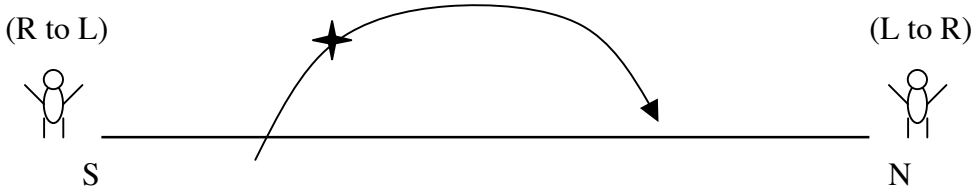
COMMENTS ON QUIZ 1

Part A

A1. b. A2. a. A3. 2°5', 1°, 2'10", 5", 0".02

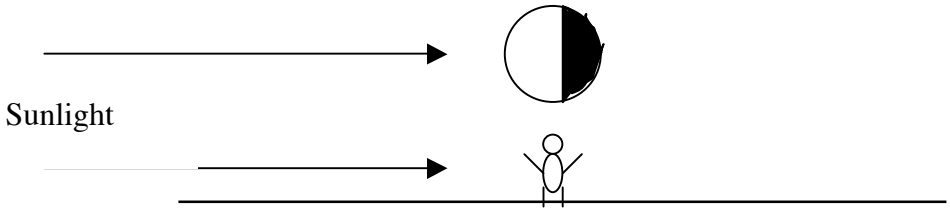
A4. b. A5. a.

A6. b. Chile is south of the equator. Imagine the celestial sphere as a dome of stars moving E to W thanks, of course, to the rotation of the Earth W to E. North of the equator, E to W is a left to right motion. South of the equator E to W is a right to left motion. The following diagram may help you visualize the situation.



A7. a. Today the tip of the Moon's umbra just grazes the Earth's surface. If the Moon were just slightly farther away from the Earth, the tip would always pass above the Earth's surface. Then, we would see partial but never total solar eclipses.

A8. b. Consider the angle at the Moon between us and the Sun.



A9. a. See Homework 1.

A10. a. Full

A11. d. (See Kepler's Law No. 2)

A12. b.

A13. P is the orbital period of the planet around the Sun. (Strictly, the sidereal not the synodic period).
a is the semi-major axis of the planet's orbit around the Sun.

A14. Recall $P^2=a^3$. Here $P^2=4 \times 4 \times 4=64$, and, therefore, P=8 years.

A15. a.

A16. The force increases 16-fold. That is the force on the Earth AND the force on the Moon increases 16-fold.

This can be seen with a little algebra if necessary:

$$F = G\frac{4M_E \times 4M_M}{d^2} = 16G\frac{M_E M_M}{d^2}$$

A17. The force decreases to one-sixteenth of its original strength.

$$F = G\frac{M_E M_M}{(4D)^2} = G\frac{M_E M_M}{16D^2}$$

A18. a. This problem is much like the others we have done yet there were a surprising number of incorrect answers. The basic points were covered in a set of classnotes but are repeated here.

The force on the Earth is: $F = G\frac{M_E M_s}{d^2}$

The acceleration of the Earth towards the Sun is this force divided by the mass of the earth.

$$a_E = \frac{F}{M_E} = G\frac{M_S}{d^2}$$

Similarly, the acceleration of the Sun towards the Earth is:

$$a_S = \frac{F}{M_S} = G\frac{M_E}{d^2}$$

Clearly, the Earth's acceleration is much larger ($M_{Sun} >> M_{Earth}$).

A19. The entire electromagnetic spectrum is observable from the lunar surface; the Moon has no atmosphere to block portions of the atmosphere.

A20. Gamma ray, uv, blue, red, radio

A21. The red and blue beams are reflected at the SAME angle.

A22. Recall light gathering power scales as the AREA of the primary mirror (s), telescopes are described by the diameter of their primary mirrors, and the area of a mirror scales as its diameter squared.

Then, an 8-meter mirror has an area that is $8^2 = 64$ times that of a 1 meter mirror (assuming the 8m and 1m mirrors have the same shape).

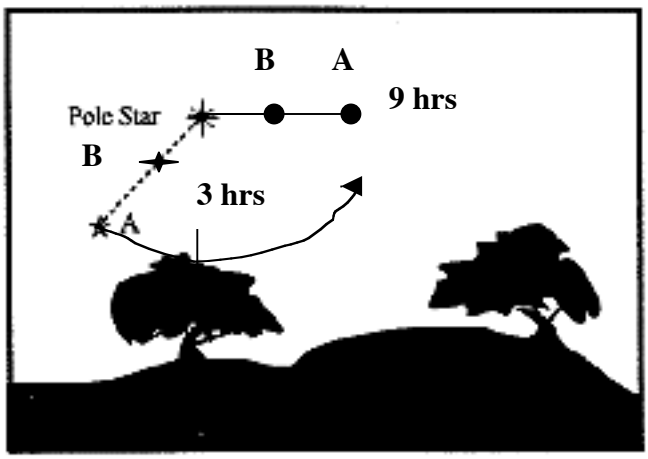
A23. a. False b. True c. False

A24. Sound waves are pressure changes in a gas (solid, or liquid). Electromagnetic waves involve oscillating electric and magnetic fields.

A25. atomic nucleus, atom, you, campus, earth, solar system, Galaxy, Local Group

Part B

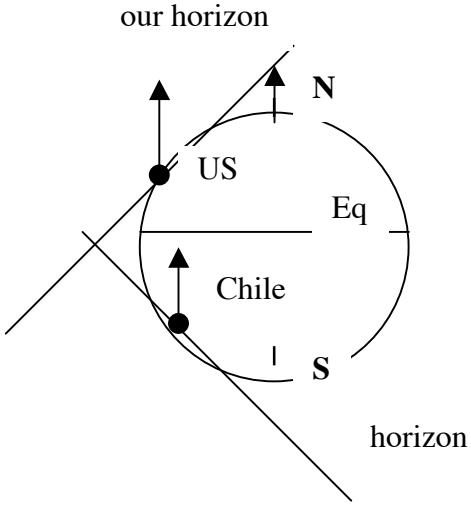
B1.a. Imagine walking under the dome of stars. The stars in the S move L to R. Looking W the stars rise behind you and set in front of you. To turn your gaze N, the stars must move counterclockwise around the Pole Star or they are **NOT** fixed.



In 3 hours the line connecting the Pole Star and stars A and B will be vertical, i.e., A and B will be below the Pole Star which does not move relative to your horizon. In 9 hours, B and A will be off to the right of the Pole Star.

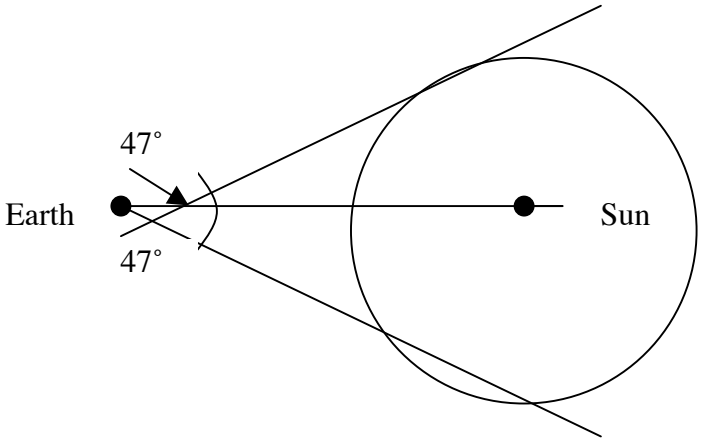
b. Stars are FIXED on the celestial sphere – a star north of the equator stays at its northern celestial latitude ('declination') throughout the year and the next year and… (It slowly moves due to precession.) From a given place on earth, a star follows the SAME path across the sky EVERY day, but not at the same time. The difference is due to the fact that we orbit the Earth or, equivalently, the Sun moves around the celestial sphere on a path called the ecliptic.

c. The Big Dipper and Pole Star are always below the horizon from Chile. This diagram shows this and also shows why we can see the BD on any night.



The arrows show the direction to the Pole Star. These arrows are parallel to the N-S axis of the Earth. Clearly, the arrow points below the horizon from Chile.

B2.a. The key observation made long before Copernicus, was that the angular separation of Venus from the Sun never exceeds 47°. Venus moves relative to the Sun to 47° west before turning back towards the Sun and out to 47° east.
The key assumption was that the planets including the Earth orbit the stationary Sun. A secondary assumption was the orbits were circular.
Then, the orbit of Venus is defined as the following diagram shows:



If the orbit is made smaller (larger) for a fixed Earth-Sun distance, the maximum angle away from the Sun must be less (greater) than the observed 47°. There is one and only one orbit that satisfies the observed angle of 47°.

In answering this question it is insufficient to say 'greatest elongation'. Your answer to be judged complete must explain how the orbital radius is constrained by knowledge of the angle of greatest elongation.

b. Here the answer must explain that in order to appear as a crescent Mercury must be between us and the Sun, and in order to appear full Mercury has to be on the far side of the Sun. As always, a clearly labeled diagram helps.

Next, should come the relation between distance and angular size. Mercury is the same size wherever it is in its orbit. But its angular size as seen by us varies: if close, it appears large and, if distant, it appears small.

B3.a. Seeds b. Seeds. See also HW1.

c.

i) If the Moon's diameter is halved, the length of the umbral cone is also halved. At present, the tip of the cone just grazes the Earth's surface. If length of the cone is halved, the tip will be 100,000 miles or so above the surface. Total solar eclipses will never be seen from Earth.

ii) Presently, the Sun and Moon have the same angular diameter as viewed from Earth, which is why total solar eclipses are visible at a given moment from a very small area on Earth.
If the Sun's diameter were halved, the lunar umbral cone is approximately doubled in length. At the Earth's distance from the Moon, the width of the umbral cone will be about half the Moon's diameter or about 1000 miles. Therefore, the frequency of total solar eclipses will be increased.

iii) Of course, this depends on whether Texas is doubled in size. If it is the frequency of eclipses will decrease; the size of the total eclipse zone is unaffected by the Earth's size and, therefore, the probability of a given zone crossing a particular place on Earth is decreased.

B4. See the classnotes on Rutherford's experiment.

a. A description has to include mention of the radioactive source, the gold foil, AND the detector.

b. Describe what was expected for scattering of alpha particles on the Thomson model., and then what was actually found.
Describe how only a nucleus-electron cloud picture of a very small positively charged massive nucleus can account for the observation that some alpha particles were scattered back towards the source. Mention the positive-positive repulsive force. Mention the high mass of the nucleus that allows the nucleus to absorb the impact of the high speed alpha particles and lets them 'bounce off.'

B5. a. There are three technical reasons. Each of these is roughly equivalent to saying 'mirrors cost less than lenses' but we were calling for the technical reasons behind the dollars.

i) Lenses suffer from chromatic aberration. Your answer must explain what this aberration is AND why mirrors are not similarly affected.

ii) Mirrors are more easily supported than lenses. Point out that glass is not very stiff ('a frozen liquid' is one description) and sags under its own weight. The degree of sag obviously depends on the orientation of the lens/mirror and this changes as the telescope is pointed around the sky. A lens can be supported only around its edge – the light has to pass through the lens. A mirror, on the other hand, can be supported over its entire rear surface. In addition, the mirror does not have to be made of a solid block of glass; a honeycomb structure weighs less than a solid block. Thin mirrors can be made and supported if necessary under computer control, in order to maintain the desired surface shape. A thin lens can be made but then it has a long focal length (ok?) and the telescope is long.

iii) Glass quality is a premium consideration with a lens – the light has to pass through the lens. In the case of a mirror, the light does not enter the glass. Even the surface is coated with a reflective layer such as aluminum metal. The glass merely provides the accurate surface onto which the reflective coating is deposited.

b. The resolving power of telescopes in the absence of the Earth's atmosphere is higher for larger telescopes – scaling as the diameter of the telescope and inversely as the wavelength of the light. In practice, however, the Earth's atmosphere blurs images more than the diffraction blurs them. Unless clever techniques are used (not

discussed in class), we may assume the atmosphere sets the resolving power for all astronomical telescopes.

Question called for a discussion of diffraction and atmospheric blurring.

c. Access to the entire electromagnetic spectrum.
No atmosphere to degrade images.
Lower surface gravity leads to smaller distortions of mirrors and supporting structures.
Dark (cloudless) skies even close to the Sun.

B6. a. Seeds.
b. In short, Uranus was seen to depart from the orbit predicted by taking into account the gravitational pulls on it from the Sun and known planets (Jupiter especially).
The orbit implied another planet was pulling on it. Assuming Newton's law of gravitation, the location of the planet was estimated. A search revealed this planet we call Neptune.
c. Seeds.