ASTR 1010 Exam 2 Review Session

March 9, 2020

1 The Scientific Method

1. Make observations
2. _____
3. Suggest a hypothesis
4. _____
5. Perform a test: experiment or additional observation

If the test supports the hypothesis, _____.

If the test does not support the hypothesis, _____.

Astronomy -

Astrology -

Pseudoscience -

Explain in your own words why astrology is a pseudoscience whereas astronomy is a science:

_____

_____

_____

2 Newton's Laws of Motion

Velocity consists of both _____ and _____.

Acceleration -

Newton's Laws of Motion:

1. Law of Inertia: An object moves at a constant velocity if there is no net force acting upon it.
2. $F = ma$ or

$$a = \_\_\_\_\_$$

3. For any force, there is always an equal and opposite reaction force.

Which of Newton's laws explains why the Earth doesn't "come up to meet you" when you jump?

Which of Newton's laws explains the recoil motion of a gun?

Which of Newton's laws explains why a parachutist falls at a constant speed?

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3 Newton's Universal Law of Gravity

Newton's Universal Law of Gravity says:

$$F_g = G\frac{M_1 M_2}{d^2}$$

where $G = 6.67 \times 10^{-11}\text{m}^3/(\text{kg s}^2)$ (you don't need to memorize this number).

Newton's Universal Law of Gravity (and also Newton's Third Law) implies that the gravitational force you exert on the person sitting next to you is _____ to the gravitational force they exert on you.

The acceleration due to gravity can be calculated by applying Newton's Universal Law of Gravity and Newton's _____.

$$g = \frac{GM}{R^2}$$

where M is the mass of the object of interest and R is the radius of the object of interest (for us, the object of interest is usually the Earth).

3.1 Example Problems: Ratios with Newton's Universal Law of Gravity

1. How much stronger/weaker would the force of gravity between the Earth and the Moon be if we doubled the distance between them?

2. How much stronger/weaker would the force of gravity between the Sun and the Earth be if we doubled the mass of the Sun and halved the distance between them?

3. (Challenge) What would the acceleration of gravity g at the surface of Earth be if the radius of Earth was halved and its mass was also halved?

4 Orbits and Newton's Version of Kepler's Third Law

Orbit -

Objects in orbit very close to the surface of Earth are accelerating at _____.

Newton's Version of Kepler's Third Law is:

$$P^2 = \frac{4\pi^2}{GM}a^3$$

where we have simplified $M_1 + M_2$ as just M. Why can we do this?

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Explain in your own words why astronauts feel weightless in space although they feel the force of gravity almost as much as we do:

The circular orbit speed is given by:

$$v_{\text{circular}} = \sqrt{\frac{GM_{\text{orbitee}}}{r}}$$

Note that the equation only depends on the mass of the orbitee. This means that if I were to be able to fling an apple into the same circular orbit as the International Space Station, they will be orbiting at _____ speed(s).

The escape velocity is given by:

$$v_{\text{escape}} = \sqrt{\frac{2GM_{\text{orbitee}}}{r}}$$

Explain in your own words how we are able to measure the mass of a supermassive black hole:

4.1 Example Problems: Ratios with Newton's Version of Kepler's Third Law

1. What would the period of Earth's orbit be if the mass of the Sun was quadrupled (but the Sun-Earth distance stays the same)?
2. What would the period of Earth's orbit be if the mass of the Earth was halved (but the Sun-Earth distance stays the same)?
3. What would the period of our Moon's orbit around Earth be if the mass of Earth was doubled but the Earth-Moon distance was also doubled?

5 Planetology

General Patterns:

- Most objects in the solar system orbit and rotate in the _____ direction.
- Rocky/terrestrial planets are _____ and gaseous giants are _____ from the Sun.
- There are numerous small objects orbiting the Sun in distinct regions. There are three main regions and they are: _____, _____, and _____.

What is the Sun mostly made of? _____

What are some noteworthy features of each planet?

Mercury -

Venus -

Earth -

Mars -

Jupiter -

Saturn -

Uranus -

Neptune -

Remember: My Very Energetic Mother Just Sent Us Nachos

6 Formation of the Solar System

Nebula -

Where did the elements of the solar nebula come from? From _____ and _____.

Describe the evolution of the "Astronomer's Periodic Table":

Hydrogen _____ by _____.

Helium _____ by _____.

Other elements _____ by _____.

What happens during nebular collapse?

- Rotation rate _____.
- Temperature _____.
- A spherical blob becomes a _____.

Which physical law explains the increase of rotation rate?

_____

The nebula heats up as a result of energy conversion!

_____ becomes _____.

The flattening of the disk is caused by _____.

In astronomy, we generally classify matter into four categories:

- _____
- _____
- _____
- _____

Condensation -

Frost Line -

Accretion -

Gas Capture -

Solar Wind Clearing -

Heavy Bombardment -

Why are the rocky/terrestrial planets close and the gaseous giants far from the Sun?

Why is the asteroid belt where it is?

What caused the Oort cloud to be more of a spherical shape than a disk?

Where did Earth's water and atmosphere come from?

Explain in your own words how the Giant Impact Hypothesis explains how the moon formed:

Other notable properties of our Solar System explained by the period of Heavy Bombardment:

- Uranus's axis of rotation
- Venus's backwards spin
- Pluto and Charon
- Mercury's large core

How do we know the age of our Solar System very accurately?

6.1 Example Problems: What-If Questions about Solar System Formation

1. How would planets in our solar system be different if the nebula had been cleared away before the capture of any nebular gas?
2. How would the solar system look if the ices condensed at 50K instead of 150K?
3. How would planets in our solar system be different if the whole solar nebula had cooled below the condensation temperature of hydrogen compounds before solar wind clearing?