Measurement of the specific heat capacity for a solid
* P22E Investigation of the variation of intensity of gamma radiation with distance
* P23E Determination of the charging and discharging of a capacitor to determine the time constant
* P24E Investigation of the energy stored in a capacitor

**P01E Basic Physics**

* In which order should we place the columns?

In order,

* + - object description,
		- mass,
		- length,
		- width,
		- height
		- calculated volume

In reality, the order of length, width and height does not really matter but the object description should be first and the calculated volume last.

* What independent variables are involved?
	+ Mass, length, width, height
* Where should the units go in a table?
	+ In the column heading
* Many people get confused between mass and weight. Are we measuring mass or weight?
	+ Mass
* What is the difference?
	+ Mass is a measure of the quantity of substance.
	+ Weight is the force acting on a substance due to gravity
* What is the point of a Vernier gauge?
	+ Vernier gauges allow very precise measurements of very small distances.
* Why not just use a ruler?
	+ Rulers are not precise enough and are not suitable for measuring very small distances
* Explain the difference between the terms ‘accuracy’ and ‘precision’.
	+ Accuracy: the closeness of a figure to the true value.
	+ Precision: an indication of how exact a value is. Generally, the greater the number of significant figures, the greater the precision. Precision has little to do with accuracy since an incorrectly calibrated instrument may give a very precise reading which is wholly inaccurate.
* How many significant figures should we use?
	+ That depends on the precision of measurement. We can only use as many significant figures as there are in all readings. For example, if three quantities are measured to 3 s.f. but one quantity is measured to 2 s.f. then any calculated result can only be recorded to 2 s.f.

**P02E Moments**

* Why do we use the 70cm mark?
	+ In order to be able to observe and measure a sufficiently large distance for sufficient precision.
	+ Too small a distance and there will be too small a movement and vice versa.
* By rearrangement and calculation, show that the equation reduces to **mass = 9.80 l**
	+ - * + 0.20 × metre rule mass = Ɩ × 1.96
		- metre rule mass = Ɩ x 1.96/0.20
			* + 1.96/0.20 = 9.80
		- metre rule mass = 9.80 Ɩ
* What is the difference between weight and mass?
	+ Mass is a measure of the quantity of substance.
	+ Weight is the force acting on a substance due to gravity
* What do we mean by the term systematic error?
	+ A situation where readings to differ from the true value by a consistent amount each time a measurement is made. Sources of systematic error can include the environment, methods of observation or instruments used. A common cause of a systematic error is through incorrect calibration of an instrument. Systematic errors cannot be dealt with simply by repeating measurements since the cause of the error will still exist. If a systematic error is suspected, the data collection should be repeated using a different technique or a different set of equipment, and the results compared.

**P03E Kinematics - Measurement of g by freefall**

* What is the difference between precision and accuracy?
	+ Precision: an indication of how exact a value is. Generally, the greater the number of significant figures, the greater the precision. Precision has little to do with accuracy since an incorrectly calibrated instrument may give a very precise reading which is wholly inaccurate.
	+ Accuracy: the closeness of a figure to the true value.
* No measurements made here should be used as results. Why?
	+ The initial measurements are purely to check that the equipment is working correctly and the gate opens etc;
* What is meant by the term **parallax**?
	+ Thedifference in the apparent position of an object viewed along two different lines of sight, and is measured by the angle or semi-angle of inclination between those two lines.
* This test should be performed at least three times. Why should we conduct the measurement three times?
	+ There will some variation in the measurements due to the very brief time measurement interval so repeating the experiment should improve precision.
* Which is the dependent variable?
	+ The time of fall
* What other measurements could we make?
	+ Change the
* Height (distance of fall)
* The mass of the ball (to show that the mass of the object is irrelevant)
	+ - * The shape of the object to fall (to demonstrate the effect of air resistance).
* What range of measurements should be made?
* Using the metre rule the range should be as large as possible with a greater number allowing a drop of at least 40cm (to allow for the accuracy of timing. An example could be 20cm, 30cm, 40cm, 50cm, 60cm, 70cm, 80cm, 90cm.
* How many different height measurements should be used?
* At least six since we do not yet know if the graph will be a straight line or a curve.
* How many repeat measurements should be made at each height?
* At least 3, for repeatability.
* What is plotted on the:
	+ x-axis?
		- * Distance of fall
	+ y-axis?
		- * Time of fall
* As we have only completed one set of measurements we do not yet know if the graph will be a straight line or a curve. How many points needed for a:
	+ Straight line?
		- * A minimum of two points
	+ Curve?
		- * An absolute minimum of three points but ideally at least 6 to 8.
* Should the graph be a curve or a straight line?
	+ A straight line
* The measured gradient is equal to ½ of the value of g. Why?
* An equation of motion can be used to calculate the acceleration due to gravity, g.

s = ut + ½at2

where: u = initial velocity = 0, s = height, h and a = acceleration due to gravity, g

replacing the symbol s for h (height) and since the initial velocity is zero, this means that the equation reduces to

 h = ½gt2

A graph of height, h, (y-axis) is plotted against time squared, t2, (x-axis) will have a gradient equal to ½ g.

In other words, g = 2 × gradient.

**P05E Young Modulus**

* Why add a weight at this point?
	+ It is to help keep the wire straight.
* Why do we measure the diameter in several places?
	+ Being very thin, the wire may vary in cross sectional area. Taking a number of measurements allows for variations to be accounted for.
* What should be plotted on the:
* x – axis
	+ Force
* y – axis?
	+ Extension of wire.

**P07E Resistance**

* The ammeter which measures the current and must be connected in series. Why?
	+ The ammeter measures the current flowing through the circuit so must be integrated in to the circuit.
* The voltmeter measures the potential difference (p.d.) Why must it be connected in parallel?
	+ The voltmeter measures the gain or loss of potential as the current flows through the circuit so must be able to contact both sides of the component. This is only possible when connected in parallel.
* Which is the independent variable
	+ The applied voltage
* Which are the dependent variables?
	+ The measured current and potential difference.
* Which variable should be plotted on each axis?
* x – axis
* Applied voltage
* y – axis?
* Measured current.

**P08E Resistivity of a wire**

* The ammeter which measures the current and must be connected in series. Why?
	+ The ammeter measures the current flowing through the circuit so must be integrated in to the circuit.
* The voltmeter measures the potential difference (p.d.) Why must it be connected in parallel?
	+ The voltmeter measures the gain or loss of potential as the current flows through the circuit so must be able to contact both sides of the component. This is only possible when connected in parallel.
* Which variable should be plotted on each axis?
* x – axis
* Length of wire
* y – axis?
* Measured resistance

**P09E Variation of resistance with temperature**

* The ohmmeter must ***in series*** with the coil. Why is this?
	+ In order to measure the current and hence calculate the resistance as it varies with temperature.
* The temperature must be stable before heating is begun. Why?
	+ To ensure that temperatures changes are measured accurately.
* Which variable is plotted on each axis?
	+ x – axis
* Resistance
	+ y – axis
* Temperature
* Why does the graph NOT pass through the origin?
	+ The x-axis does not begin at absolute zero (0 K). This means that there will be some resistance at temperatures below the temperature range used in this experiment.

**P10E Determination of internal resistance of a cell**

* The ammeter must be connected in **series**. Why is this?
	+ The ammeter measures the current flowing through the circuit so must be integrated in to the circuit.
* The cells must be connected in **series**. Why is this?
	+ So that the combined voltage is additive
* There is something wrong with the circuit diagram. What is it?
	+ It does not show a switch
* Which variable goes on each axis
	+ x – axis
* 1 / Ɩ
	+ y – axis
* Resistance

**P16E Determination of h using LEDs**

* Rearrange the equation to show that h equals 5.333 x 10-28 divided by the gradient of the graph

Vmin= h c

 e 

where

* c = speed of light (3.00 x 108 ms-1),
* e = charge on electron (1.60 x 10-19 C) and
*  = wavelength of emitted light

This means that a graph of Vmin against 1/ will have a gradient equal to h c

 e 

Since c/e = 5.333 x 10-28 , h equals 5.333 x 10-28 divided by the gradient of the graph

**P20E Measurement of the specific heat capacity for a solid**

* What do you think **is** the appropriate final temperature?
	+ Approximately 15-20oC above the starting temperature to allow for thermal equilibration after heating has been stopped. (The temperature will continue to rise even after the heating has been stopped as the heat dissipates into the block.)
* Compare your answer with a data book value. Was your calculated value of specific thermal capacity too high / low?
	+ It will be too low due to
* inadequate insulation
* accuracy of measuring equipment
* time for the heating to complete.
* Which of the measurements you made is likely to be the one most in error? In which direction is it in error, and why might this be?
	+ Temperature due to precision of thermometer, insulation etc;

**P22E Investigation of the variation of intensity of gamma radiation with distance**

* Why is there a background count?
	+ We are, naturally, exposed to a small amount of radiation due to emissions from some types of rocks, cosmic radiation and even food. For example,
* Cosmic rays which originate from the sun, stars and other major events in outer space are striking the Earth continually. Most cosmic rays are absorbed by the atmosphere but some e.g. gamma rays can make it through the atmosphere to the Earth's surface.
* The Earth contains radioactive rocks. Although short lived isotopes will have decayed some radioisotopes with long half lives, e.g. 235U, 238U and 232Th still remain together with the daughter radioisotopes formed from the decay of these isotopes.
* Uranium decay also produces radon gas which is radioactive and accounts for a large proportion of the natural background radiation.
* Small traces of radioactive materials are present in the human body. These come from natural radioactive sources such as 14C in the air we breathe. Food crops absorb radioactive materials from the soil as well as 14C from the air. These are introduced into the body when they are eaten or via the food chain when meat or milk from animals grazing on the crops is consumed.
	+ Emphasise that background radiation is nothing to worry about and that the human body is developed to account for its existence.

**P23E Determination of the charging and discharging of a capacitor to determine the time constant**

* Why is it necessary to take care with the polarities of the components?
* In their simplest forms, capacitors are made with two parallel plates.  In practice, there are often many plates stacked with a dielectric (insulator) between the plates.  If a capacitor is connected incorrectly, the dielectric can be destroyed and the capacitor can explode due to interactions between the plates.

**P24E Investigation of the energy stored in a capacitor**

* The initial electrostatic energy stored in the capacitor was ½ CV = 0.5J. This is less than the mechanical energy gained. Where else has the initial energy gone?
	+ Heating of the components of the circuit. Passage of an electric current always generates heat due to the friction between the moving, conducting electrons and the metal ions.