



The authoritative online STEM education resource

Platform User Guide



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Homepage

The screenshot shows the AccessScience homepage with the following features highlighted by numbered callouts:

- 1** Enter search terms or use advanced search: Points to the search bar and the 'Search' button.
- 2** Browse articles by subject: Points to the subject categories list.
- 3** View popular and timely content: Points to the 'Editors' Picks' and 'Popular This Week' sections.
- 4** Browse by content type: Points to the navigation menu items: Home, Articles, Briefings, Biographies, Media, Projects, For Faculty, and For Admins.
- 5** Your Personal Account: Points to the 'Your Personal Account' button.

The AccessScience homepage highlights the breadth and variety of content available on the site. The main content of the site is composed of articles originating from the McGraw-Hill Encyclopedia of Science and Engineering. These in-depth and expert-written articles cover everything from astronomy to zoology.

As shown in the image above, the homepage allows users to:

1. Start a search by entering terms into the general search bar or use the advanced search feature for more options.
2. Select a subject from the list to browse available articles.
3. View articles that are trending this week, or select an editor's pick to view content that is new or newsworthy.
4. Browse through additional content types including briefings, biographies, media, and projects.
5. Create a personal account to unlock additional functionality such as saving resources or getting new content alerts.

Search & Browse

Explore content on AccessScience using the search bar to enter terms, or browse through lists of content by topic. The typeahead feature suggests content relevant to your search terms as you type.

From the search results:

1. See a definition of your search term
2. Apply filters to refine your results by content type or topic
3. Quickly identify the content types of displayed results
4. Save this search to your personal account
5. Save specific results to your personal account

To browse for content:

6. From any of the content tabs, select “by Topic” to browse that content
7. Select a topic to browse from the dropdown menu
8. Select a subtopic from the menu on the left
9. View available articles for the selected subtopic

Articles

AccessScience > Articles

Article

Astronomy & Space Science > Astronomy - general > Black hole
 Astronomy & Space Science > Astrophysics > Black hole
 Physics > Relativity > Black hole

Black hole

Article by:
 Pasachoff, Jay M. Hopkins Observatory, Williams College, Williamstown, Massachusetts.
 Last reviewed: March 2019
 DOI: <https://doi.org/10.1036/1097-8542.085900>
 Show previous versions

1 Article metadata

2 Save, cite and share

3 Most salient points of article

4 Explore related content

5 Related search terms for each paragraph

6 View and download images

7 Self-assessment of learning

8 Access to primary literature and further reading

Content

- Black hole classes
- Stellar black holes
- Supermassive black holes
- Observation
- Black holes and gravitational waves
- Fate of black holes
- Links to Primary Literature
- Additional Readings

Key Concepts

- A black hole is a region of spacetime exerting a gravitational field so strong that neither matter nor radiation can escape.
- Within a boundary known as the event horizon, the escape velocity needed to overcome the gravitational attraction of a black hole would exceed the speed of light, meaning that nothing that crosses over the event horizon can ever leave.
- At the center of a black hole, a finite mass collapses to an infinitely dense state of

A region of spacetime exerting a gravitational field so strong that neither matter nor radiation can escape. Black holes are extreme cosmic objects predicted by German-born U.S. physicist Albert Einstein's theory of general relativity. Within a boundary known as the event horizon, the escape velocity needed to overcome the gravitational attraction of the black hole would exceed the speed of light, meaning that nothing that crosses over the event horizon can ever leave. Black holes are therefore by definition invisible, but because of their powerful gravitational fields, they can be indirectly observed through the highly conspicuous effects they have on their cosmic environment. These effects include the gravitational intake of matter through accretion disks, a process which generates tremendous heat and light and is well-observed at scales from binary star systems to the cores of galaxies. In the absence of ongoing accretion, black holes should also theoretically cause severe localized warping of spacetime, gravitationally lensing light from luminous sources and distorting their appearance (Fig. 1). The merging of two black holes each of about 30 times the Sun's mass, detected in 2015 with the Laser Interferometer Gravitational-wave Detector (LIGO), opened a new and fruitful way of studying black holes, and revealed a mass range of stellar black holes greater than had been thought to be possible. See also: [Astronomy](#); [Escape velocity](#); [Gravitation](#); [Gravitational lens](#); [Gravitational radiation](#); [LIGO \(Laser Interferometer Gravitational-wave Observatory\)](#); [Relativity](#)

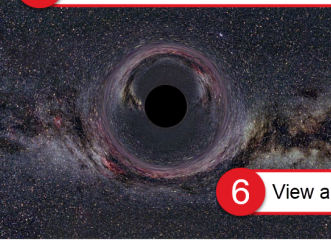


Fig. 1 An artist's impression of the gravitational lensing caused by a black hole's warping of localized spacetime. (Credit: Ute Kraus, Physics education group Kraus, Universität Hildesheim)

Full-size image

Test Your Understanding

- How does the horizon of a black hole act as a one-way membrane?
- How were black holes first detected?
- Critical Thinking: Why might Hawking radiation never be detectable?

Links to Primary Literature

B. P. Abbott et al., Observation of gravitational waves from a binary black hole merger, *Phys. Rev. Lett.*, 116(6):061102, 2016 DOI: <https://doi.org/10.1103/PhysRevLett.116.061102>

E. Kara et al., The corona contracts in a black-hole transient, *Nature*, 565(7738):198, 2019 DOI: <https://doi.org/10.1038/s41586-018-0803-x>

F. Pacucci et al., Conditions for optimal growth of black hole seeds, *Astrophys. J.*, 850(2):L42, 2017 DOI: <https://doi.org/10.3847/2041-8213/aa9aea>

K. Parfrey, A. Philippov, and B. Cerutti, First-principles plasma simulations of black-hole jet launching, *Phys. Rev. Lett.*, 122(3):035101, 2019 DOI: <https://doi.org/10.1103/PhysRevLett.122.035101>

Additional Readings

C. Bambi (ed.), *Astrophysics of Black Holes: From Fundamental Aspects to Latest Developments*, Springer, 2016

M. Bartuskiak, *Einstein's Unfinished Symphony: The Story of a Gamble, Two Black Holes, and a New Age of Astronomy*, Yale University Press, 2017

J. M. Pasachoff and A. Filippenko, *The Cosmos: Astronomy in the New Millennium*, 5th ed. Cambridge University Press, 2019

AccessScience articles are written by world-renowned scientists and experts in their field. Thousands of expert scientists and engineers have contributed, including over 40 Nobel Prize Laureates. Articles are skillfully edited to be engaging and informative and contain pedagogical features to increase student understanding.

Features of most articles include:

1. Article metadata, including authors and their affiliations and the date the article was last reviewed, and previous versions
2. Tools to save the article to your personal account, generate a citation, or share via email, link, or social media
3. Key Concepts highlighting major points students will be able to identify from the article
4. Internal links to related content such as articles, media, and biographies to explore a topic further
5. Cross-references to related articles also appear at the end of each paragraph in the article
6. Images and figures appear throughout the articles and can be downloaded individually or for the whole article
7. Self-assessment questions test student understanding and encourage higher-level critical thinking
8. External links to related primary literature and references to additional readings and websites direct students to deeper research

Briefings

AccessScience briefings are shorter, topical articles written by AccessScience editors on the latest discoveries, phenomena, and scientific breakthroughs.

A new briefing is always featured on the homepage under Editor's Picks, or users can browse through all briefings by topic. With their engaging titles and highly relevant topics, briefings are a great tool for helping students pick a topic for a research assignment.

Briefings contain many of the same features as articles, such as:

1. Date the briefing was published on AccessScience
2. Content tools to save the briefing to your personal account, generate a citation, or share via email, link, or social media
3. Links to related articles, media, and biographies to explore a topic further
4. Links to related articles to dive deeper and learn more about the concepts and topics discussed in the briefing
5. Links to additional external sources, including the original paper or report where this discovery was published, as well as additional resources to give more background on the underlying concepts

The screenshot shows a briefing page titled "Possible new species of killer whale" under the "Biology & Biomedicine" and "Zoology" categories. The page includes a "Content tools" menu with options like Save, Cite, Email, Print, Share, and Link. A "Date of briefing" callout points to the text "Last reviewed: April 2019". A "Related articles and media" callout points to a sidebar with sections for "Related Articles", "Related Media", and "Related Biographies". A "Links to articles related to each paragraph" callout points to a "Links to Primary Literature" section. A "Links to additional sources" callout points to an "Additional Readings" section. The main text discusses the discovery of a new species of killer whale (Type D orca) near Cape Horn, Chile, and mentions genetic analysis of DNA samples.

Biographies, Media & Projects

AccessScience contains additional multimedia content including biographies, animations, videos, and projects to bring STEM learning to life. All content types have tools to save, cite, and share direct links to these resources, and all videos include closed-captioning.

1. View our collection of text and video biographies of prominent scientists. Video biographies are all under six minutes and describe the featured scientist's background and developing interest in science as well as their significant contributions.
2. Choose from over 300 videos and animations to illustrate and explain various scientific concepts. Videos include a curated collection from the American Chemical Society on the chemistry of everyday life.
3. Browse available projects to find step-by-step illustrated guides to hands-on maker activities. Supply lists and introductory background details are available for each project.

AccessScience > Biographies

Video Biography

1 **Biographies**

Chemistry > Dresselhaus, Mildred S.
Engineering & Materials > Dresselhaus, Mildred S.
Physics > Dresselhaus, Mildred S.

Dresselhaus, Mildred S.

Benjamin Franklin Medal in Materials Science and Engineering

0:00 / 4:22

Massachusetts Institute of Technology
Cambridge, Massachusetts
Year: 2017
Award: Benjamin Franklin Medal in Materials Science and Engineering

Citation: The 2017 Benjamin Franklin Medal in Materials Science and Engineering was presented to Mildred S. Dresselhaus for her fundamental contributions to the development of nanomaterials, such as the spheres known as buckyballs and the single-atom-thick sheets of carbon known as graphene, and her work on the direct conversion of heat to electricity.

Related Articles

- Carbon A chemical element, C, with an atomic number of 6.
- Carbon nanotubes Molecular-scale tubes of graphitic carbon with...
- Fullerene A hollow, pure carbon molecule in which the atoms...
- Graphene The basic building block of graphite, a...

Related Media

- How to Make Electronic Skin with Stanford University's Zhenan Bao

AccessScience > Projects

Project

3 **Projects**

Engineering & Materials > Light and Temperature Logger

Light and Temperature Logger

Skill level: ★★★

By: Simon Monk, electronics hobbyist and author
Publication year: 2016
DOI: <https://doi.org/10.1039/1097-8542.PR000015>
Adapted from S. Monk, *The TAB Book of Arduino Projects: 36 Things to Make with Shields and Proto Shields*, McGraw-Hill Education, 2014

The completed data logger. [Full-size image](#)

Environmental research often involves the use of data loggers to record data at regular intervals over a period of time. Most data loggers are based on digital processors, and can be fairly expensive, but you can build your own. This project uses a microcontroller board (an Arduino Uno) and some extra components soldered onto a prototyping shield (protoshield) to allow you to log temperature and light readings for environmental monitoring purposes, and send them to your computer. When you have finished logging, you can import the data into a spreadsheet to display or analyze them.

Things You Will Need

| Part | Description | Source |
|---------|--|--|
| Arduino | Arduino Uno R3 | Arduino online store |
| | Protoshield R3 (A000077) PCB and header pins | Newark 7871602 or Digikey 1050-1035-ND |
| | 1 kΩ photoreistor [†] | Adafruit 161 or Sparkfun SEN-00988 |
| | TMP36 temperature sensor | Adafruit 165 or Sparkfun SEN-10988 |
| | 1 kΩ resistor | Mouser 293-1K-RC |
| | 270 Ω resistor | Mouser 273-270-RC |
| | Red LED [†] | Adafruit 845 or Sparkfun COM-10632 |
| | Tactile push switch | Adafruit 367 or Sparkfun COM-09190 |
| | USB battery backup pack [‡] | Computer or electronics store |
| | Table-tennis ball (optional) [§] | Sporting goods store |
| | Waterproof food container | Home goods store |

considerably in resistance range. The one used in this project has a "light" resistance of 1 kΩ. If you of higher resistance, then select a resistor of the same value for R1.

of the LED is your choice. It does not have to be red.

ack is of the sort used to provide backup power to a cell phone. The idea is that you connect the SB socket of your computer or to a USB charger, it charges its own internal battery, and you can then to it and charge or run your phone (or an Arduino). Be warned, though, that some of these devices will power consumption of the Arduino, and may turn themselves off after a while.

you can add half a table-tennis ball or some other hemispherical, translucent diffuser over the top of the by no means essential, and you can just place the whole unit in a translucent plastic food-storage have the added advantage of protecting the unit against the elements.

review Fig. 1, which shows the protoshield layout for the project.

Related Articles

- Helium A gaseous chemical element, He, atomic number 2.
- Noble gases The group 18 elements of the periodic table...
- Periodic table A list of chemical elements arranged along...
- Atmosphere A gaseous layer that envelops the Earth and most...

Related Media

- The Periodic Table

Related Biographies

- Lorius, Claude
- Simon, Franz Eugen (1893–1956)
- Ramsay, William (1852–1919)
- Dewar, James (1842–1923)

AccessScience > Media > Video / Animation

Video / Animation

2 **Videos**

Chemistry > Inorganic chemistry > Are We Running Out of Helium?
Physics > Low temperature physics > Are We Running Out of Helium?

Are We Running Out of Helium?

Helium has helped create revolutionary scientific innovations, and has industrial uses that simply cannot be replicated. Yet helium—a gas that defies gravity—is constantly being lost as it escapes Earth's atmosphere into space. This video explores innovations of the industrial era of helium, how much helium remains, and whether or not this element will go extinct.

Credit: Reactions/American Chemical Society

0:00 / 4:34

See also: Absolute zero; Arc welding; Atmosphere; Diving; Helium; Liquid helium; Magnetic resonance; Natural gas; Noble gases; Nuclear magnetic resonance (NMR); Periodic table; Superconductivity

Curriculum Maps

The For Faculty section of AccessScience provides additional resources specifically for faculty using AccessScience in their courses. One of these resources are our curriculum maps, which make it easy to incorporate engaging content into lessons. These maps were designed by leading science and engineering faculty and highlight content relevant to common course topics for all of the subject areas covered in AccessScience.

1 List of maps by subject

2 Outline of course topics

3 Content type, description, and suggested use

AccessScience Curriculum Maps

These Curriculum Maps guide you to highly relevant and engaging content from throughout AccessScience for use in your teaching. These maps have been designed by leading science and engineering faculty, who have carefully selected useful content, such as tables, graphs, diagrams, photos, animations, and videos, and then mapped that content to standard topics taught within each course. You can easily incorporate this content into your curriculum by using the "Copy Link" functionality to paste a direct link into your school's learning management system.

AccessScience > For Faculty > Curriculum Maps

Curriculum Map

Astronomy

Author:
Martin Hackworth, Senior Lecturer, Idaho State University, Pocatello, Idaho

This Curriculum Map provides a list of highly relevant and engaging content from throughout AccessScience for use in enriching your teaching. Site assets such as tables, graphs, diagrams, photos, and animations have been mapped to standard topics taught in an introductory Astronomy course. Use the "Copy Link" functionality to paste a direct link from each asset into your school's learning management system for easy incorporation into your curriculum.

Course Topics

- ▶ Historical Astronomy
- ▶ Celestial Mechanics
- ▶ The Night Sky
- ▶ The Earth-Moon System
- ▶ The Solar System
- ▶ The Sun
- ▶ Stars
- ▶ Galaxies
- ▶ Cosmology

Historical Astronomy

| Asset | Description |
|-----------|---|
| Diagram | This diagram from the article <i>Archeoastronomy</i> shows how some features of Stonehenge were probably used to keep track of celestial events. Suggested use: Have students use this diagram to set up a "mini" Stonehenge in the classroom to determine various lunar and solar observing events. |
| Diagram | This illustration from the article <i>Retrograde motion</i> shows Ptolemy's early geocentric view of retrograde motion. Suggested use: Show this diagram while reviewing the terms epicycle, equant, and deferent. Have students explain how a planet moving in an epicycle (whose deferent circles Earth) would appear to move in Earth's skies. |
| Biography | Suggested use: Have students read this biography, and, referring back to the Ptolemy biography (see above), create a chart comparing the Copernican and Ptolemaic models of the universe. Then, pose the question of whether Copernicus really solved any issues, and, if so, which issues. Discuss whether there was enough evidence in Copernicus' time to support a heliocentric model. This biography details the meticulous observations of Tycho Brahe and the role that he played in influencing Kepler and others. Suggested use: After assigning this biography as reading material, ask students to provide reasons why Tycho was not fully convinced of the Copernican model. Discuss the Tychoian model in which the Sun orbited Earth, but all the other planets orbited the Sun. Have students attempt to make a 3D model of such a compromised system. |
| Biography | |

Celestial Mechanics

| Asset | Description |
|---------|---|
| Diagram | This diagram from the <i>Planet</i> article illustrates the seven orbital elements that define the position of a planet in its orbit and the orientation of the orbit in space. Suggested use: Use the diagram as a starting point to review the orbital elements, which include the ascending node N , the descending node N' , the longitude of the ascending node, which is the angle Ω measured in the plane of the ecliptic from the vernal equinox ϵ , the orientation and size of the ellipse in the plane, and the position of the planet on the ellipse at any given time. |
| Table | This table from the <i>Planet</i> article summarizes orbital data from our own solar system. These data include distance from the Sun, period of revolution around the Sun, orbital velocity, orbital eccentricity, and orbital inclination. Suggested use: Based on data in the table, have students list a few characteristics that they think define the differences between Jovian planets (Jupiter, Saturn, Uranus, and Neptune), terrestrial planets (Mercury, Venus, Earth, and Mars), and dwarf planets. |
| Diagram | This simple diagram from the article <i>Kepler's laws</i> illustrates Kepler's first and second laws, showing that when a planet moves along an elliptical orbit at a nonuniform rate, the radius vector drawn to the Sun sweeps out areas that are proportional to time; thus, the planet will take equal times to traverse unequal distances along the ellipse. Suggested use: Use this diagram to review Kepler's first two laws with students, pointing out that the Sun is at one of the two foci of the ellipse when it travels in its orbit, and that the planet moves faster when it is closer to the Sun than when it is farther away. |

1. View the list of available curriculum maps by subject, or view correlations to Next Generation Science Standards (for high school teachers)
2. Each curriculum map has an outline of available course topics, with specific content linked to each topic
3. The specific content is labeled by content type, and includes a detailed description with a direct link. Each item also has a suggested use for how it might be incorporated into a lesson or learning activity.

Personal Account

AccessScience has several features which are available only after signing up for a free personal account. Personal accounts are an optional feature and are not required to view or use any of the content on the site.

To register for a free personal account:

1. Click on Your Personal Account from the homepage or any content page to open the sign-in window
2. Click Register, then fill in the form with your name, role, email address, and a password and accept the terms and conditions
**Check the box under email to receive periodic newsletter updates of new content and features*
3. (Optional) Select topics of interest to receive email alerts when new content is added in those areas

Access your personal account by using the My Account link on the right sidebar or the My AccessScience link in the site footer.

Personal account features include:

4. Save individual items to your account or save searches and receive email alerts when new content is added relevant to that search
5. Filter your list of saved items by content type
6. Generate a citation or email a link to resources saved in your account. Items can also be removed from this list at any time.

The image shows a sequence of steps for creating and using a personal account. Step 1 shows the sign-in window with a 'Register' button. Step 2 shows the registration form with fields for first and last name, email, password, and role selection (Student). Step 3 shows the topic selection screen for email alerts. Step 4 shows the 'Personal account features' menu with options for Saved items, Saved searches, and My Account. Step 5 shows the 'Filter items' section with checkboxes for All, Article, Briefing, and Video / Animation. Step 6 shows the 'Cite or share' options for saved items, including CITE, EMAIL, and DELETE buttons.

Administration

The Administration portal contains a wealth of resources for using and promoting AccessScience at your institution.

AccessScience > For Admins

For Administrators

Welcome!

This page is designed to assist you in managing your AccessScience subscription.

Usage Statistics and Account Information **1** Get usage statistics

Your **Subscriber Services Portal** (now called SAMS Sigma) provides access to important tools for managing your institution's AccessScience subscription. Using your administrative log-in credentials*, enter the **Portal** to view usage statistics, update your contact information, review your access mechanisms, and customize the site with your institution's logo and URL. Once you log in, click on the drop-down menu in the upper right hand corner of the screen to select the name of your institution.

Promoting AccessScience at Your Institution **2** Get promo materials

Actively promoting AccessScience to your user community is essential to maintaining high usage and maximizing the value of your subscription. Available here are the **AccessScience brochure in PDF format**, as well as the **AccessScience search widget**. Other materials, including posters, bookmarks, and flyers, can be requested via email from our Marketing Department at digitalmktg@mhprofessional.com.

- Embed the AccessScience search widget in your LibGuide and/or library's web pages. Patrons will then be able to search AccessScience from those pages.

3 Embed our search widget

Training

Please join one of our webinars where we will show you how to navigate AccessScience and the content and resources that are available to you. You must register for a session by clicking on the event below and filling out the form.

Custom Training: **4** Attend a webinar or request training

If you have individuals interested in a training session, and our schedule does not accommodate yours, please contact userservices@mheducation.com. We will be happy to schedule a session at a time that's convenient for you.

Frequently Asked Questions **5** Troubleshoot with our FAQs

Our **help page** provides answers to many frequently asked questions regarding AccessScience. If you can't find an answer to your question, then please **contact us**, and we will respond to your inquiry as soon as possible.

Conferences and Events **6** Visit us at a conference

We will be at the conferences and events listed below. Please plan to stop by the McGraw-Hill booth to learn more about AccessScience, as well as our other latest products and offerings. To arrange an appointment at a conference, please contact digitalmktg@mhprofessional.com.

7 View new content or contact us

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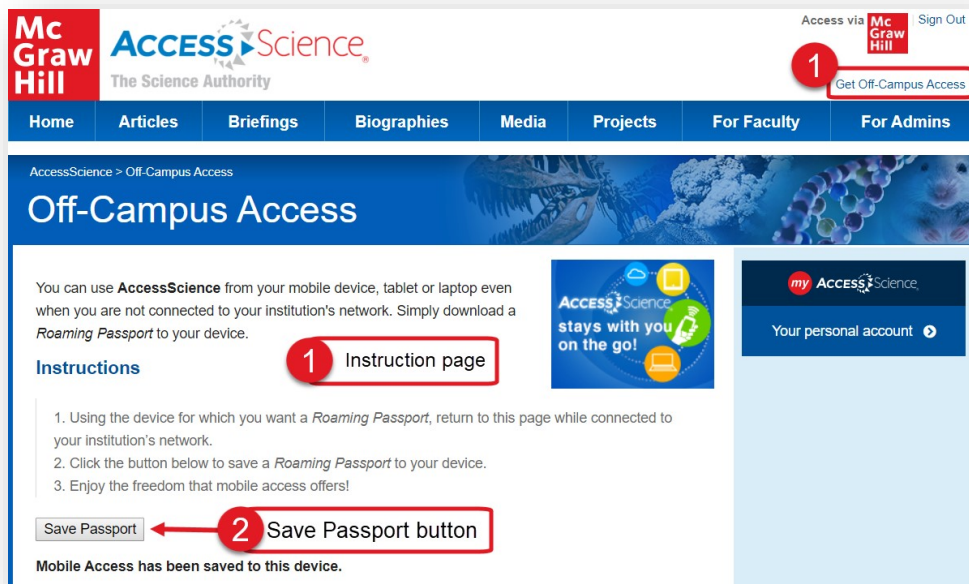
Features of the Administration portal include:

1. Information on downloading usage reports and managing account information
2. Promotional materials to increase awareness of AccessScience at your institution
3. Embeddable search widget to include on your homepage or subject guides
4. Links to register for upcoming AccessScience webinars, or request a custom training by contacting User Services
5. Detailed FAQ help page with more information on the platform and solutions for common issues
6. Information on where to find McGraw-Hill Education at upcoming industry conferences
7. Footer links include a list of newly added content and contact form for any questions or feedback

Mobile Access

Use AccessScience on your mobile device, tablet, or laptop even when not connected to your institution's network with the Roaming Passport feature.

1. View instructions and download the Passport from any page in the site using the "Get Off-Campus Access" link.
2. Save the passport to your device while connected to your institution's network and enjoy the freedom that mobile access provides



Please note:

- The lifetime of each Roaming Passport is six (6) months, after which you will need to complete the process again
- Logging out of the site will remove the Passport, requiring you to re-authenticate and download the Passport again
- Roaming Passports are only available for institutions that authenticate through an IP address and are not available to public library patrons

Need additional assistance?

Contact McGraw-Hill Education's User Services team at userservices@mheducation.com for questions on using the platform, requests for additional training, or help with promoting usage at your institution.