

# Development of an Open Education Homework System for Transforming Large Introductory Astronomy Courses

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## Introduction

In many large introductory university courses, including astronomy, online homework systems have mostly replaced traditional hand-written assignments; however, the most common online systems are provided by textbook publishers, which can be expensive and inflexible. One reason that faculty are reluctant to adopt open education resource (OER) textbooks is the dearth of complementary OER online resources, including homework and assignment systems.

Courses using OERs that have no additional costs reduce the systematic inequities and barriers currently present in higher education. They also allow more flexible yet targeted learning materials and potentially improved learning outcomes.

An OER astronomy homework system was developed and deployed allowing the adoption of a complimentary OER textbook.

## Homework System

To improve effectiveness and eliminate cost of online homework systems for three large astronomy courses at Ontario Tech University, a homework system with a new pool of assignments was created in the open-source LON-CAPA system. The purpose of the modules is to allow students to take information presented during lectures and incorporate it into their developing knowledge and skillset in astronomy.

To implement this mastery setting we used LON-CAPA, a web-based learning content management system created by Michigan State University ([www.lon-capa.org](http://www.lon-capa.org)). LON-CAPA is a very flexible, open source system that allows us to create a variety of different questions and add hints, feedback, and solutions. The questions must be created and programmed initially but are then simple to reuse. LON-CAPA is hosted on our own server and has zero cost to the student.

## Question Types

Select the correct name of each phase of the moon

**Identify**

Submit Answer Tries 0/8

### Rank

Listed following are several astronomical objects. Rank these objects based on their diameter, from largest (1) to smallest (6).

**Rank**

Choose the correct answer from the drop down menu.

- Our Moon was most likely formed by a collision between Earth and a Mars-sized .
- Our solar system was created by the gravitational collapse of the .
- The first few hundred million years of the solar system's history were the time of , during which Earth suffered many large impacts.
- Mars was formed by the  of smaller objects.
- The era of planet formation ended when the remaining hydrogen and helium gas was swept into interstellar space by the .
- Ice can form from a gas through the process of .
- Hydrogen compounds in the solar system can condense into ices only beyond the .
- allows us to determine the age of a solid rock.

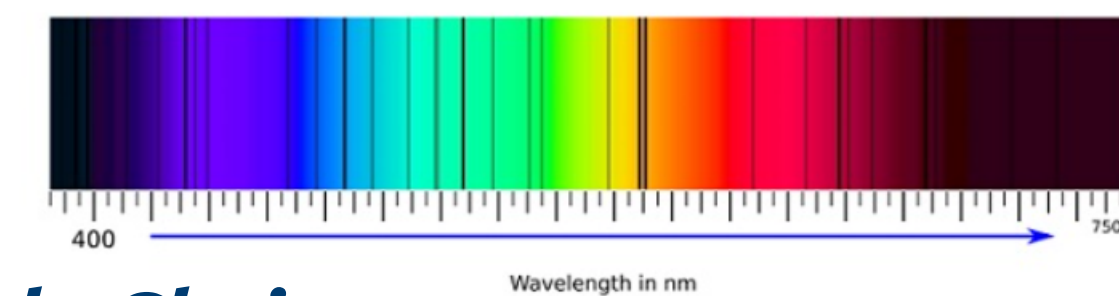
**Fill in the Blank**

Consider the image below. Click on all the Jovian planets in the picture.

**Click on Image**

**Click on Image**

The image below shows the Sun's visible-light spectrum. Observe the image below and answer the following questions.



### Multiple Choice

a) Which of the following best describes why the Sun's spectrum contains black lines over an underlying rainbow?

- The Sun produces a continuous rainbow of color, while the black lines are caused by imperfections in the instruments used to record the spectrum.
- The rainbow colors represent emission by particular chemical elements, while the black lines represent gaps where no element can emit light.
- The Sun produces a continuous rainbow of color, while the black lines are caused by atoms and molecules in Earth's atmosphere.
- The Sun's hot interior produces a continuous rainbow of color, but cooler gas at the surface absorbs light at particular wavelengths.

Which of the following must occur for a star's core to reach equilibrium after an initial change in fusion rate? Select all that are **True**.

- If the fusion rate initially decreases, then the core contracts.
- If the fusion rate initially increases, then the core expands.
- If the fusion rate initially increases, then the core contracts.
- If the fusion rate initially decreases, then the core expands.

### Select All

Sort each of the planetary properties below based on whether they apply to some, all, or none of the four jovian planets in our solar system.

**Match/Sort**

## Results

This Astronomy homework system has now been deployed in 3 different courses by the authors as well as sessional lecturers. It has been used in over 10 classes by well over 1000 students. The success of the system has enabled the replacement of the previously used publisher's textbook with the OER Astronomy: OpenStax by Fraknoi, Morrison, and Wolff. Rather than having the students download the entire text, professors extract and edit highly relevant material from the original work as files that complement each lecture.

The most easily defined benefit of these initiatives is the increased access to high-quality learning resources. The cost of a publisher's astronomy text and corresponding online homework system for all students who have used the OERs equates to hundreds of thousands of Canadian dollars. This initiative also helps decrease the practice of copyright infringement which is unfortunately common when students are faced with high costs of learning materials.

## Summary

- Each student is fully prepared with updated and high-quality learning resources from day 1.
- Each student is given more relevant homework to build on lecture material.
- Each student is given more relevant readings that give students an avenue to reflect on gaps in their knowledge
- This new Astronomy homework system is beneficial and easily adoptable and adaptable to any large introductory university astronomy course.

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