14. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 20.0 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 90 s using a wrist watch of 1s resolution. The accuracy in the determination of g is :

(1) 1%

(2) 5%

(3) 2%

(4) 3% ← Correct

$T = 2\pi\sqrt{\frac{L}{g}}$

For error analysis, take log on both sides and differentiate

$\frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta L}{L} + \frac{1}{2}\frac{\Delta g}{g}$ (I ignore the signs)

$\therefore \frac{\Delta g}{g} = 2\frac{\Delta T}{T} + \frac{\Delta L}{L}$

$\Delta T = 1/100\ s$, $T = 0.9\ s$

$\Delta L = 1\ mm$, $L = 20.0\ cm$

$\therefore \frac{\Delta g}{g} = \frac{1}{90} \times 2 + \frac{10^{-3}}{20 \times 10^{-2}} = \left(\frac{2}{90} + \frac{1}{200}\right)$

Percentage error $= \frac{\Delta g}{g} \times 100 = 3\%$