Accessible Science Labs:

A Resource with Experiments for Junior and Senior High Students who are Blind or Visually Impaired

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DEDICATION:

Many thanks to our colleague LMS for her initial contributions, continued interest, and participation in Accessible Science since 2008; a thank you to RJM through his work for its contribution of resources to make possible the work we have done; and most thanks go to Dr. Dennis Fantin of *Cal Poly* (*California Polytechnic State University*) and his "2nd Annual Access Chemistry Project" camp, for sharing his expertise and showing us possibilities.

SECTION 1: Preface

Originally this resource book was to begin with a wide variety of adapted laboratory experiments. This revised edition still includes several experiments, outlined using best practices that maximize the inclusion of students who are blind or students with low vision (or both).

However, during the duration of the Accessible Science project (and the writing of this resource) the feedback from most classroom science teachers began with “What equipment do you have to use?” Many of these teachers already based their selection of labs for any given semester on the maximum benefit to their students. As such, if a teacher had a choice of two similar labs, and that for one of them the Vision Resource Centre could loan a piece of equipment (that facilitates inclusion for the student who is visually impaired), the teacher typically selected that lab.

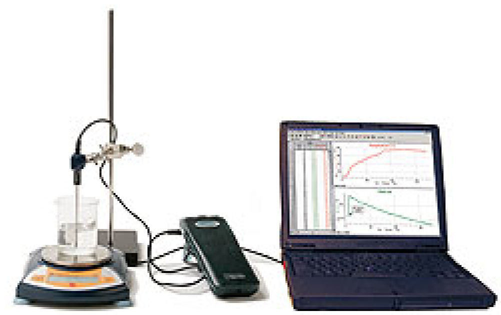
Therefore, this resource was revised to indicate first and foremost the types of equipment that one can use to adapt laboratory experiments, or is available to borrow. Following this, sample labs from the curriculum are included, with revisions to each showing accessible adaptations.

SECTION 2: Introduction

Full and meaningful inclusion is the preferred educational program for all students, regardless if the student is sighted or is visually impaired. In Alberta it is common to find academic students with visual impairments who are capable of performing the coursework in Science courses, and they typically have access to the textbook in an alternate format. However, the area where many students lack participation is in the hands-on practical laboratory experiments.

Most lab equipment requires visual confirmation for amounts and measures; therefore, the majority of students with visual impairments have limited participation in labs. At times, these students have been relegated the task of data recorder during experiments, but nothing more. Best practices in teaching Science would pair bookwork with the practical hands-on experiences to maximize student learning. Without access to full participation in labs, students with visual impairments are hampered in their learning.

However, recent developments in accessible computer software and science equipment enable even a person who is blind to participate more fully in labs. These students are able to gather their own data from various sensors, probes and digital equipment, when interfaced through a computer and rendered accessible through text-to-speech software or magnification programs.



Scale and temperature sensor, interfaced with data software on a laptop computer

This resource book begins with the items for loan from the various Vision Resource Centres, and then followed by sample lab experiments. Also included are appendices that may be useful for equipment setup and calibration.

SECTION 2: Introduction (continued)

About the Vision Resource Centres…

Vision Resource Centre - North

Presently there are three Vision Resource Centres (or VRC): the VRC-Calgary which initially started this model of student support; the VRC-Southern Alberta located in Lethbridge, encompassing that region of the province including Medicine Hat; and the VRC-North located in Edmonton, encompassing the region north of Red Deer and as far north as Fort McMurray (including supports to the Grande Prairie region).

In 2009 Alberta Education provided funding for science equipment through the Students with Vision Loss Initiative to each of the VRC. This equipment is designated specifically to provide supports to schools to better include students with visual impairments in academic science laboratory experiments.

At each of the VRC is a basic "kit" of equipment for Physics, Chemistry and Biology. However, the items outlined in this resource book are based on the present inventory of the VRC-North, but every item listed is not necessarily available at every VRC as additional items have been purchased since 2009. As well, some items may have duplicates in inventory, whereas other items may be the lone item on hand – therefore, certain equipment items on loan to one school may not be available at the same time to another school.

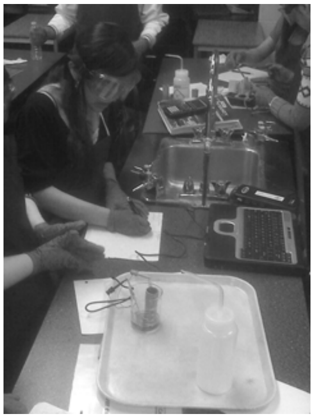
Loan of the equipment to schools is without cost, with the exception of transportation to/from the VRC. As well, schools would be financially responsible for the return of damaged or missing items.

Please contact the nearest VRC to your school to inquire as to equipment availability. Refer to the Vision Alberta website (http://vision.alberta.ca) for the contact information of each VRC.

SECTION 3: Equipment, General

A. Oversized Cafeteria Trays

This piece (or pieces) of equipment needs no further adaptation to be functional in laboratory experiments. Regardless of colour, both students with low vision or those who are blind would benefit from its use – keeps all their equipment contained in a defined work area, as well as limits accidental spills from spreading.



In addition, use of the contrasting colours of black and white assists students with low vision – depending on the type of experiment and/or the equipment used, a student with low vision may choose one colour over the other to better see, or one of each tray.

For experiments that utilize electronics such as a laptop with data software and probes to collect information, these electronics could be placed on one tray and the actual chemical experiment conducted on the other tray.

Approximate size: 45 cm (18”) × 65 cm (25”), available at food merchandising vendors such as Hubert.com

SECTION 3: Equipment, General (cont'd)

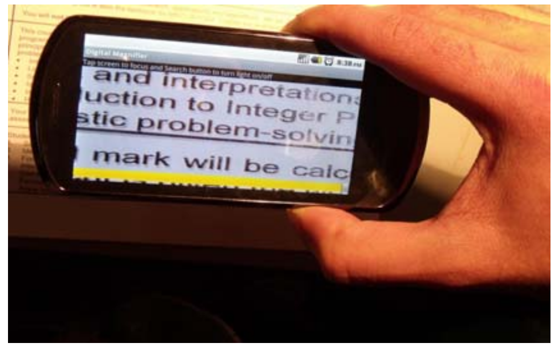
B. Task Lighting

Ideally a battery-powered natural-light task lamp would be best for use by the student with low vision – in the event an electrical outlet is not available or conveniently located. However, as many laboratories have outlets nearby, the necessity for battery-power is not the be-all and end-all.

Some lamps also include a built-in magnification lens, which may also prove to be invaluable during experiments for the student with low vision to better see details or equipment readings.

SECTION 3: Equipment, General (cont’d)

C. Hand-held Magnifiers



Whether low tech (optical lens) or higher tech (electronic magnification), this simple tool is valuable in laboratory experiments for the student with low vision. From reading the WHMIS information on a solvent to observations during a dissection, a magnifier is an excellent tool to have at the ready.

Students observing hydrogen gas forming when magnesium contacts hydrochloric acid. Note the use of both magnifiers and task lighting

SECTION 3: Equipment, General (cont'd)

D. Cut-resistant Gloves

Whether these are Kevlar® brand or other, for the student with low or no vision the use of a cut-resistant glove in various lab experiments saves the fingers – and allows for better participation in lab activities that otherwise would be deemed too risky.

Although they can be sterilized, one could also use the cut-resistant glove with a latex (or non-latex rubber) glove overtop to reduce contamination.

SECTION 3: Equipment, General (cont'd)

E. Measurement Devices

Available for loan from Alberta Education's Learning Resources Centre (LRC) are various protractors and rulers with tactile markings and/or braille labels. For the student with low vision, other measuring tools would also prove useful in various experiments.

Pictured below (but not available from the LRC) is a digital-readout tape measure – purchased commercially, locally available, and switches easily from metric to imperial measurements – as well as a "blindman's caliper" – erroneously named as it provides a large-print digital display of the minute readings from the caliper gauge. Both are useful for use by students with low vision.

SECTION 3: Equipment, General (cont'd)

F. Vernier LabPro Interface

Similar to the PASCO® brand of sensor/probe data collection system, the Vernier® line of science equipment collects data and stores/displays the results on a computer (Mac or PC).

Background: A few years ago (approximately 2008) a grant project at Penn State University focused on creating additional programming scripts for one specific text-to-speech program to better interface with Vernier software for a user who is blind. Originally designed to work with the Vernier LoggerPro 3.5 software and JAWS (JobAccessWithSpeech) 7.1 software, these scripts (available on Penn State's *Independent Laboratory Access for the Blind* website, ilab.psu.edu/links.html) enable the user to view data collected from a wide variety of Vernier probes and sensors. These scripts continue to work with LoggerPro 3.7 and any JAWS upgrades up and including 12.0.

The use of PASCO® brand software with a text-to-speech program may also be accessible to a user who is blind; as well, using Vernier's LoggerPro software may also be accessible with other text-to-speech software (other than JAWS). However, tested results have been achieved using JAWS with LoggerPro, as well as there being tips/tech advice from other users and through the ILAB website.

This interface (LabPro) with the accompanying LoggerPro software have a wide range of sensors and probes that are applicable for Biology, Chemistry and Physics laboratory experiments. Many of these have been tested with the JAWS software and are accessible to users who are blind. In addition, for the users with low vision, almost any magnification software program will enlarge the data results in the LoggerPro program.

SECTION 3: Equipment, General (cont'd)

G. Data Vest

The Vernier Data Vest allows for portability in data collection. With the LoggerPro interface powered by AA batteries, sensors can log data while being worn by the participant – for example, measuring the rate of acceleration on an amusement park ride for a Physics experiment, or recording pulse and respiration while jogging for a Biology lab.

To change the data collection settings, refer to documentation in the LoggerPro software help menu, or refer to the appendix on "Using LabPro Remotely".

Student wearing data vest while collecting data on roller coaster

SECTION 3: Equipment, General (cont'd)

H. Temperature Probe

The Vernier stainless-steel temperature probe is a described as a general-purpose device that can be used in various solutions for chemistry experiments, but it can also be used as a general thermometer in Physics and Biology as well.

In comparison to sighted students using the traditional glass 'candy thermometer' in experiments – which students with low vision find difficult to read, and is not appropriate for use by a student who is blind – the Vernier probe is far more accurate and allows for complete independence. As an additional advantage, unlike the fragile 'candy thermometer', this stainless-steel probe is very forgiving when accidentally dropped!

SECTION 3: Equipment, General (cont'd)

I. Ohaus Scout® Pro Portable Digital Scale

When used with the optional USB Interface kit, the digital scale can connect to the LoggerPro software and display its data on the computer. For the student using either JAWS or a magnification program, this renders scale measurements during a lab experiment completely accessible.

The scale included in the inventory of each of the three Vision Resource Centres is the SPE202, capable of measurements up to 200 grams and up to 2 decimal places. Other Ohaus Scout Pro models are capable of greater measurement (6000 grams) and also interface with Vernier's LoggerPro software.

Measuring sodium-chloride by mass, a student with low vision is using a magnification program to enlarge the mass readout in the LoggerPro software from the Scout Pro scale

SECTION 4: Equipment, Chemistry-specific

A. BRIGHT Atom Kit

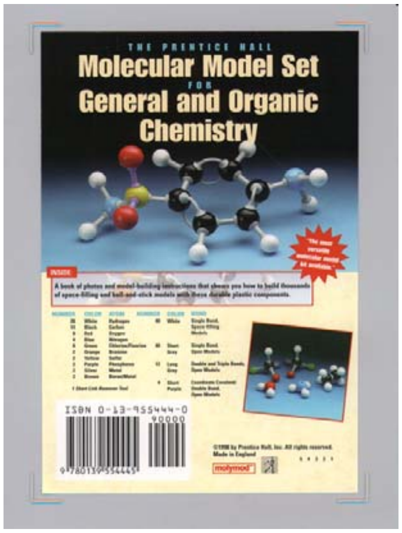
This Swedish product is available as a 'mainstream' teaching tool for use in Chemistry classrooms – in fitting with the curriculum at the junior high level – but was originally designed for the visually impaired.

A black-line on white lid can be used side-by-side with the white-line on black base; the pieces in the kit can be arranged to show students the various electron levels of atoms and their reciprocal protons (and neutrons) in the nucleus. Due to their high black-and-white contrast, it is easily read by a student with low vision, and each piece is tactile for viewing by a student who is blind. There is one kit in the inventory of each of the three Vision Resource Centres.

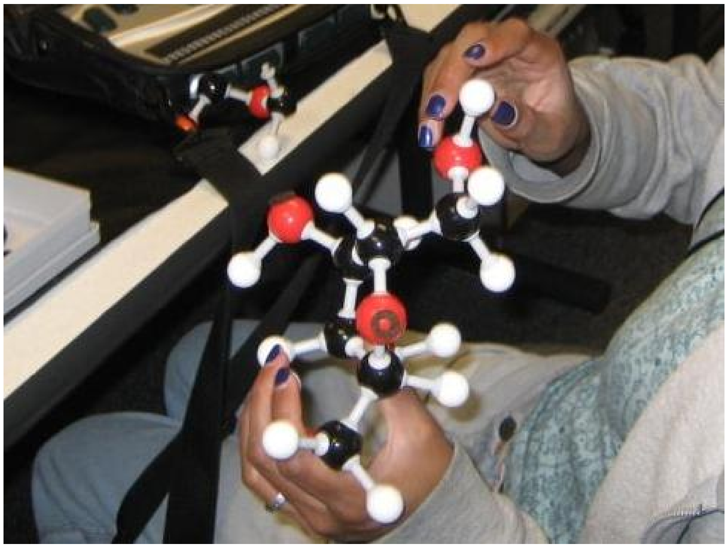
A representation of an oxygen atom

SECTION 4: Equipment, Chemistry-specific (cont'd)

B. Molecular Model Set



Most high school Chemistry departments are already stocked with this teaching tool. All that is required is to tactually mark some of the various pieces: for example, except for their difference in colour, Carbon and Nitrogen pieces are identical. Adding small felt pads, cork or vinyl bumpers (available at any hardware store) to one set of colours would help to indicate carbon from nitrogen, etc.



Student "looking" at a tactile representation of a hydrocarbon molecule. Note her use of a braille notetaking device (pictured in the background) to read lab protocols

SECTION 4: Equipment, Chemistry-specific (cont'd)

C. Auto-repeating Manual Pipette

Illustrated above is the Rainin "AutoRep M" manual repetitive pipette (by Mettler-Toledo), for use with either hand. Similar to other manual models, this pipette has a "stepping mechanism" to allow for precise repeat dispensing, and has various sizes of tips available.

If the student is unable to read the measurements on the side of a graduated cylinder, he or she could draw up a full amount of solution into the tip, select one of five dispensing steps, and pump out a precise amount each time until he or she achieves the desired amount – all this while peers use the graduated cylinder. A practiced hand at the manual pipette can more accurately* and quickly dispense a solution than his or her peers using the cylinder.

* According to Rainin's literature, their various tips range from ± 0.3-0.8% accuracy.

Student using manual pipette

To encourage independence, the reference chart – indicating the dispensing amount for each tip at each of the 5 step-settings – can be reproduced from the appedix in large print, or can be produced in braille using the accompanying electronic braille file version of the chart.

SECTION 4: Equipment, Chemistry-specific (cont'd)

D. Stirring Hotplate

Pictured above is the analog Corning Stirrer Hotplate, which comes with a Teflon-coated stir bar (pictured below) for hands-free agitation of chemicals. There are a number of models of stirring hotplates that can easily be adapted for use by students with visual impairments. The important aspect is *analog*, that is to say there is the absence of a digital display and push-buttons; dials are much easier to marked with braille to indicate temperature and stir-speed levels.

When a experiment is conducted where heat is required (not just stirring), it is advised that the student uses a 'tool' (e.g. tongs, wooden spoon, etc.) to locate the base of the hotplate and then work his/her way upwards with the 'tool' to find the top of the beaker (to avoid burns when needing to add more chemical, etc.). The alternate is to use an oven mitt in the non-dominant hand to locate the beaker (then adding more solvent etc. with the dominant hand, using the aforementioned auto-repeating manual pipette).

SECTION 4: Equipment, Chemistry-specific (cont'd)

E. pH Sensor

This is a tremendously valuable sensor! Far more accurate than a litmus paper test, for the student with a visual impairment this pH sensor renders accessible a host of chemistry experiments that otherwise require visual confirmation by a sighted peer. Some students with low vision could continue to utilize litmus paper like their peers; however, some students who may have enough vision to read a thermometer may also be colour-deficient – making the litmus test impossible for them. Again, this pH sensor becomes a valuable tool.

Because it give ongoing data regarding a solution's pH, this sensor would also be used in titration activities (see sample lab on titration).

Please note that at times, this sensor requires special calibration using 2 or more buffer solutions of known pH. Most importantly, this sensor needs to be stored upright and in its storage solution when not in use!

Two students with severe low vision monitoring the pH during a modified titration experiment (note use of manual repeating pipette)