Answers

1.1

4 3.75×10^{7} m s^{-1}

1.2

4 9.0×10^{-4} V m^{-1}

1.3

1 **a** 3.39×10^{7} m s^{-1}

b 1.75×10^{11} C kg^{-1}

2 1.80×10^{11} C kg^{-1}

3 1.79×10^{11} C kg^{-1}

4 The value was many times larger than the largest known specific charge which was that of the hydrogen ion. The magnitude of the charge of the electron was not known at the time. However it was realised the electron either has much less mass than the hydrogen ion or it has much more charge.

1.4

1 **a** 4.78×10^{-19} C

b 3

2 **b** **i** 6.40×10^{-19} C, positive

ii 4

3 **a** 3.96×10^{-15} kg

b 3.18×10^{-19} C

2.2

4 **a** 55.1 μs

b **i** Reflected light is not seen at this frequency because a gap must be replaced by a tooth in the time taken, t, for light to travel from the cog wheel to the reflector and back. At 12.6 Hz, the cog wheel turns through a small angle θ when a gap is replaced by the adjacent tooth in time t. At 3×12.6 Hz, a gap is replaced by the tooth next to the adjacent tooth as the cog wheel turns through an angle 3θ in time t.

ii 63.0 Hz

2.3

1 **a** 3.72×10^{-19} J

b 7.60×10^{-20} J

2 **a** 4.85×10^{-19} J

b 1.61×10^{-19} J

c +1.31 V

2.4

1 **a** 2.27×10^{-10} m

b 1.24×10^{-13} m

2 3.14×10^{6} m s^{-1}, 2.32×10^{-11} m

3.2

2 **a** **i** 680 ns

ii 135 ns

b 40 m

3 **a** 2.9×10^{-30} kg

b 1.8×10^{-13} J

c 1.1(3) MV

4 **a** 0.99995*c*