Physical Experiment I

Experimental Title

P48 Exercise

Your Chinese Name 郑长刚
(Your UESTC Number 2016200302027)

Instructor: Yuanjun Guo
Teaching Assistant: Yichao Chen

Date Performed:

1. Rewrite the following values in unit of mm (keep the significant figures consistent).

(a) 0.050 m; **(b) 1.37 m;** **(c) 4.0 cm;** **(d) 6.0 μm**

2. Rewrite the following equations in their clearest and most appropriate forms.

(a) $x = (3.323 \pm 1.4)$ **mm;** **(b)** $t = (1\,234\,567 \pm 54\,321)$ **s ;**

(c) $\lambda = (5.33 \times 10^{-7} \pm 3.21 \times 10^{-9})$ **m ;** **(d)** $r = (0.000\,000\,538 \pm 0.000\,000\,03)$**mm**

3. State the number of significant figures that there is for each of the followin quantities, respectively.

(a) $U = 1.000$ **kV;** **(b)** $L = 1.001$ **cm;** **(c)** $T = 0.0010$ **s;**

(d) $V = 3.900 \times 10^3$ **m/s;** **(e)** $m = 10.010$ **kg;** **(f) Natural number 10**

Answer (1)

$(a) 5.0 \times 10^{1}$

$(b) 1.37 \times 10^{3}$

$(c) 4.0 \times 10^{2}$

$(d) 6.0 \times 10^{-3}$

(unit mm)

Answer 2

$(a) x = (3.3 \pm 1.4) mm$

$(b) t = (1.23 \times 10^{6} \pm 5 \times 10^{4}) s$

$(c) \lambda = (5.33 \times 10^{-7} \pm 3 \times 10^{-9}) m$

$(d) r = (5.4 \times 10^{-7} \pm 3 \times 10^{-8}) mm$

Answer 3

(a) 4

(b) 4

(c) 2

(d) 4

(e) 5

(f) 2

4. Emend the incorrect expressions according to the rules for the final measurement results.

(a) $L = 2.0\ \text{km} \pm 100\ \text{m}$;

(b) $m = (72.320 \pm 0.4)\ \text{kg}$;

(c) $v = (1.23 \pm 0.015)\ \text{m/s}$;

(d) $h = (27.3 \times 10^4 \pm 2000)\ \text{km}$;

(e) $E = (1.93 \times 10^{11} \pm 6.79 \times 10^9)\ \text{N/m}^2$

Answer 4

$(a)(2.0\times10^3 \pm 1\times10^2)m$

$(b)(72.3\pm0.4)kg$

$(c)(1.23\pm0.02)m/s$

$(d)(2.73\times10^5 \pm 2\times10^3)km$

$(e)(1.93\times10^{11} \pm 7\times10^9)N/m^2$

5. Use the rules for significant figures and rounding to compute the following arithmetic expressions.

(a) $123.98 - 40.456 + 7.8$;

(b) $\lg 10.00$;

(c) $789.30 \times 50 \div 0.100$;

(d) 1.00^2;

(e) $\dfrac{4.0345}{9.0121-9.011}+58.1$;

(f) $\sqrt{1.00}$;

(g) 100.0^2

Answer 5

$(a)91.3$

$(b)1.0000$

$(c)3.9\times10^5$

$(d)1.00$

$(e)4058.1$

$(f)1.00$

$(g)1.000\times10^4$

6. Write the expressions for the propagation of uncertainty for the following functions.

(a) $N = x + y - 2z$;

(b) $N = \dfrac{x-y}{x+y}$;

(c) $N = \dfrac{v}{\sqrt{1+at}}$ (a is constant);

(d) $V = \dfrac{\pi d^2 h}{4}$

Answer 6

$$(a)dN = dx + dy - 2dz$$

$$(b)\frac{dN}{N} = \frac{dx}{x-y} - \frac{dy}{x+y}$$

$$(c)\frac{dN}{N} = \frac{dv}{v} - \frac{a}{2(1+at)}dt$$

$$(d)\frac{dv}{V} = \frac{1}{2d\ln 4}d(d) + \frac{1}{h\ln 4}dh$$

7. For the following instruments state which reading(s) is/are possibly correct.

(a)A vernier caliper has accuracy of 0.05 mm. Which reading(s) is/are possibly correct?

32.50 mm; 32.48 mm; 33.26 mm; 32.5 mm; 32.500 mm

(b)A vernier caliper has accuracy of 0.02 mm. Which reading(s) is/are possibly correct?

45.22 mm; 52.78 mm; 64.05 mm; 84 mm; 73.464 mm

Answer 7

(a)32.50mm

(b)45.22mm,52.78mm

(c)0.500mm

8. A wheatstone bridge method is used to measure resistance, *R*. The instrument error and the accuracy of the apparatus are 2 Ω and 1Ω, respectively. Ten readings are taken as follows; R_i=142.3; 142.7; 141.9; 142.4; 142.8; 142.1; 142.0; 141.8; 142.2; 142.3 (unit: Ω). Compute the mean value of R_i, the Type A uncertainty of *R*, the Type B uncertainty of *R*, and the combined uncertainty of *R*, respectively. Write the final measurement result.

$$\overline{R_i} = \frac{1}{10}(142.3 + 142.7 + 141.9 ... + 142.2 + 142.3) = 142.25\Omega$$

$$\mu_A = \sqrt{\frac{\sum_{i=1}^{n}(N_i - \overline{N})^2}{n(n-1)}} = \sqrt{\frac{(142.3-142.25)^2 ... + (142.3-142.5)^2}{10\times 9}} = 0.118\Omega$$

$accuracy = 1\Omega$

$scale = 1\Omega, \Delta est = 0.2\Omega$

$\mu_{\Delta est} = \frac{0.2}{\sqrt{3}}\Omega, \mu_{\Delta ins} = \frac{2}{\sqrt{3}}\Omega$

$\mu_B = \sqrt{\mu_{\Delta est}{}^2 + \mu_{\Delta ins}{}^2} = 1.16\Omega$

$\sigma = \sqrt{\mu_B^2 + \mu_A^2} = 1.17\Omega$

$R = (142.3 \pm 1.2)\Omega$

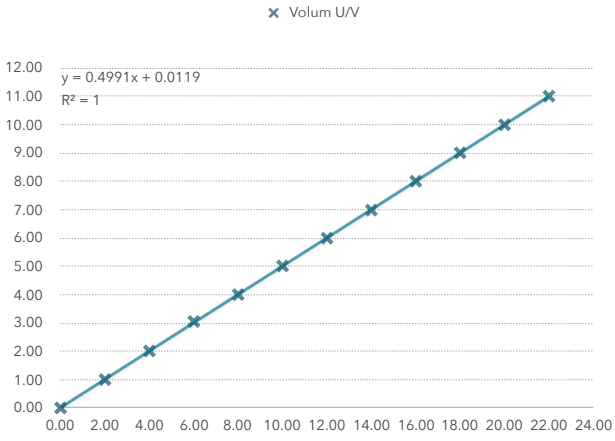
9. Ammeter-Voltmeter method was used to measure resistance. The data are listed in the table below.

Voltage, *U*/V	0.00	1.00	2.01	3.05	4.00	5.01	5.99	6.98	8.00	9.00	9.99	11.00
Current, *I*/mA	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00

Use these data to draw a graph and use the graph to determine the relationship between voltage and current.

Data

Numbers	Volum U/V	Current I/mA
1	0.00	0.00
2	1.00	2.00
3	2.01	4.00
4	3.05	6.00
5	4.00	8.00
6	5.01	10.00
7	5.99	12.00
8	6.98	14.00
9	8.00	16.00
10	9.00	18.00
11	9.99	20.00
12	11.00	22.00



u / v = 0.499 is relatively close to 0.5

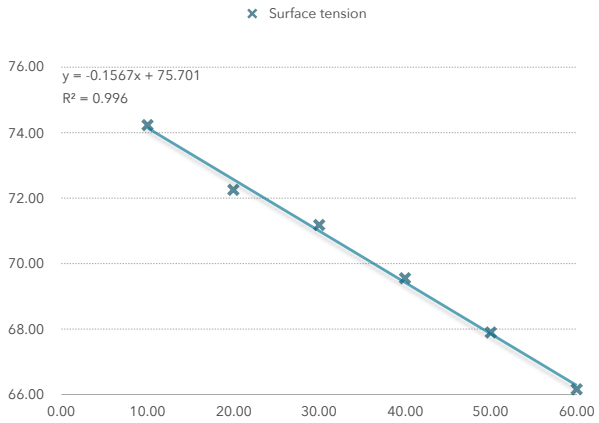
10. The measured surface tension γ ($\times 10^{-3}$ N/m) of water at different temperatures are as following.

Temperature, t/℃	10	20	30	40	50	60
Surface tension, γ/ ($\times 10^{-3}$ N/m)	74.22	72.75	71.18	69.56	67.91	66.18

Suppose that $\gamma = aT - b$ (T is in the unit of Kelvin, K). Use the above data and least-squares fitting method to find a and b. Compute the relation coefficient and interpret the result in terms of how well the line fits the data.

Data

Numbers	Surface tension	Temperature
1	74.22	10.00
2	72.25	20.00
3	71.18	30.00
4	69.56	40.00
5	67.91	50.00
6	66.18	60.00



By using the APP “numbers” to get the answer automatically a= -0.1567

b=

$$\lambda = \frac{\sum_{i=1}^{k}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{k}(x_i - \bar{x})^2 \sum_{i=1}^{k}(y_i - \bar{y})^2}} = -0.996 \approx 1$$

-75.701

So it si extremely close to a line dependent data.