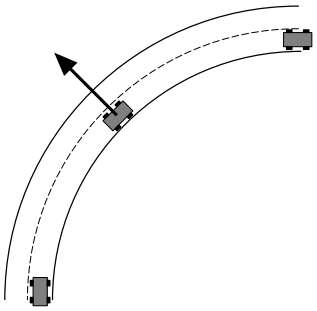
Except for questions 17–19, and 31–32 marks/answers on these sheets are not graded.

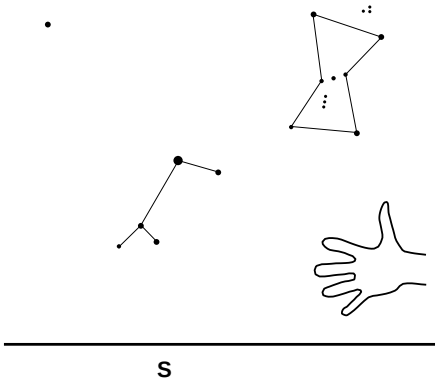
Answer *TRUE* or *FALSE* (<u>not</u> *T* or *F*) (2 pts each)

1. If SI units (the "metric system") were being properly used a <u>Mega</u> mall would be a billion times bigger than a normal mall.
2. On the Earth's equator (latitude=0°) every day the Sun will go through zenith at about noon.
3. The declination of the star Kochab (in Ursa Minor) is about 74°, so using your 'handy protractor' it should take a bit less than an outstretched hand to reach the star Polaris.
4. The right ascension of the Sun increases by about 1^h per hour of clock time.
5. Latitude is to longitude as right ascension is to declination.
6. Generally the Moon is a bit above or below the ecliptic. It is only on the ecliptic if it is at one of the two *nodes*.
7. Kepler's areal law substituted for Ptolemy's equant.
8. Newton died before 1776.
9. Since Venus and Saturn both orbit the Sun, from Earth they both display all possible phases from new to full.
10. Since the Sun is more massive than the Earth, the gravitational force of the Sun on the Earth is greater than the gravitational force of the Earth on the Sun.
11. Newton's second law states that the speed of an object is proportional to the force and inversely proportional to its mass.
12. The force of gravity on an astronaut orbiting in the Space Shuttle is much less than it is on the surface of the Earth.
13. The changing direction of the Earth's axis (the axis pointing in different directions during the year), is the primary cause of the seasons.
14. According to Newton, a constant force is needed to keep an object moving with a constant velocity.
15. A satellite orbiting the Earth in a circle at a constant speed is not accelerating.
16. According to Newton's mechanics, if you make a right hand turn at high speed (as shown right) there is an outward force on you as shown in the diagram.



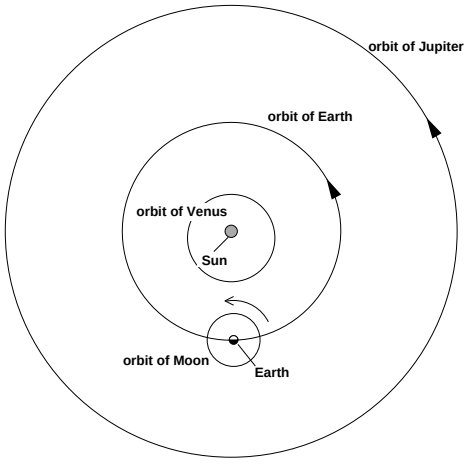
Give a short explanation (5 pts each)

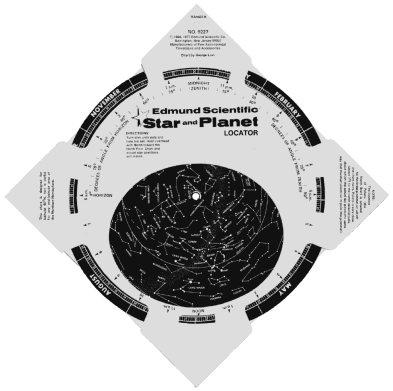
17. The below left is a strangely oriented sky map for February nights. Directly on top of this diagram find and label the location of the north celestial pole using the "pointers" of the Big Dipper. Label the cardinal directions: north, east, and zenith. I have circled the constellation Cepheus. Directly on this sheet, to the left of the sky map, draw a horizontal line representing the horizon, and place Cepheus above your horizon oriented as it would appear in the sky.



18. Consider the above right picture of a 9 P.M. tonight view looking due south at CSB/SJU at the winter triangle. Directly on top of this picture, sketch what the view would look like 1 hour later.

19. The diagram below left shows the orbits of Venus, Earth, Jupiter and the Moon (not to scale). Tonight Venus is an evening star very close to the Sun. If viewed in a telescope Venus would show a nearly 100% illuminated disk. Jupiter is about a month from starting its retrograde motion. The Moon was new yesterday. Directly on the diagram, write "**L**" at the location of the Moon in the Solar System, "**V**" at the location of Venus, and "**J**" at the location of Jupiter.





20. Consider the (re-touched) photocopy of your Star Locator shown above right. Redraw on your answer sheet the Star Locator's oval that represents the sky and clearly label where the following are found: zenith, north celestial pole, meridian, south and west point on the horizon.

21. Why do we see different stars December evenings than we do June evenings?

22. Good Friday is 6 weeks from today and according to question 19 the Moon was New yesterday. What phase of Moon should you expect to see on Easter? At sunrise on Easter, will the Moon be above the horizon? If so report its location (very approximate altitude/azimuth) in the sky.

23. Describe the cause of our seasons. (I.e., why in Minnesota is it colder in December than it is in June?)

24. Identify an important contribution of each of the following people: Copernicus, Tycho, and Ptolemy.

25. State two of Newton's laws of motion.

26. What evidence did Galileo use to support the heliocentric model? Describe two of Galileo's telescopic observations that provided evidence supporting the Copernican theory. In each case report exactly how the observation contradicted the Ptolemaic theory, i.e., report what Ptolemy would have expected to see.

27. Draw an elliptical orbit and display on your drawing the location of the Sun. Label on your ellipse the spot where the planet would be moving its fastest and where the planet would be moving slowest. Directly on top of your first orbit, draw a new orbit about your Sun with a large eccentricity. Label this orbit with the word "Large". Which or your two orbits has the longer period? Label it "Long".

28. When Pluto was discovered on 18-Feb-1930 it was at RA=7^h21^m (in Gemini). 87 years later on 18-Feb-2017 Pluto was at RA=19^h19^m (in Sagittarius). I want you to use this data to figure out how long it takes Pluto to complete a circuit around the celestial sphere. Towards this goal answer the following questions:

    (a) Through how many hours of RA did Pluto move in 87 years? Round your answer to this question to a whole number of hours of RA.

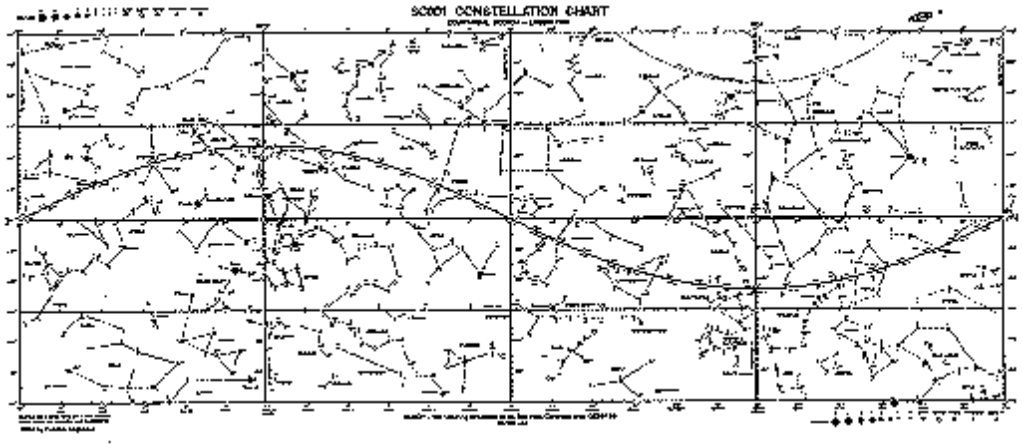
    (b) Given that Pluto has gone the above number of hours in 87 years, how many years would it take Pluto to go 24 hours of RA, i.e., all the way around the celestial sphere?

    (c) It turns out your answer is too short by about 75 years. What went wrong? (Hint: Pluto was at perihelion on 3-Sep-1989.)

Write out a complete answer (10 pts each)

29. Damascus, Syria has a latitude of about 34°N and a longitude of about 36°E. On February 21 the planet Jupiter will have a right ascension of 15^h22^m and a declination of $-17°$. Report the time of day (on February 21) when Jupiter crosses the meridian and its maximum altitude on that day at Damascus (you must report your reasoning to receive any credit).

30. The space shuttle can "orbit" the Earth, i.e., not fall down, for a long time. How does that work? What exactly is needed? Astronauts in the space shuttle float, i.e., nothing seems to hold them down. How does that work?



31. Consider the above photocopy of your SC001 star map. Directly on this diagram clearly label where the following are found: celestial equator, ecliptic, an hour circle and a diurnal circle. Using the data in question 19 label directly on the above SC001 the location of the Sun, Venus, Moon, and Jupiter today.

32. Consider the below diagrams of the dome of the sky which show the location of the Sun and possible positions for the Moon. For each possible position of the Moon you are to name the Moon (waning/waxing, crescent/gibbous, etc) and draw what the Moon would look like to the stick figure (i.e., a person on Earth). Thus for each Moon position, you should draw (directly on this sheet below this question) a horizontal line representing the horizon and a shaded circle representing the Moon. Show and label which parts of the Moon would be bright. In the left diagram the Sun is rising in the east and Moon positions A, B, and C are spread across the sky from east to west. In the right diagram it is noon; Moon position D is in the east and Moon position E is in the west.