

Week 26: Black Holes and Supernovae

You can fill out this worksheet as we go along to get the most out of time together, or you can use it as a review exercise at the end of the class to see where your strengths are.

What we're going to cover today:

- Astronomy
 - Binary system
 - Black hole
 - Escape velocity
 - Event horizon
 - Detecting black holes
 - Gravity
 - Neutron star
 - Pulsar
 - Supernovae
-

Write down two things you really want to know about astronomy:

1. _____

2. _____

Do this NOW: Write down WHY you want to learn about the things you mentioned above. What will it give you, or provide you with, or make possible for you if you now understand these things that you wanted to learn?

IMPORTANT: During class, you can either fill out the worksheet, OR just set it aside and fill it out after class is over so you can enjoy watching the class.

Answer key is on the last page, so put it in a place where you won't be tempted to peek at the answers until after you've given it your best shot.

Material List for Experiments:

We will be doing experiments during and after class. Gather as many of the materials as you can. It's fine if you don't have everything. You will be able to choose from several different experiments, so pick experiments that you have the stuff for. If you do not have all of these materials, you can still fully participate.

(Asterisk () indicates the materials that are used again in other months)*

- balls (two
- different sizes)
- bedsheet
- strong magnets
- ball bearings (any size)
- 2 buckets with holes in the bottom
- 2 bungee cords
- 3 different sizes of marbles
- 2.5 lb weight
- 0.5 lb weight
- 3 squares of stretchy fabric
- rubber band
- 4 feet of string
- fishing bobber (if you have one)
- straws
- softball or baseball
- playdough or clay (optional)
- wine glass (not your favorite)

Science Experiments: There are so many experiments to choose from! This month we are in Unit 7, so I put together a smaller set (below) to help get you started. You don't need to do all of them, just pick the ones you have time and materials for.

Week 29: Deep Space, Black Holes & Supernovae (Unit 7 Module 2)

- Black Hole Chart
- Black Hole Bucket
- In-class experiments:*
- Bedsheet Gravity-Space Model
- Gravitational Lensing
- Supernova Ball Bounce
- Rocketship Ball Bearings

During the Lesson:

You can look over the worksheet so you know what to listen for as you go through the class with me, or you can go through it along with me during class. OR... flip it over and forget about it and just enjoy the class. When class is over, flip it back over and fill it out and be amazed at how much you've picked up and learned!

1. When a star like our sun runs out of fuel, it can no longer keep the fusion reaction going
and it collapses down into a _____
2. What holds a star together? It's a balance of
_____ pushing in on the star and heat and pressure
pushing outward from the star's core.
3. A _____ star is the collapsed core of a giant star.
4. If the star is more than 3-10X mass of our sun, a
_____ can form.
5. A black hole is an object that has an _____ greater
than the speed of light.
6. The largest black holes are inside _____ clusters and in
the centers of most _____.
7. Gravitational _____ are ripples in space-time that
move outward like a wave.

8. A black hole is a region of space-time with an immense gravitational pull from which _____ can escape.

9. They are thought to lie at the centers of most _____

10. The event _____ is a boundary that light cannot escape.

11. Gas and dust get _____ at the event horizon in a superheated glowing disk.

12. The shadow is caused by gravitational _____ and capture of light by the event horizon reveals a lot about the black hole.

13. To image a black hole, you'd need a _____ the size of the earth.

14. What I didn't know about astronomy until class today was:

Astronomy Resource Recommendations

Welcome to our month on Astronomy and Astrophysics! Astrophysics is the branch of astronomy that deals with the physics of the universe. Astronomers study celestial objects (things like stars, planets, moons, asteroids, comets, galaxies, and so forth) that exist outside Earth's atmosphere. It's the one field of study that combines the most science, engineering and technology areas in one fell swoop. Astronomy is also one of the oldest sciences on the planet.

Early astronomers tracked the movement of the stars so accurately that in most cases, we've only made minor adjustments to their data. Although Galileo wasn't the first person to look through a telescope, he was the first to point it at the stars. Originally, astronomy was used for celestial navigation and was involved with the making of calendars, but nowadays it's mostly classified in the field called astrophysics.

I've put together a list of books that supplement our labs. The first thing you'll notice is a list of scientists that really made a contribution to the field. To be honest, there are hundreds of scientists that we could list here, so instead of overwhelming you with options, I will provide you with a few well-known scientists as well as some which may be new to you.

Take this list with you to your local library and see if you can find books, either biographical or historical, and enjoy reading and learning. I also see if I can find an autobiography, because I learn so much more about the scientist when they share their thoughts and tell me their personal story.

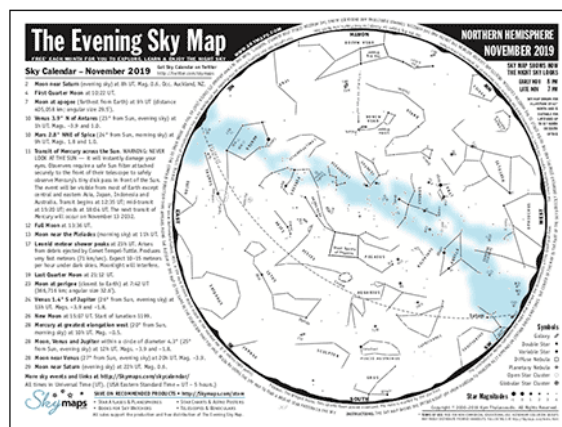
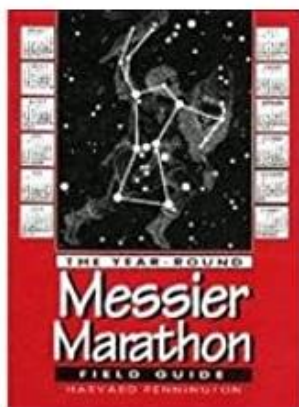
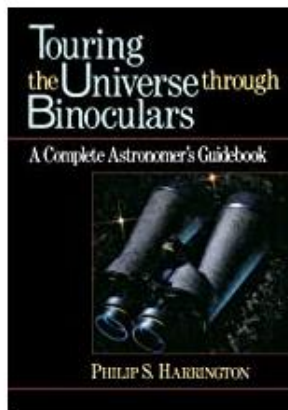
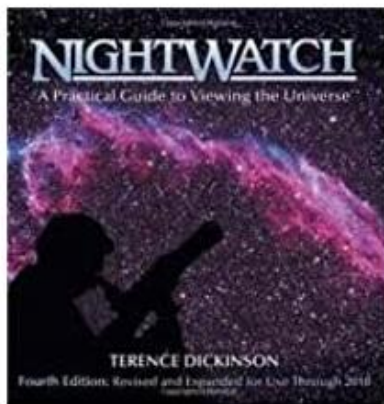
I also recommend skimming the bibliography or "suggested reading" list (usually listed near the back of a book). I've read some amazing books this way that I would never have found on my own. It's like following an unknown path through a forest on your nature walk!

List of Astronomers:

- | | | |
|-------------------------|--------------------------|--------------------------------|
| 1. Archimedes | 10. Edmond Halley | 19. Vera Rubin |
| 2. Aristarchus of Samos | 11. Edwin Hubble | 20. Nancy Grace Roman |
| 3. Eratosthenes | 12. Simon Marius | 21. Stephen Hawking |
| 4. Hypatia | 13. William Herschel | 22. Roger Penrose |
| 5. Ptolemy | 14. Caroline Herschel | 23. Andrea Chez |
| 6. Galileo Galilei | 15. Annie Jump Cannon | 24. Subrahmanyan Chandrasekhar |
| 7. Johannes Kepler | 16. Charles Messier | |
| 8. Nicolaus Copernicus | 17. Jocelyn Bell Burnell | |
| 9. Tycho Brahe | 18. Caroline Herschel | |

Book Recommendations:

1. *Nightwatch* by Dickinson
2. *Touring the Universe through Binoculars* by Harrington
3. *Turn Left at Orion* by Consolmagno and Davis
4. *The Year-Round Messier Marathon Field Guide* by Harvard Pennington
5. [Skymaps](#) for your hemisphere
6. [Planisphere](#) for your latitude range



Vocabulary Words:

Binary systems – Describes a system that consists of two stars that are gravitationally bound to each other and orbit their common center of gravity following Kepler's laws of motion. Binary can also describe asteroids that orbit each other.

Black Hole – A region of space where gravity is so strong that nothing, including light can escape.

Escape Velocity – The lowest velocity which an object must have in order to escape the gravitational attraction of a particular planet or other object.

Event Horizon – The boundary around a black hole beyond which no light or other radiation can escape.

Galaxy – A system of millions or billions of stars, together with gas and dust, held together by gravitational attraction.

Globular Cluster – A large compact spherical collection of stars.

Gravitational Microlensing – Describes the refraction of light caused by gravity when massive objects lie between a distant object and the observer, thus causing the distant object to be magnified.

Gravitational Waves – Ripples in space-time which are generated by the acceleration or deceleration of massive objects in space.

Gravity – A force of attraction that pulls together all matter. The more matter something has, the greater the force of its gravity.

Magnetic Field - Magnetic field – The magnetic influence produced by electric currents and magnetic materials.

Neutron Star – A highly dense celestial object composed mainly of closely packed neutrons. They are thought to form by the gravitational collapse of the remnant of a massive star after a supernova explosion, when the star was not massive enough to produce a black hole.

Supernovae – (plural for supernova) Stars that suddenly increase greatly in brightness due to a catastrophic explosion that ejects most of their mass.

Telescope - A device used to magnify distant objects through the use of lenses and/or mirrors to collect and focus light.

Answer key:

1. When a star like our sun runs out of fuel, it can no longer keep the fusion reaction going and it collapses down into a white dwarf star.
2. What holds a star together? It's a balance of gravity pushing in on the star and heat and pressure pushing outward from the star's core.
3. A neutron star is the collapsed core of a giant star.
4. If the star is more than 3-10X mass of our sun, a black hole can form.
5. A black hole is an object that has an escape velocity greater than the speed of light.
6. The largest black holes are inside globular clusters and in the centers of most galaxies.
7. Gravitational waves are ripples in space-time that move outward like a wave.
8. A black hole is a region of space-time with an immense gravitational pull from which nothing can escape.
9. They are thought to lie at the centers of most galaxies.
10. The event horizon is a boundary that light cannot escape.
11. Gas and dust get trapped at the event horizon in a superheated glowing disk.
12. The shadow is caused by gravitational bending and capture of light by the event horizon reveals a lot about the black hole.
13. To image a black hole, you'd need a telescope the size of the earth.