# Name:____________________________

## Intro Astro Lab Prep Quiz: Sunspots

**Instructions:** There are $X$ multiple-choice problems each worth 1 mark for a total of $X$ marks altogether. Choose the **BEST** answer, completion, etc., and **DARKEN** fully the appropriate circle on the table provided below. Leave no answers blank. If you do not know answer, eliminate wrong ones and guess. Read all responses carefully. **NOTE** long detailed responses won't depend on hidden keywords: keywords in such responses are bold-faced capitalized.
This is a $2X$ minute quiz.

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007 qmult 00100 1 1 1 easy memory: observational sunspot definition

1. Observationally, a ____________ is a small dark region of roughly circular or irregular shape or some other kinds of shape on the surface (i.e., photosphere) of the Sun.

   a) sunspot  b) sun dog  c) sun hole  d) sun pit  e) sun welt

   **SUGGESTED ANSWER:** (a)

   **Wrong answers:**
   a) C'mon.

   Fortran-95 Code

   **Redaction:** Jeffery, 2013jan01

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007 qmult 00110 1 1 2 easy memory: first record of the sunspots

2. The earliest record of a sunspot was by Chinese astronomer Ge Dan (4th century BCE) in:

   a) 1000 BCE.  b) 364 BCE.  c) 1066.  d) 1610.  e) 1929.

   **SUGGESTED ANSWER:** (b)

   **Wrong answers:**
   c) *1066 and All That* (1930). A mild humor book in cosmic present, but it wowed them in 1930.

   **Redaction:** Jeffery, 2013jan01

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007 qmult 00140 1 1 1 easy memory: early discovery of the rotating sun

3. An early consequence of the telescopic discovery of sunspots was the discovery that the Sun:

   a) rotated.  b) periodically deformed into a cigar shape.  c) was red.
   d) had magnetic fields.  e) had electric fields.

   **SUGGESTED ANSWER:** (a)

   **Wrong answers:**
   d) It has magnetic fields, but that was not an early discovery.

   **Redaction:** Jeffery, 2013jan01

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007 qmult 00200 1 1 3 easy memory: Sun rotation

4. The Sun rotates:

   a) once around every hour.  b) like solid sphere.  c) differentially.
   d) on an axis lying in the ecliptic plane  e) not at all.

   **SUGGESTED ANSWER:** (c)

   **Wrong answers:**
   a) Oh c'mon.

   **Redaction:** Jeffery, 2013jan01

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007 qmult 00210 1 1 5 easy memory: sun differential rotation because a gas sphere

5. The Sun can rotate differentially since it is:

a) not in orbit. b) like the Earth. c) a liquid sphere. d) a solid sphere.
e) a gas sphere.

**SUGGESTED ANSWER:** (e)

**Wrong answers:**
a) A nonsense answer.

**Redaction:** Jeffery, 2013jan01

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007 qmult 00220 1 1 4 easy memory: solar interior solid-like rotation

6. Helioseismology tells that the Sun interior to about $0.65R_\odot$:

a) has sunspots. b) does not rotate. c) is a solid sphere.
d) rotates approximately like a solid sphere. e) rotates very differentially.

**SUGGESTED ANSWER:** (d)

**Wrong answers:**
c) It rotates like that, but isn't that.

**Redaction:** Jeffery, 2013jan01

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007 qmult 00230 1 1 4 easy memory: Sun surface period

7. The surface equatorial sidereal period of the Sun is ____________. As one moves toward the poles, the sidereal period increases and reaches a limiting value of about ____________.

a) 38 days; 24.5 days b) 365.25 days; 38 days c) 100 days; 365.25 days
d) 24.5 days; 38 days e) 365.25 days; 1001 days

**SUGGESTED ANSWER:** (d) See Wikipedia: Solar rotation.

**Wrong answers:**
a) A nonsense answer.

**Redaction:** Jeffery, 2013jan01

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007 qmult 00240 1 4 5 easy deducto-memory: sidereal period

8. "Let's play *Jeopardy*! For $100, the answer is: This kind of rotation or revolution period is regarded as the true physically-motivated period since it is referenced to inertial frames. In our modern general relativity understanding, inertial frames are reference frames in free fall under gravity not rotating with respect to the observable universe (i.e., the bulk matter of the observable universe). All other frames of reference are noninertial frames. However, noninertial frames can changed into effective inertial frames with the use of inertial forces which are not real forces, but techniques for accounting for the noninertial nature of noninertial frames. Inertial forces are not seen as tricks since they have a fundamental connection to gravity. The supreme local inertial frame for Earth in modern understanding is the one defined by cosmologically remote galaxies and the cosmic microwave background radiation."

What is a/an ____________, Alex?

a) synodic period b) sentence period c) periodic table period d) asynchronous period
e) sidereal period

**SUGGESTED ANSWER:** (e)

**Wrong answers:**
a) Exactly wrong.

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007 qmult 00260 1 4 5 easy deducto-memory: relating synodic and sidereal periods

9. To relate synodic and sidereal periods for some kinds of astronomical motions consider the following formula:

$$360^\circ = (R - R_\oplus)p_{\rm syn} ,$$

where $R$ is the (sidereal) rotation rate of an astro-body (in degrees per unit time), $p_{\rm syn}$ is the synodic period of the body, and $R_\oplus$ is the (sidereal) revolution rate of the Earth (in degrees per unit time).

Both $R$ and $R_\oplus$ are assumed constant as a simplifying approximation. Note $(R - R_\oplus)$ is the rate of rotation of astro-body relative to the Earth. Hereafter, we will think of the astro-body and Earth as aligned at time zero as a mental simplification though this assumption is not necessary to the analysis. If $(R - R_\oplus) > 0$, the astro-body laps the Earth and $p_{\rm syn} > 0$. If $(R - R_\oplus) < 0$, the Earth laps the astro-body and $p_{\rm syn} < 0$ (i.e., one must count $p_{\rm syn}$ as a negative time in this case). If $(R - R_\oplus) = 0$, the astro-body and Earth are at relative rest and $p_{\rm syn} = \infty$. Now $R = 360^\circ/p$ and $R_\oplus = 360^\circ/p_\oplus$, where $p$ and $p_\oplus$ are the sidereal periods of, respectively, the astro-body and the Earth. Note that $p$ must be counted as negative time if the astro-body rotates opposite to the Earth: i.e., it has retrograde rotation. After a little algebra, one finds ____________________.

a) $1/p = p_\oplus + 1/p_{\rm syn}$ b) $1/p = 1/p_\oplus + p_{\rm syn}$ c) $p = 1/p_\oplus + 1/p_{\rm syn}$
d) $1/p + 1/p_\oplus = 1/p_{\rm syn}$ e) $1/p = 1/p_\oplus + 1/p_{\rm syn}$

**SUGGESTED ANSWER:** (e)

Behold:

$$1)\quad 360^\circ = (R - R_\oplus)p_{\rm syn} \qquad 2)\quad \frac{360^\circ}{p_{\rm syn}} = \frac{360^\circ}{p} - \frac{360^\circ}{p_\oplus} \qquad 3)\quad \frac{1}{p_{\rm syn}} = \frac{1}{p} - \frac{1}{p_\oplus}$$

$$4)\quad \frac{1}{p} = \frac{1}{p_\oplus} + \frac{1}{p_{\rm syn}} \qquad 5)\quad p = \frac{p_{\rm syn}p_\oplus}{p_{\rm syn} + p_\oplus} \ .$$

Note the following:

$$p_{\rm syn} = \begin{cases} \dfrac{p_\oplus p}{p_\oplus - p} & \text{in general.} \\ -p_\oplus & \text{for } p = \infty\text{. In this case, the astro-body is not moving} \\ & \text{and the Earth laps it every time } p_\oplus. \\ < 0 & \text{for } p \in (p_\oplus, \infty)\text{. The astro body is in relative retrograde rotation.} \\ & \text{It orbital period is longer than the Earth's.} \\ \infty & \text{for } p = p_\oplus\text{. The astro-body and Earth are} \\ & \text{at relative rest.} \\ p & \text{for } p = p_\oplus/2\text{. The astro-body has to go around} \\ & \text{twice to lap the Earth.} \\ 0 & \text{for } p = 0\text{. The astro-body orbits instantly.} \\ < 0 & \text{for } p < 0\text{. The astro-body is in (absolute) retrograde rotation.} \\ -\dfrac{p_\oplus}{3} & \text{for } p = -p_\oplus/2. \\ -\dfrac{p_\oplus}{2} & \text{for } p = -p_\oplus\text{. The astro-body and Earth} \\ & \text{if they started aligned come back to alignment} \\ & \text{after half time } p_\oplus. \\ -p_\oplus & \text{for } p = -\infty\text{. In this case,} \\ & \text{the astro-body is not moving and the} \\ & \text{Earth laps it every time } p_\oplus. \end{cases}$$

**Wrong answers:**
a) Not dimensionally correct.

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