

SOLUTIONS

Module - 6 / JEE-2022

IN-CHAPTER EXERCISES	Physics	EXPERIMENTS & ERRORS
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MISCELLANEOUS EXERCISE

1.(C) $LC = 1 \text{ MSD} - 1 \text{ VSD} \Rightarrow 0.02 = 0.1 - 1 \text{ VSD} \Rightarrow 1 \text{ VSD} = 0.08$

2.(A) To minimize heating effect on resistance.

3.(A) Initially: $90x = 9(10) \Rightarrow x = 1$

Finally: $(100 - l)[x(1 + \alpha_1 \Delta T)] = l[9(1 + \alpha_2 \Delta T)] \Rightarrow 100(1 + \alpha_1 \Delta T) = l[9(1 + \alpha_2 \Delta T) + (1 + \alpha_1 \Delta T)]$

$$l = \frac{100(1 + \alpha_1 \Delta T)}{10 + 9\alpha_2 \Delta T + \alpha_1 \Delta T}$$

$$\text{Shift} = l - 10 = \frac{100\alpha_1 \Delta T - 90\alpha_2 \Delta T - 10\alpha_1 \Delta T}{10 + 9\alpha_2 \Delta T + \alpha_1 \Delta T} = \frac{90(\alpha_1 - \alpha_2) \Delta T}{10 + 9\alpha_2 \Delta T + \alpha_1 \Delta T}$$

Neglecting α_1 & α_2 terms as compared to 10 in denominator, $\text{shift} = 9(\alpha_1 - \alpha_2) \Delta T$

4.(A) $\Delta l = \frac{1}{4}(1 \text{ mm}) = 0.25 \text{ mm} \Rightarrow \frac{F}{A} = Y \frac{\Delta l}{l} \Rightarrow Y = \frac{500 \times 3}{10^{-5} \times 0.25 \times 10^{-3}} = 6 \times 10^{11} \text{ N/m}^2$

5.(A) For vernier calliper $LC = 0.05 - \frac{2.45}{50} = \frac{2.5 - 2.45}{50} \text{ cm} = 0.001 \text{ cm} = 0.01 \text{ mm}$

For screw guage $LC = \text{circular scale division} = 0.01 \text{ mm}$

6.(A) Air bubble moves towards low pressure region.

7.(A) $512 = \frac{V}{4(0.17 + e)}; 512 = \frac{3V}{4(0.51 + e)} \Rightarrow \frac{V}{4(0.17 + e)} = \frac{3V}{4(0.51 + e)} \Rightarrow e = 0 \therefore V = 512 \times 4 \times 0.17 = 348 \text{ m/s}$

Side reservoir was moved downward to lower the water level.

8.(A) Zero error = $0.005 \times 5 = 0.025 \text{ mm}$, Pitch = $200 \times 0.005 = 1 \text{ mm}$

Reading = $4 \text{ mm} + 25(0.005) \text{ mm} = 4.125 \text{ mm}$

$\therefore \text{Radius} = \text{reading} - \text{zero error} = 4.125 \text{ mm} - 0.025 \text{ mm} = 4.10 \text{ mm}$

9.(A) $A = lb = 10.0 \times 1.00 = 10.00 \Rightarrow \frac{\Delta A}{A} = \frac{\Delta l}{l} + \frac{\Delta b}{b} \Rightarrow \frac{\Delta A}{10.00} = \frac{0.1}{10.0} + \frac{0.01}{1.00}$

$$\Delta A = 10.00 \left(\frac{1}{100} + \frac{1}{100} \right) = 10.00 \left(\frac{2}{100} \right) = \pm 0.2 \text{ cm}^2$$

10.(B) $\Delta t = 0.2 \text{ s} \Rightarrow t = 25 \text{ s} \Rightarrow T = \frac{t}{N} \Rightarrow \frac{\Delta T}{T} = \frac{\Delta t}{t} = \frac{0.2}{25} = 0.8\%$

11.(B) $LC = 0.1 \text{ mm}$

Zero error = $7 \times 0.1 = 0.7 \text{ mm} = 0.07 \text{ cm}$, True reading = $3.1 + 4(0.01) - 0.07 = 3.07 \text{ cm}$

12.(D) Least count = 0.05 mm

Main scale reading = $76 \times 0.5 = 38$ mm, Vernier scale reading = $4 \times 0.05 = 0.2$ mm

Length = 38.2 mm = 3.82 cm

13.(B) Pitch = $\frac{2}{4} \Rightarrow LC = \frac{2/4}{50} = 0.01$ mm Diameter = $3 \times 0.5 + 32 \times 0.01 = 1.5 + 0.32 = 1.82$ mm

14.(A) $\beta = \frac{\lambda D}{d} \Rightarrow \lambda = \frac{\beta d}{D} = \frac{2.50 \times 10^{-3} \times 3.3 \times 10^{-4}}{1.50} = 550$ nm

$$\frac{\Delta \lambda}{\lambda} = \frac{\Delta \beta}{\beta} + \frac{\Delta d}{d} + \frac{\Delta D}{D} = \frac{0.01}{0.33} + \frac{0.01}{2.50} + \frac{10^{-3}}{1.500} \Rightarrow \Delta \lambda = \frac{5.50}{0.33} + \frac{5.5}{2.5} + \frac{0.55}{1.50} = \frac{500 + 66 + 11}{30} = \frac{577}{30}$$

15.(B) $\frac{mg}{\frac{\pi d^2}{4}} = Y \left(\frac{x}{l} \right) \Rightarrow Y = \frac{mgl}{\left(\frac{\pi}{4} \right) d^2 x} \Rightarrow \left(\frac{\Delta Y}{Y} \right)_{\max} = \frac{\Delta m}{m} + \frac{\Delta l}{l} + 2 \frac{\Delta d}{d} + \frac{\Delta x}{x}$

$$m = 20.0 \text{ kg} \Rightarrow \Delta m = 0.1 \text{ kg}; \quad l = 125 \text{ cm} \Rightarrow \Delta l = 1 \text{ cm}$$

$$d = 0.05 \text{ cm} \Rightarrow \Delta d = 0.001 \text{ cm}; \quad x = 0.100 \text{ cm} \Rightarrow \Delta x = 0.001 \text{ cm}$$

$$\left(\frac{\Delta Y}{Y} \right)_{\max} = \left(\frac{0.1 \text{ kg}}{20.0 \text{ kg}} + \frac{1 \text{ cm}}{125 \text{ cm}} + \frac{0.001 \text{ cm}}{0.05 \text{ cm}} + \frac{0.001 \text{ cm}}{0.100 \text{ cm}} \right) \times 100\% = 4.3\%$$

16.(A) Reason is correct explanation.

17.(B) Index error in $u = +1$ cm $\Rightarrow u = 8$ cm

$$\text{Index error in } v = -1 \text{ cm} \Rightarrow v = 17 + 1 = 18 \text{ cm} \Rightarrow \frac{1}{f} = \frac{1}{18} + \frac{1}{8} \Rightarrow f = 5.53 \text{ cm}$$

18.(A) As temperature increases, the speed of sound increases. Hence the length of air column needed will be more than three times 18 cm, i.e. $x > 54$ cm.

19.(B) We know that $g = \frac{4\pi^2 L}{T^2} \Rightarrow \frac{\Delta g}{g} = \frac{\Delta L}{L} + 2 \left(\frac{\Delta T}{T} \right) = 0.04 + 2(0.005) = 0.05$

20.(A) $0.20 \times 10^3 \times c \times (150 - 40) = (150 \times 1 + 0.025 \times 10^3) (40 - 27) \Rightarrow c = 0.1 \text{ Jg}^{-1} \text{ } ^\circ\text{C}^{-1}$