R1-2002 Q1(e)

e) It has been shown that the volume *V* of water in the Mediterranean Sea is approximately equal to the volume of a large raindrop multiplied by the number of molecules in the raindrop. Use this result to estimate *V*.

[8]

R1-2003 Q1(a)

a) Comment on the following, giving necessary corrections:

(i) The voltage and current across a resistor are 78.46 V and 13.56 mA. One student records the power as 1.1 W and another as 1063.9 mW.

(ii) The dimensions of a rectangular block, measured in mm, are $52.5 \times 35.5 \times 95.0$. It has a density of 4.3×10^3 kgm^{-3}. The recorded volume and mass are 0.0001770525 m^3 and 0.7665356 kg.

(iii) A student calculates that the current I = 8.03 A in the circuit in Figure 1.1.

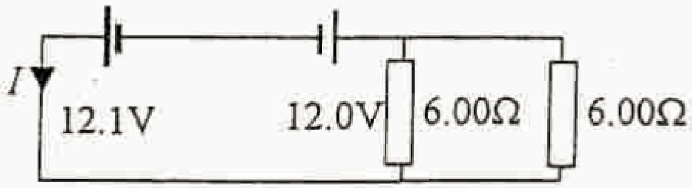

Figure 1.1

[10]

R1-2003 Q1(i)

i) Two measured quantities, *x* and *y*, are thought to satisfy one of the following two theoretical equations, where *a*, *b*, *c* and *d* are constants:

(i) $1/y = ax + b$ (ii) $y(x^2 + d) = cx$

What straight line relationships determine the best fit?

How could straight line relations be used to evaluate (i) *a* and *b*, (ii) *c* and *d*?

[10]

R1-2004 Q1(f)

f) The experimental values of two quantities, X and Y, are thought to satisfy one of the following two theoretical equations:

(i) $X = aY^b$ (ii) $X^3 = (cY + d)^2$

a, b, c and d are constants. How would you plot each relationship as a straight line graph? Explain how to determine the associated constants a, b, c and d.

[8]

R1-2006 Q1(e)

(e) Make the following estimates:

(i) the contribution of the gravitational attraction of the Sun to the acceleration of free fall on Earth.

(ii) the energy required for a man, mass m, to jump 1m on the Earth and the size of the smallest body in the solar system from which a man will be unable to escape by jumping.

(iii) the rate of working of a student's heart if it beats at 72 beats per minute, pumping 7.5×10^{-5} m^3 of blood at each beat against a pressure of 19 kPa.

[12]

R1-2007 Q1(h)

(h) Estimate, making reasonable assumptions where necessary :

(i) the pressure excess in a champagne bottle if the cork can be projected vertically 6 m. Assume the cork experiences a constant force for the first 2 cm of its flight .

(ii) the mean thickness of a layer of rubber left on the road by a car tyre which, during 50,000 km of travelling, loses 5 mm of tread.

[8]

R1-2008 Q1(c)

(c) A class of 11 students each determined a value for g using a simple pendulum. The following values were obtained:

9.80, 9.84, 9.72, 9.74, 9.87, 9.75, 9.28, 9.86, 9.81, 9.79, 9.82

(i) What is your best estimate for g ?
(ii) Estimate the accuracy , based on the deviation from the best value of g in (i). [4]

R1-2009 Q1(b)

(b) Comment on the following :

(i) The planets move with constant velocity in circles around the Sun.
(ii) The horizontal component of the energy of a tennis ball remains constant after being hit by a racket.
(iii) The speed of a light spot produced on a distant wall, by a rotating laser, can be greater than c, the speed of light.
(iv) The north magnetic pole is near the geographic north pole and the north pointing end of the needle of a compass always points to the north magnetic pole.
(v) The specific heat capacity of a gas at constant volume differs from that at constant pressure .
(vi) When gases expand rapidly they are cooled.

[6]

R1-2010 Q1(c)

(c) A viola string 0.50 m long is tuned to A ; a frequency of 440.0 Hz..

(i) What change in length will raise its frequency to 550.0 Hz ?

(ii) If it goes out of tune and vibrates at 435.6 Hz, by what fraction, and in what sense, must the tension in the string be changed to retune it ?

[5]

R1-2012 Q1(n)

(n) A rectangular block has a mass of 1.5 kg with an uncertainty of magnitude 0.03 kg, and a volume of 80 mm x 50 mm x 30 mm, with uncertainties of magnitude 1 mm in each dimension. Determine the magnitude of the fractional uncertainty in the density of the block.

[2]

R1-2013 Q1(a)

(a) In an experiment to measure the Planck constant, *h*, the following results were obtained, in units of 10^{-34} Js: 6.65, 6.67, 6.57, 6.61, 6.72, 6.60, 3.66, 6.71, 6.66, 6.64, 6.67. What would you give as:

(i) The best estimate of *h*?

(ii) The uncertainly of h from your reading?

[3]

R1-2013 Q1(o)

(o) The value of a device for storing energy can be assessed by the height to which it would rise if all the stored energy were used to propel it upwards under gravity. Calculate the height of the following:

(i) a 12 V car battery of capacity 60 Ah and mass 20 kg

(ii) a quantity of petrol of calorific value 4×10^7 J/kg

[5]

R1-2013 Q1(c)

(c) Estimate the mean density of the Earth, in g cm^{-3}, assuming that the radius of the Earth $R_E = 6.38 \times 10^3$ km and the value of $g = 9.81\ ms^{-2}$. State any assumptions made.

[5]

R1-2006 Q5

I / mA	V / μV
2	2201
3	3302
4	4428
5	5514
6	6624

(a)

t / ms	R / m
0.24	19.9
0.66	31.9
1.22	41.0
4.61	67.3
15.00	106.5

(b)

Table 5.1

(a) In an experiment to determine the self heating of a platinum resistance thermometer the values of current, I, and voltage, V, Table 5.1 (a), were transcribed from a laboratory notebook. The uncertainties in V are of the order 1 μV and the values of I were of a much greater accuracy than those of V.

(i) Identify and explain any anomalous result/s in Table 5.1 (a)
(ii) What should be done about it/them?
(iii) Show graphically that the resistance, R, of the thermometer increases linearly with I^2 due to a self heating.
(iv) Determine the parameter/s, and their accuracy, that determine the relation between R and I^2.. Give explicitly the equation relating R and I^2.

[11]

(b) The explosion of an atomic bomb in the atmosphere produces a spherical fireball of radius $R(t)$ at time t following detonation. The constant energy E released at this instant depends on R, t and ρ, where ρ is the density of the atmosphere. The relation between these parameters is given by

$$E = \rho R^{\alpha} t^{-2},$$

where α and ρ are constants.

Explain how, from a graph, you could:

(i) verify that the data in Table 5.1 (b), taken following an explosion, satisfies this relation.
(ii) deduce the relation between E and ρ.
(iii) obtain the value of α from the graph.

Determine the theoretical value of α obtained by equating units or dimensions in the equation.

[9]

R1-2007 Q4

A hard steel ball, mass m, falls vertically a distance h_1 onto the horizontal surface of a soft steel anvil. It rebounds a distance h_2 after producing a small circular indentation of diameter d. For small h_1 theory predicts

$$3mg\,h_2 \quad = P\,d^3 \,,$$

where P is a constant.

Experiments were performed with $m = 4.00 \times 10^{-3}$ kg. The data obtained are given in Table 4.1. The accuracy of the measurements is correct to the last significant figure.

h_1/mm	h_2/ mm	d / mm
1000	290	1.22
500	162	1.01
100	41	0.64
2.0	1.3	

Table 4.1

(i) Graphically investigate the range of validity of the theory. State your conclusions.
(ii) What is the value and accuracy of P ?
(iii) Plot a graph of the variation of the coefficient of restitution, α , the ratio of the rebound speed, v_R, to the impact speed, v_I, as a function of v_I .
(iv) If a ball is dropped from 900 mm, how long will elapse before the second bounce ?
(v) How is the energy dissipated by the ball ?

[20]