Course: Lab Organization, Management and Safety Method (8629)
Semester: Autumn 2018
Level: B.Ed (1.5 Years)

ASSIGNMENT No. 1

Q.1 Write different aspects of storage of Materials and Chemicals in Laboratory.

Inventory of the chemicals

Each laboratory is to maintain an inventory of the chemicals stored in the laboratory as part of the lab safety plan. Designate a storage place for each chemical, and return it to that place after each use. Store chemicals by hazard class, not the alphabet, and post storage areas to show the exact location of the chemical groups. Inspect chemical storage areas at least annually for outdated or unneeded items, illegible labels, leaking containers,

Examples of chemicals in poor condition, that you should NOT keep stored in your lab:

- Expired/outdated chemicals
- Illegible/removed labels
- Degraded containers
- Leaking lids

Paper sealing of chemical container

To prevent leakage, odors, or reaction with air, tightly seal all containers of highly toxic, highly volatile, malodorous, carcinogenic or reactive chemicals. Make sure that caps and other closures are tight on all hazardous chemicals. A limited exception is freshly-generated mixtures such as acids and organics that may generate gas pressure sufficient to burst a tightly sealed bottle. Use commercially available vent caps or keep the lids loose until sufficient time passes to complete the reactions, and then tightly close the lids. Until all reactions are completed, the contents of the bottle are not waste, but are instead the last step of the chemical procedure.

The best seal is the screw cap with a conical polyethylene or Teflon insert (Figure 4.2). Seal the caps with tape or Paradigm® "M" as a further precaution. Additional protection can include wrapping the container in an absorbent paper, sealing it inside a plastic bag, **and storing the bag inside a metal can with a friction fitting lid.**

Smaller Container Size

The real, or "life-cycle", cost of a chemical includes its initial purchase price plus the ultimate disposal costs. Keep the quantity of accumulated chemicals in the laboratory at a minimum to reduce the risk of exposures, fires, and waste disposal problems. Smaller package sizes provide the following advantages:

- Reduced storage hazards
- Reduced storage space
- Safety in handling smaller quantities
- Reduced losses due to out-of-date chemicals
- Minimized cost of disposal of "leftovers"

Frequently, it costs many times more than the original purchase price to dispose of leftover chemicals. Chemical storerooms on campus keep supplies of the most frequently used solvents and chemicals to lessen the need for laboratory stockpiles.

Storage Symbol

Most chemical manufacturers include chemical storage symbols on their labels. Many manufacturers use symbols that include a hazard ranking system, such as the National Fire Protection Association (NFPA 704) diamond symbol or the Hazardous Materials Identification System (HMIS) colored rectangle. Picture glyphs are another common label element. Below are examples of the NFPA and HMIS hazard ranking.

Recognizing the need for a universal method to identify potentially hazardous substances, the United Nations has created a worldwide Globally Harmonized System (GHS) for label elements and safety data sheets. Because of the numerous languages used by the

worldwide research community, the GHS relies heavily on picture glyphs to convey the basic information. Below are GHS glyphs that will begin appearing on chemical labels and SDSs.

Color Code

Some chemical manufacturers also use color codes on labels and/or caps to indicate health, physical, and chemical hazards. These colors can be used as a guide for storage group's store same colors together, segregate from other colors. Unfortunately, the color schemes are not always consistent among manufacturers. Under most schemes, colors convey the following message:

Red

Fire Hazard and/or Flammables

White

Contact Hazard and/or Corrosive (acids or bases)

Blue

Health Hazard and/or Toxic or Poisonous

Yellow

Reactivity Hazard and/or Oxidizers

Green, Gray or Orange

Moderate or slight hazard (general chemical storage)

Striped or "Stop"

Exceptions within the same color code labels (example – yellow label chemicals are stored apart from striped yellow label chemicals)

Chemical Storage Location

Optimally, incompatible chemicals such as acids and alkalis should be stored completely separate from one another to prevent mixing in the event of an accidental spill or release of the materials. Limited storage space within the laboratories, however, sometimes prevents such prudent practice of chemical segregation and storage. If space is limited, you can store incompatible chemicals in the same storage cabinet if you segregate the chemicals according to their hazard class and you store them in tubs, trays, or buckets while in the cabinet. These secondary containers reduce the chance that incompatible chemicals will inadvertently contact each other.

Do not store chemicals in laboratory hoods because the containers may impede airflow and thereby reduce the effectiveness of the hood.

Store chemicals in the laboratory according to their compatibility groups. Do not store chemicals in alphabetical order, as this might place incompatible chemicals next to each other (examples include acetic acid and acetaldehyde, sodium cyanide and sulfuric acid, sodium borohydride and sodium chlorate), increasing the potential for accidental mixing of incompatible chemicals. The diagram entitled "Suggested Shelf Storage Pattern" (Appendix 4-A) indicates a recommended arrangement of chemicals according to compatibility. These compatibility groups should be stored separately, especially chemicals with an NFPA 704 or HMIS reactive rating of 3 or higher, (see Section IV) and in dedicated and labeled cabinets. Within any compatibility group, you can arrange chemicals alphabetically to facilitate ease of retrieval. The following are recommended compatibility groupings:

Group A – Acids, Inorganics

Store large bottles of acid in special acid cabinets, cabinets under lab benches, or on low shelves. Place acids in plastic trays for secondary containment in case of breakage. Segregate inorganic and oxidizing acids from organic compounds including organic acids (e.g., acetic acid) and other combustible materials. Segregate nitric acid (>40%) from organic chemicals, including organic acids. Store acids separate from bases and other reducing agents. Inorganic salts, except those of heavy metals, may be stored in this group. Glacial acetic acid should be stored with flammable and combustible materials since it is combustible.

Group B – Bases

Segregate bases from acids and oxidizers on shelves near the floor. The preferred storage container for inorganic hydroxides is polyethylene instead of glass. Place containers in trays for secondary containment in the event of leakage or breaks.

Group C – Organic chemicals

Segregate organic compounds from inorganics. Organics and inorganics with NFPA 704 or HMIS reactive hazard rating of two (2) or less may be stored together. Chemicals with a reactive hazard rating of three (3) or four (4) are to be stored separately.

Group D – Flammable and Combustible Organic Liquids

Flammable and combustible liquid storage per room is limited to 10 gallons (37.9 liters) in open storage and use, 25 gallons (94.7 liters) in safety cans, and 60 gallons (227.3 liters) in flammable storage cabinets. Remember that only 30 gallons (113.6 liters) of Class I liquids are permitted per room, and International Fire Code restrictions might limit this even further if your lab is located on an upper floor in a new or renovated building. Store flammable and combustible materials away from sources of ignition such as heat, sparks, or open flames, and segregated from oxidizers.

Group E – Inorganic Oxidizers and Salts

Store inorganic oxidizers in a cool, dry place away from combustible materials such as zinc, alkaline metals, formic acid, and other reducing agents. Inorganic salts may also be stored in this group. Store ammonium nitrate separately.

Q.2 Why these documents are important in Science Laboratory: Demand notes, Quotations, Orders, Delivery notes, invoices, catalogues, pamphlets, Stock cards and acknowledgement letters (20)

Important Notes

Specific science courses can be used to fulfill an Associate's degree requirement, or a certificate program requirement, or transfer to a 4-year college or university. In some programs, students only need one semester of a science but in most degree programs, a full-year sequence of a science is needed to meet graduation requirements. Please note that for the Associates in Science Degree at LFCC a full year sequence of either chemistry or physics is required as a portion of the degree requirements.

Biological Sciences

- **General Biology**
  - BIO 101 / BIO 102. General Biology I & II is our most popular science course as it satisfies the two semesters of science requirements for most transfer degrees. BIO 101 topics include biology at the cellular level and biological processes. BIO 102 topics include plants, animals, ecological and environmental principles.
- **Anatomy & Physiology**
  - BIO 145. Human Anatomy & Physiology for the Health Sciences is a one-semester course with lab that is an overview of the structure and function of the human body. It is required for students in areas such as Health Information Management, Transcription, Medical Coding and Billing, EMS, and Physical Training. This is also a course that is highly recommended to prepare students for the more challenging BIO 141 / BIO 142 Anatomy & Physiology classes. This course usually does not qualify as a transfer course to 4-year institutions.
  - BIO 141 / BIO 142. Anatomy & Physiology I & II is a foundational course for students entering the health care field. As this is a keystone course for entry into many health fields it is highly recommended that students take courses such as chemistry, microbiology and BIO 145 (a great prep course) before enrolling in BIO 141 / BIO 142.
- **Microbiology**
  - BIO 150. Introduction to Microbiology is a course typically taken by students entering biology or the health care fields. Practical hands on work in the lab is an integral part of this course that delves into the world of the unseen. If possible, it is advised that students take microbiology before taking A&P.
- **Cell and Molecular Biology**

- BIO 206. Topics included in this course include cell and molecular processes as well as basic biochemistry concepts. At this time, BIO 206 is currently offered only in the fall semester at the Middletown campus.

Chemistry

- **General Chemistry**
  - CHM 110. Survey of Chemistry is a one-semester course without lab designed to introduce students to the field of chemistry. This course usually does not qualify as a transfer course to 4-year institutions.
  - CHM 101 / CHM 102. General Chemistry I & II topics introduce students to basic chemistry with practical applications. CHM 101 / CHM 102 will satisfy the requirement for a two-semester science sequence for most Associate degrees and transfer degrees. Students who are planning on transferring into a science degree program at a 4-year institution should take CHM 111 / CHM 112 instead.
  - CHM 111 / CHM 112. College Chemistry I & II is a two-semester sequence designed for students that are preparing to transfer into a science program at a 4-year college or university. Successful completion of high school chemistry or CHM 101 / CHM 102 is highly recommended before taking CHM 111 / CHM 112.
- **Organic Chemistry**
  - CHM 251 / CHM 252. Organic chemistry offers students an advanced course in chemistry with or without lab. While most colleges and universities accept this course, students should check with their planned 4-year institution to confirm transferability of this course.
- **Biochemistry**
  - CHM 270. Biochemistry is a one-semester advanced course that is currently only offered only in spring semesters at the Middletown campus.

Physics

- PHY 101 / PHY 102. Introduction to Physics I & II is a general physics course that will meet the two semester requirements for many Associate degrees at LFCC. This course typically does not meet the requirements for transfer to 4-year institutions for science degree students but may fulfill the requirements for many other transfer degrees. Students planning on entering a radiology program are encouraged to take both PHY 101 and 102.
- PHY 201 / PHY 202. General College Physics I & II is a transfer course designed for students entering the sciences, engineering and for prospective science teachers in middle and high school.
- PHY 241 / PHY 242. University Physics I & II is an advanced physics transfer course for science students. Students pursuing an advanced degree in chemistry or physics should take PHY 241 / PHY 242.

quotation

A quotation is a document that a seller provides to a buyer to offer goods or services at a stated price, under specified conditions.

Also known as quotes, sales quotes, or sales quotations, quotations are used to let a potential buyer know how much their goods or services will cost before they commit to the purchase.

Quotations are usually not legally binding unless they are part of an official contract; however, it is generally accepted that a customer has committed to a sale, and a specific price, if they accept a quotation.

proforma invoice

A proforma invoice is a non-official invoice that is sent to a customer before the final details of a sale are confirmed. They are often used at the same point in the sales process as a quotation; however, quotes and proforma invoices serve slightly different purposes.

A quotation would normally be sent if a customer makes an enquiry, or if they want to find out more about a product or service . A proforma invoice is sent if a customer has committed to a purchase, but cannot be sent a true invoice because the final details of the sale are not certain.

Order:

Banking: An instrument (such as a check or draft) through which its maker or issuer (drawer) authorizes a bank or other financial institution to pay the stated sum to a named holder (drawee or payee).
Invoice
invoice amount is the **amount** of the bill. the **amount** stated in the bill is called the**invoice amount**.

Q.3 Write necessary materials and procedures for the conduct of following practicals:

i. To find melting point of a substance.

Determination of Melting Point

Determining the melting point of a compound is one way to test if the substance is pure. A pure substance generally has a melting range (the difference between the temperature where the sample starts to melt and the temperature where melting is complete) of one or two degrees. Impurities tend to depress and broaden the melting range so the purified sample should have a higher and smaller melting range than the original, impure sample.

1. Fill a capillary tube with crystals about 3 mm high. Put the capillary tube (open end down) into the crystals and tap it on the bottom of the crystallization dish to get the crystals into the tube. Force the crystals to slide to the bottom of the tube using one of the following methods: tap the tube (open end up) on the lab bench; drop the capillary tube through a 2-3 foot piece of glass tubing; or rub the capillary tube along a piece of wire gauze.
2. Place the capillary tube in the MEL-TEMP melting point apparatus. Set the MEL-TEMP at a high enough level to make a rapid determination of melting point. Observe the melting process though the magnifying lens.
3. Once a melting point range is determined, prepare another capillary tube (tubes should only be used once and then discarded) and set the MEL-TEMP to the appropriate power level, based on the power level/temperature chart. This time, make sure that the increase in temperature is no more than 2oC per minute. Again, observe through the lens.

Figure 1. A Fisher-Johns melting point apparatus.

1. Place a lens cover in the circular well and scoop crystals onto the lens cover (see Figure 2).
2. Place another lens cover on top of the crystals and move the magnifying glass over the well.
3. Set the temperature by using the dial and turn on the apparatus by flipping the switch.
4. Watch the compound through the magnifying glass and record the temperature at which it melts (see Figure 3).

Figure 2. Crystals on the lens cover

Figure 3. Compound after being melted

1. Set up a ring stand with a bunsen burner (which should be attached to a gas valve using rubber tubing), a ring above it, and wire gauze on the ring (see Figure 4).

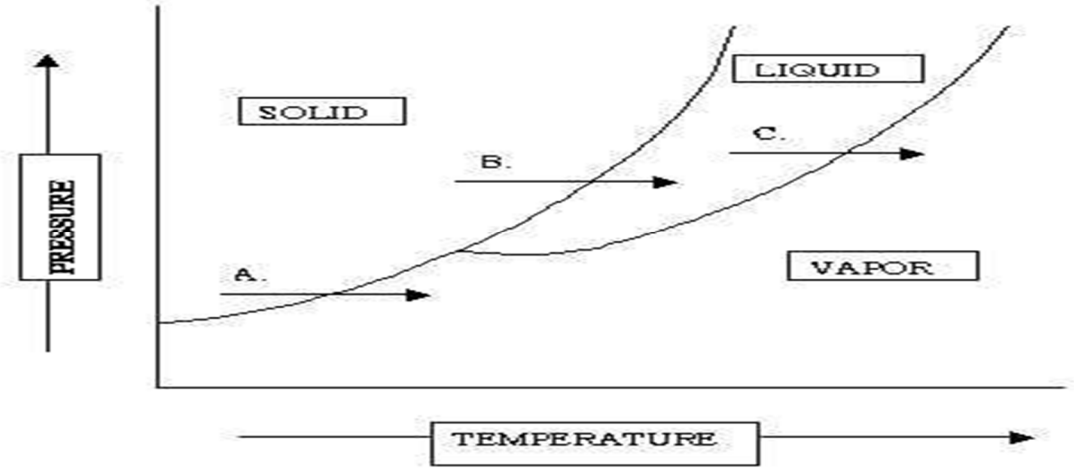
2. Place a beaker of mineral oil on the wire gauze.
3. Place a sample of the compound into a capillary tube and use a thin piece of rubber tubing as a rubber band to attach the capillary tube to a thermometer (see Figure 5).
4. Insert the thermometer through a hole in a cork, and clamp the cork to the ring stand as shown.

Figure 4. The set-up for the procedure

Figure 5. The thermometer with a capillary tube attached using rubber tubing

5. Use the bunsen burner to heat the mineral oil slowly.
6. Record the temperature at which the solid in the capillary tube melts.

1. When a satisfactory melting point range has been determined, choose a known substance that has a melting point within 5°C of the observed value. Make a homogeneous mixture of equal amounts of the unknown and the known substances. Grind them together using a mortar and pestle or a fire polished glass stirring rod and then fill a capillary tube with the mixture.
2. Determine the melting point of the mixture. If the unknown sample is identical to the known sample, the melting point will remain unchanged. If the two samples are different, the melting point will be depressed.



A. Sublimation
B. Melting
C. Evaporation

ii. To find the value of 'g'. (20)

The Value of g

- Gravity is More Than a Name
- The Apple, the Moon, and the Inverse Square Law
- Newton's Law of Universal Gravitation
- Cavendish and the Value of G
- The Value of g

In Unit 2 of The Physics Classroom, an equation was given for determining the force of gravity ($\mathbf{F_{grav}}$) with which an object of mass **m** was attracted to the earth

$$\mathbf{F_{grav} = m*g}$$

Now in this unit, a second equation has been introduced for calculating the force of gravity with which an object is attracted to the earth.

$$F_{grav} = \frac{G * M_{earth} * m}{d^2}$$

where **d** represents the distance from the center of the object to the center of the earth.

In the first equation above, **g** is referred to as the acceleration of gravity. Its value is **9.8 m/s^2** on Earth. That is to say, the acceleration of gravity on the surface of the earth at sea level is 9.8 m/s^2. When discussing the acceleration of gravity, it was mentioned that the value of g is dependent upon location. There are slight variations in the value of g about earth's surface. These variations result from the varying density of the geologic structures below each specific surface location. They also result from the fact that the earth is not truly spherical; the earth's surface is further from its center at the equator than it is at the poles. This would result in larger g values at the poles. As one proceeds further from earth's surface - say into a location of orbit about the earth - the value of g changes still.

The Value of g Depends on Location

To understand why the value of g is so location dependent, we will use the two equations above to derive an equation for the value of g. First, both expressions for the force of gravity are set equal to each other.

$$m*g = \frac{G * M_{earth} * m}{d^2}$$

Now observe that the mass of the object - **m** - is present on both sides of the equal sign. Thus, m can be canceled from the equation. This leaves us with an equation for the acceleration of gravity.

$$g = \frac{G * M_{earth}}{d^2}$$

The above equation demonstrates that the acceleration of gravity is dependent upon the mass of the earth (approx. 5.98x10^{24} kg) and the distance (**d**) that an object is from the center of the earth. If the value 6.38x10^6 m (a typical earth radius value) is used for the distance from Earth's center, then g will be calculated to be 9.8 m/s^2. And of course, the value of g will change as an object is moved further from Earth's center. For instance, if an object were moved to a location that is two earth-radii from the center of the earth - that is, two times 6.38x10^6 m - then a significantly different value of g will be found. As shown below, at twice the distance from the center of the earth, the value of g becomes 2.45 m/s^2.

$$g = \frac{(6.673 \times 10^{-11}\ N \cdot m^2/kg^2) * (5.98 \times 10^{24}\ kg)}{(1.276 \times 10^{7}\ m)^2}$$

$$g = 2.45\ m/s^2$$

As is evident from both the equation and the table above, the value of g varies inversely with the distance from the center of the earth. In fact, the variation in g with distance follows an inverse square law where g is inversely proportional to the distance from earth's center. This inverse square relationship means that as the distance is doubled, the value of g decreases by a factor of 4. As the distance is tripled, the value of g decreases by a factor of 9. And so on. This inverse square relationship is depicted in the graphic at the right.

Calculating g on Other Planets

The same equation used to determine the value of g on Earth' surface can also be used to determine the acceleration of gravity on the surface of other planets. The value of g on any other planet can be calculated from the mass of the planet and the radius of the planet. The equation takes the following form:

$$g = \frac{G \cdot M_{planet}}{R_{planet}^{2}}$$

Q.4 Write method and steps to prepare molar solutions of following compounds: Sodium Hydroxide and Aluminum Sulphate. (20)

Preparing Standard Sodium Hydroxide Solution

N solution of NaOH

From the discussion above, it should be clear that to make 1 Normal solution we need to know the, equivalent of NaOH, which is calculated by dividing Molecular weight by 1, that is 40 divided by 1= 40. So the equivalent weight of NaOH is 40. To make 1 N solution, dissolve 40.00 g of sodium hydroxide in water to make volume 1 liter. For a 0.1 N solution (used for wine analysis) 4.00 g of NaOH per liter is needed.

Standardization

Before we begin titrating that wine sample we have one more important step, standardization of NaOH solution. Standardization simply is a way of checking our work, and determining the exact concentration of our NaOH (or other) reagent. Maybe our dilution was inaccurate, or maybe the balance was not calibrated and as a result the normality of our sodium hydroxide solution is not exactly 1 N as we intended. So we need to check it. This is achieved by titrating the NaOH solution with an acid of known strength (Normality). Generally 0.1 N HCI is used to titrate the base. The reagent, 0.1 N HCI solution is purchased from a chemical supplier that is certified in concentration. That means it was standardized to a base of known concentration. "But isn't that going in circles?" you ask. No, because acids are standardized to a powdered base called KHP, or potassium hydrogen phthalate. This can be very accurately weighed out because it is a fine powder, and then is titrated with the acid.

To standardize NaOH, start by pipetting 10.0 ml of 0.1 N hydrochloric acid (HC1) into a flask. Add approximately 50 ml of water (remember, not tap water) and three drops of methyl red indicator. Fill a 25 ml buret with the 0.1 N sodium hydroxide solution and record the initial volume. Titrate the hydrochloric acid to the point at which a lemon yellow color appears and stays constant. Record the final volume.

Subtract the initial volume from the final to yield the volume of NaOH used, and plug that into the equation below.

$$\text{Normality of NaOH} = \frac{\text{Volume of HCI} \times \text{Normality of HCI}}{\text{Volume of NaOH used}}$$

Titration Techniques

Before conquering volumetric analysis totally, we need to discuss some titration techniques. First of all, handle the buret with care. Avoid damaging the tip and petcock assembly because damage and leaks in these areas can and will alter performance. Also, be sure to always record your final and initial volume readings accurately by reading the bottom of the meniscus of the solution. Don't try to squeeze in that last sample and drain the buret past its lowest mark; take the time to refill it properly. For help in reading a buret, take a white index card and color a black square on it as shown. Hold this behind the buret scale when taking readings to aid in seeing the meniscus. Some burets actually come with a stripe painted on them for this reason.

Next, remember to stir your sample as you titrate. Whether using a stir plate (recommended) or stirring by swirling the flask manually, it is imperative that the solution be mixed. Be sure not to slosh the sample outside of the beaker/flask and don't allow the buret's contents to fall outside of the beaker. Also, lower your buret enough so that splatter from the sample does not exit the flask as you titrate. This is not only bad lab practice but can also be dangerous.
Safety is an important consideration when working with burets, acids and bases. Realize that you are handling corrosive chemicals and delicate glassware, treat it like an irreplaceable wine in the daintiest glass. That means deliberately and with respect. Wear safety glasses and a labcoat at least, and gloves are also recommended. When filling a buret, take it out of the stand and hold it at an angle with the tip above the sink. That way any spills will drain into the sink and you can stand safely on the floor, not a stool. Leaning over the buret while it is on the benchtop is dangerous.
Be sure to have access to an eyewash station or something that can supply a stream of water to your body and/or eyes for 15 minutes, the OSHA recommended treatment for chemical spills to the eyes and body. Remember you will have sodium hydroxide in the buret at and above eye level so make sure your equipment is attached to a steady base.
Good laboratory practices can help you monitor the quality of your wines more accurately and efficiently. Volumetric analysis by titration is one of the most common techniques the winemaker employs to analyze his product. Improving your skills in this area is important in the quest for excellent wines on a consistent basis.
Aluminium sulfate is a chemical compound with the formula $Al_2(SO_4)_3$. It is soluble in water and is mainly used as a coagulating agent(promoting particle collision by neutralizing charge) in the purification of drinking water[3][4] and waste water treatment plants, and also in paper manufacturing.
The anhydrous form occurs naturally as a rare mineral millosevichite, found e.g. in volcanic environments and on burning coal-mining waste dumps. Aluminium sulfate is rarely, if ever, encountered as the anhydrous salt. It forms a number of different hydrates, of which the hexadecahydrate $Al_2(SO_4)_3 \bullet 16H_2O$ and octadecahydrate $Al_2(SO_4)_3 \bullet 18H_2O$ are the most common. The heptadecahydrate, whose formula can be written as $[Al(H_2O)_6]_2(SO_4)_3 \bullet 5H_2O$, occurs naturally as the mineral alunogen.
Aluminium sulfate is sometimes called **alum** or **papermaker's alum** in certain industries.
However, the name "alum" is more commonly and properly used for any double sulfate salt with the generic formula XAl(SO
4)
2·12H
2O, where X is a monovalent cation such as potassium or ammonium

Q.5 Explain Barriers to change in Laboratory practices in Pakistan. (20)

Identifying and overcoming individual-level barriers to change
Relevance for Public Health
This guide was developed to support professionals' and managers' change in practice within a clincial setting. However, the strategies outlined would be appropriate for other settings, including public health. For instance, this method could inform the implementation of a surveillance and monitoring system for childhood immunizations.
Description
This method provides practical suggestions to facilitate change in clinical practice. These suggestions are also applicable in public health settings. By understanding barriers at the individual level that may hinder the adoption and implementation of innovation, this guide outlines how to identify and overcome those barriers. This guide is divided into four major sections:

- understanding barriers to change
- identifying barriers to change
- overcoming barriers to change
- mapping barriers to methods.

Accessing the Method/Tool

Language(s)

- English
- Format(s)
- On-line Access
- Cost
- None

Implementing the Method/Tool

- Time for Participation/Completion
- Information not available
- Depending on the nature of the innovation and the organization, varying levels of commitment with respect to resources and time would be required.
- Additional Resources and/or Skills Needed for Implementation
- Not Specified
- Steps for Using Method/Tool

This method consists of four sections:

1. Understanding barriers to change

Assess which barriers and facilitators of change are present at the individual level, including:

- lack of awareness and knowledge among practitioners and staff of how current ways of working need to change to align with evidence;
- motivators, both external and internal, such as financial incentives and personal goals and priorities, respectively, or lack of motivators;
- personal beliefs, attitudes and perceptions of change, and the associated risks and benefits of the change;
- individual skills and capacities to carry out the change in practice;
- practical barriers, including lack of resources, equipment or staffing; and the external environment, which can influence the individual's ability to adopt a new intervention, such as financial structuring.

2. Identifying barriers to change

Conduct a baseline assessment to identify the gap between recommended practice and current ways of working. This baseline assessment of barriers permits tailoring implementation of the innovation. Data collections methods used to conduct an assessment of barriers include the following:

- Learn from key individuals with knowledge, authority and skills to speak to implementation of the innovation.
- Observe individuals in practice, especially for routine behaviours.
- Use a questionnaire to explore individuals' knowledge, beliefs, attitudes and behaviour.
- Brainstorm informally in small groups to explore solutions to a problem.
- Conduct a focus group to evaluate current practice and explore new ways of working.
- The developers also discuss potential advantages and disadvantages of each data collection method.

3. Overcoming barriers to change

This section examines different strategies for overcoming barriers to implementing change in practice. The developers outline when specific strategies are used, and briefly discuss evidence of their effectiveness.

Strategies include the following:

- Educational materials (booklets, CD-ROMs, DVDs, etc.) can raise awareness of a new way of working and are effective in changing behaviour when combined with other strategies.
- Informational meetings (conferences, training courses, lectures, etc.) can increase awareness of change. However, informational meetings with interactive participation, like workshops, are more likely to result in behaviour change.
- Educational outreach visits (or academic detailing) involve trained individuals visiting individuals in their organization to offer information and support in adopting new ways of working. Outreach visits are effective in changing certain kinds of behaviour, such as the delivery of preventive services or prescribing behaviour.

- Opinion leaders can influence their colleagues to adopt an innovation. The use of opinion leaders is an effective way of disseminating information
- . Audit and feedback, where information is given back to individuals or teams about their practice as a way to monitor and improve practice, is an effective method for changing behaviour. Audit and feedback is particularly effective when staff buy in and are involved in the process, when feedback is timely and when combined with financial incentives.
- Reminder systems and decision-support systems are effective in changing behaviour, especially at the point of decision-making. Decision support systems are effective for specific decisions, such as delivery of preventative services, and less so for complex decision-making.
- Patient-mediated strategies, which provide information to the general public, are effective in changing the behaviour of practitioners. Such strategies include mass media campaigns, which increase awareness of an innovation among the public and practitioners.

4. Mapping barriers to methods

In this last section, the developers provide a series of questions to assist in conducting a baseline assessment of barriers and include ways of overcoming those barriers. This is followed by two case studies outlining different strategies for overcoming barriers to changing practice, along with a list of additional resources to assist with implementation change.

Who is involved

Various roles would be involved in administering and participating in this method, including individuals at management and service delivery levels. Specific individuals could include: program directors, program coordinators, public health nutritionists, public health nurses, health promotion officers and team leaders.

Evaluation and Measurement Characteristics

- Evaluation
- Information not available
- Validity
- Not applicable
- Reliability
- Not applicable
- Methodological Rating
- Unknown/No evidence

Method/Tool Development

Method of Development

This method is one in a series of documents that support implementation of the National Institute for Health and Clinical Excellence (NICE) guidance through the NICE Implementation Strategy. NICE is an independent organization providing national guidance on clinical care to establish and maintain high standards of patient care and safety in England. The NICE Implementation Strategy provides practical resources to support the implementation of NICE guidance into practice.