Izrada interaktivne e-knjige = Tools and methodologies for developing interactive electronic books

Brajković, Martina

Master's thesis / Diplomski rad

2014

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:216:853877

Download date / Datum preuzimanja: **2025-02-26**

Repository / Repozitorij:

Faculty of Graphic Arts Repository

zir.nsk.hr

dabar
DIGITALNI AKADEMSKI ARHIVI I REPOZITORIJI

UNIVERSITY OF ZAGREB

FACULTY OF GRAPHIC ARTS

MARTINA BRAJKOVIĆ

TOOLS AND METHODOLOGIES FOR DEVELOPING INTERACTIVE ELECTRONIC BOOKS

GRADUATE WORK

Zagreb, 2014.

MARTINA BRAJKOVIĆ

IZRADA INTERAKTIVNE E-KNJIGE

DIPLOMSKI RAD

Mentori: Student:

Doc.dr.sc. Lidija Mandić   Martina Brajković

Federico Peinado

Zagreb, 2014

Rješenje o odobrenju teme diplomskog rada

SAŽETAK

Elektroničke knjige su elektroničke kopije knjige ili digitalne publikacije dužine knjige. U prošlom desetljeću postale su vrlo popularne i često korištene. Svakim danom sve više i više nakladnika digitalizira svoje knjige, a sve više i više uređaja su prikladni za čitanje elektroničkih knjiga.

Krajem dvadesetog i početkom dvadeset i prvog stoljeća dogodile su se velike promjene u komunikaciji ljudi. Zahvaljujući izumu interneta, informacije su postale široko dostupne,što je promjenilo svako polje ljudskog života, a pogotovo obrazovanje. Jedna od najbitnijih upotreba elektroničkih knjiga je učenje. Elektroničko učenje uključuje razne vrste medija, kao što su video, zvuk, tekst, slike i animacije. Interaktivnost elektroničke knjige može povećati pozornost u učionici i rezultirati boljom izvedbom nastave.

U ovom radu istražen je i analiziran proces izrade interaktivne elektroničke knjige. Proces uključuje korištenje popularnih Adobeovih programa: InDesign, Photoshop, Illustrator, Captivate i Edge Animate, ali i Appleov iBooks Author. Glavni cilj ovog rada je stvoriti interaktivnu elektroničku knjigu, opisati proces stvaranja i istaknuti prednosti i mane različitih dostupnih tehnologija. Kao primjer je napravljena elektronička knjiga koja sadrži izabrana poglavlja iz srednjoškolskog udžbenika fizike. Originalna knjiga obogaćena je slikama, videima, upitnicima i interaktivnim animacijama kako bi se ilustrirale mogućnosti ovog medija.

KLJUČNE RIJEČI:

Elektroničke publikacije, Digital Publishing, animacija, interaktivna animacija, tekst, slika, video, interaktivnost, iPad

ABSTRACT

Electronic books are electronic copy of a book or a book-length digital publication. In the past decade they have become very popular and widely used. Each day more and more publishers digitalize their textbooks and more and more devices are suitable for reading of the electronic books.

Huge changes in human communication happened in the late 20th and early 21st century. Due to invention of Internet, information became widely available which changed every segment of human life, especially education. One of the most important applications of electronic books is electronic learning. Electronic learning includes various types of media, such as video, audio, text, images and animations. Interactivity of an electronic book can increase the attention in the classroom and result with better educational performance.

In this work the process of creation of an interactive electronic book is researched and analyzed. The process includes use of popular Adobe software: InDesign, Photoshop, Illustrator, Captivate and Edge Animate, but also Apple's iBooks Author. Main goal of this work is to create an interactive electronic book, describe the process and identify advantages and disadvantages of the different available techniques. An e-book containing some chapters from a high school book of physics is developed as a case of study. Original book is enriched with pictures, videos, quizzes and interactive animations in order to illustrate the possibilities of the medium.

KEYWORDS:

TABLE OF CONTENTS

TABLE OF FIGURES

1 INTRODUCTION

Nowadays Electronic Learning (e-Learning) is becoming more and more common in education thanks to its numerous advantages compared to classic learning. Educators are continuously challenged to deliver innovative ways to educate in order to achieve better outcomes. Keeping students motivated and classes interesting is a huge challenge for educators.

There are various possibilities to implement electronic learning into the educational system. It can be applied to create completely new learning system or it can act as supplement for the classic system. The term 'e-learning' refers to the learning helped by some electronic device. Development of computers made digital transfer of information and knowledge possible, which eliminated the problem created by the physical distance between students and teachers, made quality education available to wider range of people, made literature available at any moment, and eliminating the problem of monotony of isolated learning by adding interaction to the process. This way of learning is especially suitable for students whose college is too far away, too expensive or for students who work at the same time, but also for the students that cannot attend the classes due to some illness.

The great difference between classical and electronic learning is that e-learning can include multimedia content. Therefore, it includes various types of media, such as text, audio, images, animation and video and processes of computer-based and web-based learning. It can be performed inside or outside of the classroom, by teachers or other students that act as tutors and combined with classical face-to-face teaching. It is suited for distance and flexible learning. Each student can select learning materials that are suitable for their level of knowledge and interest and they can approach the materials at any time of the day. If student is already familiar with certain area, it does not have to spend hours on it again; it can skim over and use that time to concentrate on something it feels it should work more at.

Electronic learning also has its flaws: it requires certain knowledge and skills from the user, equipment for e-learning is not available to everyone and is not completely reliable because there are always possible bugs, malfunction or technical

issues, and e-learning systems have to develop all the time, in accordance with programs and technology they use. Lack of the face-to-face contact between student and teacher can lead to low engagement of the students in e-learning class. The great flaw of most of the e-learning systems is that students can reach them only if they have proper device and internet connection.

Electronic book is relatively new invention, but in very few years it became widely and commonly used. This fact was the main motivation to start this work. The reason why the physics textbook was chosen as a subject is that physics is one of the fields that students have most problems understanding and visualize. The main goal of this work is to create a functional and educational electronic textbook that will contain multimedia and will be interactive. The content of the textbook has to present the information correctly and clearly. The main hypothesis of the work is that students react much better to multimedia and interactive content than conventional printed book; they pay much more attention to the content and understand it better. Therefore, the education produces better results. The main purpose of this electronic book is to make physics more interesting and easier to understand to the students. Lessons are enriched with animations, pictures and videos in order to clarify the text of the lessons. All this multimedia added interactivity to the book.

This work encourages the creation of electronic books, especially books for schooling. Electronic books can be stored on devices and therefore are way easier to carry to and out of school than printed books. Modern devices for e-book reading can store more than thousands of books. Students can easily search trough the text and some readers even have built-in dictionaries. Most of them have Wi-Fi connectivity so students can search for additional information on Internet. There is also possibility to create on-line quizzes and tests for students and include them into the book. The book can be connected to Learning Management System (LMS) where test results can be submitted, stored and reviewed. Learning Management System is a software application for creation and revision of e-learning educational courses. Due to the modern technology, it is not necessary to have an e-book reader in order to read the electronic book because most of the formats can be read on smart phones and tablets.

Electronic books are great way to improve learning because they can contain a lot of multimedia materials, but also some hyperlinks that can lead to the sources on internet with more information. Although they are extremely useful, these interactive contents can be distractive. That is why it is important to find the perfect balance between static and interactive content of the book.

Interactive electronic books can be designed in different ways and can have different features. They can offer the possibility of doing the homework right in the textbook, students can interact with other learners in order to discuss the lessons, interactive questions help students to focus and keep track of their learning progress. Teachers do not have to waste time on test grading because software can do it for them. Students can take notes or highlight the text. The hardest parts of the lessons can be clarified by adding multimedia.

Creation of contents, static or interactive, is explained in this work in detail in order to encourage other electronic book developers to study it and try to make their own interactive e-book. Programs used in the creation process are also explained in order to describe their purpose and possibilities. Lots of screenshots of the creation process are taken in order to clarify the steps and make them more understandable. Problems that occurred in process of the creation are also explained, just like the solutions, if found. At the end of the work, process is reviewed in order to point out its advantages and flaws.

2   STATE OF THE ART ON ELECTRONIC BOOKS

The transfer of information, documents, and content via electronic media can provide innovative alternatives to print media. For example, CD-ROM version of an encyclopedia is much easier to use than conventional book due to its small size, practicality, easiness of research trough the text, possibility of including web links with more information about the topics, its potential for integrating video clips, animations, audio contents and graphics. Therefore, electronic media can greatly increase interactivity. [1]

Electronic book (e-book, eBook, e-Book, ebook, digital book or e-edition) is term first defined by American expert in computer graphics Andries van Dam. He said that e-book is just a stored file that contains the complete text of a book that was initially published, or could have been published, in usual printed form. Generally, it is a book-length publication in digital form, consisting of text, images, or both and it is readable on computers or other electronic devices. Sometimes it is defined as "an electronic version of a printed book", [2] but many electronic books do not have any printed form. They are usually intended to be read on e-book readers, portable electronic devices designed for primarily for the purpose of reading e-books and periodicals, but they can be read using any sophisticated electronic device that features a controllable viewing screen. This means they can be read using computers, some mobile phones and all smart phones. This can also be disadvantage of electronic books. While handling of the common book is easy, simple and flexible, electronic book reading devices lack book-like handling. Also the fact that a device is needed to read such book is a great disadvantage. [3]

There are a lot of discussions about the electronic books slowly replacing printed books. Some people claim that printed book could never be replaced by electronic one, while others say that printed books will soon disappear completely. Big advantage of the electronic book is that one device can store a large number of books so that user does not have to carry physical books with him. Today every e-book reader has ability to store thousands of books in one device. On the other hand, electronic books are often considered as "colder" than the printed books. Printed books can be read in direct sunlight. Electronic books can also, but only if they are read on the device

with electronic paper screen. If the book is read on tablet, this cannot be done. There is also the problem of loaning the books. While printed books can be freely borrowed between people, it is not the case with electronic books. Some e-book readers have lending applications, for example the Nook's LendMe feature, but they often have some limitations, including time constrains on lending periods.

Some studies have shown that, when it comes to reading comprehension of the children, printed books are better choice. One such study was conducted by the Joan Ganz Cooney Center at Sesame Workshop and results found that literacy building in children is more effective with printed book than with electronic book. On the other hand, there are other studies that found that audio and animation in electronic books helps young children identify printed words. While electronic books encourage children to participate with interactive add-ons, the research concluded that sometimes "click-trough" added features can detract children from the reading because of all the interruptions. Some experts worry that devices can distract little kids from the real world. On the other hand, electronic books are extremely helpful for beginning readers, who can zoom in unfamiliar words or click links that help reader to make connection between the word and its meaning. For adult people, who are more able to comprehend the overall story or meaning in the text, these interactive features such as linking, bookmarking, highlighting, video, audio and animations mean huge benefit.

Electronic books are widely accepted nowadays. Publishers all over the world are making their books, catalogs, brochures and other print media digital. Greatest markets of the electronic books today are United States of America and United Kingdom (Wischenbart, 2011). In United States several book titles are sold in more than a million digital copies, regular digital bestseller lists are popping up and tools for creation and distribution of electronic books are developing rapidly. Besides United Kingdom, European biggest e-book markets are Germany and France. Some future projections see a double digit market share for electronic books by 2015 in most European markets. These big markets are targeted by the global brands such as Amazon, Google, Apple and Kobo.

Amazon, creator of the Kindle reading platform, offers both printed and electronic books. Google Editions brought a lot of electronic books to various mobile

platforms. Apple, with its products iPad, iPhone and iTunes, is integrating distribution and consumption of the electronic books.

Electronic books can be read on various devices. Some of the devices are e-book readers and they can only be used to display digital books, newspapers and magazines. Some of those devices are Amazon's Kindle, the Sony Reader, Borders' Kobo and Barnes and Noble's Nook. Some of them can offer internet connectivity and other useful functionality, but their main purpose is to display e-books. However, nowadays electronic books can be displayed on other devices, such as tablets and smart phones (Willams, 2013). These devices are equipped with features like Wi-Fi, MP3 support and full-color touch screen. Market of devices for digital reading also differs between countries. For example, in Asia, especially in China, Japan and Korea, most popular device for electronic book reading are mobile platforms. In continental Europe, tablet is the most popular reading device, and Apple's iPad is most commonly used tablet. Besides iPad, devices with an E Ink Screen are commonly used.

When costs of the producing the book are considered, print books cost more because more resources are needed. Even though devices needed to read electronic book can be expensive, cost per electronic book is much lower than cost per printed book. On the other hand, printed books can be bought in second hand bookshops for a low price, and electronic books cannot.

As every other digital media available on internet, there is a problem with electronic book piracy. Publishers are fighting it by putting in an electronic book digital watermarks that are specifically linked to a person's account, so if a copy of that book ends up on some pirating website, a publisher know whose book that is. There are many controversies about this method because anyone's account can be hacked, electronic books can be stolen and put into pirating website.

2.1 **History**

The inventor of the first electronic book is not agreed upon. The first electronic book might be *Index Thomisticus*, prepared in late 1940s by Roberto Busa. It was electronic index to the works of Thomas Aquinas. In 1949 Angela Ruiz, a Spanish teacher, patents what is most often considered to be the first real electronic book,

Mechanical Encyclopedia (La Enciclopedia Mecánica). However, there are historians who consider that electronic book have started in the early 1960s, when Doug Engelbart started his NLS (oN-Line System) project at Stanford Research Institute, and Andries van Dam [4] started Hypertext Editing System and FRESS (File Retrieval and Editing System) projects at Brown University. FRESS documents were structure-oriented rather than line-oriented; they were formed dynamically for different users, and had automated tables of contents and indexes. All these systems also provided extensive hyper linking, graphics, and other capabilities. Van Dam is generally considered to be coiner of the term "electronic book".

One of the most important persons in the history of electronic books is Michael Hart, founder of the Project Gutenberg. He started it in 1971 and today it is the oldest digital library. The two main goals of the project are to transfer printed books to electronic form, in order to preserve them, and to make them available to anyone. First publication was digitalization of the United States Declaration of Independence. Hart was a student of the University of Illinois and he obtained access to a Xerox Sigma V mainframe computer in the university's Materials Research Lab. He received an account with a virtually unlimited amount of computer time. He decided to do something that could be considered to be of a great public value and set his goal to make the 10000 most consulted books available to the public at little or no charge, and to do it by the end of 20th century. He named the project after Johannes Gutenberg, the German printer who propelled the movable type printing press revolution in fifteenth century.

By the middle of the 1990s, Hart was running Project Gutenberg from Illinois Benedictine College and more and more volunteers had joined the project. Due to the lack of technology, by 1989 all of the text was entered manually. At 1989 image scanners and optical character recognition software improved and became more available, which facilitated text entering.

In April 2014 it had 45000 publications, with an average of over fifty new e-books added each week. Most of the items in library are full texts of public domain books, they are mainly free and in open formats that can be used on almost any computer. Therefore, whenever possible, the releases are available in plain text, but

they are also available in other formats, such as HTML, PDF, EPUB, MOBI and Plucker. Most of releases are written in English language, but there are also publications in other languages. In 2004 an improved Project Gutenberg online catalog was presented. It made content easier to browse, access and hyperlink. Project Gutenberg is now hosted by Ibiblio digital library at the University of North Carolina at Chapel Hill. Project Gutenberg founder, Michael Hart, died on 6 September 2011, at the age of 64, but the Project keeps running.

Early electronic books were generally written for specialty areas and for limited audience. In 1992, Sony launched the Data Discman, an electronic book reader that could read e-books that were stored on CDs. In 1990, when internet became widely used and transfer of the files became easier, electronic books became more available.

2.2 E-book formats

Most widely supported is EPUB format. It can be read at most of the electronic book readers and it is XML-based. In following lines e-book formats are described.

BBeB (Broad Band eBook) is electronic book file format that is developed by Sony and Canon. BBeB files have extensions .lrs and .lrf or .lrx. LRS files are XML files and they represent the source code of BBeB electronic book. LRF is unencrypted format, while LRX is encrypted for DRM (Digital Rights Management) purposes. They are compressed versions of LRS files that are used by electronic book readers. LRS format is openly available to the public, but LRF and LRX are not, but they can be converted to LRS format. As of 2010, the Sony ebook store does not use BBeB format and they have converted all books to EPUB format.

Comic book archive or Comic book reader file is archive file for sequential viewing of images, especially comic books. It mainly consists of a series of image files, usually PNG or JPG files, stored as a single archive file. GIF, BMP and TIFF image files can also be used. File extensions of this format are: .cb7, .cba, .cbr, .cbt and .cbz. Comic book archive files are not a distinct file format, but file name extension indicates the archive file used.

Compiled HTML or CHM format is based on HTML. It is designed by Microsoft Company. Single compressed file includes multiple pages and embedded

graphics. Filename extension is .chm and files support following features: data compression, built-in search engine, ability to merge multiple .chm files and extended character support.

The Digital Accessible Information System (DAISY) is format based on XML and MP3. Textual content is based on XML, and audio content is human or synthetic speech recorded in MP3 format. It is created by DAISY Consortium for people with print disabilities who cannot effectively read printed media because of a visual, physical, perceptual, cognitive or learning disability. This e-book format is designed to be audio substitute for people with print disabilities, including blindness, impaired vision and dyslexia. This format has advanced features compared to traditional audio book, for example ability to search the text, place bookmarks, precisely navigate line by line and regulate the speaking speed without distortion. It also provides accessible tables, references and additional information and as a result it allows visually impaired listeners to navigate something complex such as encyclopedia or textbook.

DjVu is a format specialized for storing scanned documents, especially those containing a combination of text, images and photographs. Filename extension is .djvu. It can take high-resolution scan (300-400 dpi) which is good enough for both on-screen reading and printing.

DOC is e-book file format supported by most of the e-book readers. It is file format of word processing documents, most commonly in the proprietary Microsoft Word Binary File Format. It can be easily edited and converted to other e-book formats. [5]

DOCX file extension stand for Office Open XML file format developed by Microsoft. It is a zipped, XML-based file format for representing spreadsheets, charts, presentations and word processing documents. Starting with Microsoft Office 2007 it became default target file format of Microsoft Office. Like DOC files, DOCX files are also supported by many e-book readers and they can also be converted to other e-book formats.

EPUB is one of the most commonly used e-book file formats. The name EPUB stands for electronic publication. It is a free and open e-book standard developed by

International Digital Publishing Forum (IDPF) and is XML based. Files have extension .epub and their content is reflowable, which means that an EPUB reader can optimize text for particular display device. It also provides support for audio and video content, dependent on device support, and it uses CSS styling.

eReader is a freeware program used to view Palm Digital Media electronic books, electronic book format with filename extension .pdb. Versions of the program are available for a lot of e-book readers. The program supports features like footnotes and bookmarks.

FictionBook is XML-based electronic book format with filename extension .fb2. The format is convenient to store books and convert them into other formats. It does not specify the appearance of a document but it describes the structure.

Founder Electronics developed APABI format with filename extensions .xeb and .ceb. This format is popular for Chinese electronic books. APABI book can be produced using Apabi Publisher and read using Apabi Reader.

Hypertext Markup Language is a markup language used for most web pages. Electronic books that use HTML can be read using any web browser. Filename extensions are .htm and .html. Generally, HTML is not suitable to store information in because it requires more storage space than most of the other formats. However, a lot of electronic book readers store each chapter in HTML format and then use ZIP compression to compress HTML data, images and style sheets into a single and smaller file.

iBook is e-book format developed by Apple. These e-books are created by Apple's free software iBook Author. Format is based on the EPUB standard. The iBook Author software currently supports import and export of three formats: ibook, Plain Text ad PDF. Filename extension is .ibooks.

Kindle Format 8, or KF8, is file format released by Amazon.com when Kindle Fire reader was released in 2011. Filename extensions are .azw and .kf8. the .kf8 file format supports a subset of HTML5 and CSS3 features. Older Kindle electronic book readers use .azw format.

The Mobipocket is an e-book format based on XHTML and can include JavaScript and frames. There is a corresponding e-book reader called the Mobipocket Reader. It offers features such as highlights, bookmarks, corrections, notes, drawing, adding a blank page anywhere in the book and free-hand drawing. It also has built-in dictionary. Filename extensions are .prc and .mobi.

Newton eBook is commonly known as Apple Newton book with filename extension .pkg. A single Newton package file can contain multiple books. All systems running Newton operating system have built-in support for reading Newton books. Books support internal links, tables of content and indexes, embedded grayscale images and some scripting capability.

Portable Document Format, widely known as PDF is one of the most commonly used electronic book formats. It is developed by Adobe Systems and derived from PostScript. PDF documents can easily be both read and printed and they are very common on World Wide Web. PDF files are supported by almost every e-book reader, tablets and smart phones. PDF files can also contain interactive elements such as buttons, annotations, bookmarks, hyperlinks, cross-references, page transitions, audio and video content or flash animations. [6] Document can be set up in InDesign and converted to this kind of PDF file using Adobe Acrobat software.

Plain text files, with .txt filename extension, can also be electronic books, although they don't support formation options, colors, graphics or interaction. However, plain text files are the simplest electronic books and they can be read an almost all operating systems.

Plucker is an open source free e-book reader application developed for mobile and desktop reading. It has its own file format associated and software that generates Plucker files from PDF, HTML, text or other file formats. Filename extension is .pdb.

Rich Text Format, with .rtf filename extension, is supported by a lot of e-book readers. It can be edited very easy, and also converted to other e-book formats. Lots of e-book readers support this format. [7]

TomeRaider is e-book format that has various versions: for Windows, Windows Mobile, Palm, Symbian and iPhone. Filename extensions are .tr2 and .tr3. Capabilities of TomeRaider3 e-book reader vary considerably per platform: the Windows and Windows Mobile editions support HTML and CSS, while the Palm edition supports limited HTML and does not support CSS. Symbian reader can only read older .tr2 format, which does not have search features and does not render images.

2.3   E-book readers

An e-book reader (e-book device or e-reader) is electronic device designed primarily to read electronic books or periodicals. Any device that can display text on a screen can be an e-book reader, but specialized e-book readers are designed to make reading of the electronic books as easy as possible, and similar to reading a conventional book. These devices are portable, with specialized screen that optimizes reading in any conditions (darkness, sunlight, etc.). They use modern technologies like electronic paper and electronic ink which imitate real paper and ink. Furthermore, many readers can use internet trough Wi-Fi so that users can buy, borrow and download electronic books.

Electronic paper and ink are designed to imitate ordinary paper and ink. Conventional displays emit light, but the electronic paper reflects the light from its surrounding, just like real paper, which makes reading more comfortable. Electronic paper can be read in direct sunlight without the image appearing to fade. Electronic ink is the optical component of a film used in electronic paper displays and it uses the same pigments used in the printing industry today.

Some of the most important manufacturers of e-book readers are Amazon, Barnes & Noble, Bookeen, Ectaco, Kobo, Onyx and PocketBook.

Amazon's e-book readers are named Kindle (see Image 1). They allow users to shop, download browse and read electronic books, newspapers, magazines and other media using wireless internet. There are six generations and the modern ones use modern technologies like electronic ink and paper, Android operating system and LCD screen.
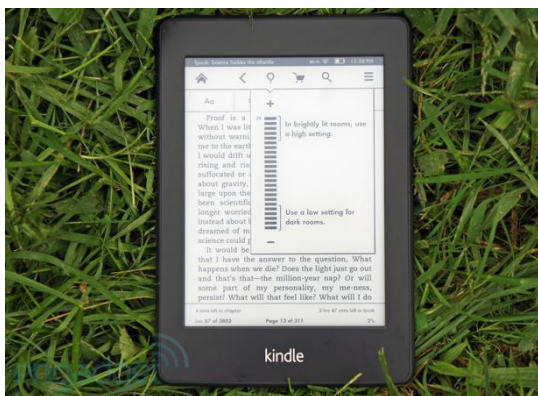
Image 1: Amazon Kindle Paperwhite (picture taken from:
http://www.engadget.com/2012/09/30/amazon-kindle-paperwhite-review/)

The Barnes & Noble Nook is American e-readers brand whose devices are based on Android operating system. Most recent device is Nook GlowLight (see Image 2) has 6 inches touch screen, has wireless connectivity, battery life of two months and storage of 4 GB.
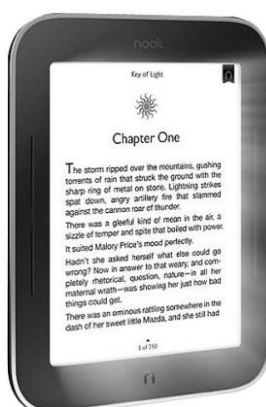
Image 2: Nook GlowLight (Image taken from:
http://i.walmartimages.com/i/p/09/78/14/00/50/0978140050171_500X500.jpg)

Bookeen is French e-book readers manufacturer whose first reader was named Cybook Gen1. In 2007 Booken presented their first with e-ink screen, Cybook Gen3. In 2011 Booken launched its own e-book store with ePub and PDF electronic books.
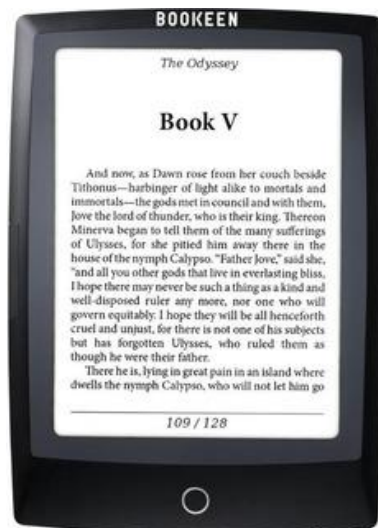
Image 3: Cybook Odyssey (image taken from: http://blog.the-ebook-reader.com/wp-content/uploads/2012/11/cyboook-odyssey-hd.jpg)

ECTACO Inc. (East-Coast Trading American Company Incorporated) is developer of jetBook e-book readers (see Image 4). They support e-books in most European and Asian languages, include features like bookmarks and auto page turn, built-in MP3 player and they also support GIF, BMP, PNG and JPEG image formats. They include dictionaries in multiple languages and some of them can be used for translation of the text.

Image 4: ETACO jetBook Lite (image taken from: http://cdn.itechnews.net/wp-content/uploads/2009/10/ECTACO-jetBook-Lite-most-affordable-eBook-Reader.jpg)

Kobo eReader is e-book reader that also uses electronic ink screen, but there are also LCD tablet versions of the reader. Current model is Kobo Aura (see Image 5) and

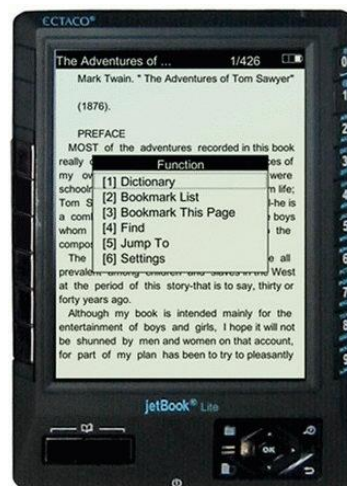it belongs to the fifth generation of Kobo readers. The touch screen is a flat plastic panel that uses e-ink technology. The reader supports various e-book and image formats and includes features like highlighting, adding notes and fonts and built-in dictionary. Kobo also has its own bookstore where users can download books.
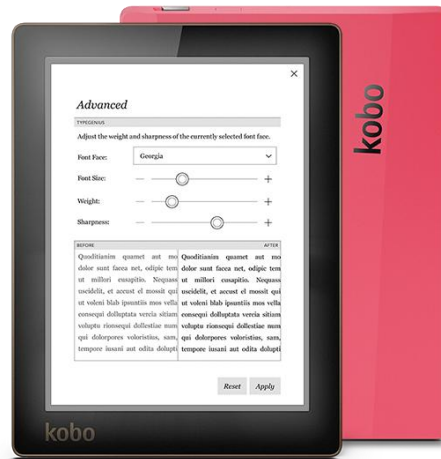

Image 5: Kobo Aura (image taken from: http://www.inmondadori.it/Kobo-Aura-eReader-Colore-Rosa-na/eai068149500633/)

2.4   Other devices for e-book reading

Nowadays reading of the electronic books is not limited to e-book readers. Users can also read books on computers and tablet and smart phone devices. One of the main problems of these devices is screen-glare that makes outdoor reading almost impossible.

Amazon has free software called Cloud Reader for Safari, Firefox and Chrome browsers so users can read books on any device that has those browsers installed. Modern smart phones have bright, vivid and high-resolution screens that are suitable for e-book reading, but the screen remained smaller than the screen of the e-book readers. A smart phone can only fit so many words on the screen so users must flip pages more often. Some of the modern smart phones are designed with a large screen, they have minimal glare and detailed colorful screen that can handle both plain text books and picture books and magazines.

Tablet devices can use e-book reader applications in order to read the electronic books. Those applications are often free. Tablet screens are bright, colorful and good

for viewing graphics. On the other hand, battery life is often much shorter, screen can be glossy and make the reading more uncomfortable than the reading on e-book readers because it strains users eyes. Tablets are often heavier than the e-book readers. Most commonly used tablet device in Europe is iPad, so this is the target device this interactive electronic book is created for.

Image 6: The iPad Air (image taken from:
http://en.wikipedia.org/wiki/IPad_Air#mediaviewer/File:IPad_Air.png)

The iPad is a line of tablet computers designed by Apple Inc., and it runs Apple's iOS. The first iPad was released in 2010, and most recent models are iPad Air (see Image 6) and second generation of iPad Mini. Device has multi-touch screen and virtual keyboard. Multi-touch screen is a screen which surface can recognize presence of more than one or more than two points of contact with the surface. The iPad has built-in Wi-Fi connectivity. It can shoot videos, take photos, play music and browse web. Users can rotate the device from vertical to landscape mode and in that way change the orientation of the content.

The iPad proved as very useful in education, especially in homeschooling. It has a lot of free applications that students can use to write and analyze data and present their work. They can make their add multimedia to their work, such as videos, pictures, animations and graphics, they can add effects to their presentations and access their work from any other device they are using.

3 SOFTWARE USED FOR CREATION OF AN E-BOOK

3.1 Adobe InDesign CS6

Adobe InDesign is desktop publishing software developed by Adobe Systems and today is one of the most used software in design of print materials such as books, posters, flyers, brochures, magazines and newspapers, but also in design of digital media such as electronic books. It is part of Adobe's Creative Suite (CS) package.

It is developed from Adobe's software PageMaker. It can export documents in Adobe's Portable Document Format (PDF), one of the most commonly used formats in prepress process. It has multilingual support and it was the first desktop publishing software to support Unicode for text processing, OpenType fonts, transparency features, layout styles and cross-platform scripting using JavaScript.
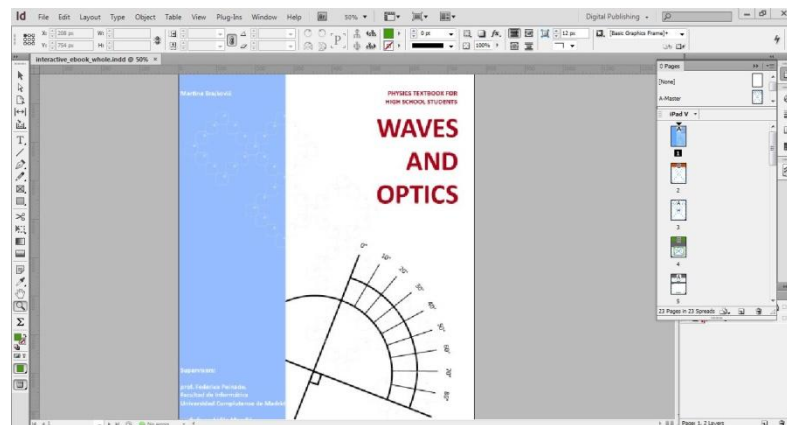
Image 7: Adobe InDesign CS6 interface

InDesign CS6 is version developed in 2012. It contains several enhancements and new features that provide pixel-perfect control over design and typography. [8] With Adobe Digital Publishing Suite, it can be used to design and publish media for tablet devices. One of the new features is Alternate layouts (see Image 8) that can be used to design horizontal and vertical layouts for devices like the Apple iPad and Android tablets.

Used in combination with Liquid Layout, it can significantly reduce the amount of manual work required to re-layout content for every new page size and orientation. It also allows creation of links to original stories, automatic copying of the text styles to a new style group and repagination of the story in the new page style.
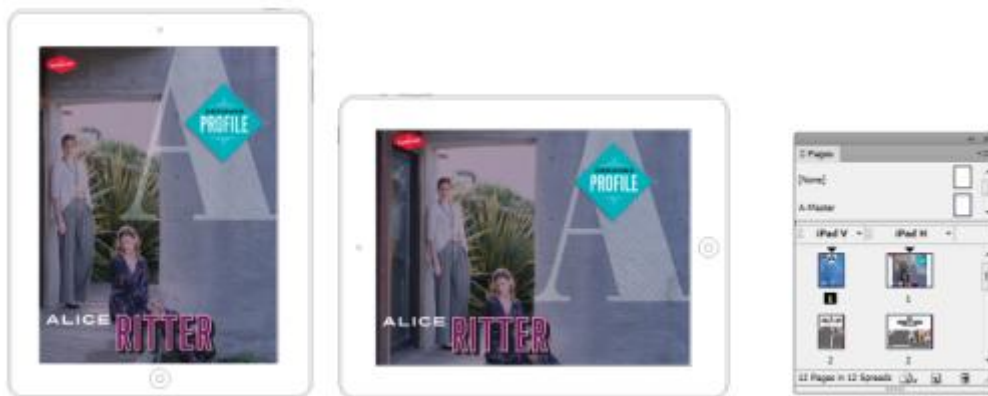
Image 8: Alternate layouts and the updated Pages panel

(image taken from: http://helpx.adobe.com/indesign/using/whats-new-cs6.html)

Second important new feature in InDesign CS6 are Liquid Layouts (see Image 9). They make design of multiple page sizes and orientations much easier. Only one liquid page rule can be applied to a page at a time.

Image 9: Liquid Layout (image taken from: http://helpx.adobe.com/indesign/using/whats-new-cs6.html)

Linked content feature is used to duplicate page items and place them to other pages. It supports both inter-document and intra-document links. It allows placing of the link stories, text frames, page items, interactive objects and groups of items. Links are very useful when working on multi-device publications.

Content Collector and Placer tools are new features that let user duplicate objects and place them on open InDesign documents. Another new feature is Custom Style Mapping. Text styles like paragraph, character, table and cell, or style groups can

be mapped to different styles while linking. This feature is useful if user, for example, wants to use sand serif fonts for digital and serif fonts for print publications, or if user wants to vary the text style between horizontal and vertical layouts.

Preserve Local Edits is feature used to modify linked content. It is useful if linked item needs to be slightly changed from the original item.

A lot of features that allow interactivity are added to this version of the Adobe InDesign. The Buttons and Forms library contains items that can be used to form interactive forms.
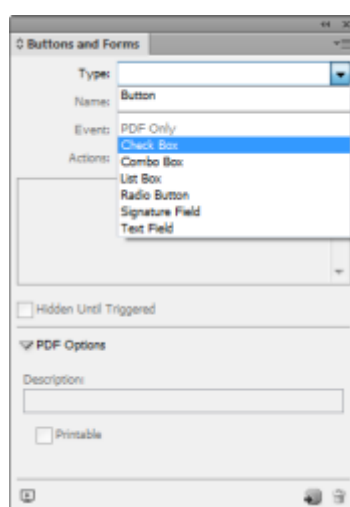
Image 10: Buttons and Forms panel with PDF form components

Interactive PDF documents can now be exported as both spreads and pages. This version also allows embedding of interactive components created by Adobe Edge design tool. Files created in Adobe Edge software must be saved as OAM files in order to be imported to InDesign document.

3.1.1 MathMagic Pro

The product line of MathMagic includes several variations: MathMagic Personal Edition for Mac OS X & Classic; MathMagic Pro Edition for Mac OS X; MathMagic Prime Edition for large Publishers; MathMagic Personal Edition for Windows and MathMagic Pro Edition for Windows.

In process of creating this interactive electronic book, MathMagic Pro Edition for windows is used. It is equation editor that can be used as plug-in in InDesign in

order to write mathematical equations and expressions, since it is not possible in InDesign itself. It allows users to create mathematical expressions fast and use them together with other applications, such as Word processors, Web editors, Presentations and graphic or publishing software. It is available both for Windows and Mac OS X. Full featured Math Magic products require license, but it also has a trial version.

MathMagic provides various benefits and feature set. All equations can be made and edited on the WYSIWYG (What You See Is What You Get) editor window which has powerful automatic equation formatting engine. It is just like word processor and there is no need to learn any text based commands, so it is easy to use. There is also no need to have any mathematical knowledge. Mouse and keyboard are just enough to create equations.

The latest MathMagic can read or paste MathML or LaTex expressions. It also supports reading MathType generated equations, such as PICT, EPS, GIF. It helps to convert you're any equations into MathMagic equation fast so that high quality output is generated. MathMagic also allows exporting equations to MathML, LaTeX, AMS LaTeX, MediaWiki (TeXvc) format so that the equations can be used in various targets. MathMagic also supports Bitmap or Vector based image formats for saving and reading, such as PDF, EPS, PNG, WMF, PICT, PNG, JPEG, and GIF.
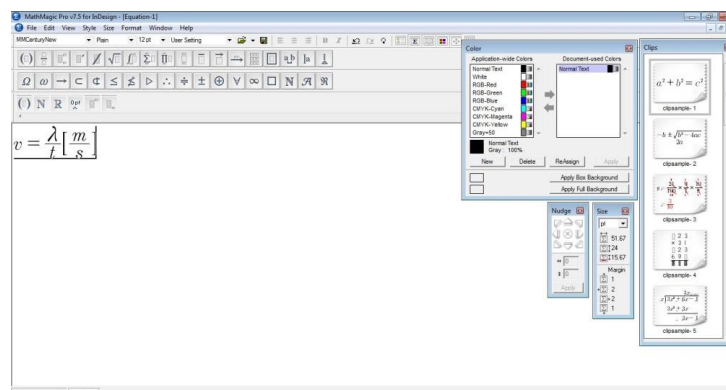

Image 11: MathMagic interface

MathMagic covers almost all kinds of mathematical expressions ranging from elementary school level to higher graduate school. Any combinations of mathematical expressions are being able to be created with just a few clicks on more than 200 default templates. Hundreds of symbols in about 40 fonts are ready to be used with the

intuitive symbol palettes that contain more than 650 frequently used symbols. MathMagic provides high quality TrueType and PostScript fonts specially designed by professional font designers for wide range of choices for equation fonts.

All the setting values of Spacings, Sizes, and Styles can be managed as a StyleSet. This feature allows users to create multiple formatting environments and switch among them quickly. The StyleSet values can be shared with other people in the team so that they can have the same working environment. Color equations can be easily created. MathMagic supports Color style list in two level: Application-wide colors and Document-wide colors. User can share the color styles with other people for a group project. And the specified colors can be easily changed later just by changing the color style used for the document. Every part of templates and symbols can have its own color. Color equations can be exported as PICT or EPS.

3.1.2 Digital Publishing Suite

The Adobe Digital Publishing Suite is available for Adobe InDesign CS5 and later versions of the software. [9] DPS Desktop Tools for InDesign CS6 are: Folio Overlays panel, Folio Builder panel, Digital Publishing Plug-in, Content Viewer and DPS App Builder. The tools are required to begin authoring, creating and previewing of the .folio files on the desktop or devices.

Folio Builder is part of the Digital Publishing Suite and it is used to create folios and add articles. A folio is a collection of articles. It includes three views: folio view, article view and layout view. When user open Folio Builder panel he is asked to sign in with its Adobe username and password, but this step is optional. Signing in to the panel allows user to upload the folios to the Folio Producer Service for testing. Folios can be downloaded to the Adobe Content Viewer on a mobile device and shared with other users. If user does not sign in to the panel, it can still create and preview local folios. When user signs in and creates a folio, a workspace is created on the acrobat.com web server. The content of any article user adds to the folio is uploaded to that workspace. After the folio is created, user can define its properties in the Folio Properties panel. Properties that can be defined are the name of the publication, Adobe Content Viewer version and cover preview images. [10]

Folio Builder allows users to create offline folios, or local folios that are not uploaded to the acrobat.com service on the web. This is useful when user is not connected to the internet, or if acrobat.com service is temporarily out of service. Once the folio is uploaded it cannot be converted to an offline folio. If user wants other people to review the folio it is working on, it can share it. Whenever user updates an article in the shared folio, recipients are notified that an update is available when they open the library in the Adobe Content Viewer. If user does not want recipients to view updates, it can unshare the folio. Folios can also be copied from user's account or user can copy the folio that has been shared with it from a different account. User can then edit and publish the copied folio. When user copies the folio, no connection between original and copied folio exists. To edit articles by changing the source files, user needs access to the source files in the original folio. Locked folios cannot be copied.

Folios can also be deleted. When user deletes the folio, it removes the workspace from the server and deletes all the articles in that folio, but not the source documents. If a folio was downloaded in a viewer before it was deleted, it remains in the viewer library until it's removed.
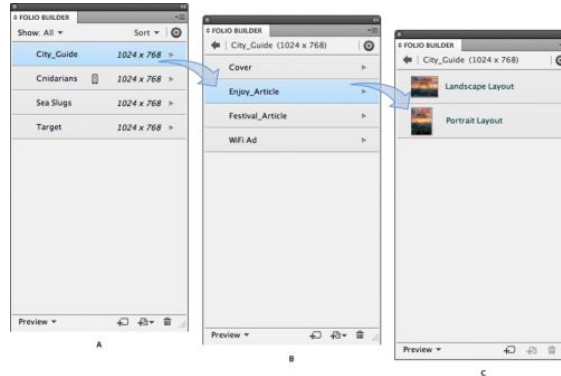

Image 12: Folio Builder panel (image taken from:

http://helpx.adobe.com/digital-publishing-suite/help/create-folios.html)

3.2 **iBooks Author**

iBooks Author is a software developed by Apple Inc. that is used to create electronic books. Books created with this software can be exported as PDF files or they can be published to the Apple iBooks Bookstore. First version of the software was released in 2012. This software is only available for Mac OS X operating system.
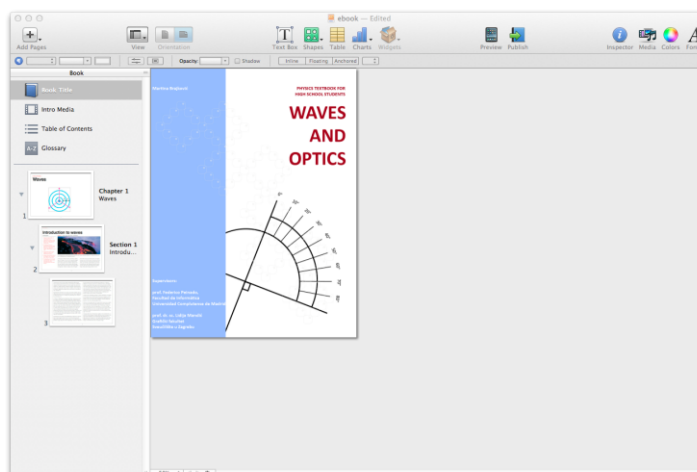

Image 13: iBooks Author interface

It is user friendly software that allows users to edit text, fonts and colors, images, and add videos, charts and interactive content. It also has an option of creating glossaries and table of contents. User can create the book using Apple's designed templates and modify them trough the work or create its own template. Text can be written directly into the book, but user can also drag and drop text documents into the book. The software automatically creates new pages, fills them with text and formats them according to the template. Software also contains different paragraph styles that can be applied to the text. Besides text, other elements can also be added to the book using drag and drop technique. Text automatically moves around those elements.

User can create interactive electronic book by adding dynamic interactive elements called widgets. There are seven different types of widgets: Gallery, Media, Review, Keynote, Interactive Image, 3D and HTML. For example, user can create photo gallery using Gallery widget by simply dragging and dropping images to the gallery and add titles and captions to each photo. Media widget is used to put media such as videos into the book and gives it interactive controls such as play, stop, pause etc. HTML widget can use web-based data so examples in the book are always up to

date. Chapter Review widget enables creation of the quizzes that are perfect for textbooks. Readers can test their knowledge right in the chapter. Interactive Image widget allows user to add some elements to the image. For example, it can be some text that explains parts of the picture and shows when user clicks on it. Keynote widget is used to create Keynote Presentations. This is the presentation where user doesn't have to see all of the slides, but he chooses the parts it is interested in and slides linked to that part open. 3D widget allows user to import 3D models to the book that are interactive, can be turned around, enlarged, moved etc.[11]

While working, user can preview the book on iPad at any moment. iPad needs to be connected to the computer.

3.2.1 Daum Equation Editor

Daum Equation Editor is the software used to import equations into the iBooks Author software. It is equation editor developed for Google Chrome browser and Mac operating system. Output formats of the equations can be PNG or LaTeX. It is very user-friendly. User can create formulas with the click of a button or with TeX input editor. Size and layout of the formula can be modified. It supports copy and paste, common text input and has task history.
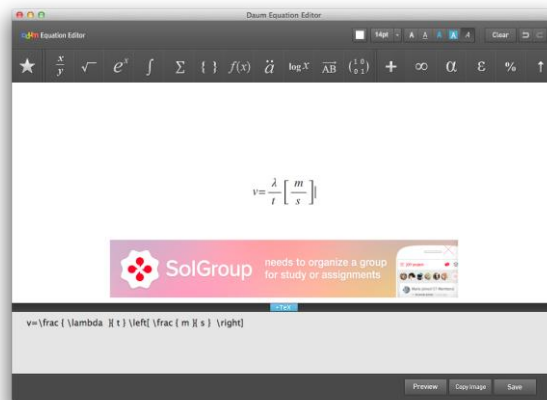

Image 14: Daum Equation Editor interface

4 SOFTWARE USED TO CREATE THE CONTENT OF ELECTRONIC BOOK

4.1 Adobe Photoshop CS6

Adobe Photoshop is software developed by Adobe Systems. It is released in two editions: Adobe Photoshop and Adobe Photoshop Extended. Extended edition has ability of 3D image creation, motion graphics editing and advanced image analysis features. Besides Photoshop and Photoshop Extended, Adobe also developed Photoshop Elements and Photoshop Lightroom, collectively called "The Adobe Photoshop Family". In 2008 Adobe also released Adobe Photoshop Express, a free web-based image editing tool which can be used to edit photos directly on blogs and social networks. Adobe Photoshop is available in both Windows and Macintosh versions.
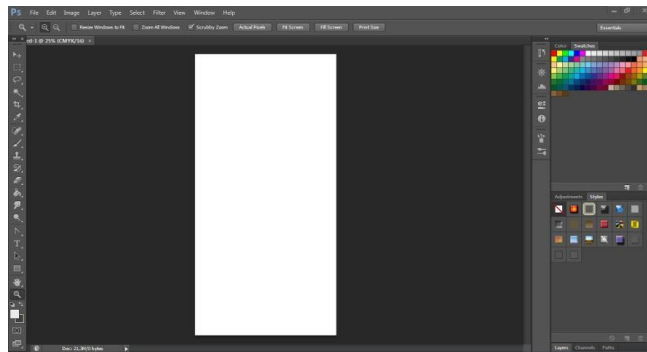
Image 15: Adobe Photoshop CS6 interface

Photoshop files have default extension as .psd, which stands for "Photoshop Document", but files can be exported in various image formats. A .psd file stores an image with all its layers, masks, text and channels and has a maximum height and width of 30000 pixels, and length limit of 3 gigabytes. Photoshop files can also have .psb extension, which stands for "Photoshop Big". This format extends the .psd format so that maximum height and width is 300000 pixels and length limit is 4 exabytes. Photoshop files can easily be exported to and from other Adobe's software, such as Adobe Illustrator, Adobe Premiere Pro and After Effects. Although it is software for raster image editing, it has tools for vector graphics editing, such as Paths, Pen tools,

Shape tools, Shape Layers, Type tools and Smart object features. These tools combine pixel-based and vector-based images in one Photoshop document, but to create more complex vector graphics, it is recommended to use vector editing software like Adobe Illustrator.

Adobe Photoshop CS6 is thirteenth version of the software. It is part of the Adobe Creative Suite 6 (CS6) package and is released in 2012. It came with a lot of new features for retouching and transforming photos, new filters, clip-based timeline for video editing etc. The redesigned, clip-based timeline panel includes transitions and effects that are used to polish finished videos. It is possible to easily change clip duration and speed, and apply motion effects to text and images. [12]

4.2 **Adobe Illustrator CS6**

Adobe Illustrator is software used to design vector graphics and it is developed by Adobe Systems. It was first developed for Apple Macintosh in 1986. Files have filename extension .ai, which stands for Adobe Illustrator Artwork. It is a file format developed by Adobe Systems for representing single-page vector-based drawings in either EPS or PDF formats. There is a lot of other software that can edit this file format, such as Adobe After Effects, CorelDRAW, FreeHand and Ghostscript. Adobe Illustrator CS6 is sixteenth generation of Adobe Illustrator and it is released in 2012. Some of the most important innovations in this version are 64-bit memory support, new user interface, gradient that can be applied on a stroke, pattern creation tool and Image Trace that replaced Live Trace.
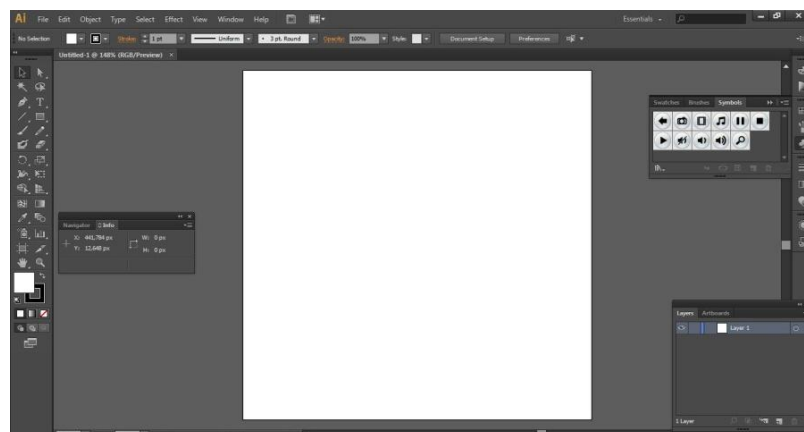

Image 16: Adobe Illustrator CS6 interface

This version introduced Adobe Mercury Performance system, which is combination of solutions that make Illustrator faster, more responsive and able to handle larger files. Processing on 64-bit Macintosh and Windows operating systems is much faster and complex tasks are better handled. The user interface is more efficient, streamlined and makes working in Adobe Illustrator much easier. It enables users to use fewer steps to achieve frequent actions. [13]

4.3   Adobe Captivate 7

Adobe Captivate is Adobe's software for electronic learning. It allows users to create demonstrations, software simulations, quizzes and interactive media without programming. The software started out as a screen recording utility but soon it became e-learning tool. Files can be saved in various formats with different filename extensions. Project files that can further be edited by Captivate software are stored with filename extension .cp, .cpdt are Captivate design template files, .cptl are Captivate project template files, .cptm are Captivate project Theme files and .crev is Captivate Review file. This type of file is published when a project is sent out for review using Review Application. Output formats are: .swf, which can be played with Adobe Flash Player and it is primary output of Adobe Captivate; .aggr or Adobe Captivate Aggregator file format; .avi, a Microsoft format for digital video; .flv, an Adobe file format for digital video that can be played with Adobe Flash Player and .qml, an XML-based file format. [14]

Adobe Captivate 7 was released in 2013. It had a lot of new features such as tools for games and quizzes creation. It also has MathMagic equation editor and interactions library. It is user friendly and easy to use. Smart Learning Interaction tools allow user to create interactive media easily. Users can add text, images, videos and sounds and create animated and interactive games, charts, learning activities and interactions for computers and mobile devices using HTML5. This software also allows creation of drag and drop interactions. Adobe Captivate also includes support for system audio recording.
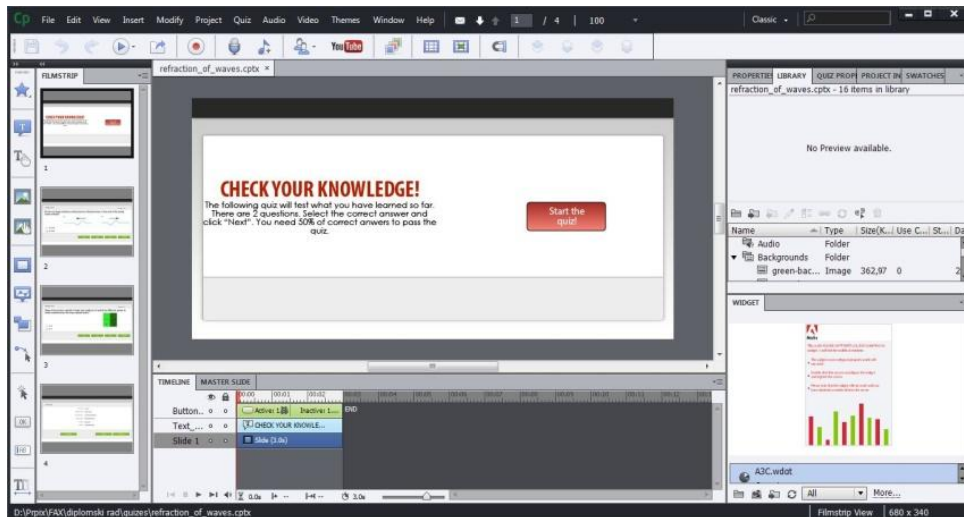
Image 17: Adobe Captivate 7 interface

4.4   Adobe Edge Animate CC

Adobe Edge Animate is software developed by Adobe Systems as a new multimedia authoring tool to succeed the Flash platform for browser-delivered content. It builds applications based on HTML5, JavaScript, jQuery and CSS3. These applications are compatible with iOS and HTML5-compatible browsers. It is part of Adobe Edge suite.

Image 18: Adobe Edge Animate CC interface

Adobe Edge Animate CC can be used on Windows and Mac OS operating systems. It enables users to easily design interactive and animated HTML content for the modern web. It has audio support, which means that users can import and sync audio files with animation playback or user interactions. User can also design

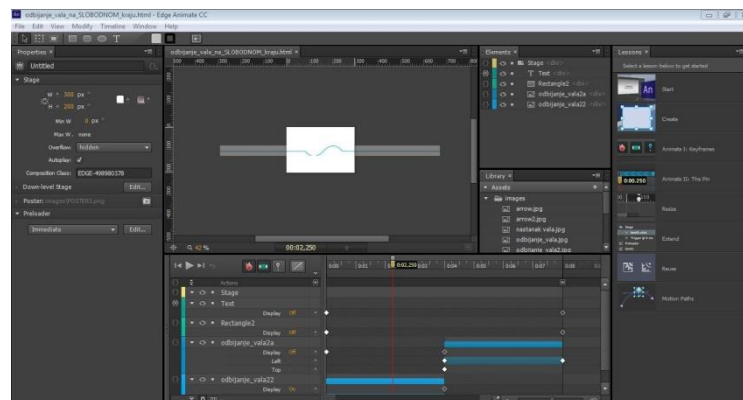responsive animations by applying scaling or percentage-based layouts to fit mobile and desktop screens. Elements and objects can be animated using motion paths. Users can create ad save their own templates and access them later, which is very useful when working on repetitive projects. It also has swipe gesture support so that users can add left and right swipe elements to their projects made for devices with touch screen. Interactivity is based on JavaScript language, but there is also built-in code library so that users who are not familiar with programming can also add some interactivity to their projects. Edge Animate Compositions can be imported into Adobe Digital Publishing Suite with Adobe InDesign CC or CS6, or into Apple iBooks Author. One of the new features is Gradient Support which allows users to style and animate elements with radial or linear gradients. Edge Animate CC also has CSS filter support. It contains filters such as blur, grayscale, sepia, brightness, contrast, hue-rotate, invert and saturate. There are multiple publishing options. [15]

5   METHODS OF MAKING AN INTERACTIVE E-BOOK

5.1   Using Adobe programs

Before making an e-book it is good to make a sample first, in order to see how programs work and how much time is necessary to make one chapter of a book. Chapter that is chosen for sample is 'Refraction of a light' chapter because it has text, images, equations and a lot of materials that can become interactive.

5.1.1   Making of a sample

First step of making an interactive e-book is designing it. [16] One of the best and most common used software to design a book is Adobe InDesign. First we have to set up the InDesign document (see Image 17). On the menu we choose File, New and Document. Dialog box appears and we can define our document. For Intent we choose Digital Publishing. For Page Size we choose iPad. This function will automatically make size of a document suitable for iPad device, which means its width is 1024 pixels, and its height is 768 pixels. We can also set up number of pages of our document; in this case there are three pages. Pages can be added or deleted easily in the process. Columns field determines number of text columns, and Gutter is length of space between columns. In this sample we will use only one column. Last thing we can set are Margins. There are four of them: Top, Bottom, Left and Right and they represent the length of blank space between elements (text, pictures, animations, videos, etc.) and the edge of the page.
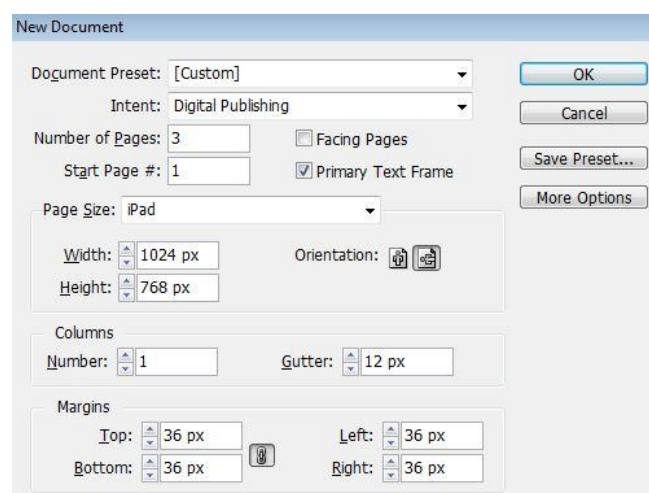

Image 19: Setting up InDesign document

It is important to set Master Pages at the beginning of work. Changes that are made on Master Pages will apply to all pages that have that Master applied so it makes work easier because it is not necessary to make same changes on each page separately. On Master Page we set elements that will repeat on every page, for example, in this sample, on Master Pages are set margins, number of columns of text and text boxes for titles and lessons. After that, front page is designed. Graphics, like pictures or illustrations, can be designed with programs Adobe Photoshop (for raster graphics) and Adobe Illustrator (for vector graphics). In this sample, front page has picture that is created in Adobe Photoshop CS6.

First step in creating a front page picture is making a document in Adobe Photoshop (see Image 18). We choose File on the menu and then New. Dialog box appears where we can set options for our document. First we name it and then choose its width and height.
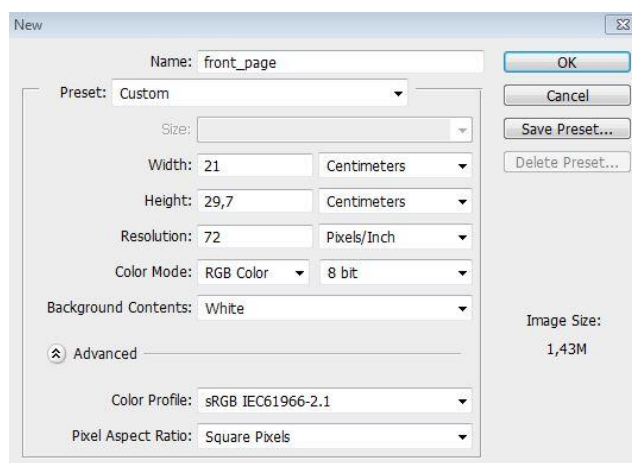
Image 20: Setting up the Photoshop document

Now we choose the resolution. Resolution is the fineness of the details in an image and it is measured in pixels per inch. The more pixels per inch image has, the greater is the resolution of an image. Pixel dimensions measure the total number of pixels along an image's width and height. For web pages, computer and mobile devices, and screens in general, resolution of 72 pixels/inch is sufficient. If we wanted to print the book in offset printing technique, 72 ppi resolution is not enough and we would need 300 pixels/inch resolution. If we leave the 72 ppi resolution, printed image

will be grainy, printed dots per inch will be visible because they are too big and text could end up unreadable. The resolution of images created to be printed can also be measured in dots per inch (dpi).

Now we choose color mode. There are two main color modes: RGB and CMYK. Color seen on the screen doesn't look the same when printed. Computer screens show color in RGB (red, green, blue) mode, but images are printed in CMYK (cyan, magenta, yellow and key) mode. RGB is the color mode associated with all electronic displays, such as CRT, LCD monitors, digital cameras and scanners. All three colors combined in the maximum amount give pure white color. When they are combined in lowest value, they give black color. RGB color mode offers wider range of colors than CMYK mode and it can produce colors that are more vivid. That is why some colors don't look the same in both modes and why they should be converted from RGB to CMYK mode if printed. Printers print images in CMYK color mode. Magenta, yellow and cyan color combined in their maximum amount give black color in theory. When printed in their maximum amount, they will not give the black color, but dark brown. That is why black color is added as key color in printing machines. Since all screens work with RGB color mode, we choose that mode. In the end, we choose background color, which is white in this example. [17]
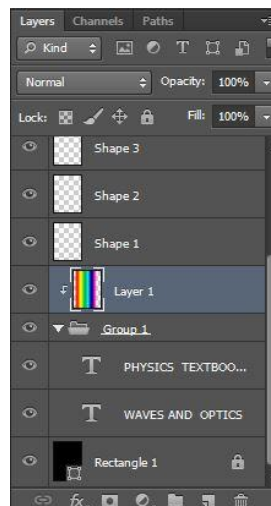

Image 21: Layers in Photoshop

If we choose white background, then the first step is to create black rectangle that will cover the whole page. To do it, Rectangle Tool is used. Then the title and

subtitle are written with Horizontal Type Tool, in new layer. The most important thing in Adobe programs like Photoshop, Illustrator, InDesign and others is to create each element in separate layer (see Image 19). It gives more control to the user and it is easier to modify, add or remove elements when they are in separate layers. In new layer we create rectangle with Rectangular Marquee Tool, then use Gradient Tool to fill the rectangular with Spectrum Gradient. Important thing is that layer with rectangular is above text layer. Now we simply select rectangle layer, do the right click and choose Create Clipping Mask. Now all the letters are colored in spectrum colors. [18]

In the end the illustration of a prism is added. It can be done simply by using Polygon Tool and Line Tool. Triangle can be easily drawn with Polygon Tool. When we choose it, we do the left click anywhere on the canvas. The dialog box appears where we can choose width, height and number of sides of a polygon. The rays of the prism are drawn with Line Tool.

Now we can save our work by choosing File from the menu, and then Save As. We can import lots of file formats into InDesign, but we choose JPEG. Next step is to copy lecture text from Microsoft Word to Adobe InDesign. If we just select all the text, copy it and paste it at Adobe InDesign, it will lose its formatting and we will have to re-format it again. Easiest way to paste text from any text editor to InDesign without having to re-format it contains few simple steps. First one is to make a Word document with text and save it as Rich Text Format (RTF). It is not essential to do, but it does get rid of some Microsoft's extra character and formatting styles when text is imported into InDesign.

So we go back to InDesign and create text box with Type Tool for our lecture text. Then we choose File from the menu bar, and then Place. We chose RTF file and placed it to our text box. The problem here is that equations cannot be imported from Microsoft Word to InDesign, so InDesign automatically makes images out of equations and puts them instead of real equations. These images have poor quality, so we have to replace them. There are two ways to import equation to InDesign.

First one is to make an image of equation and place it into the InDesign document like any other graphics. [19] The other one is to use some of the plug-ins

made for InDesign that allow copying equations from Word and pasting it automatically as an image into InDesign. For this sample, creating an image of equation is chosen. It can be done easily by Snipping Tool that can be found on Windows 7 operating system. After all the images are created, they can be simply imported with Place function, just like the text before.

To make our e-book interactive and more interesting, we will add some interactive content. Videos can be imported to InDesign easily: on the menu bar we choose File and then Place, and pick the video we want to import.

We can also make some interactive animations and import them to the InDesign document. Animations can be made using Adobe Edge Animate. It is software that is using keyframe technique, just like Adobe Flash. In this technology, user defines two or more key frames of animation where he manipulates with object, changes it, moves it, etc. Keyframe function compares those two key frames (one that presents object at the beginning and other that presents object in the end), analyses differences between them and generates all the frames between those two key frames, so that object at the beginning progressively becomes object in the end.

In the end the simple quiz about the lesson is added. It can be created in Adobe Captivate.[20] We choose File, New Project and then Blank Project. Dialog box appears where we can set up width and height of our quiz (see Image 20).
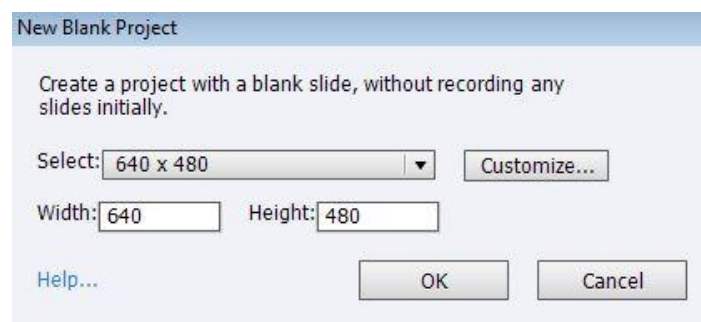

Image 22: Setting up Adobe Captivate document

From the menu bar we choose Insert and then Question Slide. Adobe Captivate offers templates for different quiz types (see Image 21). Multiple Choice is the type of question where users select one or more correct answers from a list. [21] In True/False users choose either True or False, or Yes or No. Fill-In-The-Blank is the type of the

quiz where users complete a blank in a sentence or phrase. In Short Answer users supply a word or a phrase. In Matching type Users match entries in two lists. In Hot Spot users move the pointer over areas on the slide. In Sequence users arrange listed items on the correct sequence. In Rating Scale (Likert) users indicate their level of agreement with statements. Random Question displays questions that are randomly selected from question pool to which they are linked.

Next we decide how many questions will the quiz have and write that number into the box. We can also specify will the question be Graded, Survey or Pretest. Graded Question is used to evaluate users using the score we assigned to each question. Survey Question is used to get user feedback, and Pretest is used to evaluate user's knowledge about the subject before they read the lesson.
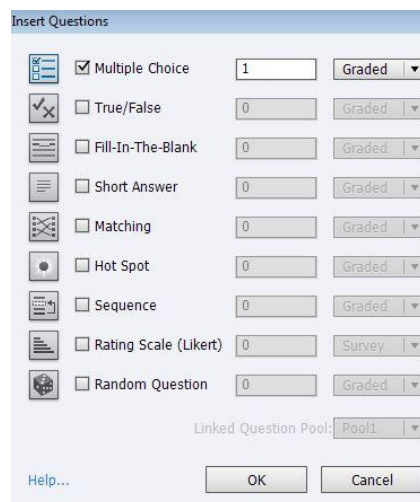

Image 23: Quiz types in Adobe Captivate

In this case, Multiple Choice question is chosen as a quiz type, number of questions is one and it will be graded. Next we type question and answers and assign some points to the correct answer. We select correct answer and leave it selected. That is how Adobe Captivate knows which answer is the correct one.

When the quiz is done, we have to publish it and import it to InDesign. We choose File from the menu, and then Publish. Dialog box appears, and here important thing is to choose HTLM5 instead of SWF in Output Format Options. Now we have to import the quiz to our InDesign document.

First we form a placeholder in InDesign, where our quiz will be placed. It can be formed with Rectangle Frame Tool. Its height and width should be the same as height and width we chose for the quiz. We select the placeholder and use Folio Overlays. It can be found in the menu bar, under Window. We will add this quiz as a Web Content (see Image 22).
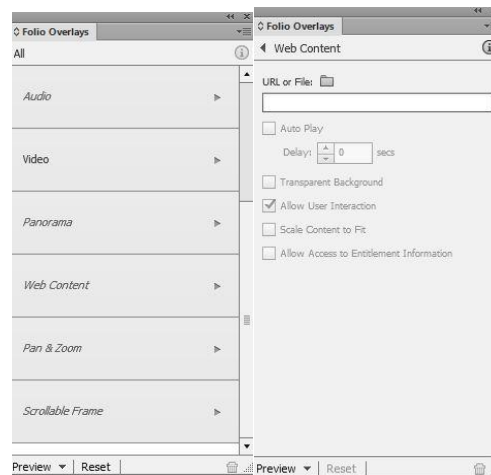

Image 24: Using Folio Overlay

We select our quiz in HTML format and place it in placeholder in Indesign. Once it is imported to our InDesign document, it is important to select Allow User Interaction in Folio Overlays panel. We are not able to see the quiz in our placeholder, but once we publish the book it will be there.

We can also add animations in interactive electronic book. To create animations, Adobe Edge Animate CC is used. Animations created With Adobe Edge Animate can be interactive, and interactivity is based on JavaScript programming language. Animations made with Adobe Captivate are in HTML5 format so they can function on iPad. Important thing is to publish animations in OAM format which can further be embedded into the InDesign document.

The final step to create an electronic book is to build DPS folio and preview it using Adobe Content Viewer. In order to do that we use plug in for Digital Publishing Suite called Folio Builder. It allows publishing InDesign document as an electronic book. When we activate Folio Builder, first we have to give a name to our folio. Next we have to choose Target Device, in our case it is Apple iPad. Next we select

orientation of the e-book. For the Default Format we choose JPEG, and Default JPEG Quality is high. Next we have to choose cover image of e-book, both in vertical and horizontal format. The document is now ready to be published.

5.1.2 Making of an interactive electronic book

Lots of methods used to create e-book sample will be used to create the whole electronic book. Again, first step is to set up the InDesign document. We open InDesign, and select File, New and then Document. We set its Intent to Digital Publishing, Page Size is iPad and Orientation is Portrait. Next step is to place cover image to the first page of the document.

Now it is important to set up Master Pages. We create two Master Pages, left and right because we want our book to have facing pages. First we set up margins of the pages. Margins are usually calculated on the principle of golden ratio (see Image 23). Golden ratio is frequently used to define ideal ratios between dimensions, or ratios that are most acceptable to the human eye. First we choose the size of the text area, in this case width is 680 pixels and height is 890 pixels. Now we subtract width of the text area from the width of the page, and height of the text area from the height of the page:

$$\text{Height: } 1024\text{px} - 890\text{px} = 134\text{px}$$

$$\text{Width: } 768\text{px} - 680\text{px} = 88\text{px}$$

We got sizes of white spaces and now we have to divide them between top (m_t), bottom (m_b), left (m_l) and right (m_r) margin. According to the golden ratio, three fifths of the white space goes to bottom and right margin, and two fifths goes to top and left margins:

$$m_t = 2/5 * 134\text{px} = 53{,}6\text{px}$$

$$m_b = 3/5 * 134\text{px} = 80{,}4\text{px}$$

$$m_l = 2/5 * 88\text{px} = 35{,}2\text{px}$$

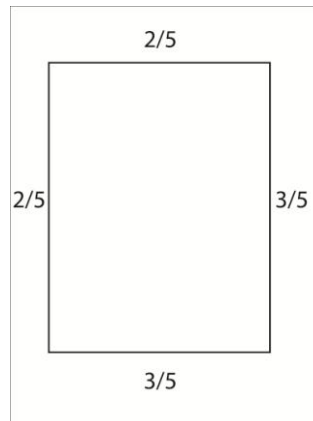$$m_r = 3/5 * 88\text{px} = 52{,}8 \text{ px}$$

Image 25: Golden ratio applied on page layout

InDesign has page numbering function that can be set up at Master Pages. In the Pages panel, we double-click the master page to which we will add page number. We create a text frame large enough to hold the longest page number and position it where we want the page number to appear. Since we have two Master Pages, left and right, we have to create separate text frames for each Master Page. Now we choose Type, Insert Special Character, Markers, and Current Page Number. Once we apply mater pages to document pages we will see page numbers appear.[22]

Now we create cover image of the book. It is good to create both vertical and horizontal versions of the image, because both will be needed later when we want to publish the book. In order to create this cover image, Adobe Illustrator CS6 is used, a program for creation of vector graphics. Dimensions of the illustration are the same as the dimensions of the book, because we want the image to cover whole front page. We go to File on the menu bar and choose New. Dialog box appears (see Image 24). First we write the name of our document. For the Profile of the document we choose Devices, which automatically sets width to 768 pixels and height to 1024 pixels, color mode to RGB and resolution of the image to 72 ppi (pixels per inch). This color mode and resolution are suitable for the images created to be reproduced on devices such as computers, tablets, mobile phones etc. Once the image is created, it should be published in JPEG format and embedded to InDesign file.
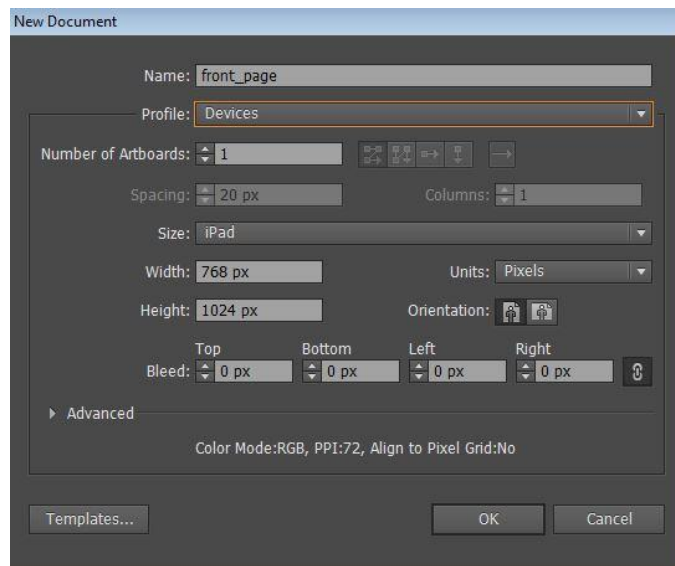
Image 26: Setting up the Adobe Illustrator document

Next thing we have to do is to copy text of electronic book from the Word document saved as Rich Text Format (RTF). We crate placeholders for the text and simply copy it from Word document and paste it into the InDesign document. This time we will use plug-in called MathMagic in order to put math equations into InDesign document. It is equation editor that enables editing of any mathematical expressions and symbols. Equation can be pasted to MathMagic interface and this plug-in will automatically create picture of equation and put it into InDesign.

Next step is to create images that will be embedded into the InDesign document and make the lessons more interesting and easier to understand. Once again we use Adobe Illustrator to create the images. First we create placeholders for the images in the InDesign document. When we create new document in Illustrator, we put the same width and height as the width and height of the placeholder. That means that in the Illustrator's dialog box for the Profile we choose Custom and for the Size also Custom, and write in width and height of the placeholder. Under Advanced options in Illustrator dialog box, we choose RGB color mode and for the Raster Effects we choose Screen (72 ppi).

Image can be created in many ways and Adobe Illustrator has a lot of useful tools for drawing. Since the case of study is to turn printed physics book into

interactive e-book, the simplest way is to take the photos of the images in the book with a camera, place them in background layer of Illustrator files and re-drew them.

Once the image is created, we choose File from the menu bar, and then Export. The file can be saved as various formats: AutoCAD Drawing (.DWG), AutoCAD Interchange File (.DXF), bitmap (.BMP), Enhanced Metafile (.EMF), Flash (.SWF), JPEG image (.JPG), Macintosh PICT (.PCT), Photoshop file (.PSD), PNG image (.PNG), Targa (.TGA), Text Format (.TXT), TIFF (.TIF) and Windows Metafile (.WMF). We choose JPEG format and the dialog box with JPEG options appears (see Image 25). Once again as the Color Model we choose RGB, high quality of the image and Resolution should be Screen (72 ppi).
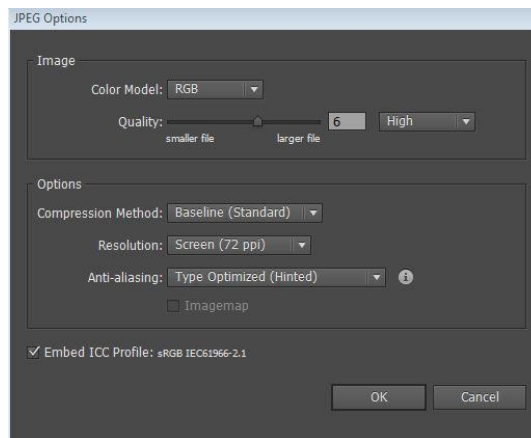

Image 27: JPEG options in Adobe Illustrator CS6

When the image is saved, we go back to InDesign document, select the placeholder where we want image to appear and choose File from the menu bar, then Place and we select the JPG image.

Once we have put static content like text and images in electronic book, it is time to make the book interactive. Easiest way to do that is to put some videos in the book. First we have to create the placeholder for the video. We can do that by using Rectangle Frame Tool. With this tool we create the placeholder with the same size as the video. Next we go to menu, select File and then Place and we choose video we want to add to electronic book. If the video's width and height are too large, we simply scale the placeholder, do the right click and choose Fitting and then Fit Content to Frame

option. This will reduce the size of the video and it will still be playable in its new size once the book is published.

Animations for interactive electronic book were created with Adobe Edge Animate CC. New project is created by choosing File from the menu, and then New. The default width of the project is 550 px and the height 400 px. It can be changed on the Properties panel, under Stage. Since this software does not have a lot of drawing tools, users can previously create the graphics that will be used in animations. In order to create them, Adobe Illustrator can be used, and the graphics can be exported as JPEG images and importedto Adobe Edge Animate. Graphics can be imported by choosing File from the Edge Animates menu, and then Import.
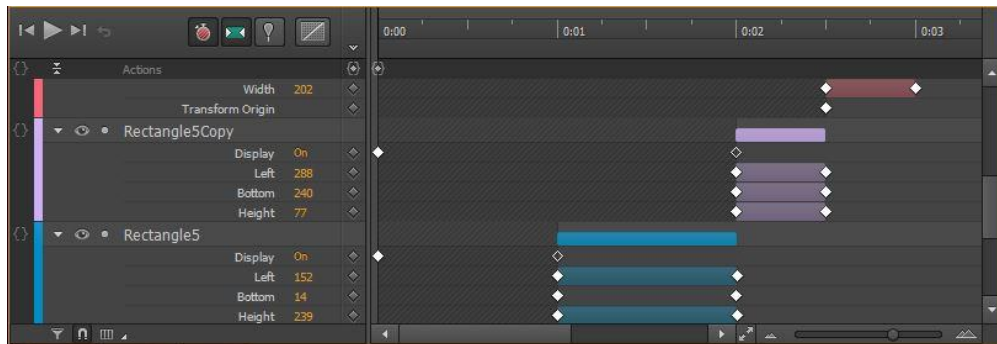

Image 28: Adobe Edge Animate CC timeline

Adobe Edge Animate can animate lots of object's properties by putting key frames in the timeline (see Image 26). Visibility of the object can be animated, so we can make object visible in certain moments of the animation. Opacity of the object can also be animated, so an object can fade in and out of the scene. Object can grow or shrink if its size is animated and it can move through the scene if its position is animated. Shadows and filter effects can be added to an object and they can also be animated. Filters that can be animated are: Invert, which inverts the colors of the object into its complementary color; Hue-Rotate filter animates hue of the object's color; Contrast filter animates contrast of the object's color; Saturate animates saturation of the colors; Sepia filter reduces the colors of the object; Grayscale filter discards the color information of the object; and Blur filter makes objects blurry.

Animations created in Adobe Edge Animate can be interactive. Animations in this electronic book are made interactive by adding the replay button. Replay button is

created by drawing a rectangle with the Rectangle Tool and then writing the word "replay" with the Text Tool and putting it on the rectangle. Next step is to select the text "replay" and do the right click and choose Open Actions for ''text''. Dialog box appears where JavaScript codes can be entered. Great advantage of this software is that it is not necessary to know how to do programming in JavaScript language because user can choose some of the default simple codes like Play, Stop, Stop at, Play from etc. In this particular case, to the text "replay" Play code is added. Rectangle and text are invisible until the end of the animation, which means that their Display in Properties panel is set to Off. At the last frame of the animation the key frame is created where their Display is set to On. In the properties panel the cursor that will appear when the user crosses over the rectangle is changed to Pointer to that user is aware that it is a button and that it is interactive. [23]

The animation can be previewed at any moment by choosing File and then Preview In Browser option. It will preview the animation in the default browser of the user. Once the animation is done it should be published in order to be embedded into the InDesign document.
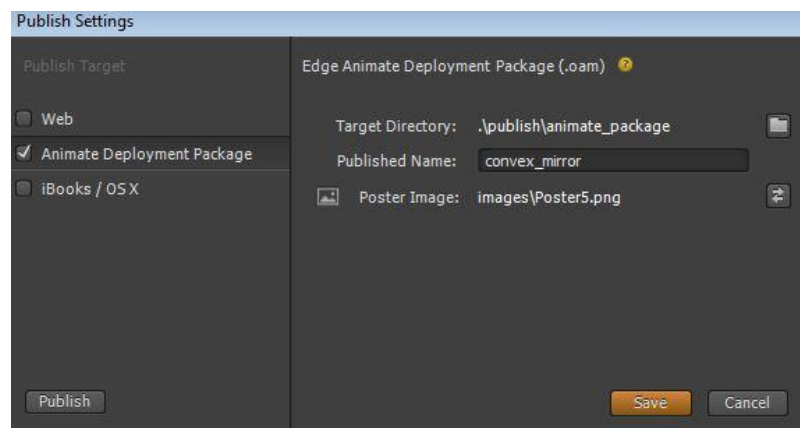

Image 29: Publish Settings in Adobe Edge Animate CC

First we choose File from the menu, and then Publish Settings (see Image 27). We check the Animate Deployment Package which will publish the document as OAM file. We set the Published Name and we can also choose Poster Image, the image that will appear in electronic book in the place where the animation is. When that is done, we choose Save and then Publish. In InDesign document we create the placeholder

which is the same size as our animation and select it. We go to File, than Place. When the Place box appears it will not show OAM files in the folders, so instead of Importable Files in Files of type box, we have to select All Files. OAM files are now visible and we can import them to the InDesign document.

The main problem with software is that it not very suitable for drawing objects like, for example, Adobe Flash software. Only drawing tools it has are Rectangle Tool, Rounded Rectangle Tool and Ellipse Tool (see Image 28). However, the reason why Adobe Edge Animate software is used instead of Adobe Flash software is that Edge Animate can publish .OAM file that can later be embedded in InDesign document, and Adobe Flash cannot.

Image 30: Drawing tools in Adobe Edge Animate CC

The problem with lack of drawing tools can be solved by importing graphics previously drawn in some other software, for example Adobe Illustrator. Image formats that can be imported are PNG, GIF, JPG, and SVG.

The other problem with Adobe Edge Animate is that once the animations are embedded into the InDesign document, they cannot be scaled like videos. If we reduce the placeholder and select Fit Content to Frame option, it will only reduce the poster image of the animation (which appears as a preview image of the animation), but animation, when played, will stay same sized. That is why, when creating new project, it is important to put in the same dimensions as the dimensions of the placeholder.

Next we create interactive quizzes after each lesson in same way we created the sample quiz. Images can also be imported to the quizzes by selecting Insert Image on the left menu bar. We can set the preferences of the quiz by choosing Quiz from the menu bar and then Quiz Preferences (see Image 29). In this electronic book all the quizzes have the same preferences (see Image 30). In Settings of the quiz we set that it is required that all the questions must be answered. We also check the box Submit All, which will give the option to submit all the answers at the end of the quiz, so that user

doesn't have to submit each answer separately. We also check the box Show progress so that user knows his progress at any moment of the quiz. Show Score at the End of the Quiz and Allow User to Review the Quiz boxes are also selected. Under the Pass or Fail preferences we set that the user needs to answer 50% of the questions correctly in order to pass the test. If the user fails the quiz, retake button appears. It can be set by checking the Show Retake Button box.
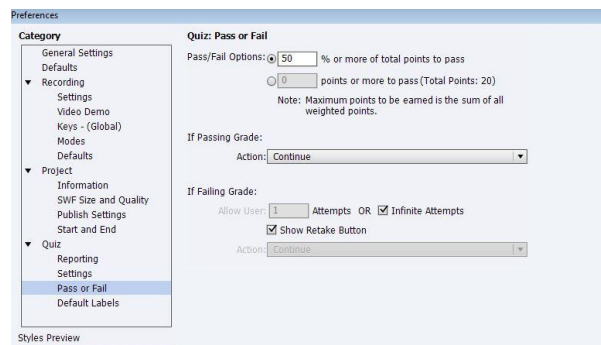

Image 31: Quiz preferences in Adobe Captivate 7

Adobe Captivate 7 has Check Spelling feature that checks spelling in all of the text in quiz and then offers replacement for incorrect words. It can be found on the menu bar under Project. Quiz can be previewed at any moment by choosing Preview button on the menu and then In Web Browser. Quiz will be previewed in the default browser of the user.
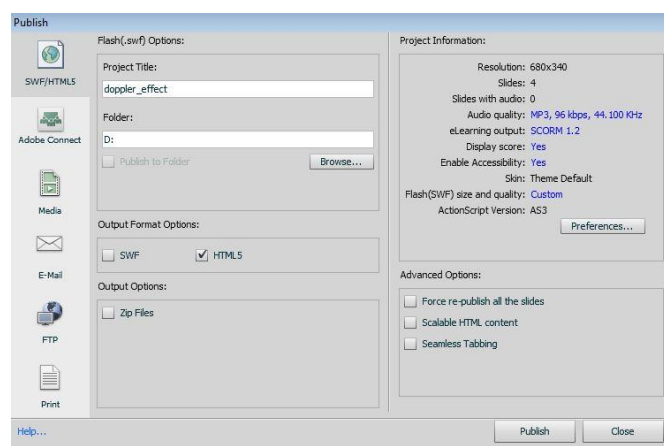

Image 32: Publish settings in Adobe Captivate 7

When the quiz is done, it should be published in HTML5 format (see Image 30) and embedded in InDesign document using Folio Overlay feature, where it can be

embedded as a Web Content. We import the HTML file published from the Adobe Captivate. When it is imported, it is important to check the box Allow User Interaction.

Once all the text, images, videos, animations and quizzes are embedded into the InDesign document, it is useful for the future users of the book to create the table of content because it helps them navigate through the content. It can be done manually, but it is easier to use InDesign's tools in order to create it. [24]

In order to do that, we have to create Paragraph Styles for both titles and subtitles. At the menu bar we select Type and then Paragraph Styles. Paragraph Styles box opens (Image 31), so we select Create new style icon at the bottom of the box. Main titles in this electronic book are Waves and Geometrical Optics so we select one of them with the Type Tool, set their font, font size, color and any other attribute. All these attributes define our new Paragraph Style. Once we defined the style, we apply it to the other main title. We do the same thing with subtitles: we create new Paragraph Style, define its attributes and apply it to all the subtitles. We join them in a group of styles in the Paragraph Styles window. In this case I named the group "Headings" and it contains paragraph styles named "Main title" and "Subtitle".

In this case table of content in two levels is made, which means that subtitles of lessons are going to be written under the main titles. Main titles will be counted in format 1., 2., 3. etc., and subtitles in format 1.1., 1.2., 1.3. etc. On the page where we want our table of content to appear, we make a text frame with Type Tool. We write ten lines of some random text, select it and create new main title paragraph style. In this case it is named "Numbered Level 1". On properties panel, under the menu bar, on the left side we select Paragraph Formatting Controls and we choose Numbered List option. InDesign creates automatic numbering.

Image 33: Paragraph Formatting Controls in InDesign CS6

The problem that appears is that the tenth line is not aligned with all other lines because number 10 has one more digit then the rest of the numbers. In order to fix that we hold the Alt key and select Numbered List option once again. The Bullets and

Numbering window appears (see Image 32). We can set the alignment on the Bullet or Number Position part of the dialog box. We simply write 0 (zero) to First Line Indent and InDesign automatically adds Tab Position that will align all the titles.

Second level of the numbered list is created in the similar way. Again we write ten lines of some random text, create new subtitle paragraph style and name it. In this case I named it "Numbered Level 2". We open the Bullets and Numbering window, and at the Level box we write 2. At Numbering Style part there is a field named Number and it shows how InDesign styles numbering in the list. The code written in the field by default is: ^#.^t

The # sign represents the number (e.g. 1). The dot next to it represents the dot in numbering (e.g. 1.). The ^ sign represents the space between number and first character of the subtitle. With this code we only have level one numbering so we need to add one more number that will make InDesign to number our subtitle in the level two format (e.g. 1.1). We select little arrow next to the Number field, choose Insert Number Placeholder and Level 1. New number is added to the numbering and the code now looks like this: ^1^#.^t

The subtitle will now be marked in this format: 11. Subtitle, which means we have to add a dot to the code: ^1.^#.^t
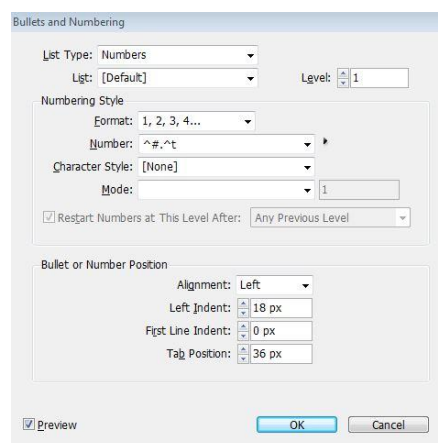

Image 34: Bullets and Numbering window in InDesign

For the Mode we have to choose Continue from Previous Number, or InDesign will number every subtitle as first. With this done, we defined our title and subtitle

paragraph styles and we can delete all the random text we used in order to define them. We group paragraph styles into one folder in Paragraph Styles window; in this case the group is named "TOC styles".

From the menu bar we choose Layout and then Table of Contents (see Image 33). At the Style box we choose the name of the group with paragraph styles of the titles and subtitles, in this case it is group "TOC styles". Next step is to choose title paragraph style from the Other Styles field and click Add in order to add them to Include Paragraph Styles box, and then we do the same with subtitle paragraph style. In this case we add "Main title" and "Subtitle" from "Headings" group of paragraph styles.

Next step is to open More Options field at the same window. When we select "Main title" from Include Paragraph Styles box, in the Entry Style field we have to choose "Numbered Level 1", and for "Subtitle" paragraph style Entry Style is "Numbered Level 2". This is how we tell InDesign how we want our titles and subtitles displayed in the table of contents. Page number field should be set at After Entry so that page numbers are showed after each title and subtitle. We click ok and create text frame and place the table of content there.
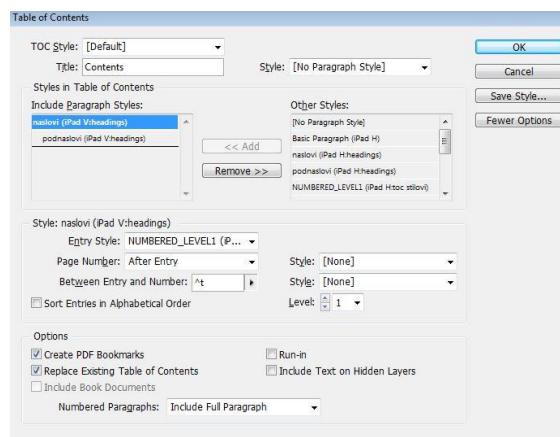

Image 35: Table of Contents window

The book is now finished, but it's still necessary to create the horizontal version of the book. It can be done easily in InDesign in Pages panel (see Image 34).
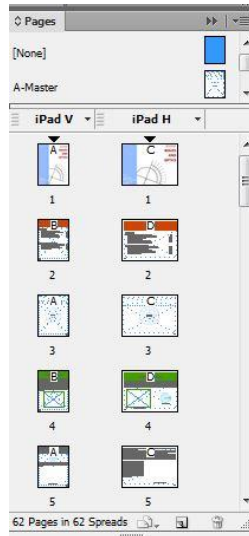
Image 36: Pages panel in InDesign CS6

We click on the iPad V, where V stands for vertical, and the dropdown menu shows up. We choose Create Alternate Layout (see Image 35). This option automatically creates horizontal version from the vertical ones.
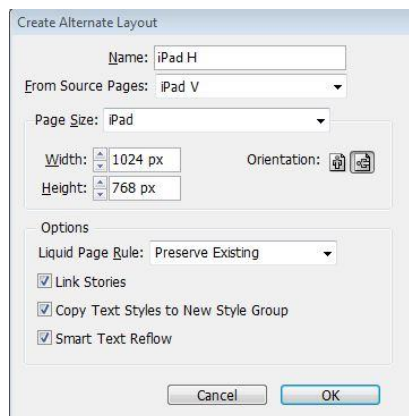

Image 37: Create Alternate Layouts window

We choose the name of the layout and its dimensions. If we want horizontal version, we have to set the width to 1024 pixels and the height to 768 pixels. When horizontal version is created, we import the horizontal version of the front page image to the first page. Dimensions of all the placeholders with text, pictures, animations, quizzes and videos are same and on the same place as they are in the vertical version of the book, so they need to be aligned properly. With this done, the book is finished and ready to be published.

The book can be previewed at any moment by choosing File from the menu, and then Folio Preview. It will be previewed in Adobe's software Adobe Content viewer which simulates iPad display. Pages can be turned by pressing up or down arrow, view can be zoomed in or out and user can choose whether he wants to see vertical or horizontal version of the book.
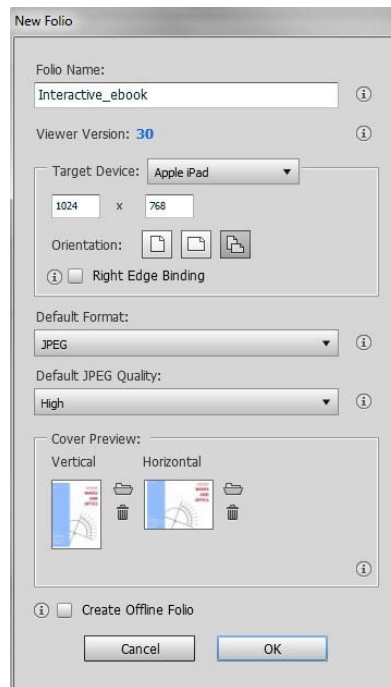

Image 38: New Folio window in InDesign CS6

To create the folio we choose Window from the menu bar and then Folio Builder. [25] To publish the folio user has to sign in with its verified Adobe ID. We choose New to create the new folio and now we have to specify its settings (see Image 36). In Folio Name field we specify the name of the folio. In Viewer Version we specify the target viewer version. This option is useful if either the newest version of the Adobe Content Viewer is awaiting approval or if the user is creating a folio for an earlier viewer app that has not yet been updated. Once the user creates a folio, it can edit folio properties to increase the version number, but cannot roll back to an earlier version. In Target Device field user specifies the target device or custom dimensions of the target device, such as 1024 x 768 px for an iPad. In Orientation field user indicates whether the folio is portrait-only, landscape-only or dual orientation. In Default Format field user chooses a default option for the folio. Automatic one is chosen if user wants

to let InDesign determine whether to export the pages as JPEG or PNG. Choosing PDF preserves vectors and reduces file size. In Default JPEG Quality field user can specify the JPEG Quality. Increased quality increases the file size. In Cover Preview field user select preview images for both vertical and horizontal versions of the folio. Images have to be created using the same pixel dimensions as the target device and exported as 72 dpi PNG or JPG files. User can also select Create Offline Folio option if it does not want to upload the folio content to the server at the time. It can later choose Upload To Folio Producer from the panel menu to upload folio contents.

Once we set all the settings correctly, we click OK, and the folio is created. Now we get the option to add a new article where we can add or import articles from our folio (see Image 37).

Image 39: Add Article option

Once user clicks that, he gets two options: either to Add Open InDesign Document or Import Article. We choose the first option in order to create the article from our existing InDesign document that we are working on. Dialog box appears where we set the name of the article, its format should be JPEG and JPEG Quality is High (see Image 38). We have to check the Horizontal Swipe Only so that pages of our folio are swapped only horizontally, not vertically, in order to achieve book reading impression.
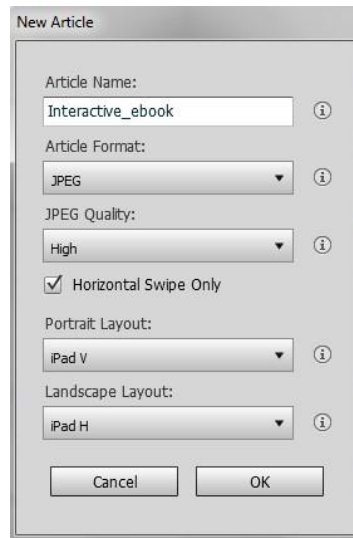
Image 40: New Article dialog box

When we click ok, Folio Builder starts building the folio. To see the progress, user can go to the dashboard and choose Folio Producer option, which opens Acrobat's Digital Publishing Suite web page (see Image 39). In this page user has to give the Publication Name, Folio Number and Description of the folio in order to publish it. When we click Publish, we have to give Product ID to our folio. Now user can share its folio with other users.
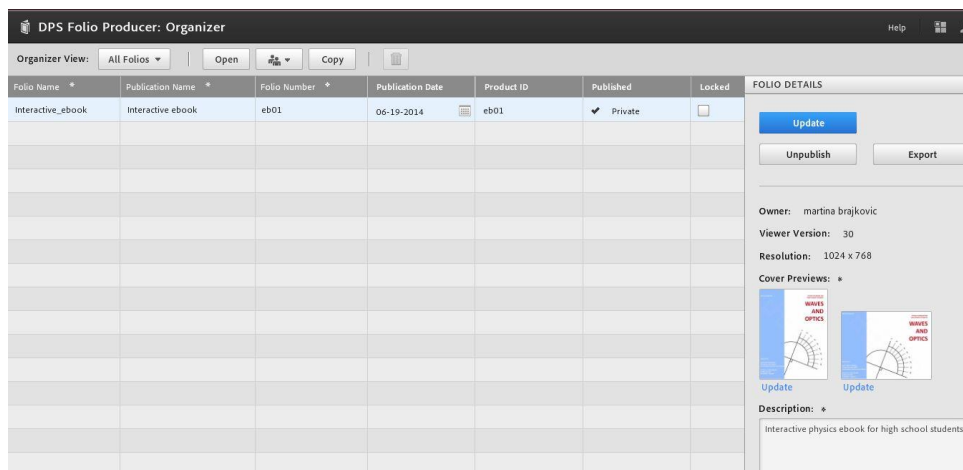

Image 41: Acrobat's Folio Producer web page

After the folio is created, user can use Folio Properties dialog box to change earlier specified properties. Some folio properties such as orientation, image format and folio size cannot be edited in the Folio Properties dialog box. If necessary, user can create a new folio with the appropriate settings. Published folios can be shared,

modified and unpublished. User can share its folio with other users so that other users can download the folio and view it on their devices. It is also possible to import some additional articles to the folio.

5.2   Using iBooks Author

First step of creating and electronic book using iBooks author is choosing the design template for the book. There are two groups of templates: Landscape with Portrait and Portrait Only. Landscape with Portrait are templates that are used if user wants to create both landscape and portrait versions of the book. Portrait Only templates are used if user wants to create just portrait version of the book. We want both versions so we choose between Landscape with Portrait templates. In this specific example, template Editorial is chosen.
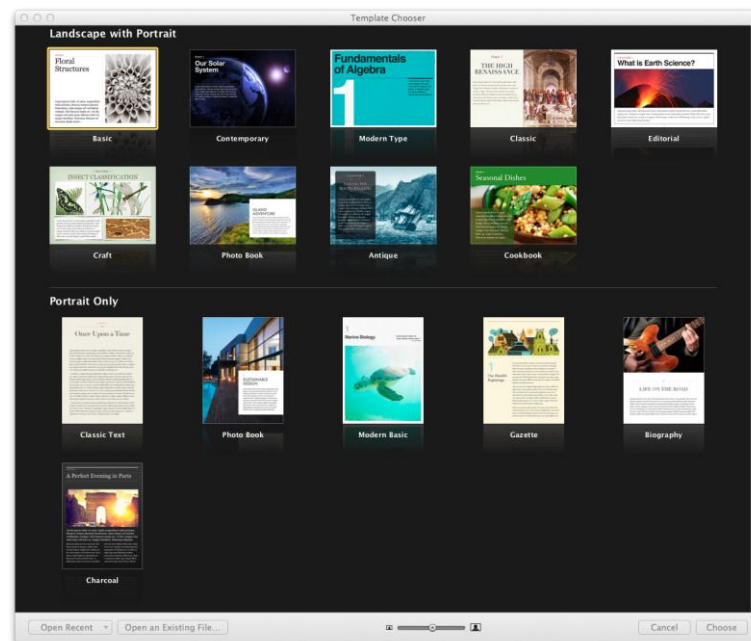
Image 42:Template Chooser

Now we can start designing the electronic book. First we create the covers. iBooks Author allows designing of only portrait cover. Landscape cover cannot be designed, so when opened on iPad, book cover can only be previewed in portrait orientation. Cover image can be simply dragged and dropped to the cover page.

Next step is to design the pages of the book: fonts, colors, position of the text, titles etc. Now we can copy the text of the book and paste it to electronic book, or we

can simply drag and drop the text document that contains the text of the book. To put text, we use Text Box tool. This software cannot write equations itself, just like Adobe InDesign, and it needs additional plug in or software to include equations in text. In this example software Daum Equation Editor is used.

Daum Equation Editor is user-friendly software that has lot of options to write equations. Using the options user writes the equations and copies them. To insert the equation to iBooks Author user chooses Insert and then Equation. Dialog box appears where the code of the equation should be pasted. Dialog box informs the user whether or not is the equation correctly written and it also gives preview of the equation. If everything works, user presses Insert and equation is inserted to the text.

Next we drag and drop images to the book. Text automatically moves around the image. Text formatting can be edited easily with lots of option that software offers to user. We can add other media to the book, for example videos. Video can be added using simple drag and drop technique. When the video is imported to iBooks Author, the software optimizes it. This is a durable process so there are only few videos in this book.

This software also has option to create a glossary. User can make any word or phrase in electronic book s glossary term. When the book is published, readers can tap or click a term to view its definition in an overlay, or view the term in the book's glossary. User can add any media to glossary; the term can be described with text, picture, music or videos. Each time the term appears in the book, it can be linked to its definition.
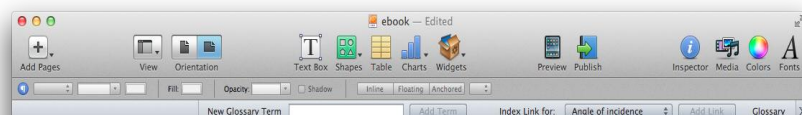

Image 43: Glossary bar in iBooks Author

Creating glossary terms is easy using Glossary Toolbar. If it is not visible, user should choose View and then Show Glossary Toolbar. First we select the text we want to make a glossary term. In the Glossary Toolbar, we choose Add Term. The new term appears in the text in boldface. To add a term's definition, we click Glossary in the

sidebar or simply click the term in the text and write the term's definition. To link another occurrence of the term to the definition, we select the occurrence in the book, choose the term from the "Index Link for" pop-up menu and click Add Link. An index link does not have to exactly match its term.

User can create quizzes for users to check their knowledge and understanding of the lessons. It can be done by using Review widget. In order to create the quiz, the page where the quiz will be must be selected. We go to Widgets and choose Review. The widget appears on the page and text automatically moves around it. We position it wherever we want and resize it if we want. We select Inspector from the right top corner of the bar. It opens dialog box where we can modify the widget. We choose the Interaction tab.

Image 44: Inspector box for Review widget

There is an option called Full-screen Only. If we check that box, the quiz will appear in full screen mode when reader starts it. iBooks Author offers different types of quizzes: Multiple Choice with or without images, or where images are choices, Drag Label to Target and Drag Thumbnail to Target. In this case, Multiple Choice type is chosen. We write the question and the possible answers. We select the correct answer so that iBooks Author knows which one is correct. In Inspector box we can also change number of possible answers up to six. If we want to add more questions, we click the plus icon in the Inspector box and once again choose the type of the question.

Drag Label to Target type of question is another useful quiz type. We drag and drop the background image to the quiz and put label circles on some parts of it. User has to name the parts of the image that are marked with labels. Drag Thumbnail to Target type of question works in similar way. Once again we drag and drop the background image and mark some parts with thumbnail circles. For each circle we choose an image that matches it. When reader takes the quiz, it will only see the circles on the image and will have to select the image that matches the right circle.

When the landscape version is finished, user can create portrait orientation. If user does not want to do that, it can go to Inspector, then Document Inspector and here choose Disable Portrait Orientation option. This way, when book is finished and published, user can only read it in landscape orientation on its iPad or other reading device. If user turns device to portrait position, the book will stay in landscape orientation. The main difference between portrait and landscape orientation is the way that pages are displayed. In landscape orientation all of the pages have the same dimensions, and user can add as much pages as it wants to the chapters and sections. All of the pages in portrait orientation have the same width, but user can change their height so that whole section can be put on the same page. When reader reads the book in the portrait orientation, it just scrolls down and the page moves from its top to the bottom, while in landscape orientation user turns the pages, just like in the real book.

6   RESULTS AND DISCUSSION

Process of the creation of this interactive electronic book had several stages. First stage was to translate the text of the book from Croatian to English language. Copy of the translated text with images is added as an annex to this work. Second stage was to take one chapter of the book and create the book sample of it. Third and final stage was to create the final interactive electronic book, using InDesing and iBooks Author.

In the process of the creation of the book using Adobe sowtware, two InDesign documents were created: short sample and the final version of the book. Short sample was created in order to see how much time is necessary to create one chapter of the book and what problems can occur while creating the content of the book.

After creating the sample of the electronic book and previewing it in Adobe Content Viewer, animations turned out to be the largest problem. When previewed in Adobe Edge Animate, they worked as it was expected, but when exported, embedded to InDesign document and previewed in Adobe Content Viewer, elements did not behave the way they were animated. This problem occurred because all the elements were drawn in the Edge Animate, which is not very suitable to draw vector graphics. Solution to this problem is to previously draw all the elements in some other software, such as Adobe Illustrator, embed them to the Edge Animate scene and use this software only to animate them. This the method used to create animations in final version of the book. Another big flaw of the Adobe Edge Animate software is lack of the drawing tools. In order to create elements that will be animated, users have to use at least one software more.

Second problem were images of equations that were imported to the book as graphics, without using MathMagic plug-in. The process of embedding the equations this way is more complicated and it requires more time. Images of the equations ended up to be of different sizes and resolution, which ruined aesthetics of the book. Those are the reasons why MathMagic plug-in was used to create the final version of the book. This method takes less time than the first one, but problems also occurred here. When the equation is copied from the word document with electronic book text and pasted to the MathMagic panel, some of the symbols or equation structures were not

recognized and had to be rewritten. Still, this method is chosen because it is faster and results in images of the same size and resolution that are automatically embedded to the text, so when text moves, the images move together with the text.

The last problem that occurred was quizzes created in Adobe Captivate software. When published from the Captivate software, default publish preferences have to be changed. Under the Quiz category, reporting of the project should be disabled. In contrary, quiz that is created will try to connect to LMS (Learning Management System) when the book is published, and when it fails to do so the quiz will be unable to run. Another big flaw of creating the electronic book using InDesign is creation of the table of content. The process is complicated and takes a lot of time.

There are also some flaws when publishing the book. Acrobat's Digital Publishing Suite web page allows the users with free accounts to upload only one folio without having to pay the fee. If user wants to publish another folio, first it has to unpublish the existing folio. Users with this account cannot publish public folios. If they want other users to see the folio, they have to share it with them via email. There is also option to publish the folio at exact time, but this feature is unavailable to users with free accounts.

The work resulted in functional interactive electronic textbook of physics that can be viewed on any device that has Adobe Content Viewer installed. However, considering all problems that occurred during the process, and also amount and the price of the software required to create the book content, it is good to research alternative ways to create interactive electronic book. Good alternative is Apple's software iBooks Author. It is free and it offers a lot of features that make the book interactive. It can create regular textbooks with just plain text, but users can also add images, videos, interactive diagrams, 3D objects, mathematical expressions and animations. This software has one useful feature where it offers pre-defined templates with various page layouts, so that user does not have to spend much time on designing the book. Adding text is much easier than in InDesign document. It is enough to drag and drop Microsoft Word document to the stage to add it as a new section. When the images are dragged and dropped to the stage that contains the text, the text will automatically flow around the images. Shapes, charts, tablets, text and widgets can be

easily added to the stage with just o one click. Mathematical expressions can be written by using integrated plug-ins LaTeX or MathML. Widgets are the features that are used to add photo galleries that can be swiped, animations with various effects and 3D objects that can be interacted with. iBooks author has built-in feature that automatically creates table of contents, much easier than in InDesign. The work can be previewed at any moment on iPad and no additional software is needed to do that, like Adobe Content Viewer is needed to preview the book created in InDesign. However, the book created in iBooks Author cannot be previewed on Mac computer, but user has to connect the iPad in order to preview the book. There is no software available for user to preview its work on the computer. When the work is done, the book can be submitted to Apple's platform iBooks for purchase or free download. iBooks automatically notifies reader of the book if there is a new version of the book available for download. Book can also be exported in iBooks format to share on iTunes U or to give it to anyone who has device to read it.

One of the flaws of this software is that it can only be used on Macintosh operating systems while Adobe software is available for both Macintosh and Windows operating systems.

Although Adobe software used to create this book has some flaws, they have a lot of useful features and options. If user has sufficient knowledge of that software, it can create almost anything it wants. InDesign offers more options in designing and formatting the text. For example, it has much more fonts and colors, unlike iBooks Author it allows subscript and superscript etc. Also, the process of creating the landscape version from the portrait one functions much better than in iBooks Author. InDesign automatically creates the other version and copies all of the content into it. User just needs to arrange it so it fits the page properly. In iBooks Author some of the content gets lost. For example, it does not copy the videos, but user has to import them one more time. The software then optimizes the video for the book, which is a very durable process. This is not the issue with InDesign.

Adobe Edge Animate animations are based on JavaScript language, so if user has sufficient knowledge in JavaScript programming, it can create various animations by adding any kind of interactivity to it. Adobe Captivate is software that can be used

to create a lot of diverse interactive content. Aside from quizzes, it can be used to make drag and drop interactive animations, simulations and other interactive e-learning content. InDesign is one of the best software to design books. User can design its book any way it wants with a lot of useful tools and options. Although iBook Author has page layout templates and is more suitable for beginner users of the software, InDesign gives complete freedom to the user to design the pages of the book. On the other hand, iBooks Author allows user to create a lot of interactive content using the same software. For example, user can create quizzes right in the iBooks Author software, while if we want to include the quizzes in InDesign book, we have to use additional software.

Both software have the same flaw: equations cannot be written in the software itself, but additional software has to be used, or equations can be imported as regular images.

The great flaw of first method is that it requires knowledge about Adobe software used to create the book, while iBook Author is user-friendly software that has a lot of automatic features at requires minimum knowledge about itself. Adobe software is more complicated and it requires time and practice in order to understand and learn it. Positive side is that all Adobe Creative Suite software is alike and they work in similar way. Therefore, if the user already possesses the knowledge about some of Creative Suite software, it will probably learn other software much easier. Unlike iBook Author these are not free software, but they do have 30 day free trial versions.

7   CONCLUSION AND FUTURE WORK

The process of creating this interactive electronic book was durable and sometimes complicated due to flaws of some software used in the creation. However, interactive electronic books are field that is developing fast so there is no doubt that in the near future there will be more software developed, hopefully software that does not require a lot of computing knowledge so that user with any level of computer literacy can create its own interactive electronic book. This could be very useful for teachers who want to enrich their classes with interactive multimedia materials.

Nowadays children grow up in computing environment and interactive electronic books are good way to help them learn. Growing up in such an environment makes them computer literate at very young age so they would have no problem in using this kind of books. Electronic book will probably never replace the printed book, but it can be extremely useful in learning with all the multimedia that can be embedded. Students see its great advantage in its small weight, because they do not have to carry heavy books on their backs in and out of school. [26]

Although printed book will probably never be replaced, electronic book definitely has a bright future. [27] Every day more and more electronic publications are sold, new reading devices are developed, electronic libraries get bigger and bigger, publishers tend to convert their publications into the digital format. In the future, electronic books will probably be available in parallel with printed books, letting the user to choose his preferred form of the book. More and more electronic book libraries are created every day. [28] For example, Project Gutenberg has a great amount of free electronic books and almost every classic title can be found there.

In the future, development of the interactive electronic books will continue. New software for creation will be developed and existing one will be improved. Hopefully in the future more options and features will be available while creating the book and more simple software for creation will be developed. Creation of an interactive electronic book will be available to anyone. Electronic learning will also continue to develop and more and more schools will implement it to its educational system. Some schools will completely replace traditional educating system with electronic one, and other will use electronic learning as supplement to their

conventional classes. Either way, multimedia and interactive learning materials will be crucial in the future of education. Unfortunately, schools will have to invest money to add electronic learning to their educational system, to get needed devices and buy studying materials. However, some studies have shown that educational results get higher when electronic learning is used in the process. [29]

Most of the tools used in this process sowed up to be very useful and with an awful lot of options. With these software electronic book designer can make any creative idea real and functional. Latest versions of InDesign software have a lot of new features that are useful in the process of electronic book creation. It is possible to embed videos, animations, sound, and web content like local HTML file or hyperlink to some web content. iBooks Author has the same features, but is much easier to use.

Nowadays there is a lot of software that can be used to create an interactive electronic book and it can be hard for a user to decide which method to use and which file format to create. The best way is to estimate one's own capabilities, knowledge and available software in order to select the method.

In the future research on software that could be used to substitute Adobe Edge Animate will be done, the software that showed out to be at least suitable for this process. The reason that it is used in creating animations is that it can publish animation in OAM format that can be imported into the InDesign document. Adobe's software that is most suitable to create animations is Adobe Flash software, but it publishes animations in SWF format that cannot be imported into the InDesign document, and it cannot export animations into the OAM format. Still, Adobe Flash can be used to create animations for electronic books that will be published in PDF format. Once the PDF is created, SWF animation can be added to the document. There will also be done the research on the software to conclude why some animations do not work when published.

8   REFERENCES

1.   Kipphan, H. (2001) *Handbook of print media: technologies and production methods.* Berlin, Germany: Springer-Verlag Berlin Heidelberg

2.   ***http://www.oxforddictionaries.com/us/definition/american_english/e-book - *Definition of e-book in English* (last request 20.03.2014.)

3.   Day, B. H.; Wortman, W.A. (2000) *Literature in English: A Guide for Librarians in the Digital Age.* Chicago: Association of College and Research Libraries

4.   Reilly, E. D. (2003) *Milestones in Computer Science and Information Technology.* Westport, Connecticut, USA: Greenwood Press

5.   ***http://webarchive.nationalarchives.gov.uk/+/cabinetoffice.gov.uk/e-government/resources/handbook/html/4-3.asp - *The National Archives: Non-HTML file formats* (2002) (last request 03.05.2014.)

6.   ***http://help.adobe.com/en_US/indesign/cs/using/WS328f5ee33f08f77d1e63e3 d120f2667a4c-7ffe.html#WS25B6E685-EB91-4c42-9EC4-87E1F94D68B2 – *InDesign / Dynamic PDF documents* (last request 20.04.2014.)

7.   ***http://accessproject.colostate.edu/udl/modules/word/tut_rtf.cfm - *Colorado State University: Rich Text Format from Microsoft Word, Introduction to RTF* (last request 12.05.2014.)

8.   ***http://helpx.adobe.com/indesign/using/whats-new-cs6.html - *InDesign Help / What's new in CS6* (last request 18.05.2014.)

9.   ***http://helpx.adobe.com/digital-publishing-suite/help/create-folios.html - *Digital Publishing Suite Help / Creating folios* (last request 10.06.2014.)

10. ***http://helpx.adobe.com/digital-publishing-suite/help/installing-digital-publishing-tools.html - *Digital Publishing Suite Help / Installing DPS tools* (last request 10.06.2014.)

11. ***http://www.apple.com/ibooks-author/ - *iBooks Author* (last request 20.05.2014.)

12. ***http://help.adobe.com/archive/en/photoshop/cs6/photoshop_reference.pdf - *Adobe Photoshop: Help and tutorials* (last request: 28.05.2014.)

13. ***http://help.adobe.com/archive/en/illustrator/cs6/illustrator_reference.pdf - *Adobe Illustrator: Help and Tutorials* (last request: 29.05.2014.)

14. ***http://blogs.adobe.com/captivate/2013/06/everything-you-need-for-elearning-with-amazing-adobe-captivate-7.html - Allan Partrige, *Everything You Need for eLearning with Amazing Adobe Captivate 7* (last request 01.06.2014.)

15. ***http://html.adobe.com/edge/animate/features.html - *Adobe Creative Cloud: Edge Animate CC* (last request 01.06.2014.)

16. ***http://blogs.adobe.com/captivate/2013/08/a-step-by-step-guide-to-create-an-interactive-ebook.html - *A Step-by-step guide to create an Interactive eBook* (last request 28.05.2014.)

17. ***http://www.overnightprints.com/difference-between-cmyk-rgb - *Differences between RGB and CMYK Color Modes* (last request 12.05.2014.)

18. ***http://designshack.net/articles/graphics/a-complete-beginners-guide-to-masking-in-photoshop/ - *Joshua Jackson: A Complete Beginner's Guide to Masking in Photoshop* (last request 20.05.2014.)

19. ***http://indesignsecrets.com/typesetting-math-in-indesign.php - *David Blatner: Typesetting Math in InDesign* (2008) (last request 17.04.2014.)

20. ***http://www.adobe.com/support/captivate/gettingstarted.html - *Adobe Captivate Tutorials* (last request 10.06.2014.)

21. ***http://help.adobe.com/en_US/captivate/cp/using/WS16484b78be4e1542-49d8496e13205a3aa39-8000.html - *Captivate / Insert question slides* (last request 28.05.2014.)

22. ***http://helpx.adobe.com/indesign/using/layout-design-9.html - *InDesign Help / Add basic page numbering* (last request 20.05.2014.)

23. ***http://tv.adobe.com/watch/adobe-evangelists-paul-trani/adobe-edge-animate-adding-interactivity-4-of-4/ - *Adobe Edge Animate: Adding Interactivity (4 of 4)* (last request 03.06.2014.)

24. ***http://help.adobe.com/archive/en/indesign/cs6/indesign_reference.pdf - *Adobe InDesign: Help and tutorials* (last request: 28.05.2014.)

25. ***http://help.adobe.com/en_US/digitalpubsuite/tutorials/WS67cb9e293e2f1f60-21ba9a4512e5e5e0b8d-7ffb.html -*Tutorial 2: Creating a simple folio* (last request 05.06.2014.)

26. ***https://www.apple.com/education/ipad/in-the-classroom/ - *iPad in Education* (last request 02.06.2014.)

27. ***http://conversations.nokia.com/2013/11/21/are-big-smartphones-the-future-of-e-books/ - *Joel Willans: Are Big Smartphones the Future of e-books?* (last request 20.05.2014.)

28. ***http://www.spreeder.com/blog/ebooks-vs-printed-books-which-is-preferred-now/ - *Ebooks VS Printed Books: Which Is Preferred Now?* (last request 17.05.2014.)

29. ***http://www.publishersweekly.com/binary-data/ARTICLE_ATTACHMENT/file/000/000/522-1.pdf - *Rüdiger Wischenbart: The global eBook Market: Current Conditions & Future Projections* (last request 04.06.2014.)

30. Labor, J. (2007) *Fizika 3*. Zagreb: ALFA d.d.

31. ***https://www.khanacademy.org/science/physics/waves-and-optics - *Physics: Waves and optics* (last request 27.04.2014.)

ANNEX

CONTENT OF THE INTERACTIVE E-BOOK [30]

TABLE OF FIGURES

1. Waves

1.   Introduction to waves

If we throw a rock on the still water surface, a phenomenon that is called wave will occur. It occurs because the rock, when falls into the water, conduces disturbance in the water. Generally, transfer of any disturbance trough certain medium is called wave. [31]

Wave transfers energy. We can imagine a piece of cork on still water surface. It has no kinetic energy. If we disturb the water on some distance away from the cork, we gave energy to those particles of water. After some time we will notice that the piece of cork is moving, which means it has kinetic energy. Kinetic energy is transferred by the wave from our hand, trough the water, to the piece of cork.

Harmonic wave. We can observe spreading of the wave on elastic spring. If we make oscillation that is vertical to the length of the spring on one end of the spring, peeks and troughs will move along the spring. If we make harmonic oscillation with one end of the spring, the wave that occurs is called **harmonic wave**.

Transverse and longitudinal waves. When the particles of medium move vertically on the direction of wave spreading, the wave is called transverse wave. It can be spread only trough solid mediums.

Particles of the medium can move parallel with the direction of wave spread. That kind of wave is called longitudinal wave. Longitudinal harmonic wave can be observed on elastic spring when we are producing longitudinally harmonic oscillations with one of its ends. It appears in the form of denser and sparser parts that move one after another along the spring.

Longitudinal wave can be spread trough solid mediums, liquids and gases. Most common example of longitudinal wave is sound.

Mechanical and electromagnetic waves. Waves transfer energy. It can be mechanical energy, but it can also be energy of electrical and magnetic field. According to that we differentiate between mechanical and electromagnetic waves.

Wavelength. We can observe generation of harmonic wave by watching how the appearance of the medium is changed while its end harmonically makes one whole oscillation. One part of the medium that transfers oscillations represents the source of the wave. The distance that wave makes while spreading in the time of one oscillation is called wavelength (λ). The units are meters (m). We can also say that wavelength is distance between two particles that oscillate in phase. Two points in phase are separate by an integer (0, 1, 2, 3…) number of complete wave cycles. They don't have to be peaks or trough but they must be separated by a complete number of waves.
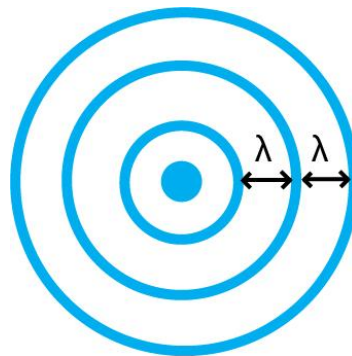

Image 1:Wavelength of a wave

Period. If we look at the wave, we will notice that it's formed of peaks and troughs. First comes one peak, then a trough and then another peak. If we measure the time between two adjacent peaks we will wind that it is the same. If we measure the time between two adjacent troughs we will notice that it is also the same. The time we have been measuring is the time for one wavelength to pass by. We call this time the period and it is characteristic of the wave. It is the time it takes for any two adjacent points which are in phase to pass a fixed point. The symbol is T and the units are seconds (s).

2. Speed of the wave propagation

Propagation of a transverse wave occurs as moving peaks and troughs, and propagation of longitudinal wave occurs as moving of denser and sparser parts. Speed of the wave is the speed of peaks and troughs, or denser and sparser parts moving. Generally, speed is the distance object travels divided by the time necessary to travel

that distance. In this case, wave travels the distance λ in a time T. This means that the speed of the wave is:

$$v = \frac{\lambda}{t} \quad \left[\frac{m}{s}\right] (a)$$

3.   Reflection and refraction of waves

Reflection of a wave. When a wave comes to the end of the medium, it reflects. There is a difference between reflection on fixed and non-fixed end.

Experiment 1.: If one end of a string is fixed and we make transverse wave on other, the wave will reflect when it reaches fixed end. If peak was in front of the trough before reflection, after reflection trough will be in front of the peak. Phase of the oscillation has changed for amount of π. During the propagation of wave, phase changes for π when wave crosses the length that is equal to half of the wavelength. Therefore, when the wave reflects on fixed end, phase changes in amount of π. This means that travelling of the wave will be longer for half of the wavelength (λ/2).

Why does the phase change when wave is reflected on the fixed end? Wave comes to the end of the string that is fixed on, for example, the wall. The end of the string is affects the wall upwards, and at the same time the wall affects with the same force (F) downwards (Third Newton's law). End is still, but wall affects the string so they move downwards instead of upwards (they would move upwards if there were no wall). That is how peak becomes trough.
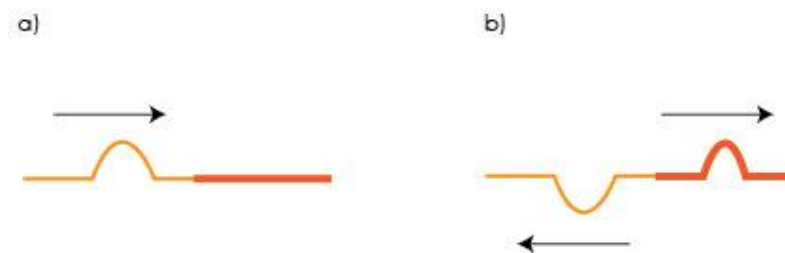

Image 2: Reflection of a wave travelling from normal to thicker string

Image 3: Reflection of a wave travelling from thicker to normal string

Experiment 2.: If we leave both ends free, reflection will still occur, but there will be no phase shift. We can explain it this way: when the last piece of the string reaches the top of the peak, the next piece of the string comes to the top of the peak afterwards. Since there is no more string in the direction in which wave moves, next piece of the string is the one that is in front of the last piece. it was already at the top of the peak and it comes back again at that place, and after it all of the other pieces of the string.

Experiment 3.: We attach thicker string on one end of the normal string and send one wave that has form of the peak from the free end of a normal string. When the wave comes to the join of two strings it will continue to move through the thicker string in the form of peak, but one part of the wave will reflect and move back trough the normal string in the form of the trough. But if the peak of the wave comes through the thicker string, after coming to the join, wave will move in the form of peaks through both normal and ticker string, but in opposite directions.

This experiment shows that on the border of two mediums wave partially reflects and partially transits to the other medium. In first part of the experiment wave has a phase shift in amount of π, and in the second part of the experiment there is no phase shift. In firs part of the experiment wave reflected when it came into thicker string. In thicker string the speed of the wave is lower than in thinner string. Therefore, when the wave reflects on the border of two mediums, reflected wave has phase shift in amount of π if the incoming wave reflect from the medium with lower propagation speed. There is no phase shift if wave reflects from the medium with higher propagation speed.

Refraction of a wave. Sometimes waves move from one medium to another. The medium is the substance that is carrying the waves. In our example this is the water. When the medium properties change it can affect the wave.

We can start with the simple case of a water wave moving from one depth to another. The speed of the wave depends on the depth. If the wave moves directly from the one medium to the other then we should look closely at the boundary. When a peak arrives at the boundary and moves across it must remain a peak on the other side of the boundary. Frequency of a wave is determined by the source and it does not change when wave goes from deeper to shallower water. Since the speed of the wave propagation depends on wavelength and frequency ($v=\lambda*f$), *(b)* the change of the wavelength means change of the speed of the wave propagation. The change of the direction of the wave propagation, while the speed of propagation is also changing, is called refraction of a wave.

We can take a look at the transition of the wave from the medium with higher propagation speed to the medium with lower propagation speed ($v_1 > v_2$) *(c)*. The angle between the ray of incoming wave and perpendicular on the medium boundary is called angle of incidence (α). Angle of refraction (β) is the angle between the refracted wave ray and perpendicular.
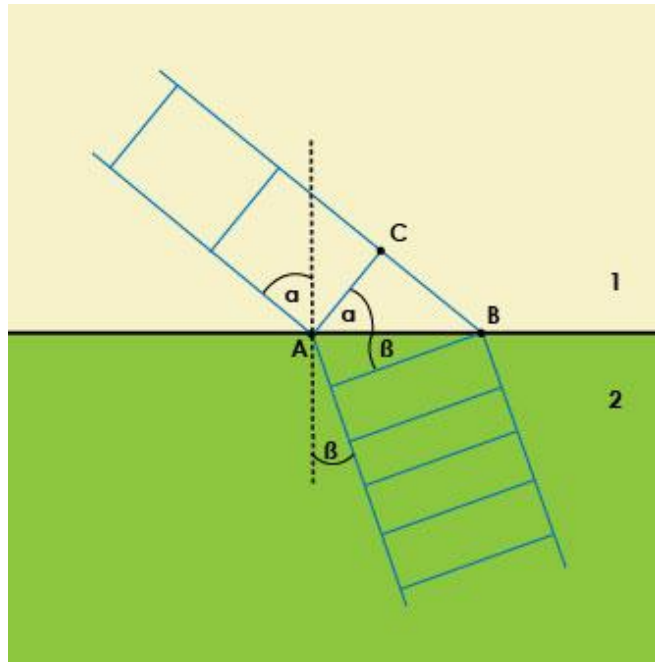
Image 4: Refraction of the wave

Length ICBI is the path that wave crosses in time (t) in first medium, and IADI is the path that wave crosses in second medium in same time (t). Those paths are proportional to the speeds: ICBI=v_1t *(d)*, IADI=v_2t *(e)*.

From the right-angled rectangle ABC we can conclude:

$$\sin \alpha = \frac{\text{ICBI}}{\text{IABI}} \text{ , (f)}$$

and from the right-angled rectangle ADB:

$$\sin \beta = \frac{\text{IADI}}{\text{IABI}} \text{ (g).}$$

If we divide those equations, we get:

$$\frac{\sin \alpha}{\sin \beta} = \frac{\text{ICBI}}{\text{IADI}} = \frac{v_1 t}{v_2 t} \text{ (h), which means: } \frac{\sin \alpha}{\sin \beta} = \frac{v_1}{v_2} \text{ (i).}$$

Ratio of the sinuses of the angles that rays of incident and refracted waves close with perpendicular on the medium boundary is constant for two mediums and is equal to the ratio of wave speeds in those two mediums. The angle between the ray of the

wave and perpendicular is higher in medium with higher wave propagation speed. This means that wave refracts towards the perpendicular when it transfers from medium with higher speed of propagation to medium with lower speed of propagation.

4.   Interference of waves

If many waves spread through the same medium at the same time, they all contribute to the movement of the particles from the equilibrium position. Waves that spread through the medium at the same time interfere. Movement of every particle of the medium from the equilibrium position is equal to the sum of the movements caused by each wave.

If two identical (same wavelength, amplitude and frequency) waves are both trying to form a peak then they are able to achieve the sum of their efforts. The resulting motion will be a peak which has a height which is the sum of the heights of the two waves. If two waves are both trying to form a trough in the same place then a deeper trough is formed, the depth of which is the sum of the depths of the two waves. Now in this case the two waves have been trying to do the same thing and so add together constructively. This is called constructive interference.

If one wave is trying to form a peak and the other is trying to form a trough then they are competing to do different things. In this case they can cancel out. The amplitude of the resulting wave will depend on the amplitudes of the two waves that are interfering. If the depth of the trough is the same as the height of the peak nothing will happen. If the height of the peak is bigger than the depth of the trough a smaller peak will appear and if the trough is deeper then a less deep trough will appear. This is destructive interference.

Length in which one wave lags behind other is called path difference (Δ). It is equal to difference between paths of the waves from their sources to any point where both waves are present. Path difference is equal to the wavelength for constructive interference. Constructive interference also occurs when path difference is equal to

zero, or when it is equal to integer number of wavelengths. For destructive interference it is equal to half of the wavelength multiplied with an odd number.
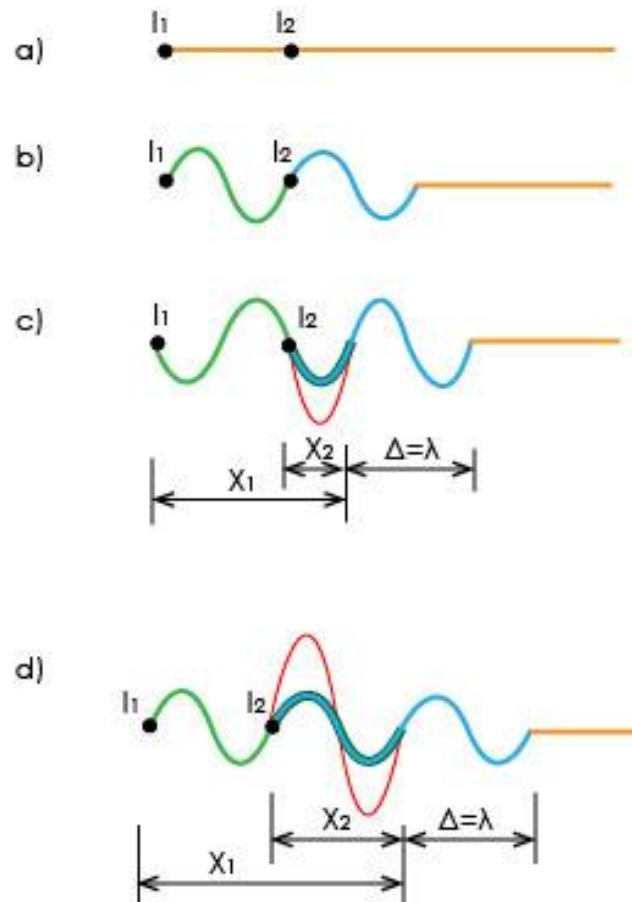

Image 5: Constructive interference of two equal harmonic waves when path difference is equal to wavelength

Path difference in constructive interference:

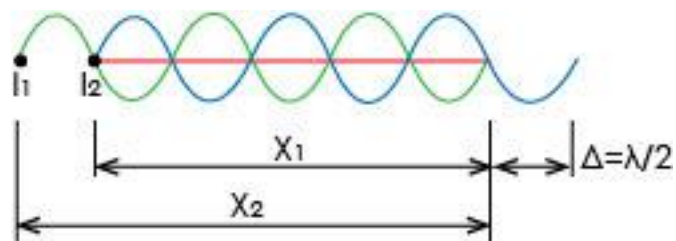$$\Delta = x_1 - x_2 = k\lambda; \quad k = 0, 1, 2, 3 \dots \text{ (j)}$$

Image 6: Destructive interference of two equal harmonic waves when path difference is equal to half of the wavelength

Path difference for destructive interference:

$$\Delta = (2k - 1)\frac{\lambda}{2}, \quad k = 1, 2, 3 \ldots \text{ (k)}$$

5. Standing wave

When two waves move in opposite directions, through each other, interference takes place. If the two waves have the same frequency and wavelength then a specific type of constructive interference can occur: standing waves can form. Standing waves are disturbances that don't appear to move, they look like they stay in the same place even though the waves that from them are moving. Peaks and troughs of a standing wave don't move, it doesn't propagate through the medium, it is standing in place and that is why it is called standing wave. Spots where particles oscillate with highest amplitude are called anti-nodes and places where particles don't oscillate are called nodes. In other words, a node is a place where the two waves cancel out completely as two waves destructively interfere in the same place. An anti-node is a place where the two waves constructively interfere. Length between two nodes or two anti-nodes is equal to half of the wavelength because it is the distance from a peak to a trough in one of the waves forming the standing wave. It is the same as the distance between two adjacent nodes.

If we have two identical point sources from which waves propagate in every directions, standing wave will be formed by interference. Nodes and anti-nodes of that wave are hyperboloids. Standing wave can be formed by two identical point sources of the sound.

6. Doppler Effect

The Doppler shift is an effect which becomes apparent when the source of sound waves or the person hearing the sound waves is moving. In this case the frequency of the sounds waves can be different. The height of the tone we hear while, for example, car approaches us is higher than the height of the tone we hear when a car

is distancing from us. This might seem strange but you have probably experienced the Doppler Effect in everyday life. The effect depends on whether the source of the sound is moving away from the listener or if it is moving towards the listener.

The car itself is source of the sound and it emits the tone with constant frequency, but observer registers higher or lower frequency. The observer will also register higher or lower frequency if the source of sound is still, but observer is moving and when both observer and source are moving.

We will discuss three cases: when source is still and observer is moving, when source is moving and observer is still, and when both observer and source are moving.

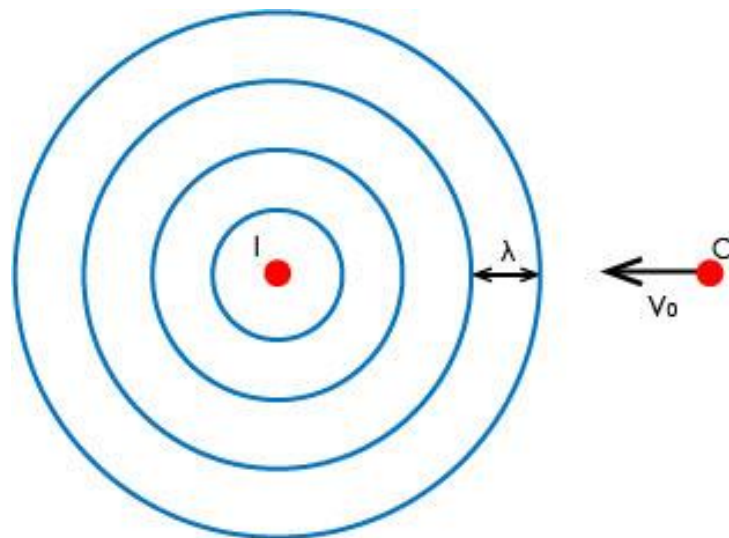**1.   The source is still and the observer is moving**

Image 7: The source is still and the observer is moving

Wave is propagating with the speed v from the point source I. If we say that observer is moving towards the source with the speed v_0, then the speed of the wave for the observer is $v+v_0$, and the frequency is:

$$f'=\frac{v+v_0}{\lambda}. \quad (l)$$

If observer were still, he would register frequency:

$$f=\frac{v}{\lambda}. \quad (m)$$

From the last two equations we get:

$$f'=f\frac{v+v_0}{v}. \quad (n)$$

If observer moves away from the source, his speed has negative sign:

$$f'=f\frac{v-v_0}{v}. \quad (o)$$

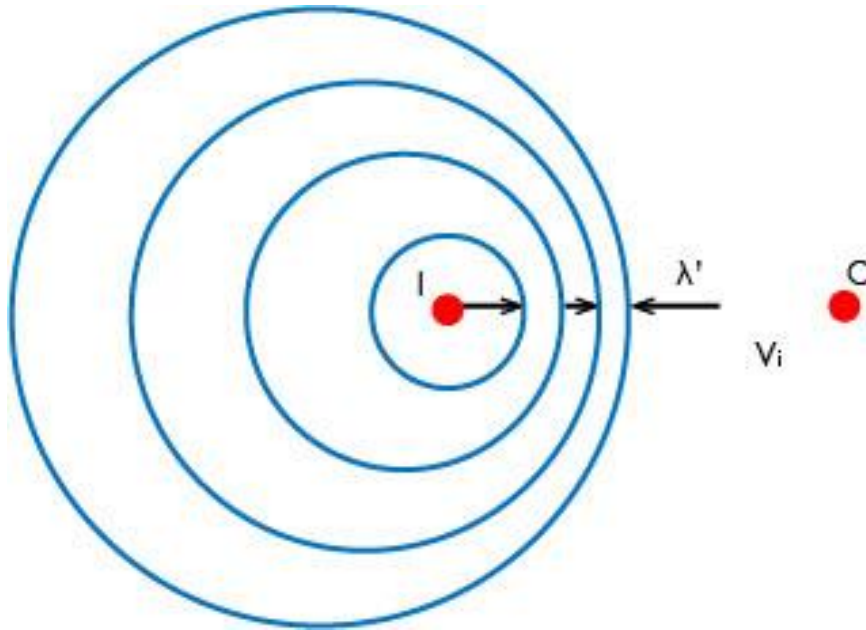## 2. The observer is still and the source is moving

Image 8: The observer is still and the source is moving

When source moves, it emits waves from different points. Wavelength is lower in the direction in which source moves (λ') than it would be when source would be still. Since the speed of the wave does not change, by changing wavelength, frequency also changes ($v=f\lambda$) *(p)*. How does the frequency that observer registers (*f'*) depends on speed of the source?

In direction in which source moves wavelength decreases for amount of the path that wave crosses in one period (*T*). If speed of the source is v_i, that path is v_iT, and decreased wavelength is: $\lambda'=\lambda- v_iT$ *(q)*.

If we include corresponding frequencies, we get:

$$\frac{v}{f'}=\frac{v}{f}-\frac{v_i}{f} \quad (r)$$

That means that frequency that observer registers is:

$$f'=f\frac{v}{v-v_i}. \quad (s)$$

If the source moves away from the observer, the speed of the source has positive sign:

$$f'=f\frac{v}{v+v_i}. \ (t)$$

3. Both source and observer move

Formula for the frequency that observer registers while both him and source move contains both previous cases:

$$f'=f\frac{v\pm v_0}{v\pm v_i}. \ (u)$$

Numerator has positive sign if observer moves towards the source and denominator has positive sign if source moves away from the observer. Negative sign is for the situations where observer moves away from the source and when source moves towards the observer.

It is known that bats use ultrasonic Doppler Effect for orientation and hunting. Bat emits ultrasonic waves and receives reflected ones. Based on the time that passed between emitting and receiving the signal, bat gets information about the distance of the object that reflects waves, and based on the difference between frequencies of emitted and received signal it gets information about the speed of the object.

7. Frontal wave

While studying Doppler Effect we saw that wave fronts thicken in direction of wave propagation. They are thicker as speed of the source is higher. If speed of source is higher than the speed of the wave, wave with front in shape of cone will be formed. That kind of wave front is called Mach cone. It is envelope of wave fronts that source emitted from different points. On the front of the wave is source, therefore that kind of wave is called frontal wave. Frontal sound wave is also called shock wave.
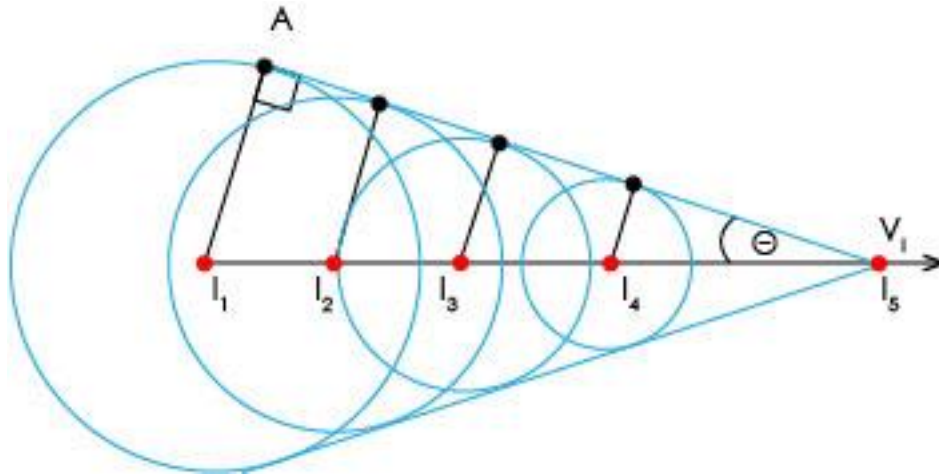
Image 9: Mach cone

If the source moves in the speed of v_i, in some time (t) it will cross the path $|I_1I_5|=v_it$ (v). In the same time wave moves with the speed v and crosses distance $|I_1A|=vt$. (w) From the right triangle I_1I_5A we can conclude:

$$\sin \theta = \frac{|I_1AI|}{|I_1I_5I|} = \frac{vt}{v_1t} \quad (x)$$

$$\sin \theta = \frac{v}{v_i} \quad (y)$$

Ratio between speed of source and speed of wave is called Mach number (Ma):

$$Ma=\frac{v_i}{v}. \quad (z)$$

Moving at the speed of sound is called Mach one. When we say that plane has Mach two speed, it means that it moves at twice the speed of sound.

If the plane moves at the speed of sound, wave fronts that it emits are thicken right in front of it in one wave front. Pressure, density and energy of the particles of the air have high values at that place. That kind of wave front acts like barrier, so when plane speeds up with additional energy and crosses that barrier, we say that it broke the sound barrier. After breaking the sound barrier wave front in form of the cone is formed. Here energy, pressure and density of the particles are as big as at the place in front of the plane before breaking the sound barrier. That is why wave front in the form of cone of shock wave can cause breaking of the window glass or some other damage.

Observer at the ground registers the breaking of the sound barrier when coned wave front comes to him.
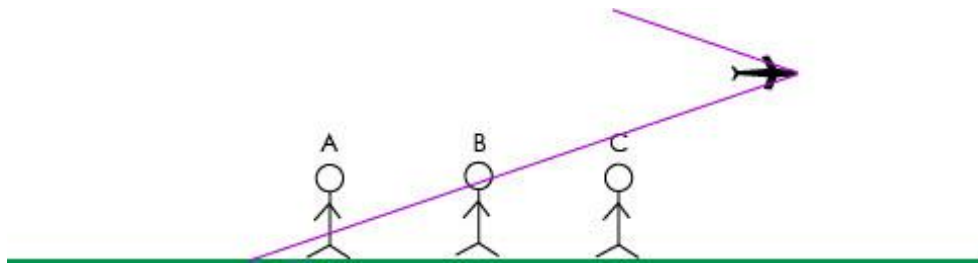

Image 10: Observers on the ground register breaking of the sound barrier

2. Geometrical Optics

Geometrical optics describes propagation, reflection and refraction of the light, and waves of light are shown with rays. Rays of the wave are lines along which wave is spreading and they are vertical on the wave surfaces. Using the laws of geometrical optics we can explain how does the human eye work, but also how do the optical devices work, such as microscope, binocular, devices for projection, camera.

1.   Propagation and reflection of the light

Light propagates rectilinear in homogenous medium. This fact is known as the law of rectilinear propagation of the light. Proof that light propagates rectilinear is the shadow we see on the screen when we lighten an object with the light from point source. The shadow is geometrical projection of the object on the screen.

By using the law of rectilinear propagation of the light we can explain how the picture of the object is formed in camera obscura, forerunner of the photo camera. Picture that occurs in camera obscura is real and reverse. Its size can be equal to the size of the object, but it can also be bigger or smaller.

Light reflects from the surface of the object. Angle that is closed by incident ray of light and perpendicular on surface of the object in the point of incidence is called angle of incidence (α), and the angle that is closed by perpendicular and the ray of reflected light is called angle of refection (ß). Angle of incidence is equal to the angle of reflection and incident and reflected rays and perpendicular lay in the same level that is vertical to the surface that reflects light. This is the law of reflection and it is valid for all the waves, not just light.
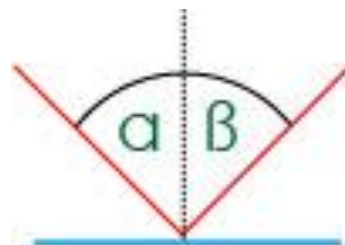

Image 11:Reflection of the light

There is a difference between regular and diffuse reflection. After the regular reflection parallel beam of light rays stays parallel. It occurs on smooth surfaces like mirrors. Diffuse reflection occurs on rough surfaces, like surface of the wall. After reflection on that kind of surface rays of light propagate in different directions. That happens because rough surface contains many small flat surfaces that are angled and for each one of that surface the law of reflection is valid.

Image 12: Reflection of the light: a) regular and b) diffuse

Flat mirror is a smooth opaque surface that reflects light rays. Rays come out in different directions from the point source. After reflection the picture of the source that we see in mirror is virtual and equally distant from the mirror as a source itself. If illuminated object is in front of the mirror, picture of every its part is equally distant from the mirror as that part. Picture that we get in the mirror is virtual, vertical, has the same size as the object, is equally distant from the mirror as the object, and its sides are reverse.
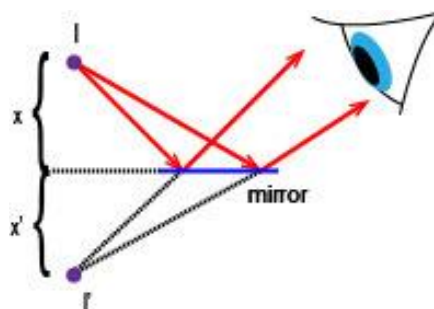

Image 13: Reflection on the flat mirror

2.   Spherical mirrors

Spherical mirror is a part of a surface of a sphere that reflects light rays on one of its sides. If the mirror reflects light rays with its inner side, it is called concave mirror, and if it reflects light rays with its outer side, it is called convex mirror.
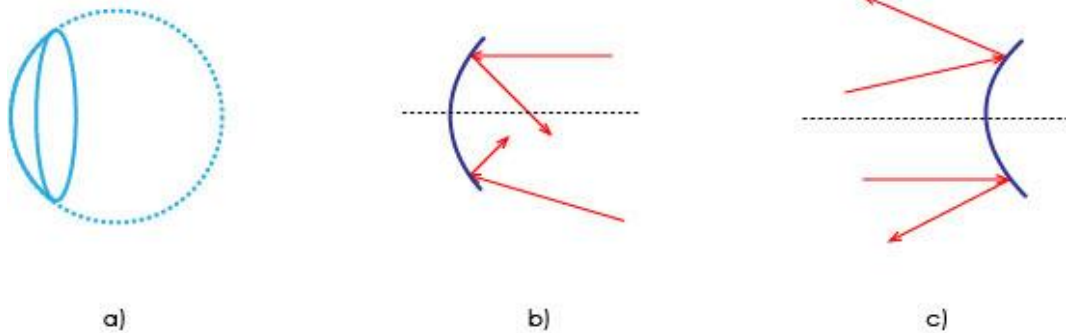

Image 14: Mirrors:

a) Spherical mirror is a part of a surface of a sphere.

b) Concave mirror reflects rays with its inner side.

c) Convex mirror reflects rays with its outer side.

Picture created in the mirror can be real or virtual, smaller or bigger and straight or reverse. Picture of the object created in concave mirror is real, smaller and reverse. Picture created in convex mirror is virtual, straight and smaller.

3.   Refraction of the light

Light can propagate trough different optical mediums (vacuum, air, water, glass etc.). When light travels from one medium to another it changes direction, except when it is incident normally on the separating surface. The change of direction is caused by the change in the velocity of the light as it passes from one medium to the other.

When the light travels from the medium with higher velocity speed to medium with lower velocity speed, it refracts towards the perpendicular. The speed of light is highest in the vacuum so when light travels from vacuum to some other medium, it will always refract towards the perpendicular. We can say that all other mediums are optically denser than vacuum.

Refractive index is equal to the ratio between sine of the angle of incidence (α) and sine of the angle of the refraction (ß).

$$n=\frac{\sin\alpha}{\sin\beta} \quad (aa)$$

That ratio is equal to the ratio of the wave speeds in certain mediums. If we say that c is the speed of light in vacuum, and v is the speed of light in some other medium, refractive index of the other medium is:

$$n=\frac{c}{v}. \quad (bb)$$

If the ray is travelling from one medium to another, and none of the medium is vacuum, than we consider relative refractive index. When ray travels from medium 1 to medium 2, relative refractive index of the second medium in regard to the first one is:

$$n_{2,1}=\frac{\sin\alpha}{\sin\beta}=\frac{v_1}{v_2} , \quad (cc)$$

where v_1 and v_2 are the speeds of light in certain mediums. Since $v=\frac{c}{n}$ (dd), we can conclude:

$$n_{2,1}=\frac{v_1}{v_2} = \frac{\frac{c}{n_1}}{\frac{c}{n_2}} = \frac{n_2}{n_1}. \quad (ee)$$
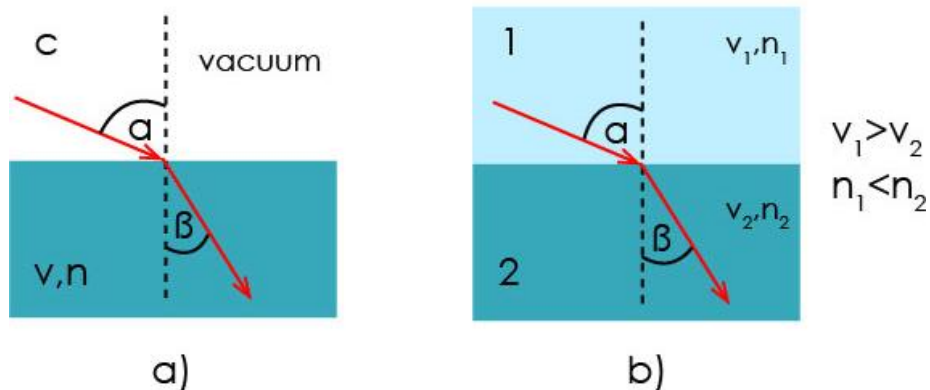

Image 15: Refraction of the light

If the ray travels from medium 2 to medium 1, relative refractive index of the first medium in regard of the second one is:

$$n_{2,1} = \frac{\sin \beta}{\sin \alpha} = \frac{v_2}{v_1} = \frac{n_1}{n_2} = \frac{1}{n_{2,1}} \quad (ff)$$

Snell's law or law of refraction says that the ratio of the sinuses of angles that are closed by incident and refracted ray and perpendicular is constant.

MEDIUM	REFRACTIVE INDEX	MEDIUM	REFRACTIVE INDEX
Air	1,0003	Glass	1,50
Ice	1,31	Water	1,33

Table 1: Refractive index of some transparent mediums

In the border of two transparent mediums light, as every other wave, partially reflects and travels to the second medium. If the ray is travelling from optically denser medium to optically sparser medium, it refracts away from the perpendicular. If the angle of incidence increases, the angle of refraction will also increase. If the angle of incidence is bigger than the certain amount, ray will not travel to second medium, but it will refract completely. This is called total internal reflection. Angle of incidence that corresponds to the angle of the refraction of $90°$ is called the critical angle (α_c). It depends on mediums and their relative refractive index:

$$\frac{n_2}{n_1} = \frac{\sin 90°}{\sin \alpha_c} = \frac{1}{\sin \alpha_c} \quad (gg), \text{ and therefore: } \sin \alpha_c = \frac{n_1}{n_2} \quad (hh).$$

If the sparser medium is vacuum, than $n_1 = 1$, and instead of n_2 we can simply write n:

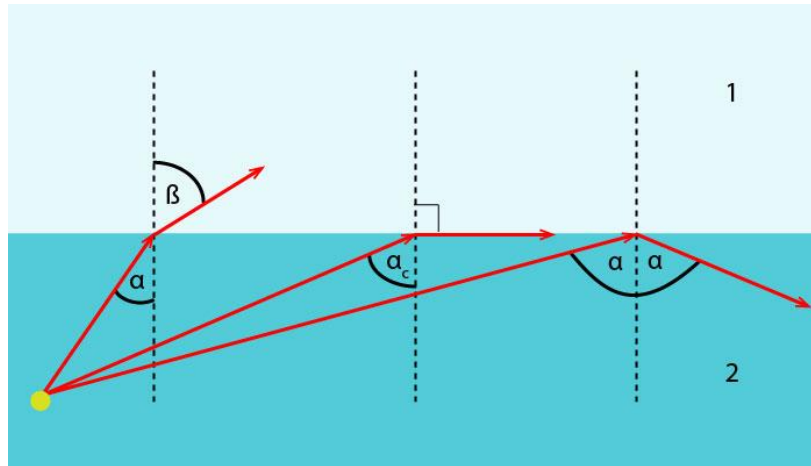$$\sin \alpha_c = \frac{1}{n} \quad (ii)$$

Image 16: Total refraction

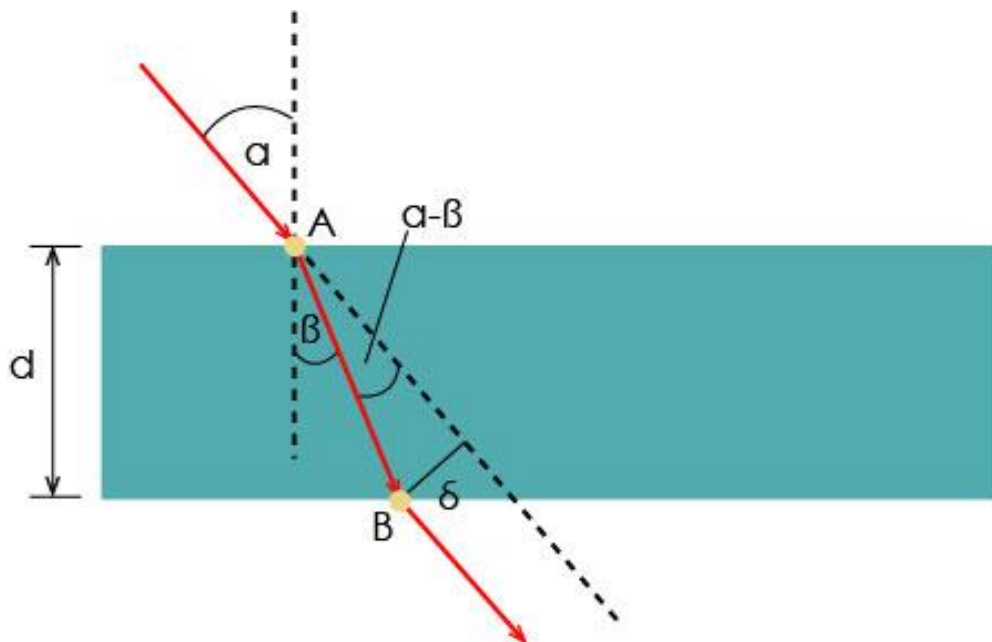4. Plane-parallel plate and optical prism

Image 17: Refraction of the ray of light on the plan-parallel plate

Plane-parallel plate is an optical device that is bounded with two flat parallel refraction surfaces. If ray is travelling from vacuum to plan-parallel plate, it will refract towards the perpendicular. When it is travelling from plan-parallel plate it will refract from the perpendicular. Output ray is parallel with the incident one, but it is shifted in regard to incident ray. Shift is marked with δ, and thickness of the plan-parallel plate is marked with d.

$$\delta = |AB| * \sin(\alpha - \beta) \;\; (jj), \text{ and } |AB| = \frac{d}{\cos \beta} \;\; (kk).$$

Shift is equal to:

ll

$$\delta = \frac{d * \sin(\alpha - \beta)}{\cos \beta}.$$

Optical prism is an optical device with two flat surfaces that together close an angle. That angle is called angle of a prism(ε). When the ray of light is coming into a prism with the angle of incidence α, it refracts towards the perpendicular under the

angle of ß$_1$. On the second surface ray is coming under the angle of ß$_2$, and when it is coming out of the prism, it refracts towards the perpendicular under the angle of α_2. The angle between incident and outgoing ray is called deviation angle or simply deviation (δ).

$$\delta = \alpha_1 - \beta_1 + \alpha_2 - \beta_2 = \alpha_1 + \alpha_2 - (\beta_1 + \beta_2) \ (mm)$$

Since $\beta_1 + \beta_2 = \varepsilon$ (nn), we can conclude that deviation is: $\delta = \alpha_1 + \alpha_2 - \varepsilon$ (oo).

The deviation is smallest (δ_m) when angles α_1 and α_2 are equal: $\alpha_1 = \alpha_2 = \alpha$ (pp). Therefore we can say that minimum deviation is equal to: $\delta_m = 2\alpha - \varepsilon$ (qq), which means that:
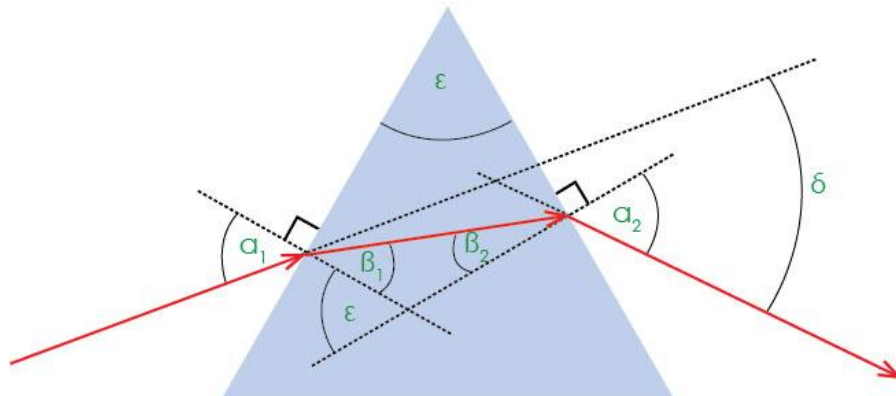
$$\alpha = \frac{\delta_m + \varepsilon}{2}. \ (rr)$$

Image 18: Refraction of the ray of light trough the optical prism

Angles ß$_1$ and ß$_2$ are also equal, which means:

$$\varepsilon = 2\beta \ (ss), \text{ or } \beta = \frac{\varepsilon}{2} \ (tt).$$

Refractive index of the prism is equal to:

$$n = \frac{\sin\frac{\delta_m + \varepsilon}{2}}{\sin\frac{\varepsilon}{2}} \ (uu).$$

5. Lenses

Lenses are used in many aspects of technology ranging from contact lenses to projectors. Lens is a transparent medium bounded by two diopters, of which at least one is spherical.
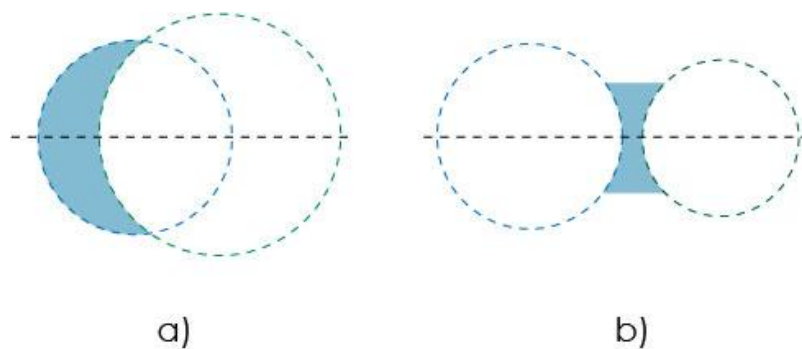

Image 19:Lenses: a) converging and b) diverging

There are two types of lenses, namely: Converging: Lenses that cause parallel light rays to converge to a point. Diverging: Lenses that cause parallel light rays to diverge. Such deviation of light rays is caused by refraction.
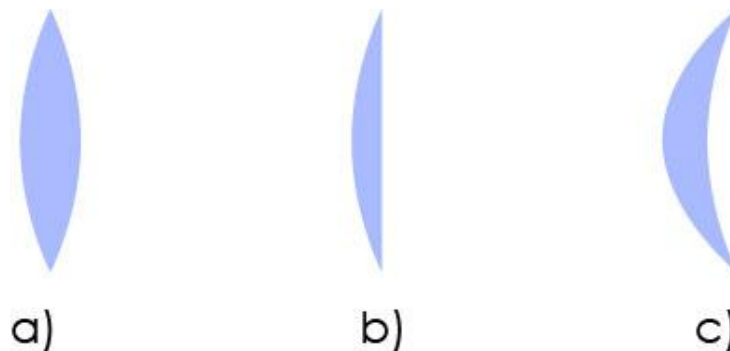

Image 20: Converging lenses: a) biconvex, b) plano-convex

and c) concave-convex

There are three types of converging lenses: biconvex, plano-convex and concave-convex. A lens is biconvex if both surfaces are convex. Plano-convex lens

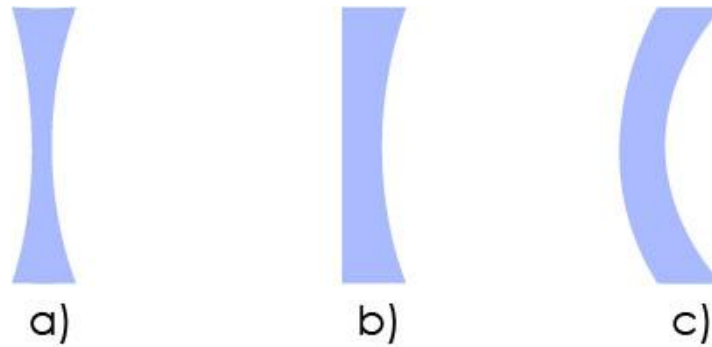have one surface convex and other plane. Concave-convex lens has one concave and other convex surface.

Image 21:Diverging lenses: a) biconcave, b) plano-concave and c) convex-concave

There are also three types of diverging lenses: biconcave, plano-concave and convex-concave. Biconcave lens has both surfaces concave, plano-concave has one surface concave and other plane and convex-concave has one convex and other concave surface.

Optical center is the center of the lens and principal axis is the line joining two centers of curvature of the surfaces of the lens. Focal point is the point at which light rays, parallel to the principal axis, converge, or appear to converge, after passing through the lens. Focal length is the distance between the optical center and the focal point.

The focal point of a converging lens is real, and the focal point of a diverging lens is virtual.