

2509

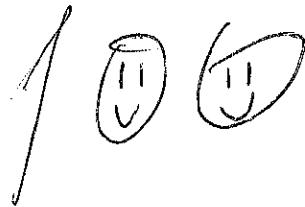
Tour of the Solar System

Spring 2009, Exam #2

March 5, 2009

Instructions: There are a total of 20 problems in this exam, worth 5 points each. Attempt as many problems as possible, write your answers on the question sheet, and turn it in at the end of the class. You should need to write no more than a few sentences to answer descriptive questions. Please note that this is not an open-book exam: no books or notes may be used, and all electronic devices, including laptops, cellphones, calculators and iPods, must be switched off.

Be sure to fill out your name below.



NAME: _____

(please print legibly)

[1] Of the five rocky bodies in the inner solar system (the four terrestrial planets and the Earth's Moon), which has:

- (a) The tallest volcanoes? Mars
- (b) The densest atmosphere? Venus
- (c) A rotational period equal to its orbital period? Moon ~~Mercury~~
- (d) Evidence for currently active volcanoes? Earth
- (e) The largest core in proportion to its size? Mercury ~~Moon~~

(Each part has a unique answer).

[2] Match up each of the following space missions (1 – 5) with the object it was designed to study (a – e):

- | | | |
|---------------|----------|-------------|
| 1. Pathfinder | <u>B</u> | a. Venus |
| 2. Stereo | <u>C</u> | b. Mars |
| 3. Clementine | <u>D</u> | c. The Sun |
| 4. Messenger | <u>E</u> | d. The Moon |
| 5. Magellan | <u>A</u> | e. Mercury |

[3] Match up each of the surface features (1 – 5) with the bodies on which they are located (a – e):

- | | | |
|--------------------------|----------|--------------|
| 1. The Caloris Basin | <u>B</u> | a. The Earth |
| 2. Mare Imbrium | <u>D</u> | b. Mercury |
| 3. The Barringer Crater | <u>A</u> | c. Mars |
| 4. The Maxwell Mountains | <u>E</u> | d. The Moon |
| 5. Valles Marineris | <u>C</u> | e. Venus |

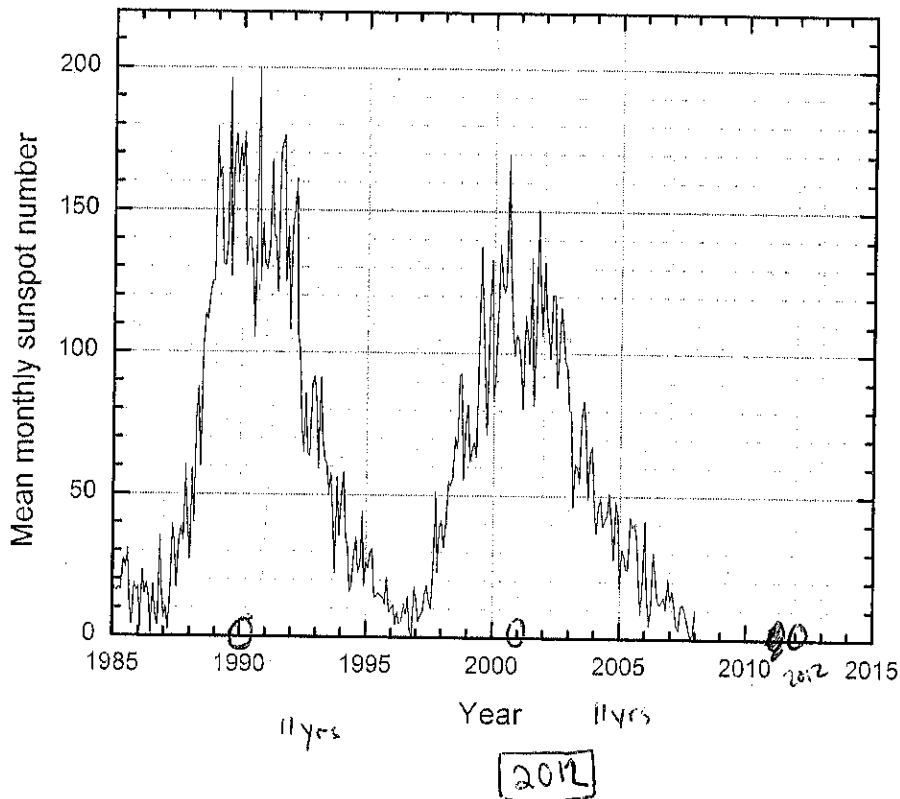
[4] Which of the following statements most accurately describes the distribution of impact craters on Mars? Select one:

- 1. The entire surface is very densely cratered, comparable to the most cratered areas of the Moon
- 2 Some areas are quite densely cratered, others have very few.
- 3. The entire surface is uniformly cratered, but with a density much less than the most cratered areas of the Moon

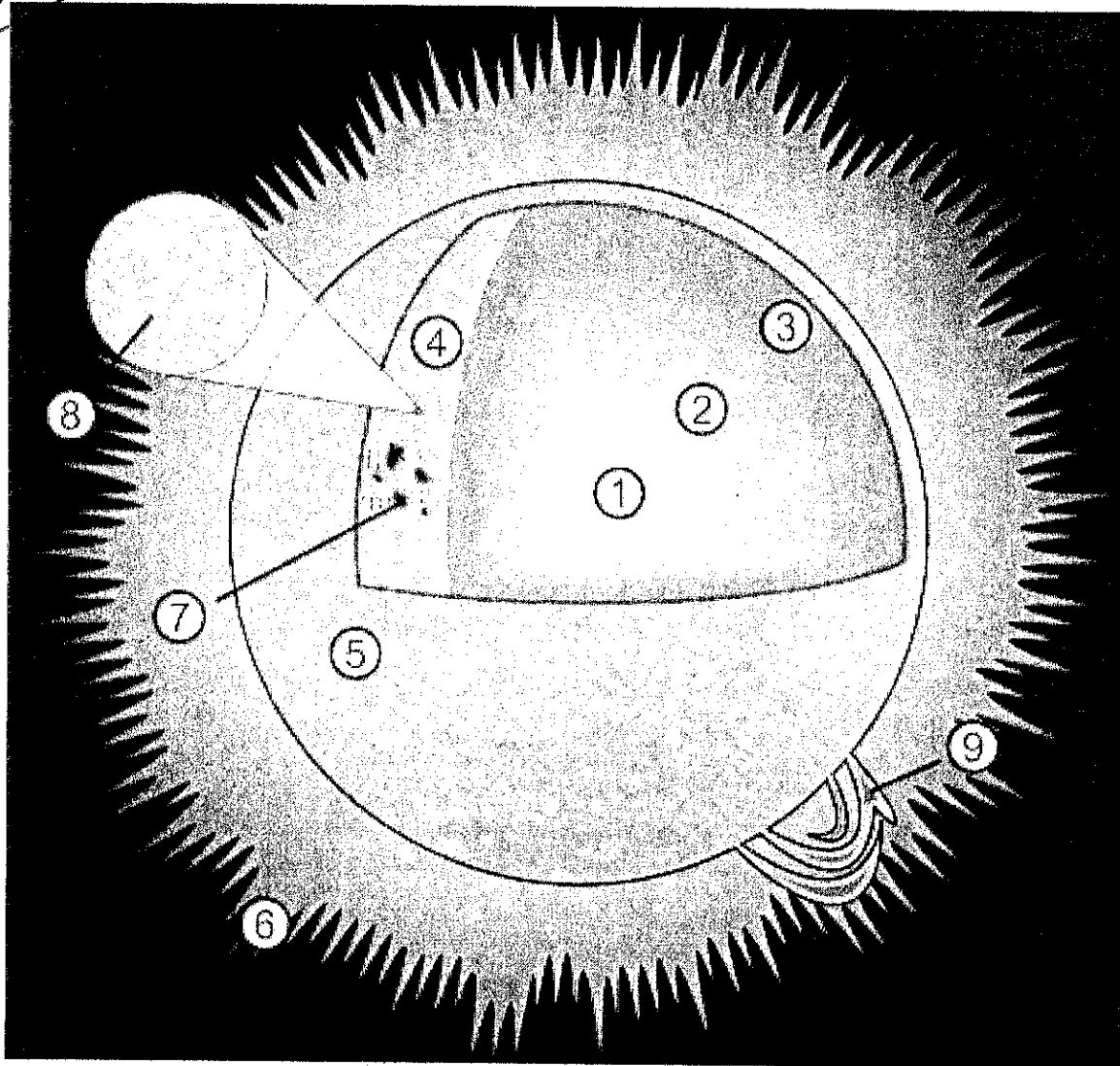
[5] Explain what is meant by "differential solar rotation" and briefly describe a set of simple observations that would enable you to verify that it occurs.

Differential solar rotation means that different parts of the sun rotate around its axis at different times. Since the sun isn't a solid, it is possible for this to occur. The rotation occurs the fastest near the equator and goes slower towards the poles. We could observe sunspots to verify that this occurs because if they were lined up longitude, their alignment would change because the sunspots near the equator would be rotating faster than the sunspots nearest the North & South hemispheres. We could also verify that it occurs because differential solar rotation causes the magnetic field lines to wrap around the sun further increasing solar activity as we observe solar maximum in which the magnetic field would then dissipate and reform.

[6] Use the graph below to predict the approximate date (to the nearest year) of the next maximum in solar activity.



[7] Identify the regions of the Sun numbered in the diagram below (full credit for any five correct, bonus points for more than five).



- ① Core
- ② Radiative Zone
- ③ Convective Zone
- ④ Photosphere (visible disk)
- ⑤ ~~Outer Atmosphere~~ (Chromosphere)
- ⑥ ~~Solar Flare~~
- ⑦ Sun spot
- ⑧
- ⑨ Prominence

[8] Explain why aurora displays are generally seen only at very northerly or very southerly latitudes of the Earth.

Aurora displays are generally seen at very northerly or southerly latitudes of Earth because the magnetic field lines are such a way that particles can only enter Earth through the North and South Pole. The Earth is wrapped up in magnetic field lines everywhere else. Once the charged particles enter, they generally travel along lines from the North pole to the South pole leaving no room to enter any place else on Earth.

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[9] Explain why fusing four hydrogen nuclei together to form one helium nucleus in the Sun's core leads to a release of energy.

Fusing 4 hydrogen nuclei together to form one helium nucleus in the Sun's core leads to a release of energy because one helium nucleus is slightly less massive than 4 hydrogen nuclei and the difference is converted to energy via: $E = mc^2$.

proton proton chain

— 0

[10] Match up the following components of the Sun (1 – 4) with the most appropriate temperature (a – d):

1. The photosphere
2. The corona
3. The region where fusion occurs
4. A typical sunspot

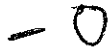
- a. 15,000,000 K (3)
- b. 1,000,000 K (2)
- c. 5,800 K (1)
- d. 4,000 K (4)

[11] State whether each of the following statements is true or false:

- (a) The direction of the Sun's magnetic field reverses every 22 years. *false*
- (b) Coronal streamers are less common on the Sun at solar maximum compared with solar minimum. *false*
- (c) Eruptive prominences are more common on the Sun at solar maximum compared with solar minimum. *True*
- (d) Looped prominences are associated with open magnetic field lines that allow charged particles to escape from the Sun. *False*
- (e) The solar wind causes comet tails to point away from the Sun. *True*

[12] Explain what is meant by a bipolar sunspot group.

When the Sun's magnetic flux tubes get too close to the surface, it causes a double sunspot, one with a N charge and one with a S charge. This is a "bipolar sunspot group" and they have opposite orientation. The white sunspot part is ~~white~~ to the right of the black one above the Sun's center and to the left of the black below the center.



[13] The Sun radiates most energy in the form of visible light, but it is also a significant source of X-rays, especially during times of solar activity. Which of the following is the most important source of the Sun's X-ray emission? Select one:

- (a) The entire photosphere
- (b) Sunspots in the photosphere
- ☒ (c) Active regions in the corona
- (d) Polar regions of the chromosphere

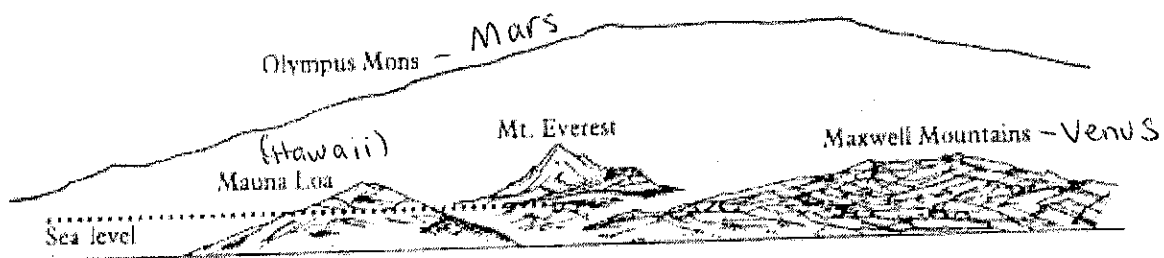
[14] The Hawaiian Islands are made up of an almost linear chain of volcanic islands, with older, extinct volcanoes at one end of the chain and younger, active volcanoes at the other. Briefly explain how the Hawaiian Islands are believed to have formed.

The Hawaiian Islands sit in the middle of the Pacific Plate that moves in the direction of the island from newer to older. Beneath the islands, in the mantle, is a hot spot that lets out heat above it which causes a volcano to be almost continuously active - (Mauna Loa today). As the plate drifts across the mantle, the hot spot ^{the} burns holes which ~~have~~ has resulted in islands.

-0

[15] The diagram below compares mountains on three planets (Venus, Earth and Mars). Three of the four mountains are volcanoes of the same type, the other had a completely different origin.

- (a) Which is the odd one out? Mount Everest
- (b) Which of the following describes the most probable origin of the mountain you selected in part (a):
- (i) A collision between tectonic plates
 - (ii) A different type of volcano
 - (iii) The central peak of a complex crater



[16] Of the two major types of volcano found on Earth (strato and shield), only one is found on Mars. Which one? What is the significance of this result?

only the shield type is found on Mars. This result is significant because it shows that Mars has a volcanic past and explains its high percentage of CO_2 in the atmosphere. It also fails to show strong evidence for tectonic plates or lack thereof.

- 0

[17] List three types of surface feature present on Earth that we should expect to see on other planets if they have plate tectonics. Are any such features visible on Mars?

1) rift zone

2) mountains caused by tectonic plate collisions

3) Strato volcano

- 0

We only believe rift zones to be visible on Mars.

There are no mountains caused by tectonic plate collision or strato volcanoes.

[18] The largest volcanic mountain on Mars is about three times taller than the largest volcanic mountain on Earth. Does this fact imply that Mars must have been much more volcanically active than the Earth at some time in its history? Explain your answer.

Even though the largest volcanic mountain on Mars is about 3 times taller than the largest one on Earth, it does not imply that Mars was more volcanically active. The reason why volcanoes on Mars are so big is because of the ^{general} lack of plate movement.

- 0

[19] The atmospheres of Earth and Mars are thought to have originated in similar ways, i.e. by release of volcanic gases, yet Mars' atmosphere is now less than one hundredth the density of Earth's. Suggest **two** reasons why Mars' atmosphere is now so thin.

1) Mars is smaller than Earth so lighter gases escape easily.

2) Because of the lack of volcanic activity on Mars, ~~as it decreased~~, fewer gases were put into the atmosphere to replenish it. As Mars got cooler, gases froze out into the polar caps.

3) The lack of gravity on Mars = lose heat quickly
[20] If Mars (as it exists today) could be moved toward the Sun, to a distance similar to the distance of the Earth from the Sun, do you think it would become a suitable habitat for life? Explain your answer. (Assume that Mars and the Earth do not collide!)

If Mars moved toward the Sun, it would become warmer causing the polar caps to melt and release the water there. This would be very suitable for photo-synthetic life. Also, the green gases would cause Mars to warm up as well. However, the pressure on Mars is extremely low. I think Mars may be a suitable habitat for life, but only microbial life; ^{and} they would have to be able to survive in the low pressure.

2508

Tour of the Solar System

ASTR 1530

Spring 2008, Exam #2

March 6, 2008

Instructions: There are a total of 20 problems in this exam, worth 5 points each. Attempt as many problems as possible, write your answers on the question sheet, and turn it in at the end of the class. You should need to write no more than a few sentences to answer descriptive questions. Please note that this is not an open-book exam: no books, notes or laptops may be used.

Be sure to fill out your name below.

NAME:

~~William~~ ~~William~~ 88.5

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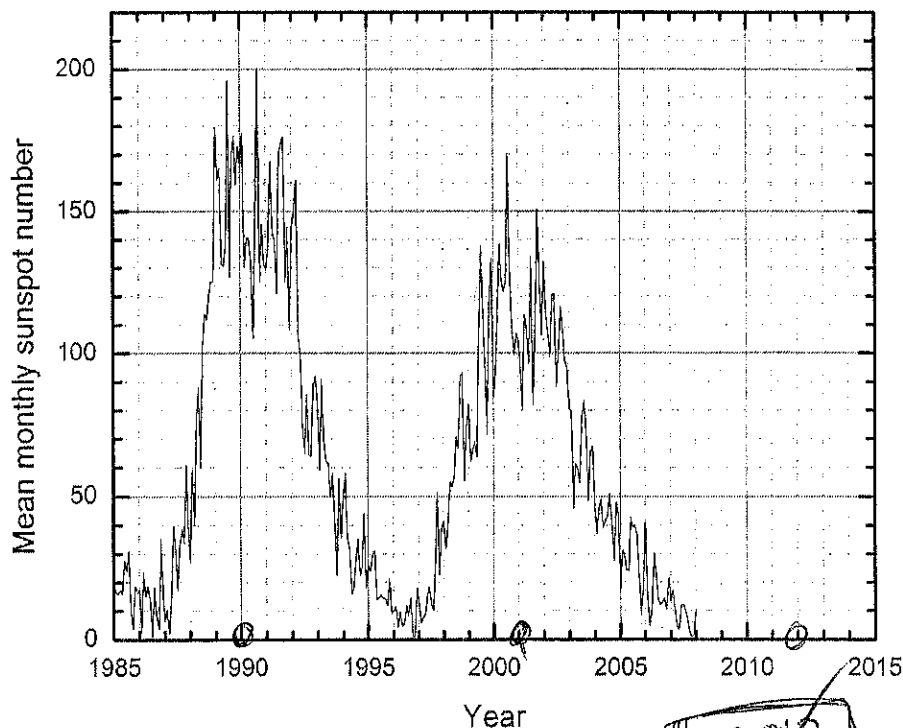
[1] Of the four terrestrial planets (Mercury, Venus, Earth and Mars), which has:

- (i) The densest atmosphere? ~~Earth~~ Venus
(ii) The tallest volcanoes? ~~Mars~~
(iii) The largest moon? ~~Earth~~
(iv) The only currently active volcanoes? ~~Earth~~
(v) The greatest density of craters on its surface? ~~Mercury~~

[2] Match up each of the following space missions (1 – 5) with the object it was designed to study (a – e):

- | | | |
|---------------|--------------|-----------------------|
| 1. Pathfinder | b ✓ | a. Venus |
| 2. SOHO | c ✓ | b. Mars |
| 3. Clementine | d | c. The Sun |
| 4. Messenger | e | d. The Moon |
| 5. Magellan | a | e. Mercury |

[3] Use the graph below to predict the approximate date (to the nearest year) of the next maximum in solar activity.



[4] A strato (cone-shaped) volcano is observed at a particular location on the Earth's surface. Which of the following statements is most likely to be true?

- (a) The region is close to a subduction zone
- (b) The region is close to a rift zone
- (c) The region is remote from any tectonic plate boundary

[5] A shield volcano is observed at a particular location on the Earth's surface. Which of the following statements is most likely to be true?

- (a) The region is close to a lateral fault
- (b) The region could be close to either a rift zone or a "hotspot" remote from any tectonic plate boundary
- (c) The region is close to a subduction zone

[6] The Hawaiian Islands are made up of an almost linear chain of volcanic islands, with older, extinct volcanoes at one end of the chain and younger, active volcanoes at the other. Briefly explain how the Hawaiian Islands are believed to have formed.

The Hawaiian Islands sit in the middle of the Pacific plate, which is moving in the direction of the islands, from ~~newest~~ to ~~oldest~~ westward. Beneath the islands, in the mantle the earth is a hotspot, this hotspot exudes such heat that it creates a nearly continuously active volcano above it. Presently that volcano is Mauna Loa, previously it has been the other - older - islands in the chain. As the Pacific plate drifts across the mantle the hotspot burns new holes in it, resulting in the Hawaiian Islands.

[7] Of the two major types of volcano found on Earth (strato and shield), only one is found on Mars. Which one? What is the significance of this result?

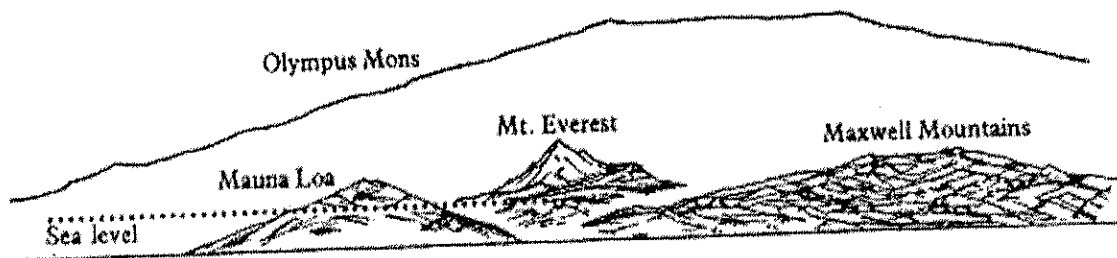
only shield volcanoes are found on Mars. This is significant because it shows that Mars had a volcanic past and explains the exceptionally high percentage of CO_2 in the thin atmosphere (90+%). It also fails to show concrete evidence of tectonic plates, or lack thereof.

[8] The diagram below compares mountains on three planets (Venus, Earth and Mars). Three of the four mountains are volcanoes of the same type, the other had a completely different origin.

(a) Which is the odd one out? Mt. Everest

(b) Which of the following describes the most probable origin of the mountain you selected in part (a):

- (i) A different type of volcano
- ☒ (ii) A collision between tectonic plates
- (iii) The central peak of a complex crater



[9] The largest volcanic mountain on Mars is about three times taller than the largest volcanic mountain on Earth. Does this fact imply that Mars must have been much more volcanically active than the Earth at some time in its history?

YES ☒ NO

Explain your answer (explanation required for full credit):

Because Earth has a consistently new crust ~~because of~~ because of tectonic activity compared to Mars, there is no summation of volcanic activity on Earth as there is presumed to be on Mars.

[10] The atmospheres of Earth and Mars are thought to have originated in similar ways, i.e. by release of volcanic gases, yet Mars' atmosphere is now less than one hundredth the density of Earth's. Suggest **two** reasons why Mars' atmosphere is now so thin.

- 1) Mars is much smaller than Earth, and so lighter gases can escape it far more easily.
- 2) As Mars's volcanism lessened, fewer gases were put into the atmosphere to replenish it. As Mars cooled off much of the gas froze out, depositing in to the polar caps and ground.

[11] Which of the following statements most accurately describes the distribution of impact craters on Mars? Select one:

- (a) The entire surface is very densely cratered, comparable to the most cratered areas of the Moon
- (b) The entire surface is uniformly cratered, with a density much less than the most cratered areas of the Moon
- ☒ (c) Some areas are quite densely cratered, others have very few

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[12] List three types of surface feature present on Earth that we should expect to see on other planets if they have plate tectonics. Are any such features visible on Mars?

strato volcanoes, mountains caused by colliding tectonic plates, rift zones

Mars does not have strato volcanoes or mountains caused by colliding tectonic plates, but it does have what has been ~~supposed~~ supposed as ~~an~~ rift zones.

[13] If Mars (as it exists today) could be moved toward the Sun, to a distance similar to the distance of the Earth from the Sun, do you think it would become a suitable habitat for life? Explain your answer. (Assume that Mars and the Earth do not collide!)

If Mars were ~~equal~~ at an equal distance from the sun as Earth, it would warm up considerably, allowing its polar caps to melt, releasing the water held there. Mars' atmosphere would be favorable to photosynthetic life if they could stand the very low pressure. The greenhouse gases would also come into play, making Mars gradually much warmer. So, maybe a photosynthetic extremophile that liked insanely low pressure could survive on Mars at Earth's distance from the sun.

[14] Why does fusing four hydrogen nuclei together to form one helium nucleus in the Sun's core lead to a net release of energy?

Because by $E = mc^2$ ~~more energy is released~~
vastly more energy is emitted by such a
fusion than is taken up in the fusing.

[15] Match up the following components of the Sun (i) – (iv) with the most appropriate temperature (a) – (d):

- ~~(i)~~ the visible disk (photosphere)
- ~~(ii)~~ a typical sunspot
- (iii) the outer atmosphere (corona)
- ~~(iv)~~ the inner core (where fusion occurs)

- (a) 15,000,000 K ~~(iv)~~
- (b) 1,000,000 K ~~(iii)~~
- (c) 5,800 K ~~(i)~~
- (d) 4,000 K ~~(ii)~~

[16] State whether each of the following statements is true or false:

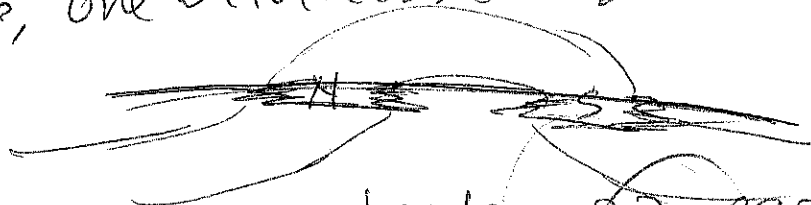
- (a) Sunspots at high solar latitude take more time to complete one revolution as the Sun spins on its axis compared with sunspots near the solar equator. ~~true~~
- (b) The direction of the Sun's magnetic field reverses every 22 years. ~~false~~
- (c) Eruptive prominences are less common on the Sun at solar maximum compared with solar minimum. ~~false~~
- (d) Coronal streamers are more common on the Sun at solar maximum compared with solar minimum. ~~true~~
- (e) Looped prominences are associated with open magnetic field lines that allow charged particles to escape from the Sun. ~~true~~

[17] The Sun radiates most energy in the form of visible light, but it is also a significant source of X-rays, especially during times of solar activity. Which of the following is the most important source of the Sun's X-ray emission? Select one:

- (a) Sunspots in the photosphere
- ☒ (b) Active regions in hot coronal gas above bipolar sunspot groups
- (c) The entire photosphere

[18] Explain what is meant by a bipolar sunspot group. Why does study of these groups indicate that the 11-year solar sunspot cycle is really a 22-year cycle?

A Bipolar sunspot means that the sun's magnetic ~~field lines~~^{flux tubes} get too close to the surface and created a double sunspot, one with a(N) charge, one with a(S) charge.



1 These sunspots indicate a 22 year cycle because after every other solar maximum when the wrapped magnetic field lines become so weak they dissapate and then reform as straight pole-pole lines, the polarity spontaneously switches.

[19] Explain what is meant by differential solar rotation and briefly describe its effect on the Sun's magnetic field during the course of a solar cycle.

Differential solar rotation means that different parts of the sun rotate around the sun's axis at different speeds. Because the sun is not solid, it is possible for this to happen. The equatorial region rotates the fastest, and the speed decreases up to the magnetic poles, where it is slowest. This differential rotation wraps the sun's magnetic field lines around itself, ever increasing the sun's activity until a solar maximum is reached, when the magnetic fields dissipate and reform.

[20] Aurora displays result from collisions between solar wind particles and atoms or molecules in the Earth's atmosphere. Explain why they are generally seen only at very northerly or very southerly latitudes.

Aurora's are generally only seen near Earth's magnetic poles because those are the places where the magnetic field lines of Earth are such that some of these particles can enter the field. Everywhere else around the Earth, the Earth is wrapped in its magnetic field lines that prevent the particles from entering there.

Once the charged particles enter Earth's magnetic field and bounce off molecules in the upper atmosphere, they generally ride Earth's magnetic field lines from one pole to the other, without much window to go any place else.