4.1. What is the Universe?

Big Question: Where did all of this "stuff" come from?

Humans have been trying to figure this one out, pretty much as long as there have been people.

Many explanations have been put forward. Once humans figured out how to use

the ___________________ , we tried to explain things using _____________.

Universe: _________________________

Pretty vague definition, right?

Huge problem for people: it can be very difficult to fully understand extremely

_________________________.

How a human will describe the universe relies greatly on how they see it.

Ex. How would a Cro-Magnon person describe "all there is" compared to Neil deGrasse Tyson?

The first tool that humankind has used to describe the Universe is the tool of

____

Early humans and pre-humans likely used their _________________ about the sky (in both day and night time) to help them survive.

Archaeologists have found discoveries showing a detailed description of the night sky at that time.

4.2. The night sky appears in mostly predictable ways.

_______________: a ____________ is a pattern of stars in the night sky which appear to form shapes or images

Keep in mind that you need to use your imagination.

Question: Does the night sky look the same from everywhere on earth?

Answer: ____________

In Canada, we can see at least _____ of the _____ accepted constellations.

Question: Why not all of them?

Things to note: Some constellations we can see at all times during the night,

others only at certain times of the __________ or _________.

Some important constellations you should be aware of: __________ , _________

Interested in learning more? Check out the Night Sky app.

What's that? You don't care about some sort of weird cosmic connect-the-dots?

Constellations have played a huge role in human history. Most early _________

____________ (before maps, GPS, and other technology) used the stars in the sky to help navigate their ship

Ex: ____________, the _________________________, etc.

When you look up at the night sky, you are looking at half of a sphere

(or_________________).

The imaginary sphere onto which all celestial objects are projected is called the

_________________________.

Fun Facts:

The night sky is slowly and consistently____________. (season, year, etc.)

Stars “twinkle” because of ____________________ when it hits our atmosphere

Some of the stars you can see in the sky ____________ millions of years ago.

The____________: the path the Sun and some other sky objects appear to take across the celestial sphere.

From earth, it looks like the sun is moving. We describe that circular pattern as the ____________. This is where we have gotten the ____________ concept from (well, European based Zodiac)

Have you ever looked out your car window as you pass a slower driver? It looks like the slow car is moving backwards, even though you are both going forwards.

The planets in the night sky do this too. It’s called _______________________.

Humans have used the night sky to navigate for a long time. To do that

effectively, you need to be able to _____________ and _____________ where the stars are.

A circle is _____°. If we call North ___°, then East is ___°, South is ____°, and West

is ____°. This distance measured from north along the horizon to a point directly

below the celestial object is called the _____________

Now that you know the_____________, you will also need _____________.

We measure altitude in _____________ as well (unlike aviators). The altitude is

the angle at which you are looking up (in math, that's the ____________________)

Humans have been able to make some astounding realizations about the workings of the universe simply by observing.

4.3. How Technology has expanded our knowledge of space

But humans are limited because of their_____________. Our eyes can only detect a narrow section of the electromagnetic spectrum. But don't worry. There are machines to help with that.

Problem #1: The ___________________

Our _____________ is great for things like living and breathing. But it also acts as

a _____________ for many of the forms of energy

To counter this, humans have done a few cool things:

Put telescopes ____

Use telescopes that operate with _________________ and not visible light

Put telescopes ___________________________

Telescopes that use a different ___________________________ than visible light are able to see things that a normal telescope would not be able to see.

Of course, computers then assign visible light to the image so humans can see it (Hubble telescope images are often like this)

A ___________________________ is the name we give to a sun (in our case, THE sun) and the orbiting planets

A _____________ is a collection of many ___________________. It is a collection of stars, gas, and dust held together by _____________

Earth is in the ___________________________ galaxy

_____________, like almost everything else, come in different types

We will have a quick look at _____________ galaxies, _____________ galaxies,

and _____________galaxies.

____________ Galaxies:

-Vary in shape from spherical to flattened oval

-Older Galaxies with very few _________________________

- ____________ of galaxies are Elliptical

____________ Galaxies:

Look like pinwheels or flattened disks with a _________________________

The center is a mix of ___________________, with old stars.

The edges are gas and dust with _________________________stars.

We live in one of these.

____________ Galaxies

No definite shape. No spiral shape, central core.

Make up about ____% of known galaxies.

When we first figured out there were things called galaxies, we first thought: Is

our sun in the center of our galaxy? Turns out, _________________________

A collection of stars held together by its own gravity is called a ____________

____________ clusters of stars still have groups of stars close together, but has only 50-1000 stars

____________ clusters of stars have a spherical shape with 100,000 – 1 million stars

We can tell a lot about the galaxy by observing star clusters.

We noticed that most of them in the Milky Way tend to be in the same general

direction. This supports the idea that our solar system ____________ at the center of the galaxy (yet again, we learn that we are not the most important thing in the universe)

How big is the Milky Way galaxy?

By measure with radio waves, we have determined that the diameter is about

_________________________ light years across.

So now we know that our galaxy has a halo of globular clusters in the middle, and that it is disc shaped

As a result, we concluded that it is a ____________ galaxy.

Space is big. I mean, really big. Like, bigger than that.

One way to help understand the vastness of space is to use really big spaces as our measuring device.

The first one of these measuring tricks is something called _______________Units.

The distance from the earth to the sun is _____ AU.   (fyi that's 150,000,000 km)

AU work for things inside our solar system. But space is way bigger than just that.

Another measuring trick astronomers use is something called a_______________.

Despite sounding like a measurement of time, a ________________ is the distance light can travel in one year.

Take a moment to think about that:

The stars in the sky are visible because we see their light from earth. The light from that star is likely years and years old (or more, depending on how far away the star is). So the stars you see in the sky tonight are actually different than what you see now, sometimes thousands of years old.

PS: light from the sun takes ___________________ to reach earth.

When dealing with such large distances, accurately measuring things can be a challenge. Thankfully, we can use math skills to measure these celestial distances pretty accurately.

Triangles are super useful in math. We use triangles to measure these great distances.

Have you ever looked at something with one eye closed, then switch which eye is open and which eye is closed?

You are experiencing something called ____________, and it is the key to using triangles to measure great distances

Stars come in many colours and sizes. Remember that some are also

________________________ than others.

So the brightest star in the sky might actually ________________________ to earth than dimmer looking stars.

…also the brightest star in the sky is ____________

Because closer stars look brighter, we often refer to what is called

____________ magnitude: how bright a star would be at 32.6 light-years from earth.

FYI: our sun, THE sun, has an absolute magnitude of ____________

So what are stars made of?

____________ and ____________ mostly. But mostly is not the whole picture.

Almost every single element in the universe got its start inside______________.

Everything on Earth is actually made from ____________. That is not just a song, it is the truth.

We can tell what is in a star simply by looking at__________________. This device filters the light into distinct lines. Each element has its own distinct set of lines. So we can tell what a star is made of despite it being thousands of light-years away.

Mass of Stars

This can be tricky to determine, unless the star is part of a _________________ (two stars orbiting each other).

We can use our understanding of orbit trajectory and gravitational force to calculate the star's mass.

Most of the stars seen from ____________ are binary stars.

Because we use our sun as what is “normal”, we use the mass of our sun as the basic unit of solar mass.

Our sun is 10×10^{30} kg We call this a solar mass of ____

Other stars range from ______ solar masses to over ______ solar masses

The universe is constantly changing, despite what people thought in the olden days.

Stars change over time as well. Let’s take a quick look at the life cycle of stars, as well as the different categories of stars.

Stars form when _____________ in space condense into gas balls due to gravity. If

there is enough ____________ , the force of gravity is enough to start a reaction which releases a ton of energy. When this occurs a new star is born.

Astronomers don’t usually have the luxury of directly observing the objects they study. Instead, they need to look for patterns in the data their probes and telescopes provide.

It was just this kind of pattern recognition which led to the discovery of the life cycle of stars.

Ejnar Hertzsprung (NED) and Henry Norris Russell (USA) were both independently looking over star data. They both realized there was a certain pattern to most

stars when looking at their ____________ ____________ (ie: brightness),

____________, and ______________________________. A visual representation of this pattern is now called a Hertzsprung-Russell (H-R) diagram.

About _____% of the stars you can see from Earth are what we call main sequence stars (That’s the big band of stars diagonally across the H-R diagram).

This shows us that: the hottest stars are ____________, medium stars___________ , and cooler stars ___________.

It also shows that ___________ stars are very large and ___________ stars are small (well, small for a star anyway)

As it turns out, the ___________ of the star is a key component to determine what type of life cycle the star will undergo. Let's look at Low Mass, Intermediate Mass, and High Mass stars.

Low Mass Stars.

These stars are smaller than ______________________. Over their lives, they use

up their ___________ supply (losing significant mass) and eventually "evaporate" away.

We think that after enough time they will form a "black dwarf", which is nothing more than a burnt out ember. However, the universe is not old enough to contain any black dwarfs yet.

Intermediate Mass Stars

Medium sized (like our Sun). After about _______________ years, Hydrogen

stores will be used up. This causes the core to ________________ and temperature increases. This leads to a big expansion in size of the outer layers.

It is now called a ______________________ When this happens to our sun, it will

take up to the orbit of ___________ in size!

The red giant will disperse over time, leaving a nebula behind, then eventually a

______________________.

High Mass Stars

These are ____ or more solar masses large.

This extra mass has large effects too. The star burns though its hydrogen supply

________________________ than intermediate stars. As it runs out of

_______________, it starts to fuse helium and other atoms.

Eventually, ____________ forms in the core. ____________ cannot release energy through fusion.

This causes a massive explosion, called a ________________________.

_______________'s are responsible for the synthesis and distribution of all heavier elements in the universe!

Depending on the initial mass, a high mass star will form either a

________________________ or________________________.

So what is a ________________________ anyway?

Remember if you add an ____________ to a ____________, you get a neutron?

Well, this happens in a ____________ star thanks to the extreme gravity. The light gasses escape as nebula, and the rest get squished into neutrons.

If the original star had a really large mass, the left-overs have enough mass to

create a ________________________.

They are called "black" because their gravitational field is so strong, not even ____________ can escape.

A _______________ technically has "no volume", but it does have______________.

As you can imagine, that made finding one difficult. But we figured it out.

But what about the 10% of stars that don't fit in that sequence?

As is often the case in science, Scientists are currently trying to figure out a way to explain how those stars are formed.

4.4. Explaining the Big Bang Theory.

The two best pieces of evidence for the big bang:

1. If the big bang is true, then most of the universe should be _____________ from us. We use the idea of _________________ to prove this to be likely
2. If the big bang is true, there will be a lot of _______________________ from this event. We use ___________to prove this to be likely.

_______________________.

This is how police can tell if you are speeding.

When something is travelling toward you, the waves (like radio waves or light) tend to get _______________________.

When it is travelling away from you, it's the opposite, they tend to get

____

If you lengthen the _________________ of visible light, it moves closer to the

___________ end of the scale. = _______________________

If you lengthen the _________________ of visible light, it moves closer to the

___________ end of the scale. = ______________________

R. O. Y. G. B. I. V

Edwin Hubble and Milton Humason discovered that a galaxy's ______________ and the distance of that galaxy from earth are related.

Long story short, the data supports the idea that the universe is currently

______________________. They even used graphing to calculate how much that rate of change is (Rate of change = slope = graphs are useful)

A "big bang" like the theory suggests would release a ______________________.

Our telescopes look far across the universe and detect radiation from a very long time ago.

We actually realized that there is still background radiation throughout space.

This is called ___________ ___________ ___________ ___________ (CMBR).

Stuff We Know is Stuff, But That's About It.

There are still many unknowns about space. Here are a couple you may have heard about before…

Scientists were studying the Andromeda Galaxy because it has a similar size and structure to the Milky Way.

Here's the thing: when they started measuring stuff, they noticed that the

___________ in which the stars were traveling was way more than what the predicted value should have been.

The most logical explanation was that there must me more ___________ there than we were detecting (since in space, gravity makes things move and the more mass the stronger the gravity).

They have no idea what it was. So they called it "______________________" just because it was something, but they couldn't see it. And the name seems to have stuck.

They think that ____% of our Galaxy's matter may be dark matter as well.

Another weird thing is the fact that the universe is not only expanding, but the

expansion is ______________________

With nothing else factored in, this makes no sense. So scientists figured there must be some "unseen energy" responsible for the speeding up. And since we can't see it yet….

……___________ is born!

The whole point of mentioning dark matter and dark energy?
There is an awful lot we don't know!

Breakdown of stuff in the Universe:

Dark Energy: ___%

Dark Matter: ___%

Visible Matter: ___%