The Solar Wind and Magnetosphere

1. List the three parts of the interior of the Sun.

The interior of the Sun consists of three main regions:

1. the core, within which nuclear fusion takes place

2. the radiative zone, through which energy is transported by photons

3. the convective zone, where energy is transported by convection.

1. Describe the main event that occurs in each of the three parts. As above
2. List the parts of the atmosphere of the Sun and describe the main features of each.

The photosphere is the visible surface of the Sun and appears smooth and featureless, marked by occasional relatively dark spots, called sunspots.

Moving outwards, next is the chromosphere. Sharp spicules and prominences emerge from the top of the chromosphere.

The corona (from the Greek for crown) extends from the top of the chromosphere. The corona is not visible from Earth during the day because of the glare of scattered light from the brilliant photosphere, but its outermost parts are visible during a total solar eclipse.

The depth of each layer relative to the radius of the Sun (RS) is shown. The photosphere is about 330 km deep (0.0005Rs) and the chromosphere is about 2000 km (0.003Rs) deep.

1. Which part of the sun is only visible during a solar eclipse and why?

Corona, sun is too bright to see it before then

1. Draw a labelled diagram showing the main parts of the sun.



1. What were the objectives of the SOHO mission?

SOHO was designed to answer the following three fundamental scientific questions about the Sun:

• What is the structure and dynamics of the solar interior?

• Why does the solar corona exist and how is it heated to the extremely high temperature of about 1 000 000°C?

• Where is the solar wind produced and how is it accelerated?

Clues on the solar interior come from studying seismic waves that are produced in the turbulent outer shell of the Sun and which appear as ripples on its surface.

1. Where is SOHO mission control?

SOHO is operated from NASA’s Goddard Space Flight Center (GSFC) near Washington. There an integrated team of scientists and engineers from NASA, partner industries, research laboratories and universities works under the overall responsibility of ESA. Ground control is provided via NASA’s Deep Space Network antennae, located at Goldstone (California), Canberra (Australia), and Madrid (Spain).

1. List the 7 major finds of the SOHO mission

Some of the key results include:

• Revealing the first images ever of a star’s convection zone (its turbulent outer shell) and of the structure of sunspots below the surface.

• Providing the most detailed and precise measurements of the temperature structure, the interior rotation, and gas flows in the solar interior.

• Measuring the acceleration of the slow and fast solar wind.

• Identifying the source regions and acceleration mechanism of the fast solar wind in the magnetically "open" regions at the Sun's poles.

• Discovering new dynamic solar phenomena such as coronal waves and solar tornadoes.

• Revolutionising our ability to forecast space weather, by giving up to three days’ notice of Earth-directed disturbances, and playing a lead role in the early warning system for space weather.

• Monitoring the total solar irradiance (the ‘solar constant’) as well as variations in the extreme ultra violet flux, both of which are important to understand the impact of solar variability on Earth’s climate.

***Besides watching the Sun, SOHO has become the most prolific discoverer of comets in astronomical history: as of January 2011, more than 2000 comets had been found by SOHO.***

1. What is the current cost of the SOHO mission?

About a thousand million Euros. These costs have been spread between ESA and its member states, and NASA.

1. What is the solar wind?
2. Describe the make-up of the solar wind.
3. Describe solar flares?
4. Explain the solar cycle.
5. What are sun spots?
6. Describe the magnetosphere.
7. Describe the interaction of the Earth’s magnetic field and the solar wind, use diagrams to help you
8. What is the Van Allen belt?

The Earth’s Magnetic field affects the movement of charged particles. Some of this is now covered in the Higher Physics course. So review this section either with the new Higher Physics notes or the old AH Virtual notes.

You should know the “secret sign of the Physicists”

***Write notes of motion of charged particles in fields***

1. Why do charged particles move in a magnetic field?
2. What gives rise to the helical motion of charged particles?
3. Describe the Aurorae; is there a difference between the Aurora Borealis and the Aurora Australis?

***Answer AH Paper 2015 Revised Question 9***

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| **Question** | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
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| **9** | **a** | **i** | Force acts on particle at right angles to the direction of its velocity/motion**or** a central force on particle. | **1** | “Centre Force” not accepted. |
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| **9** | **a** | **ii** |    **(½)** for both equations and **(½)** for equality **(½)****(½)**   ***SHOW QUESTION*.** | **2** | ←**Start here, Zero Marks.**Watch out for neutron mass1·675 × 10−27 max **(1)****(½)** for *m***(½)** for *q*No final relationship stated **(−½)** |
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|  |  |  |  |  |  |
| **9** | **b** |  | (Component of) velocity at right angles to field/ *v* sin θ, results in circular motion/central force. **(1)**(Component of) velocity parallel to field/ *v* cosθ is constant/no unbalance force (in this direction). **(1)** | **2** | Circular Motion perpendicular to *B* **(1)**.Constant speed parallel to *B* **(1)**.Candidates using horizontal and vertical instead of parallel and perpendicular should be given credit. |
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| **9** | **c** | **i** | *f* = 4·0 Hz, *T* = 1/*f* = 0·25 s **(½)** time between mirror points = 0⋅125 s **(½)** *d = vt* **(½)**  = 1·2 × 107 × 0·125 **(½)**  = 1·5 × 106 m **(1)** | **3** | Using *t =* 0∙25 s will give *d* = 3∙0 × 106 m. **(2½)** |
|  |  |  |  |  |  |
| **9** | **c** | **ii** | Magnetic field strength has decreased. | **1** | Correct application of eqn or **(1)** |
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| **9** | **c** | **iii** |  **(½)**  **(½)**  B = 1·3 × 10-5 T **(1)** | **2** | Using original equation and values will give 1·25 × 10-5 TAccept 1·26 |
|  |  |  |  | **(11)** |  |