Solutions for Topic 1 – Measurements and uncertainties

1. **a)** kg ms^{-2}

   b) kg m^{2}s^{-3}

   c) kg m^{-1}s^{-2}

   d) A s

   e) kg m^{2}s^{-1}A^{-1}

2. **a)** 258

   b) 0.00235

   c) 0.178

   d) 7870

   e) 2.00

3. **a)** 4.3

   b) 6.4×10^{-2}

   c) 2.16×10^3

   d) 2.0×10^9

   e) 3.8×10^2

4. **a)** 11 kV

   b) 0.422 mm or 422 μm

   c) 85 GW

   d) 0.422 μm or 422 nm

   e) 0.35 pC or 350 fC

5. **a)** 10^{-1} m (a few 10s of cm)

   b) $10^{-4} - 10^{-2}$ kg (flies come in many different shapes and sizes!)

   c) 10^{-19} C (1.6×10^{-19} C)

   d) 10^{10} year (13.7 billion years)

   e) 10^8 ms^{-1} (3.0×10^8 ms^{-1})

6. **a)** $\dfrac{2 \times 3 \times 5}{500} = \dfrac{6}{100} = 0.06$

   b) between 70 and 74 mJ

7. 3.0 ± 0.4; $\pm 13.3\%$ (*or rounding up $\pm 14\%$*)

8. $\dfrac{\Delta s}{s} = \dfrac{\Delta g}{g} + 2\dfrac{\Delta t}{t} = 0.02 + (2 \times 0.03) = 0.08 = \pm 8\%$

9. $\dfrac{\Delta r}{r} = \dfrac{1}{2}\left(\dfrac{\Delta h}{h} + \dfrac{\Delta V}{V}\right) = 0.5 \times 0.02 \times 0.05 = 0.035 = \pm 4\%$

10. **a)** check line of best fit reasonable

    b) A = y-intercept; B = gradient

    c) use difference between steepest and shallowest gradients

11. **a)** check line of best fit reasonable

    b) log $F = n$ log x + log k; plot log F against log x and find gradient of graph which is n

    c) $p = \dfrac{8.5 \times 10^{-2}}{\pi \times 4.5 \times 10^{-6}} = 1.3 \times 10^9$ Nm^{-2}

    d) $\dfrac{\Delta A}{A} = 2\dfrac{\Delta r}{r} = 2 \times \dfrac{0.1 \times 10^{-6}}{4.5 \times 10^{-6}} = 0.04 = \pm 4\%$

12. (1850 ± 50) m at angle of N (60 ± 5) °E from scale starting point

13. magnitude $= \sqrt{5^2 + 3^2} = 5.8$ N

    $\tan\theta = \dfrac{5}{3}$; $\theta = 31°$ to horizontal

14. **a)** magnitude of velocity $= \sqrt{1.5^2 + 0.8^2} = 1.7$ m s^{-1}

    $\tan\theta = \dfrac{0.8}{1.5}$; $\theta = 28°$ with original direction

    b) $s \cos 28 = 50$; displacement $s = 57$ m

15. component parallel to slope $= mg \sin\theta = 850 \times 9.8 \sin 25 = 3500$ N