Essential Pre-Uni Physics F6.4

A Level

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

Mass of Earth = $5.98 \times 10^{24}\,\mathrm{kg}$

Radius of Earth = $6400\,\mathrm{km}$

The Moon's orbit round the Earth has a radius of $3.8 \times 10^{8}\,\mathrm{m}$. Calculate the Moon's speed in its orbit.

Essential Pre-Uni Physics F6.5

A Level

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

Mass of Earth = $5.98 \times 10^{24}\,\mathrm{kg}$

Radius of Earth = $6400\,\mathrm{km}$

Part A Orbiting the Earth

If you want something to orbit the Earth at a height of $200\,\mathrm{km}$ above the surface, at what speed must it travel? Give your answer to 3 significant figures.

Part B Time period

What is the time period of the orbit in Part A? Give your answer to 3 significant figures.

Gameboard:

STEM SMART Physics 39 - School of Fields - Orbits

Essential Pre-Uni Physics F6.6

A Level

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

Mass of Earth = $5.98 \times 10^{24}\,\mathrm{kg}$

Radius of Earth = $6400\,\mathrm{km}$

Part A Kepler's Third Law

Starting from $F = \frac{GMm}{r^2}$ and $F = \frac{mv^2}{r}$, derive Kepler's 3rd Law relating the radius of an orbit r to the mass of the planet M and the orbital speed v.

Give your answer in a form where r is on the left hand side of the equation and all other terms are on the right hand side.

The following symbols may be useful: `G, M, pi, r, v`

Part B Time period

Repeat the question, but this time to relate r and M to the time period T.

Gameboard:

STEM SMART Physics 39 - School of Fields - Orbits

Physics. You work it out.

Orbits 26.5

A Level

Calculate the orbital period of Jupiter in units of Earth years given that the mass of the Sun, $M = 2.0 \times 10^{30}\,\text{kg}$, the mass of Jupiter, $m = 1.9 \times 10^{27}\,\text{kg}$ and the average radius of Jupiter's orbit around the sun is $R = 7.8 \times 10^{8}\,\text{km}$.

Gameboard:

STEM SMART Physics 39 - School of Fields - Orbits

Orbits 26.7

A Level

C C C

61 Cygni is a wide binary star system. It contains two stars of nearly equal mass which orbit once around their mid point every $659\,\text{years}$. They are $1.26 \times 10^{13}\,\text{m}$ apart. Assuming that the two stars have equal mass, calculate:

Part A Speed

the speed of the stars.

Part B Total mass

the total mass of the system.

Gameboard:

STEM SMART Physics 39 - School of Fields - Orbits

Physics. You work it out.

Orbits 26.2

A Level

A positron of charge $+q$ and mass m enters a magnetic field B travelling at a speed v perpendicular to the direction of the magnetic field.

Part A Radius of orbit

Derive an expression for r in terms of q, B, m and v.

The following symbols may be useful: `B, m, q, r, v`

Part B From positron to proton

If we now change the particle from a positron to a proton, keeping the magnetic field and the velocity of the particle the same, what would happen? Complete the sentence below.

The proton will move in a [ ] [ ] with [ ] [ ].

Items:

circular **non-circular** **straight** **orbit** **line** **a smaller** **a larger** **the same** **varying**

no **radius** **curvature**

Gameboard:

STEM SMART Physics 39 - School of Fields - Orbits

Physics. You work it out.

Orbits 26.9

A Level

In a particle accelerator protons are accelerated in the $+x$-direction until they have a velocity of $v = 6.5 \times 10^6\,\mathrm{m\,s^{-1}}$. They then pass into a magnetic field of strength $0.10\,\mathrm{T}$ that is oriented in the $+y$-direction.

Part A Direction of motion

In which direction do the protons accelerate when they first enter the magnetic field?

- $+x$ direction
- $-x$ direction
- $+y$ direction
- $-y$ direction
- $+z$ direction
- $-z$ direction

Part B Radius

What is the radius of the orbital path that the protons take?

Gameboard:

STEM SMART Physics 39 - School of Fields - Orbits

Physics. You work it out.

Essential Pre-Uni Physics H6.4

A Level

C C C

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

Part A Momentum of a muon

Work out the momentum of a muon (same charge as an electron, but mass $= 207 \times$ electron mass) taking a curved path with a $90\,\mathrm{cm}$ radius perpendicular to a $0.0076\,\mathrm{T}$ magnetic field.

Part B Momentum of an electron

Work out the momentum of an electron which would take the same path in the same field as in Part A.