1. The volume of a ball is measured as $6356\,\mathrm{m}^3$. What is its radius?

2. Compute $\frac{2.3\times10^{-16}\,\mathrm{J}}{1.602\times10^{-19}\,\mathrm{C}}$?

3. (a) The flow rate of blood, Q , through the aorta is found to be $81.5\,\mathrm{cm}^3/\mathrm{s}$ with a standard uncertainty of $1.5\,\mathrm{cm}^3/\mathrm{s}$. The cross sectional area, A , of the aorta is $2.10\,\mathrm{cm}^2$ with a standard uncertainty of $0.10\,\mathrm{cm}^2$. Find the flow speed of the blood, v and its standard uncertainty using,

$$Q = Av$$

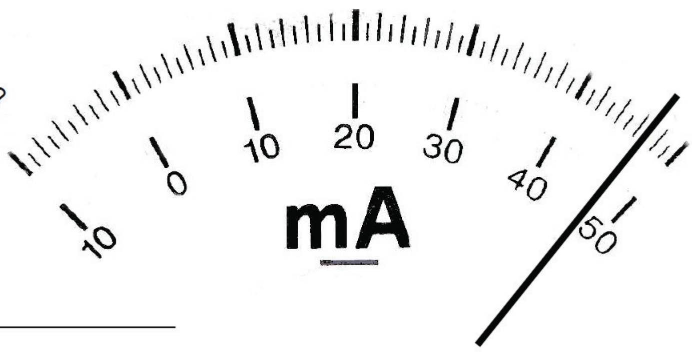
(b) The velocity, v , of a wave on a stretched string is given by,

$$v = \sqrt{\frac{F}{\mu}},$$

where F is the tension in the string and μ is the mass per unit length. Given that $F = (18.5 \pm 0.7)\,\mathrm{N}$, and $\mu = (0.30 \pm 0.01)\,\mathrm{Kg/m}$. Calculate the velocity of the wave?

4. .

What is the current I shown on the ammeter ?



Best approximation of I = ______________

Standard uncertainty $u(I)$ associated with reading the scale =

Which probability density function did you use to model your knowledge about I?

5. Suppose you measure four numbers as:

$$x = 200 \pm 2, \quad y = 50 \pm 2, \quad z = 20 \pm 1, \quad u = 3.0 \pm 0.1,$$

where the uncertainties are independent and random. What would you give values to the following quantities with their uncertainties?

(a) $q = x/(y - z)$.

(b) $p = e^u$.

(c) $r = x(y - z\sin(u))$.

6. A student measures g, the acceleration of gravity, using a simple pendulum. The period is well known to be $T = 2\pi\sqrt{l/g}$, where l is the length of this pendulum. If l and T are measured as,

$$l = 92.95 \pm 0.01 \text{ cm},$$
$$T = 1.936 \pm .004 \text{ s},$$

calculate the best estimate of g and its uncertainty.

7. The resistance of a coil is measured in ohms (Ω), and the following set of data is obtained,

$$4.615, 4.638, 4.597, 4.634, 4.613, 4.623, 4.659, 4.623.$$

Find the best estimated value and standard error in the mean.

8. Suppose we have to measure accurately the area A of a rectangular plate approximately 2.5 cm×5 cm. We make several measurements of the length l and breadth b of the plate at different positions. We make 10 measurements for length and breadth and the results are shown in Table (I).

l **(mm)**	24.25	24.26	24.22	24.28	24.24	24.25	24.22	24.26	24.23	24.24
b **(mm)**	50.36	50.35	50.41	50.37	50.36	50.32	50.39	50.38	50.36	50.38

TABLE I: Measured values of length and breadth in (mm).

Find the best estimated values of length l and breadth b along with standard error in the mean. Calculate the best estimate for area ($A = lb$) and its uncertainty.

9. In an experiment of measuring absolute zero with a constant volume gas thermometer, and if the volume of an ideal gas is kept constant, the relationship between temperature and pressure is,

$$T = mP + c,$$

where c is the temperature at which the pressure drops to zero, called the absolute zero of temperature. A set of five measurements of temperatures T with different pressure P is taken as given in Table (II).

Pressure (mm of mercury)	65	75	85	95	105
Temperature (°C)	−20	17	42	94	127

TABLE II: Pressure and temperature of a gas at constant volume.

Calculate the best estimate for slope and intercept using mathematical expressions.

10. Suppose we have two functions,

$$y = 3.5^{-0.5x}\cos(6x),$$
$$z = \sin(4x).$$

Draw graphs for both functions simultaneously on the same plot for the range $-4 \leq x \leq 2$.

11. An exponentially decaying sine function is defined as,

$$y = e^{-0.4x}\sin(x),$$

for $0 \leq x \leq 4\pi$. Draw graphs by taking 10 and 100 points in the interval. The plot with 10 points should be a solid line joining data points in circles. Plot both graphs simultaneously, one on top of another.

12. A student aims to find the spring constant of a spring, he loads it with various masses m and measures the corresponding lengths l. The force acting on the spring is $mg = k(l - l_o)$, where l_o is the unstretched length of the spring. The results are shown in Table (III).

Mass (g)	200	300	400	500	600	700	800	900
Length (cm)	5.1	5.5	5.9	6.8	7.4	7.5	8.6	9.4

TABLE III: Length versus load for a spring.

Plot a graph for the data given in Table (III), and fit that on a straight line $l = l_o + (g/k)m$. Make a least-squares fit to this line, and find the best estimates for the unstretched length l_o and the spring constant k.

13. The rate at which a radioactive sample emits radiation decreases exponentially as the the sample is depleted. To record the number of decays, a Geiger counter is placed near the source and data is given in Table (IV).

Elapsed time (min)	10	20	30	40	50
Counts detected	409	304	260	192	170

TABLE IV: Number of counts detected versus elapsed time.

If the sample decays exponentially, the number $v(t)$ can be written as,

$$v(t) = v_o e^{-t/\tau}, \tag{1}$$

where τ is the mean life of the sample and v_o is the number at time $t = 0$.
Plot the data, fit it to the function (1) using least-squares fitting and find the mean life τ. (1).

14. Suppose we directed a sinusoidal AC voltage into the computer using a data acquisition system. The hardware acquires voltage by taking one sample in 50 ms and saves the first 21 points. The time sampling information is stored in a row vector t with an increment of 0.05 s. The voltage data is taken as,

5.4792	7.4488	7.5311	5.7060	2.4202	-1.5217	-5.1546
-7.5890	-8.2290	-6.9178	-3.9765	-0.1252	3.6932	6.5438
7.7287	6.9577	4.4196	0.7359	-3.1915	-6.4012	-8.1072

TABLE V: The voltage measurement (Volts).

Fit the data given above on a sinusoidal function $V = A\sin(\omega t + \phi)$ using least squares fitting technique and find the best estimates of amplitude A, angular frequency ω and phase ϕ.