Essential Pre-Uni Physics H3.2

A Level

Physical constants which may be necessary to answer the problems on this page can be found within the hint tabs.

For electrons moving at a speed greater than 10% of the speed of light, you should only claim that your answer is approximate (unless you have used relativistic equations). If you reckon that the electron is travelling at a speed greater than 80% of the speed of light, you should decline to give your answer unless using relativity

Convert $3.0 \times 10^{-11}\ \text{J}$ into electron volts.

Essential Pre-Uni Physics H3.5

A Level

P P P

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How fast is an alpha particle going if it is accelerated by a $1.5\,\mathrm{MV}$ potential? Assume that the alpha particle has twice the charge and four times the mass of a proton.

Gameboard:

STEM SMART Physics 42 - School of Fields - Accelerators

Energy and Fields - Accelerator 23.1

A Level

Quantities:

m mass (kg)
p momentum $(\mathrm{kg\,m\,s^{-1}})$
u initial speed $(\mathrm{m\,s^{-1}})$
v final speed $(\mathrm{m\,s^{-1}})$
F force (N)
λ wavelength (m)
h Planck's constant $(\mathrm{J\,s})$

q charge (C)
K kinetic energy (J)
V accelerating voltage (V)
E electric field $(\mathrm{N\,C^{-1}})$
L length of accelerating region (m)

Equations:

$$p = mv \qquad \Delta K = K_{\text{final}} - K_{\text{initial}} = \tfrac{1}{2}mv^2 - \tfrac{1}{2}mu^2 \qquad \Delta K = qV$$

$$\lambda = \frac{h}{p} \qquad F = qE \qquad \Delta K = FL \qquad 1\,\mathrm{eV} = 1.6 \times 10^{-19}\,\mathrm{J}$$

Use the equations above to derive expressions for:

Part A Momentum

the momentum p in terms of V, m and q if $u = 0$.

The following symbols may be useful: `V, m, p, q`

Part B Speed if $u = 0$

the speed v in terms of V, m and Q if $u = 0$.

The following symbols may be useful: `Q, V, m, v`

Part C Speed if $u \neq 0$

the speed v if $u \neq 0$.

The following symbols may be useful: `Q, V, m, u, v`

Part D Additional kinetic energy

the additional kinetic energy ΔK in terms of E, L and q.

The following symbols may be useful: `Delta K, E, L, q`

Part E Electric field

the electric field E in terms of V and L.

The following symbols may be useful: `E, L, V`

Part F Momentum

the momentum p in terms of E, L, m and q if $u = 0$.

The following symbols may be useful: `E, L, m, p, q`

Part G Wavelength

the wavelength λ in terms of V, m and q when $u = 0$.

The following symbols may be useful: `V, lambda, m, q`

Gameboard:

STEM SMART Physics 42 - School of Fields - Accelerators

Energy and Fields - Accelerator 23.2

A Level

Calculate the voltage needed to accelerate a proton to $3.5 \times 10^6\,\mathrm{m\,s^{-1}}$ from rest.

Gameboard:

STEM SMART Physics 42 - School of Fields - Accelerators

Essential Pre-Uni Physics H3.6

A Level

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To trigger a particular nuclear reaction, a deuterium nucleus (same charge as the proton, but twice the mass) needs to have a kinetic energy of 4.0×10^{-13} J. What accelerating voltage is needed?

Gameboard:

STEM SMART Physics 42 - School of Fields - Accelerators

Vectors and Fields - Mass Spectrometer 30.2

A Level

Calculate the speed electrons emerge from a $95\ \mathrm{V}$ accelerator. Assume that the electrons start from rest.

Gameboard:

STEM SMART Physics 42 - School of Fields - Accelerators

Vectors and Fields - Mass Spectrometer 30.3

A Level

Calculate the radius of curvature of a $2.5 \times 10^6\,\mathrm{m\,s^{-1}}$ electron in a $1.5\,\mathrm{mT}$ magnetic field.

Gameboard:

STEM SMART Physics 42 - School of Fields - Accelerators

Vectors and Fields - Mass Spectrometer 30.6

A Level

Calculate the specific charge q/m of a particle travelling at $2.0 \times 10^6\,\mathrm{m\,s^{-1}}$ in a magnetic field if the path radius $r = 11.9\,\mathrm{mm}$ and the flux density $B = 0.175\,\mathrm{T}$.

Gameboard:

STEM SMART Physics 42 - School of Fields - Accelerators

Vectors and Fields - Mass Spectrometer 30.7

A Level

Calculate the voltage V_s needed in a velocity selector to pass $1.6 \times 10^6\,\mathrm{m\,s^{-1}}$ electrons in a $2.2\,\mathrm{T}$ magnetic field if the velocity selector plate gap $d = 6.5\,\mathrm{cm}$.

Gameboard:

STEM SMART Physics 42 - School of Fields - Accelerators

Vectors and Fields - Mass Spectrometer 30.11

A Level

A singly charged ion is accelerated by a $650\,\mathrm{kV}$ potential before passing into a region with a $1.25\,\mathrm{T}$ magnetic field. It curves with a radius of $0.322\,\mathrm{m}$. Calculate its mass.