



Physics. *You work it out.*

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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 3.0×10^{-11} J into electron volts.

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Physics. *You work it out.*

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Essential Pre-Uni Physics H3.5



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

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How fast is an alpha particle going if it is accelerated by a 1.5 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](#)

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Physics. *You work it out.*

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Energy and Fields - Accelerator 23.1

A Level



Quantities:

m mass (kg)

p momentum (kg m s⁻¹)

u initial speed (m s⁻¹)

v final speed (m s⁻¹)

F force (N)

λ wavelength (m)

h Planck's constant (J s)

q charge (C)

K kinetic energy (J)

V accelerating voltage (V)

E electric field (N C⁻¹)

L length of accelerating region (m)

Equations:

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

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

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: ΔK , 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

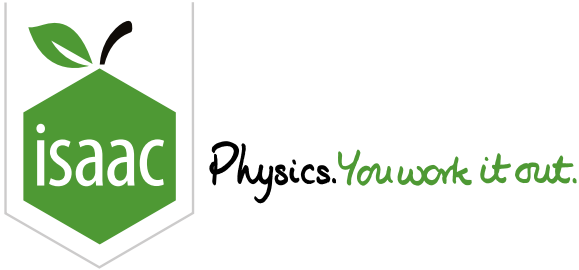
the wavelength λ in terms of V , m and q when $u = 0$.

The following symbols may be useful: V , λ , m , q

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Energy and Fields - Accelerator 23.2

A Level

P

P

P

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

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Physics. *You work it out.*

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Essential Pre-Uni Physics H3.6



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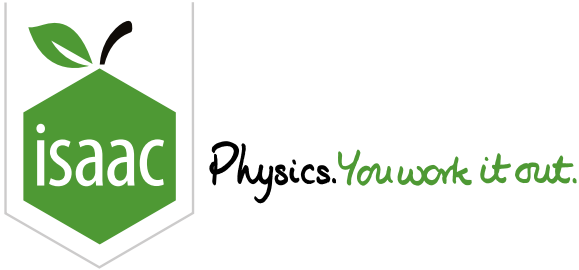
For electrons moving at a speed greater than 10% of the speed of light, you should only claim that your answer is approximate (unless you have used relativistic equations). If you reckon that the electron is travelling at a speed greater than 80% of the speed of light, you should decline to give your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

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?

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Vectors and Fields - Mass Spectrometer 30.2



Calculate the speed electrons emerge from a 95 V accelerator. Assume that the electrons start from rest.

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Physics. *You work it out.*

Vectors and Fields - Mass Spectrometer 30.3

A Level

P

P

P

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

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Physics. *You work it out.*

Vectors and Fields - Mass Spectrometer 30.6

A Level

P

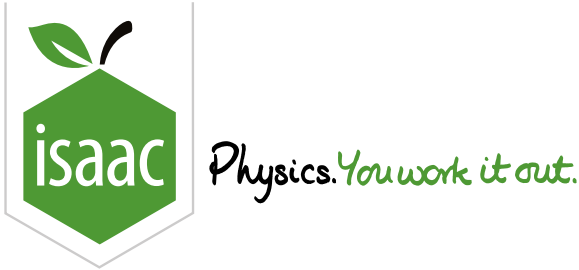
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P

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

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Vectors and Fields - Mass Spectrometer 30.7

A Level

P

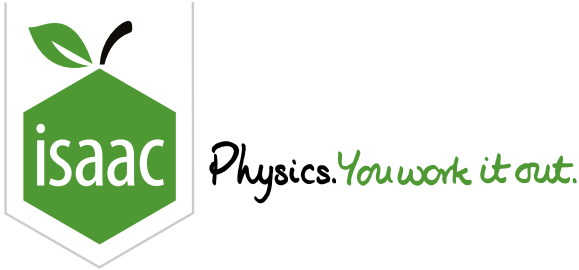
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Calculate the voltage V_s needed in a velocity selector to pass $1.6 \times 10^6 \text{ m s}^{-1}$ electrons in a 2.2 T magnetic field if the velocity selector plate gap $d = 6.5 \text{ cm}$.

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Vectors and Fields - Mass Spectrometer 30.11

A Level

P

P

P

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

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