绪论作业答案

1.基本概念(选择题)

1) C

2) A

3) A

4) B

5) B

6) F D A

7) D F A C

2. 指出下列各数是几位有效数字。

　⑴ 0.0001　一位　　　⑵ 0.0100　三位　⑶ 1.0000　五位

　⑷ 980.12300　八位　⑸ 1.35　三位　　⑹ 0.0135　三位

　⑺ 0.173　三位　　　⑻ 0.0001730　四位

3. 改正下列错误，写出正确答案。

⑴ 0.10830　　六位→ 五位

⑵ $P = (31690 \pm 200)$ kg　　→　$(3.169 \pm 0.020) \times 10^4$ kg 或 $m = (31.69 \pm 0.20) \times 10^3$ kg

⑶ $d = (10.430 \pm 0.32)$ cm　→　(10.43 ± 0.32) cm 或(10.4 ± 0.3) cm

⑷ $t = (18.5476 \pm 0.3123)$ cm　→　(18.5 ± 0.3) cm 或(18.55 ± 0.31) cm

⑸ $D = (18.652 \pm 1.4)$ cm　→　(18.7 ± 1.4) cm

⑹ $h = (27.300 \times 10^4 \pm 2000)$ km　→ $(27.30 \pm 0.20) \times 10^4$ km 或 $(273.0 \pm 2.0) \times 10^3$ km 或

　$(2.730 \pm 0.020) \times 10^5$ km

⑺ $R = 6371$ km$= 6371000$ m$= 637100000$ cm →$R = 6371$ km$= 6.371 \times 10^6$ m$= 6.371 \times 10^8$ cm

4. A

5.

解：密度$\rho = \frac{4M}{\pi D^2 H} = \frac{4 \times 236.124}{3.14 \times 2.345^2 \times 8.21} \approx 6.6625675 \ g/cm^3$

　　密度的对数及其偏导数

$$ln\rho = ln\frac{4}{\pi} + lnM - 2lnD - lnH$$

$$\frac{\partial ln\rho}{\partial M} = \frac{1}{M}$$

$$\frac{\partial ln\rho}{\partial D} = \frac{-2}{D}$$

$$\frac{\partial ln\rho}{\partial H} = \frac{-1}{H}$$

相对不确定度

$$\frac{U_\rho}{\rho} = \sqrt{\left(\frac{1}{M}\right)^2 \times (U_M)^2 + \left(\frac{-2}{D}\right)^2 \times (U_D)^2 + \left(\frac{-1}{H}\right)^2 \times (U_H)^2}$$

$$= \sqrt{(\frac{1}{236.124})^2 \times 0.004^2 + (\frac{-2}{2.345})^2 \times 0.005^2 + (\frac{-1}{8.21})^2 \times 0.03^2}$$

$$= 0.005615838$$

不确定度

$$U_\rho = \rho\left(\frac{U_\rho}{\rho}\right) = 6.6625675 \times 0.005615838 \approx 0.0374159(g/cm^3) \approx 0.037(g/cm^3)$$

或 U_ρ=0.04 g/cm^3

测量结果: $\rho = (6.663 \pm 0.037)\ g/cm^3$

或 ρ =(6.66±0.04) g/cm^3

计算各分量可知，直径 **D** 的不确定度对密度 ρ 的不确定度影响**最大**。

附：密度不确定度计算方法二

$$U_\rho = \sqrt{(\frac{\partial \rho}{\partial M}U_M)^2 + (\frac{\partial \rho}{\partial D}U_D)^2 + (\frac{\partial \rho}{\partial H}U_H)^2}$$

$$= \sqrt{(\frac{4}{\pi D^2 H}U_M)^2 + (\frac{8M}{\pi D^3 H}U_D)^2 + (\frac{4M}{\pi D^2 H^2}U_H)^2}$$

$$= \frac{4}{\pi D^2 H}\sqrt{U_M^2 + (\frac{2M}{D}U_D)^2 + (\frac{M}{H}U_H)^2}$$

$$= \frac{4}{3.14 \times 2.345^2 \times 8.21}\sqrt{0.004^2 + (\frac{2 \times 236.124}{2.345} \times 0.005)^2 + (\frac{236.124}{8.21} \times 0.03)^2}$$

$$= 0.0374159$$

$$\approx 0.037(g/cm^3)$$

或 U_ρ=0.04 g/cm^3

6.

解: 重力加速度 $g = \frac{4\pi^2 l}{T^2} = \frac{4 \times 3.14^2 \times 97.69 \times 10^{-2}}{1.9842^2} = 9.7858489(m/s^2)$

重力加速度的对数及其偏导数

$$lng = \ln(4\pi^2) + lnl - 2lnT$$

$$\frac{\partial lng}{\partial l} = \frac{1}{l}$$
$$\frac{\partial lng}{\partial T} = \frac{-2}{T}$$

相对不确定度

$$\frac{U_g}{g} = \sqrt{\left(\frac{1}{l}\right)^2 \times (U_l)^2 + \left(\frac{-2}{T}\right)^2 \times (U_T)^2} =$$

$$\sqrt{\left(\frac{1}{97.69 \times 10^{-2}}\right)^2 \times (0.07 \times 10^{-2})^2 + \left(\frac{-2}{1.9842}\right)^2 \times (0.0005)^2} \approx 0.000876039$$

不确定度

$$U_g = g\left(\frac{U_g}{g}\right) = 9.7858489 \times 0.00087603914 \approx 0.00857279(m/s^2) \approx 0.009(m/s^2)$$

或 U_g=0.0086 m/s^2

结果　$g = (9.786 \pm 0.009)\ m/s^2 = (978.6 \pm 0.9\ )\,\mathrm{cm/s}^2$

或 $U_g = (9.7858 \pm 0.0086)\ m/s^2 = (978.58 \pm 0.86)cm/s^2$

附：不确定度计算方法二

$$U_g = \sqrt{(\frac{\partial g}{\partial l}U_l)^2 + (\frac{\partial g}{\partial T}U_T)^2} = \sqrt{(\frac{4\pi^2}{T^2}U_l)^2 + (\frac{-8\pi^2 l}{T^3}U_T)^2}$$

$$= \frac{4\pi^2}{T^2}\sqrt{U_l^2 + (\frac{2l}{T}U_T)^2}$$

$$= \frac{4\times 3.14^2}{1.9842^2}\sqrt{0.07^2 + (\frac{2\times 97.69}{1.9842}\times 0.0005)^2}$$

$$= 0.857279(cm/s^2) \approx 0.9(cm/s^2)$$

或 U_g=0.86 cm/s^2

7.

解：平均值

$$\bar{x} = \frac{1}{9}\sum_{i=1}^{n}x_i = \frac{1}{9}(0.294 + 0.300 + 0.303 + 0.295 + 0.298 + 0.293 + 0.292 + 0.300 + 0.305)$$

$$= 0.2977778(mm)$$

对已定系差修正(最佳估值)：$d = \bar{x} - (-0.003) = 0.3007778(mm)$

实验标准偏差：$s = \sqrt{\dfrac{\sum_{i=1}^{9}(x_i - \bar{x})^2}{9-1}} = 0.004577\ mm$

$$t_{0.95,8} = 2.306$$

$$U_A = \frac{2.306}{\sqrt{9}}\times 0.004577 \approx 0.003518(mm)$$

$U_B \approx \Delta_{INS} = 0.004$ mm

总不确定度 $U = \sqrt{U_A^2 + U_B^2} = \sqrt{0.003518^2 + 0.004^2} \approx 0.005327(mm) \approx 0.005mm$

或 $U = 0.0053\ mm$

直径测量结果 $d = (0.301 \pm 0.005)mm$

或 $d = (0.3008 \pm 0.0053)\ mm$