Moon Morph

The moon is a half-illuminated sphere, as is the earth. Like the earth, its “dark” side is somewhat lit by its companion. Moonlight sometimes lights our night, and earthshine sometimes make the dark side of the moon faintly visible. The boundary between light & dark is the terminator. As the moon orbits the earth, we see varying fractions of its bright side. These different apparent shapes are phases, and they have eight names: new, waxing (increasing) crescent, first quarter (1/4 month is over), waxing gibbous (full minus a dark crescent), full, waning (diminishing) gibbous, third quarter, waning crescent.

The phases repeat in a synodic month, roughly a calendar month. It is not a lunar orbit period. As the moon orbits the earth in 27 days, the earth orbits the sun at 1 degree/day. The time from a new moon to the next is about 29 ½ days.

Vocabulary: Synodic, sidereal, prograde (orbital motion), direct (apparent western motion due to earth’s rotation) crescent, gibbous, new & full moon, waxing, waning, ecliptic (apparent path of the sun around the celestial sphere, elongation (sun-moon angle along the ecliptic)

Learn these ideas:

• The elongation governs the phases.
• The direct motion is a motion of the celestial sphere, caused by earth’s rotation. Everything astronomical rises in the east and sets in the west.
• Orbital motion is prograde (eastward) but is slow, and only modifies the direct speed. The prograde motion of the moon is the fastest, but still the time between moonrises is less than 25 hours.
• The lighted side of the moon points toward the sun. The full moon points toward us, so when facing it the sun is behind us. The quarter moons point sideways, so the moon is 90 degrees from the sun. Crescents are close to the sun on the sky, gibbous moons are far, but less than 180 degrees.
• There is a far side of the moon, never visible from earth, but there is no dark side. The moon rotates, but exactly one rotation per orbit. Most satellites do this.
• A new moon can’t be up at night. A full moon has to be on the opposite side of both the horizon and the equator from the sun.

These ideas and vocabulary are new to most of you. This activity will help you master them. Answers are informal, e.g. “just after midnight” or “several hours after midnight”; “just (or far) below the western horizon”. Concentrate on being right, not on being perfect. In each challenge, the line is the horizon. A dark circle is the new moon. This symbol represents the sun:
1. Below, draw the sun approximately where it must be. What time is it? __________

E_______________S_______________W________________N________________E

2. Below, draw the sun approximately where it must be. What time is it? __________

E_______________S_______________W________________N________________E

3. Below, draw the sun approximately where it must be. What time is it? __________

E_______________S_______________W________________N________________E

4. What time is it below? __________ Is it winter or summer? ________________
   Draw the moon with phase in the box in its place, and label it with its complete phase name.

E_______________S_______________W________________N________________E
5. Below, draw the sun approximately where it must be. What time is it? __________

E_____________S_____________W_____________N_____________E

6. What time is it below? __________

Draw the moon with phase in the box, and label it with its complete phase name.

E_____________S_____________W_____________N_____________E

7. What time is it below? __________

Draw the moon with phase in the box where it is, and label it with its complete phase name. The sun appears twice for convenience. Both images are at the same point on the sky.

E_____________S_____________W_____________N_____________E

8. Below, draw the sun approximately where it must be. What time is it? __________

E_____________S_____________W_____________N_____________E
9. One night, the moon is just east of the Pleiades, and Jupiter is just east of the moon. Where will the moon be the next night? ________________________.

10. You see a very bright planet a few degrees away from the full moon. Its brightness tells you that it is Jupiter or Venus. Then, considering its nearness to the full moon, you realize which it must be. Explain. ______________________________________________________________________

11. An hour before sunset, you notice a beautiful full moon, then realize that it must be gibbous, not completely full. Explain. ______________________________________________________________________

12. You see a crescent moon in the eastern sky, before sunrise. Is it east or west of the sun? _____

13. Your imaginary friend says that the sun (in question 12) is below the moon, so it’s neither east nor west, and your professor is nuts. Putting aside the larger issue, they are east and west of each other, as well as above and below. Using a diagram of the earth, viewed from above the N. pole, explain the above. E   W

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14. A neighbor walking her raccoon asks if, since the moon is much closer than the sun, the moon is below the sun. Obviously she is thinking as “up” as seen from your location. Answer her by suggesting a time when the same reasoning the sun is below the moon. ______________________________________________________________________

15. If the moon is at third quarter, how long is it to the next full moon? ______________________

16. Why can’t a gibbous moon eclipse the sun? __________________________________________

17. Why doesn’t a full moon always eclipse the sun? ______________________________________

18. A crescent moon shows a bright crescent and a faint but visible gibbous part, so we see the whole near side. Where does the faint light come from? __________________________________________________________

19. What is the rotation period of the moon? (the word, not the time interval) ______________

20. What is the name of the solar day on the moon? _______________________________________