ESS1.1, ESS1.2, and ETS1.2 Study Guide: Space Science Name_____

1. In your own words, explain the following concepts:
   A) Cosmic background radiation **-ancient heat and light red-shifted to the radio and microwave wavelengths. It has been travelling to us from the most distant parts of the universe, making it an image of the early universe. It is in a uniform pattern because when the universe was smaller it was more dense with very little empty space, and energy was released from all points in all directions. Cosmic background radiation matches this pattern.**

   B) Redshift **This is the doppler effect for light. If an object is moving away as it produces light, the light wavelengths will become stretched out, making them closer to the red end of the spectrum of colors. Red shift just means the wavelengths get longer because a source of light is moving away. It doesn't have to be red; it can be radio waves, infrared, microwaves, or any color longer than it was originally. The faster an object is moving away, the more red-shifted the light from an object will be. Red shift is measured with absorption spectra from stars, which shows a pattern of shadows in the colored light. This pattern of shadows is shifted toward red if the object is moving away.**

   C)Hubble's law **This states that the farther a galaxy is from us, the faster it is travelling. We know this because more distant galaxies are more red-shifted. Nearly all galaxies are red-shifted because the universe is expanding.**

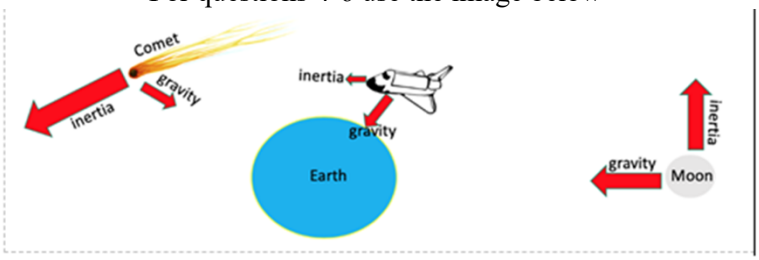
2. What was the explanation for the existence of cosmic background radiation?
   a. Since radio waves are no longer released by objects in the universe, they must have been released a long time ago by a very large explosion.
   b. This radiation is leftover energy from a giant supernova that collapsed into a massive black hole at the center of the galaxy.
   c. It is leftover light and heat from the early universe, spread out as the universe expanded, that has been traveling to us since the universe began.
   d. Cosmic Background Radiation is emitted by distant stars that are cooler than the stars which release heat and light energy.
3. How do we know that cosmic background radiation is ancient heat and light from the Big Bang? (**Select 3)**
   a. Its pattern is nearly uniform, unlike today's universe which is in clumps of matter with vast ranges of empty space. Cosmic background radiation is coming even from the empty spaces between the stars.
   b. The early universe was very hot and dense, and the heat is still hanging around as the universe cools. We can detect its presence with special technology that can measure temperatures in empty space.
   c. When we turn cosmic background radiation back into light, it looks round and blotchy. This is because the early universe was a sphere like the Earth.
   d. The light from the early universe is only just now reaching us, as it has been travelling for 13.7 billion years. This explains why it is red-shifted into radio and microwaves.
   e. If the Big Bang is how the universe began, there would have to be radiation in patterns that suggest the universe was once much denser with very little empty space between particles.
4. How can the pattern of red shift from distant galaxies give us evidence for what the universe was like in the past?
   a. Since closer galaxies are blue-shifted and more distant galaxies are red-shifted it shows that the universe began as a single point that exploded rapidly, expanding until it became stable in the present universe.
   b. Nearly all galaxies are red shifted, with the most distant galaxies being the most red shifted, showing that the universe is expanding. If it is expanding now, it must have been smaller and more dense in the past.
   c. Galaxies all appear red, showing us that they are farther away from us. This tells us that some galaxies are moving away from us and others are expanding, indicating that the universe was once very small.
   d. Red shift occurs when galaxies and stars expand, because the expansion causes cooling of matter and a change in color. This is evidence that galaxies were denser in the past.
5. In your own words, explain how cosmic background radiation and red shift give us evidence for the Big Bang. **As we look deeper into the universe, we can essentially see back in time. The oldest electromagnetic waves show a pattern of density that is very high, as these waves are travelling from all points in space. These waves are the most red-shifted, found only as radio and microwave radiation today. This is a "picture" of**

Words to know: dense, uniform, eccentricity (eccentric), orbit, inertia, expansion, scale, proportion, emit (emitted), electromagnetic radiation, radio waves, microwaves, red shift, velocity,

the early universe. If the universe was never dense, it would not have waves in this pattern. This is how cosmic background radiation gives evidence that the universe was once extremely dense. Red-shift shows that the universe is expanding, as nearly all galaxies are red-shifted, meaning they are travelling away from us.

6. In your own words, create an explanation of how telescopes allow us to see far away items. **Telescopes collect light, and allow us to see very distant objects as though they were closer. The more light collected, the more detail is in an image. Telescopes bend light using convex lenses or convex mirrors.**

For questions 4-6 use the image below



7. If a comet if flying on a path toward the Earth and its inertia is more than the amount of gravity pulling what would happen? **It would escape the Earth's orbit.**
8. According to the model, what will happen to the motion of the space shuttle and why? **The space shuttle would descend toward earth and would land, because the force of gravity is greater than the force created by inertia.**
9. Why does the moon follow its path of orbit and not move any closer or farther from the Earth? **Because the forces created by inertia and gravity are balanced, or equal.**
10. **Select all of the following** that explain the changes in the solar system during formation. **(Select 3)**
    A. After the Big Bang, gravity pulled all the particles left over from this explosion into orbits around the sun.
    B. As the mass at the center of the nebula became larger and denser, the gravity increased the heat and energy at its center until nuclear fusion reactions were created.
    C. The solar system formed from a black hole that was spinning matter and energy out into space which were caught in the gravitational force of an orbit.
    D. Gravity caused the material in a nebula to collapse in on itself and particles became larger and larger as they coalesced more and more mass.
    E. The solar system began after an older star went supernova, leaving a spinning disk of debris that would give rise to orbital motions.
11. The sun and the moon appear to be the same size in our sky. Create an explanation for how scale and proportion allow the moon to have a much greater influence over Earth's tides. **While the moon is much less massive than the sun, the moon is also much closer, causing much more gravity on one side of the planet than the other. Since the sun is already so far away, the distance from the front to back of Earth is only a small proportion of the distance from the sun. This has to do with the slope of the graph for distance vs. gravitational force decreasing steeply in a short distance away from the object. Then the gravity decreases more slowly once the distance is greater.**
12. Create an explanation for how gravity causes orbits. **If the force of gravity equals the force created by the sideways inertial movement, then an object will not collide with the planet or escape the gravitational field.**
13. Why does the sun have a stronger gravitational pull than the moon? **The sun has a greater gravitational pull than the moon because the sun has more mass.**
14. Explain the relationship between gravity and distance. **Gravity decreases rapidly at first as objects move away from each other. Then gravity decreases slowly as the distance continues to increase.**
15. Why does distance from the sun affect the velocity of a planet? **Gravity acts as a force that causes objects to accelerate toward each other. If an object is closer to the sun, the gravity will be greater, and with the force being greater, the acceleration will also increase. This causes a planet's velocity to increase as it gets closer to the sun.**

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