Checkpoints Chapter 21

Principles of practical physics

Multiple Choice questions

Question 1

The independent variable is the one that the investigator can control.

∴ A (ANS)

Question 2

Is the variable that results from the changes to the independent variables.

∴ C (ANS)

Question 3

In general terms the controlled variable is fixed for any set of experiments, and then changed for the next set of experiments

∴ D (ANS)

Question 4

Accuracy means close to the accepted value.

∴ D (ANS)

Question 5

Reliability refers to the capacity of the methodology to be reproduced by others.

∴ C (ANS)

Question 6

Systemic errors need to be minimised (or controlled and allowed for) to ensure valid data

∴ A (ANS)

Question 7

The error is a measure of your incorrectness.

∴ A (ANS)

Question 8

The experimental uncertainty is related to the difference from the data to the true value.

∴ D (ANS)

Question 9

A hypothesis needs to be testable experimentally.

∴ B (ANS)

Question 10

A scientific theory has been well tested and verified.

∴ C (ANS)

This is different to the answer in the back of the book.

Question 11 2017 Question 18, 1m, 59%

Rob's results are the same as the true value, but his readings have a wider range of values.
Accuracy is defined as the difference between the mean and the true value. Precision is defined as the range between measurements.

∴ A (ANS)

Question 12 2017 Question 19, 1m, 90%

From the definition, a hypothesis is an idea that can be tested experimentally.

∴ A (ANS)

Question 13 2017 Question 20, 1m, 63%

Systemic errors are usually due to an issue with the equipment, therefore repeated measurements are not going to reduce them

∴ A (ANS)

Extended questions

Question 14

0.000346 N
3.45×10^4 A
8.80×10^3 C

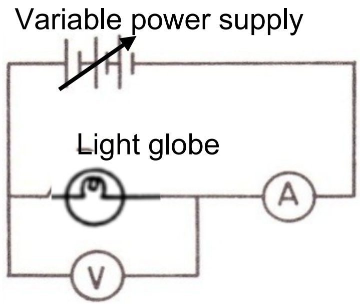
Question 15

milliamp
grams
millikelvin

Question 16

kiloampere
millivolt
megapascal
millijoule
microtesla
milliwatt

Question 17a



Question 17b

The independent variable is the voltage of the supply.
The voltage across the globe, and the current through the globe are both dependent variables.
Assuming that the current is not too large, the resistance of the wires might be considered a controlled variable. Hopefully the temperature of the components was controlled.

Question 17c

Check all the components to see that they function correctly.
Check the zero points on the meters.
Change the supply voltage, up to the maximum voltage of the globe.
Record the reading on the ammeter and voltmeter.
Repeat several times (at least 4 or 5 trials, to simplify uncertainty results)
Do appropriate calculations

Question 18a

The line of best fit should pass through the data limits as best is possible, and it should pass through the origin.

Question 18b

The force constant of the spring comes from

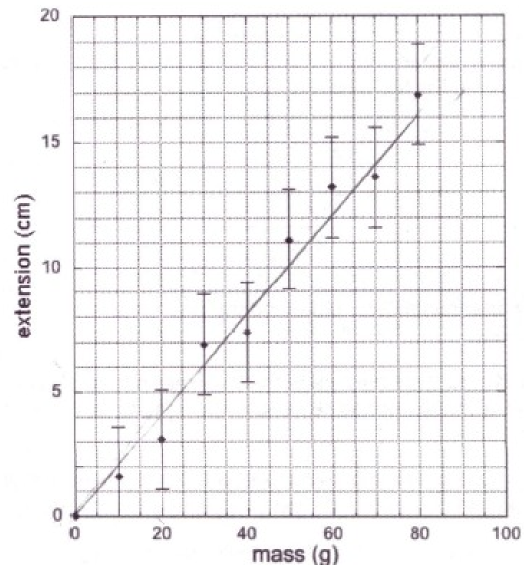
$F = k\,\Delta x$

when F is measured in N and Δx in m.
The line of best fit must go through the origin, and should be centred on the set of data points. (An equal spread above and below the line of best fit).

$\therefore k = \dfrac{F}{\Delta x}$

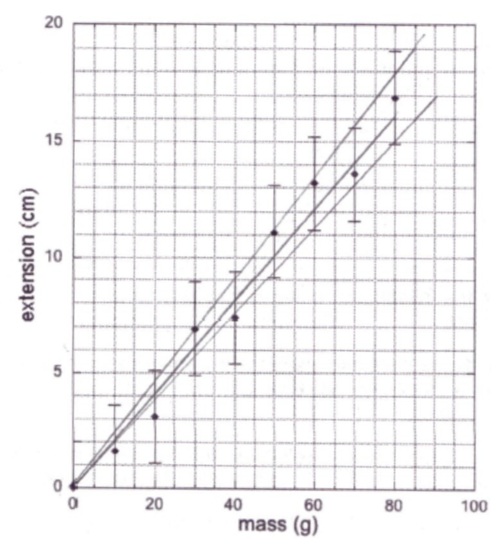
From the graph $k = \dfrac{80\times10^{-3}\times9.8}{16\times10^{-2}}$

$\therefore$ **k = 4.9 N kg^{-1} (ANS)**



Question 18c

Draw two more lines of fit, one with the steepest possible gradient and one with the least possible gradient.



From the steeper graph

$\therefore k = \dfrac{85\times10^{-3}\times9.8}{19\times10^{-2}}$

$\therefore$ **k = 4.4 N kg^{-1} (ANS)**

From the flatter graph

$\therefore k = \dfrac{80\times10^{-3}\times9.8}{15\times10^{-2}}$

$\therefore$ **k = 5.2 N kg^{-1} (ANS)**

Question 19a

To improve reliability you typically make repeated trials and find the average value. This minimises the effect of any uncertainties in the measurements.

Question 19b

The controlled variable was the angle of swing. (It did not change). The independent variable (the variable that the experimenter could change) was the mass. The dependent variable was the time it took.

Question 19c

The data doesn't show any change in the period.
It could be written as

50	1.93 – 2.05
75	1.96 – 2.08
100	1.90 – 2.02
125	1.97 – 2.09
150	1.91 – 2.03

All are within a close range of each other, well within uncertainties.
The hypothesis is not supported.

Question 19d

The period that they have averaged is for 20 swings, they have already divided their result by 20 to get the period of each swing.
As the mass does not affect the period, changing the mass has not changed the experiment, so it is acceptable to use all the data and find an average period.

∴ $\text{Period}_{\text{average}} = 1.99 \pm 0.09$
(to include all data)

Use $g = \dfrac{4\pi^2 l}{T^2}$

∴ $g = \dfrac{4\pi^2 \times 0.95}{(1.99)^2}$

∴ g = 9.47 m s^{-2} (ANS)

Question 19e

True value is 9.8.

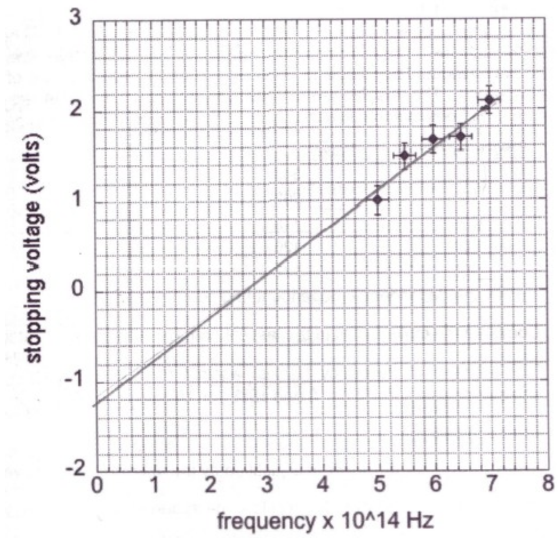
% uncertainty = $\dfrac{\text{uncertainty}}{\text{true value}} \times 100\%$

∴ % uncertainty = $\dfrac{0.34}{9.81} \times 100\%$

∴ % uncertainty = 3.5 %
This is within expectations.

Question 20a

The line of best fit should pass through the data limits as best is possible.



Question 20b

For this graph, the work function is the y intercept.

∴ 1.25 eV (ANS)

Question 20c

From the graph

∴ $h = \dfrac{2.0 - -1.2}{7 \times 10^{14}}$

∴ h = 4.6 × 10^{-15} eV s (ANS)

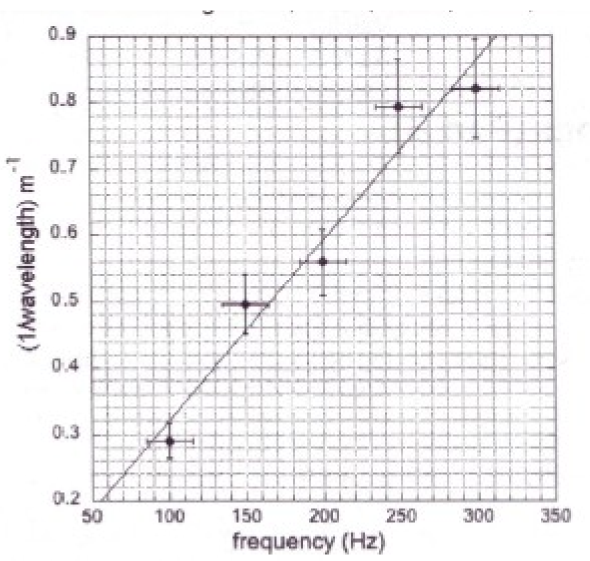
Question 21a

The wavelength is the dependent variable, the frequency is the independent variable. The temperature is the controlled variable.

Question 21b

Convert the wavelength into metres and then find the reciprocal.
0.290
0.495
0.559
0.794
0.820

Question 21c



Question 21d

See above

Question 21e

The line can be drawn to include all data points, therefore a linear fit is quite justified.

Question 21f

As the graph is $\frac{1}{\lambda}$ vs frequency the gradient in the form of $\frac{\text{run}}{\text{rise}}$ will give the velocity.
Therefore from the graph

$\therefore$ v = $\frac{315-55}{0.9-0.2}$

$\therefore$ **v = 371 m s^{-1} (ANS)**

Question 22a

Most simple protractors will give you 2^0 on the scale, therefore your uncertainty is ± 1^0.

Question 22b

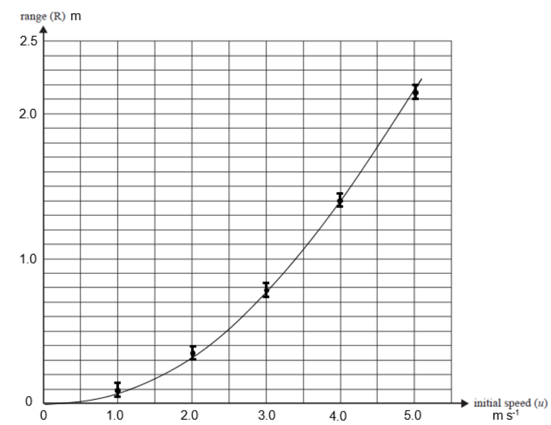
Record the values for ‘a’ and ‘b’.
Include 0 as a result.
Find sin a, and sin b.

Use $n_a$sin a = $n_b$sin b, with $n_a = n_{air} = 1$.
Plot sin a v sin b, but to have n_b as the gradient, sin a needs to be on the vertical axis.
Include uncertainties.
Find the gradient of the line of best fit.

Question 23a **2017 Question 9b, 3m, 77%**

Controlled	Angle, mass
Dependent	Range
Independent	Initial speed

Question 23b **2017 Question 9c, 8m, 83%**



2 marks for each of the following:
Points plotted correctly
Scales, units, size
Vertical uncertainties
Smooth curve joining all points

Examiners comment
Common errors included:
• omitting the units on the axes
• incorrect or omitted uncertainty bars
• ruling a straight line through the points.
