

A British 1p coin is dropped from a great height. Its terminal velocity is calculated assuming that it falls face-down and as such the area of the penny that impacts upon the skin can be derived using the terminal velocity of the penny on impact, 

\[ v = u + at \]

\[ v = 0 \Rightarrow u = v_t = -at \]

\[ \Rightarrow -a = \frac{v_t}{t} \]

where \( t \) is the time it would take the penny to decelerate upon hitting the skin. Using the relationship between deceleration \( a \) and impact force \( F_i \), we can derive an equation to find this force and an equation to find the pressure exerted on impact \( P \) (where \( A_i \) is the area of the penny that impacts upon the skin): 

\[ F_i = ma \Rightarrow P_i = \frac{ma}{A_i} = \frac{mv_i}{tA_i} \]

Discussion

The above equations assume knowledge of several constants, which are as follows. The mass \( m \), diameter \( 2r \) and thickness \( s \) of a British 1p coin are given by [1] as \( m = 3.56 \times 10^{-3} \) kg, \( 2r = 2.03 \times 10^{-2} \) m and \( s = 1.52 \times 10^{-3} \) m respectively. The drag coefficient of a thin disc \( C_d = 1.1 \) [2] and the density of air \( \rho_a = 1.29 \) kg m\(^{-3} \) [3].

Using these values for the constants, a terminal velocity is derived from Eq. (3) as \( v_t = 12.3 \) ms\(^{-1} \). This value can be put into Eq. (6) and then Eq. (7) to calculate values for the impact force \( F_i \) and the pressure exerted \( P_i \).

However, the time taken for the penny to decelerate \( t \) must be assumed. Since it is assumed that the impact would be visible on a high-speed camera (which typically record at 1000 fps [4]) and since it is desirable to minimise the time taken to decelerate to provide the highest possible force and pressure exerted on the skin, a value of \( t = 10 \) ms is assumed. The impact area of...
the penny with the skin \( A_i \) is also assumed (in this paper, \( A_i = s^2 = 2.31 \times 10^{-6} \text{ m}^2 \) is used).

In this scenario, it is found that \( F_i = 4.37 \text{ N} \) and \( P_i = 1.89 \text{ MPa} \).

**Conclusion**

It is known that the average tensile strength of human skin \( P = 20.89 \pm 4.11 \text{ MPa} \) [5]. The calculated value for the pressure exerted on the person upon landing, \( P_i = 1.89 \text{ MPa} \), is much lower than this value. The penny’s impact with its victim would not even break the skin.

**REFERENCES**

[1] royalmint.com/Corporate/facts/coins/1pCoin.aspx