



MASSACHUSETTS
DEPARTMENT of
EDUCATION

Vocational Technical Education Framework

Manufacturing, Engineering, and Technology Cluster

Biotechnology

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Strand 1: Safety and Health Knowledge and Skills

1.A Define health and safety regulations.

- 1.A.01a Identify and apply OSHA and other health and safety regulations that apply to specific tasks and jobs in the occupational area.
- 1.A.02a Identify and apply EPA and other environmental protection regulations that apply to specific tasks and jobs in the occupational area.
- 1.A.03a Identify and apply Right-To-Know (Hazard Communication Policy) and other communicative regulations that apply to specific tasks and jobs in the occupational area.
- 1.A.04a Explain procedures for documenting and reporting hazards to appropriate authorities.
- 1.A.05a List penalties for non-compliance with appropriate health and safety regulations.
- 1.A.06a Identify contact information for appropriate health and safety agencies and resources.

1.B Demonstrate health and safety practices.

- 1.B.01a Identify, describe and demonstrate the effective use of Material Safety Data Sheets (MSDS).
- 1.B.02a Read chemical, product, and equipment labels to determine appropriate health and safety considerations.
- 1.B.03a Identify, describe and demonstrate personal, shop and job site safety practices and procedures.
- 1.B.04a Demonstrate safe dress and use of relevant safety gear and personal protective equipment (PPE), including wrist rests, adjustable workspaces and equipment, gloves, boots, earplugs, eye protection, and breathing apparatus.
- 1.B.05a Illustrate appropriate safe body mechanics, including proper lifting techniques and ergonomics.
- 1.B.06a Locate emergency equipment in your lab, shop, and classroom, including (where appropriate) eyewash stations, shower facilities, sinks, fire extinguishers, fire blankets, telephone, master power switches, and emergency exits.
- 1.B.07a Demonstrate the safe use, storage, and maintenance of every piece of equipment in the lab, shop, and classroom.
- 1.B.08a Describe safety practices and procedures to be followed when working with and around electricity.
- 1.B.09a Properly handle, store, dispose of, and recycle hazardous, flammable, and combustible materials.
- 1.B.10a Demonstrate proper workspace cleaning procedures.
- 1.B.11c Discuss the relationship between health, safety, and productivity.
- 1.B.12 Determine hazard levels of substances using NFPA code.

1.C Demonstrate responses to situations that threaten health and safety.

- 1.C.01a Illustrate First Aid procedures for potential injuries and other health concerns in the occupational area.
- 1.C.02a Describe the importance of emergency preparedness and an emergency action plan.

- 1.C.03a Illustrate procedures used to handle emergency situations and accidents, including identification, reporting, response, evacuation plans, and follow-up procedures.
- 1.C.04a Identify practices used to avoid accidents.
- 1.C.05a Identify and describe fire protection, precautions and response procedures.
- 1.C.06a Discuss the role of the individual and the company/organization in ensuring workplace safety.
- 1.C.07a Discuss ways to identify and prevent workplace/school violence.

Strand 2: Technical Knowledge and Skills

2.A Apply principles of 'world class' operations (industry quality standard operation).

- 2.A.01c Explain lean techniques as applied to manufacturing/engineering and technical processes.
- 2.A.02c Identify and apply the concepts of total quality management appropriate to the field.
- 2.A.03c Develop, implement and assess plan for continuous improvement.

Performance Example:

1. The student can apply principles of total quality management techniques when carrying out their work. This will include development of benchmarks by teaming methods, use of documentation, graphing in measurement of outcomes, and understanding the need for change in processes when outcomes require it.

2.B Demonstrate and apply the design process.

- 2.B.01c List the attributes of design in a variety of technical fields (biotechnology, manufacturing, environmental, power and energy, transportation etc).
- 2.B.02c Use the design process to identify, problem solve and evaluate a solution.
- 2.B.03c Read and interpret detail prints or technical processes.
- 2.B.04 Define the process of drug development currently used in biotechnology.

Performance Example:

1. Select an invention or technological process that interests you and relates to your field of study (shop). Answer the following questions by applying the "Product Development Lifecycle" (hand-out with model has distributed by your instructor), to this invention or process. What was the need at the time for this product/process? Were any alternate solutions proposed? Please explain. Were any new products/processes developed as a result of this invention? Please explain. List some different prototypes that were developed for the product/process, and identify any relevant documentation. Please include appropriate pictures, diagrams, drawings, etc. Identify the different design development cycles for this invention (product/process).

2.C Demonstrate skills in problem solving, diagnostics, and troubleshooting.

- 2.C.01c Identify the components and process of the system(equipment).
- 2.C.02c Identify the problem or source of the problem.
- 2.C.03c Develop solutions using a structured problem solving process.
- 2.C.04c Use appropriate testing equipment and tools for diagnosing the problem.
- 2.C.05c Implement the correct strategies to remedy the problem.

Performance Example:

1. Students use appropriate software to produce a flow chart of the design or workflow process. Student teams then use problem solving approaches, including brainstorming techniques, to identify possible solutions to a problem (or set of problems). Working individually, students produce a report that would diagnose the actual problem, suggest solutions and corrections and propose strategies to prevent reoccurring problems.

2.D Maintain equipment and machinery.

- 2.D.01c Identify appropriate person(s) for maintained and repair of equipment.
- 2.D.02c Monitor equipment indicators to insure that equipment is operating correctly.
- 2.D.03c Demonstrate ability to maintain equipment.
- 2.D.04c Develop and maintain a written log for service and repair of equipment.
- 2.D.05c Maintain electronic devices and gauges as specified by manufacturer.

Performance Example:

1. Develop a preventative maintenance system and implement it for your shop area.

2.E Demonstrate and apply manufacturing process management techniques.

- 2.E.01c Identify customer needs.
- 2.E.02c Identify resources needed (supplies, personnel, equipment).
- 2.E.03c Identify and create/provide needed standard operational procedures (SOPs).
- 2.E.04c Use process control data to monitor process.
- 2.E.05c Explain inventory control and the implications to production and performance.
- 2.E.06c Test product to verify that it meets customer specifications, regulations, etc.
- 2.E.07c Demonstrate process used to document and ensure compliance.
- 2.E.08c Insure timely delivery of product to customer.
- 2.E.09 Explain CGMP Regulations.

Performance Example:

1. Identify and develop a process for project development and apply it to the completion of a product/drawing/etc.

2.F Use measurement devices.

- 2.F.01c Define attributes, units, and systems of measurement used in MET fields.
- 2.F.02c Apply a variety of techniques, tools and formulas for determining measurements.
- 2.F.03c Identify appropriate electronic device/gauge for specific tasks.
- 2.F.04c Calibrate and use electronic devices and/or gauges accurately.
- 2.F.05c Use measurement systems to solve problems.

Performance Example:

1. Using appropriate English and metric (including both linear and angular measurement tools), student reads and recognizes scaling and applies mathematical skills to obtain the measurements. The student will also demonstrate the use and application of basic formulas to prove accuracy of

an assigned project. Students can select and use mechanical measuring tools such as micrometers and dial verniers and electronic measuring devices including set up manipulation and operation of these devices as they apply to their technical field (calibrate equipment, understand working range, limits, and problems of devices used in the field). Students can use measurement skills to measure worn components for loss of functionality.

2.G Use basic laboratory workplace instrumentation.

- 2.G.01 Measure temperature using appropriate instrumentation (i.e. temperature scales, temperature measurement, etc.).
- 2.G.02 Measure pH using proper instrumentation.
- 2.G.03 Measure mass using electronic balance.
- 2.G.04 Measure optical density using a spectrophotometer at various wavelengths.
- 2.G.05 Operate an autoclave and explain its use in sterile technique.
- 2.G.06 Set up and operate electrophoresis equipment for gel electrophoresis.
- 2.G.07 Measure volume using pipettes, micropipettes, graduated cylinders.
- 2.G.08 Use microscopes to examine biological specimens.
- 2.G.09 Operate table top and clinical centrifuge.

Performance Example:

1. Prepare sterile reagents using dry chemicals and appropriate solvent following established protocols.

2.H Employ sterile and aseptic techniques.

- 2.H.01 Decontaminate work area.
- 2.H.02 Maintain a sterile environment using a biological safety cabinet.
- 2.H.03 Sterilize liquids following the appropriate filtration method.
- 2.H.04 Prepare agar plates using appropriate aseptic techniques.
- 2.H.05 Maintain sterile cultures of animal cells using a biological safety cabinet.

Performance Example:

1. Prepare nutrient agar plates free of microbial contamination.

2.I Use microscopes.

- 2.I.01 Estimate the size of an object viewed under a compound microscope.
- 2.I.02 Compare depth of field and size of the field for low power and high power objectives for a compound microscope.
- 2.I.03 Use compound microscope to view single-celled organisms.
- 2.I.04 Describe differences in viewing cells in bright field and phase microscopes.
- 2.I.05 Use inverted microscope to view cell cultures.

2.J Prepare and examine biological specimens.

- 2.J.01 Prepare slides for microscopy.
- 2.J.02 Identify and describe functions of cellular organelles.
- 2.J.03 Determine the viability of cells in culture (i.e. using trypan blue exclusion method).
- 2.J.04 Differentiate between prokaryotic and eukaryotic cells, in terms of their general structures and degrees of complexity.
- 2.J.05 Distinguish between plant and animal cells.

- 2.J.06 Separate components using filtration.
- 2.J.07 Isolate cellular organelles using centrifugation.

2.K Prepare solutions.

- 2.K.01 Prepare percent, molar, and molal solutions.
- 2.K.02 Make dilutions and calculate resulting concentrations.
- 2.K.03 Perform serial dilutions.
- 2.K.04 Prepare Dulbecco's minimal essential media (MEM).

2.L Perform DNA fingerprinting.

- 2.L.01 Isolate DNA from cells.
- 2.L.02 Perform polymerase chain reaction (PCR) to amplify specific alleles of DNA.
- 2.L.03 Use restriction enzymes to digest DNA samples.
- 2.L.04 Separate bands using gel electrophoresis.
- 2.L.05 Graph and analyze results from DNA fingerprinting.

Performance Example:

1. Identify suspect(s) from DNA samples found at a 'mock crime scene'.

2.M Maintain micro-organisms in culture.

- 2.M.01 Isolate pure cultures from a colony.
- 2.M.02 Culture bacteria in nutrient broth, on sterile agar plates, fermentation flasks, and test tubes.
- 2.M.03 Identify bacteria using stain techniques, growth on selective media, and DNA characteristic analysis.
- 2.M.04 Scale up cultures of micro-organisms to larger vessels for production of bioengineered substances.

Performance Example:

1. Isolate, streak and identify a culture of bacteria for a specified production outcome.

2.N Clone genes and genetically transform cells.

- 2.N.01 Perform polymerase chain reaction (PCR) to amplify gene of interest.
- 2.N.02 Digest PCR product and plasmid using restriction enzymes.
- 2.N.03 Gel purify products of the restriction enzyme digests.
- 2.N.04 Perform ligation reaction between purified PCR product and plasmid.
- 2.N.05 Transform bacteria with plasmids.
- 2.N.06 Transform animal cells with plasmids.
- 2.N.07 Transform plant cells with plasmids.

Performance Example:

1. Transform a culture of bacteria using antibiotic resistant plasmids.

2.O Maintain animal cells in tissue culture

- 2.O.01 Maintain cells in suspension.
- 2.O.02 Maintain cells as attached cultures.
- 2.O.03 Calculate the number of cells in a flask using a hemocytometer.
- 2.O.04 Graph cell number per flask versus days in culture.
- 2.O.05 Perform a subculture to expand cell numbers.
- 2.O.06 Calculate the rate of cell division in cultures.
- 2.O.07 Isolate chromosomes from cells for identification purposes.

- 2.O.08 Preserve cells using cryopreservation.
- 2.O.09 Illustrate the preparation of primary cells for in vitro culture.

Performance Example:

1. Transfer cells to a new flask to yield a known number of cells for production.

2.P Separate compounds from mixtures using chromatography.

- 2.P.01 Isolate protein from cell lysate using precipitation and filtration techniques.
- 2.P.02 Determine the concentration of protein in solution.
- 2.P.03 Perform gel filtration chromatography to separate compounds by size.
- 2.P.04 Perform ion exchange chromatography to separate compounds by charge.
- 2.P.05 Perform hydrophobic chromatography to separate compounds.
- 2.P.06 Use affinity chromatography to purify protein.

Performance Example:

1. Separate proteins based on charge using ion-exchange chromatography.

2.Q Evaluate and report on product quality.

- 2.Q.01 Perform enzyme-linked immunosorbant assay (ELISA).
- 2.Q.02 Use enzymes to catalyze biochemical reactions.
- 2.Q.03 Perform western blotting technique.
- 2.Q.04 Confirm final product activity meets defined standards.
- 2.Q.05 Document procedures and results.

Performance Example:

1. Perform a product quality process to insure product meets standards.

Strand 3: Embedded Academic Knowledge and Skills

VTE #	Acad #	Standard	Grade	Topic
3.A.01c	19.21	For informational/expository writing: Write reports based on research that include quotations, footnotes or endnotes, and a bibliography.	Pre-9th	Composition
3.A.02c	24.4	Apply steps for obtaining information from a variety of sources, organizing information, documenting sources, and presenting research in individual projects.	Pre-9th	Composition
3.A.03c	2.4	Integrate relevant information gathered from group discussions and interviews for reports.	Pre-9th	Language
3.A.04c	13.19	Identify and use knowledge of common graphic features (charts, maps, diagrams).	Pre-9th	Reading
3.A.05c	24.5	Formulate open-ended research questions and apply steps for obtaining and evaluating information from a variety of sources, organizing information, documenting sources in a consistent and standard format, and presenting research.	9/10	Composition
3.A.06c	19.27	For informational/expository writing: Write well-organized research papers that prove a thesis statement using logical organization, effective supporting evidence, and variety in sentence structure.	11/12	Composition
3.A.07c	24.6	Formulate original, open-ended questions to explore a topic of interest, design and carry out research, and evaluate the quality of the research paper in terms of the adequacy of its questions, materials, approach, and documentation of sources.	11/12	Composition
3.A.08c	3.17	Deliver formal presentations for particular audiences using clear enunciation and appropriate organization, gestures, tone, and vocabulary.	11/12	Language
3.A.09c	4.27	Use general dictionaries, specialized dictionaries, thesauruses, histories of language, books of quotations, and other related references as needed.	11/12	Language

3.A.10c		Follow correct procedures for technical documentation (note: no specific technical documentation/writing standard in English Language Arts Framework. This is often found in post secondary technical program courses and is found vital to many of the vocational technical programs offered across Massachusetts).		Voc
3.A.11c		Read technical manuals, guides, resource books and technical literature to gain information and solve problems.		Voc
3.A.12c		Read, comprehend, and follow written technical directions for repairs, procedures and processes.		Voc
3.A.13		Use SOP (standard operating procedure) to document laboratory procedures and results.		Voc

3.B Mathematics

VTE #	Acad #	Standard	Grade	Topic
3.B.01c	7.G.5	Use a ruler, protractor, and compass to draw polygons and circles.	Pre-9th	Geometry
3.B.02c	7.M.2	Given the formulas, convert from one system of measurement to another. Use technology as appropriate.	Pre-9th	Measurement
3.B.03c	7.P.4	Solve linear equations using tables, graphs, models, and algebraic methods.	Pre-9th	Patterns, relations, algebra
3.B.04c	8.M.2	Given the formulas, convert from one system of measurement to another. Use technology as appropriate.	Pre-9th	Measurement
3.B.05c	8.N.1	Compare, order, estimate, and translate among integers, fractions and mixed numbers (i.e., rational numbers), decimals, and percents.	Pre-9th	Numbers
3.B.06c	10.G.3	Recognize and solve problems involving angles formed by transversals of coplanar lines. Identify and determine the measure of central and inscribed angles and their associated minor and major arcs. Recognize and solve problems associated with radii, chords, and arcs within or on the same circle.	9/10	Geometry

3.B.07c	10.G.5	Apply properties of angles, parallel lines, arcs, radii, chords, tangents, and secants to solve problems.	9/10	Geometry
3.B.08c	10.G.8	Find linear equations that represent lines either perpendicular or parallel to a given line and through a point, e.g., by using the "point-slope" form of the equation.	9/10	Geometry
3.B.09c	10.G.10	Demonstrate the ability to visualize solid objects and recognize their projections and cross sections.	9/10	Geometry
3.B.10c	10.M.1	Calculate perimeter, circumference, and area of common geometric figures such as parallelograms, trapezoids, circles, and triangles.	9/10	Measurement
3.B.11c	10.P.8	Solve everyday problems that can be modeled using systems of linear equations or inequalities. Apply algebraic and graphical methods to the solution. Use technology when appropriate. Include mixture, rate, and work problems.	9/10	Patterns, relations, algebra
3.B.12c	12.M.2	Use dimensional analysis for unit conversion and to confirm that expressions and equations make sense.	11/12	Measurement
3.B.13c	12.P.8	Solve a variety of equations and inequalities using algebraic, graphical, and numerical methods, including the quadratic formula; use technology where appropriate. Include polynomial, exponential, logarithmic, and trigonometric functions; expressions involving absolute values; trigonometric relations; and simple rational expressions.	11/12	Patterns, relations, algebra
3.B.14c	12.P.11	Solve everyday problems that can be modeled using polynomial, rational, exponential, logarithmic, trigonometric, and step functions, absolute values, and square roots. Apply appropriate graphical, tabular, or symbolic methods to the solution. Include growth and decay; joint (e.g., $I = Prt$, $y = k(w_1 + w_2)$) and combined ($F = G(m_1m_2)/d^2$) variation, and periodic processes.	11/12	Patterns, relations, algebra
3.B.15	7.P.6	Use linear equations to model and analyze problems involving proportional relationships. Use technology as appropriate.	Pre-9	Patterns, relations, algebra

3.B.16	10.D.3	Describe and explain how the relative sizes of a sample and the population affect the validity of predictions from a set of data.	9/10	Data Analysis, Statistics
3.B.17	12.D.1	Design surveys and apply random sampling techniques to avoid bias in the data collection.	11/12	Data Analysis, Statistics
3.B.18	12.D.2	Select an appropriate graphical representation for a set of data and use appropriate statistics (e.g., quartile or percentile distribution) to communicate information about the data.	11/12	Data Analysis, Statistics
3.B.19	12.D.3	Apply regression results and curve fitting to make predictions from data.	11/12	Data Analysis, Statistics
3.B.20	12.D.4	Apply uniform, normal, and binomial distributions to the solutions of problems.	11/12	Data Analysis, Statistics
3.B.21	12.D.7	Compare the results of simulations (e.g., random number tables, random functions, and area models) with predicted probabilities.	11/12	Data Analysis, Statistics
3.B.22	12.M.1	Describe the relationship between degree and radian measures, and use radian measure in the solution of problems, in particular, problems involving angular velocity and acceleration.	11/12	Measurement
3.B.23	12.M.2	Use dimensional analysis for unit conversion and to confirm that expressions and equations make sense.	11/12	Measurement
3.B.24	12.P.7	Find solutions to quadratic equations (with real coefficients and real or complex roots) and apply to the solutions of problems.	11/12	Patterns, relations, algebra
3.B.25	12.P.9	Use matrices to solve systems of linear equations. Apply to the solution of everyday problems.	11/12	Patterns, relations, algebra
3.B.26		Write numbers in scientific notation.		Voc
3.B.27		Convert numbers between standard notation and scientific notation.		Voc
3.B.28		Perform calculations with numbers in scientific notation.		Voc
3.B.29		Determine formula mass of a compound or element.		

3.B.30		Calculate number of moles from the mass of a compound when given the chemical formula/ Calculate the mass of a compound from number of moles when given the chemical formula.		Voc
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3.C Science and Engineering/Technology

VTE #	Acad #	Standard	Grade	Topic
3.C.01c	1	Differentiate between weight and mass, recognizing that weight is the amount of gravitational pull on an object.	Pre-9th	Physics/Chem
3.C.02c	3	Recognize that the measurement of volume and mass requires understanding of the sensitivity of measurement tools (e.g., rulers, graduated cylinders, balances) and knowledge and appropriate use of significant digits.	Pre-9th	Physics/Chem
3.C.03c	1.1	Identify and explain the steps of the engineering design process, i.e., identify the problem, research the problem, develop possible solutions, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign.		Eng/Tech
3.C.04c	1.1	Distinguish between vector quantities (velocity, acceleration, and force) and scalar quantities (speed and mass).		Physics
3.C.05c	1.3	Describe the characteristics of waves (wavelength, frequency, velocity, amplitude).		Earth/Space
3.C.06c	1.3	Distinguish between, and solve problems involving, velocity, speed, and constant acceleration.		Physics
3.C.07c	1.4	Create and interpret graphs of motion (position vs. time, speed vs. time, velocity vs. time, constant acceleration vs. time).		Physics
3.C.08c	1.5	Explain the relationship between mass and inertia.		Physics
3.C.09c	1.6	Interpret and apply Newton's first law of motion.		Physics
3.C.10c	1.7	Interpret and apply Newton's second law of motion to show how an object's motion will change only when a net force is applied.		Physics
3.C.11c	2.3	Apply quantitatively the law of conservation of mechanical energy to simple systems.		Physics

3.C.12c	2.4	Describe the relationship among energy, work, and power both conceptually and quantitatively.		Physics
3.C.13c	2.6	Identify appropriate standard international units of measurement for energy, work, power, and momentum.		Physics
3.C.14c	4.1	Differentiate among conduction, convection, and radiation in a thermal system, e.g., heating and cooling a house, cooking.		Eng/Tech
3.C.15c	4.2	Give examples of how conduction, convection, and radiation are used in the selection of materials, e.g., home and vehicle thermostat designs, circuit breakers.		Eng/Tech
3.C.16c	5.3	Explain the relationship between resistance, voltage, and current (Ohm's Law).		Eng/Tech
3.C.17c	5.5	Identify appropriate units of measurement for current, voltage, and resistance, and explain how they are measured.		Eng/Tech
3.C.18c	5.6	Analyze circuits (find the current at any point and the potential difference between any two points in the circuit) using Kirchoff and Ohm's laws.		Eng/Tech
3.C.19	1.1	Explain the significance of carbon in organic molecules.		Biology
3.C.20	1.2	Recognize the six most common elements in organic molecules (C, H, N, O, P, S).		Biology
3.C.21	1.3	Describe the composition and functions of the four major categories of organic molecules (carbohydrates, lipids, proteins, and nucleic acids).		Biology
3.C.22	1.5	Explain the role of enzymes in biochemical reactions.		Biology
3.C.23	2.1	Relate cell parts/organelles to their functions.		Biology
3.C.24	2.2	Differentiate between prokaryotic cells and eukaryotic cells, in terms of their general structures and degrees of complexity.		Biology
3.C.25	2.3	Distinguish between plant and animal cells.		Biology

3.C.26	2.4	Describe how cells function in a narrow range of physical conditions, such as temperature and pH, to perform life functions that help to maintain homeostasis.		Biology
3.C.27	3.1	Describe the structure and function of DNA, and distinguish among replication, transcription, and translation.		Biology
3.C.28	3.2	Describe the processes of replication, transcription, and translation and how they relate to each other in molecular biology.		Biology
3.C.29	3.3	Describe the general pathway by which ribosomes synthesize proteins by using tRNAs to translate genetic information encoded in mRNAs.		Biology
3.C.30	3.4	Explain how mutations in the DNA sequence of a gene may be silent or result in phenotypic change in an organism and in its offspring.		Biology
3.C.31	3.5	Differentiate between dominant, recessive, co-dominant, polygenic, and sex-linked traits.		Biology
3.C.32	3.6	State Mendel's laws of segregation and independent assortment.		Biology
3.C.33	3.7	Use a Punnett Square to determine the genotype and phenotype of monohybrid crosses.		Biology
3.C.34	3.7	Use a Punnett Square to determine the genotype and phenotype of monohybrid crosses.		Biology
3.C.35	3.9	Recognize that while viruses lack cellular structure, they have the genetic material to invade living cells.		Biology
3.C.36	1.1	Identify and explain some of the physical properties that are used to classify matter, e.g., density, melting point, and boiling point.		Chemistry
3.C.37	1.2	Explain the difference between mixtures and pure substances.		Chemistry
3.C.38	1.3	Describe the four states of matter (solid, liquid, gas, plasma) in terms of energy, particle motion, and phase transitions.		Chemistry
3.C.39	1.4	Distinguish between chemical and physical changes.		Chemistry

3.C.40	2.3	Identify the major components of the nuclear atom (protons, neutrons, and electrons) and explain how they interact.		Chemistry
3.C.41	2.4	Understand that matter has properties of both particles and waves.		Chemistry
3.C.42	3.1	Explain the relationship of an element's position on the periodic table to its atomic number and mass.		Chemistry
3.C.43	3.2	Use the periodic table to identify metals, nonmetals, metalloids, families (groups), periods, valence electrons, and reactivity with other elements in the table.		Chemistry
3.C.44	4.1	Explain how atoms combine to form compounds through both ionic and covalent bonding.		Chemistry
3.C.45	6.1	Using the kinetic molecular theory, explain the relationship between pressure and volume (Boyle's law), volume and temperature (Charles' law), and the number of particles in a gas sample (Avogadro's hypothesis).		Chemistry
3.C.46	7.2	Identify and explain the factors that affect the rate of dissolving, (i.e., temperature, concentration, and mixing).		Chemistry
3.C.47	8.1	Define Arrhenius' theory of acids and bases in terms of the presence of hydronium and hydroxide ions, and Bronsted's theory of acids and bases in terms of proton donor and acceptor, and relate their concentrations to the pH scale.		Chemistry
3.C.48	8.3	Identify a buffer and explain how it works.		Chemistry
3.C.49	1.2	Describe the components of the electromagnetic spectrum and give examples of its impact on our lives.		Earth/Space
3.C.50	3.3	Explain the relationship among temperature change in a substance for a given amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.		Eng/Tech
3.C.51	6.1	Identify and explain the applications of light in communications, e.g., reflection, refraction, additive, and subtractive color theory.		Eng/Tech

3.C.52	4.2	Recognize the measurable properties of waves (e.g., velocity, frequency, wavelength) and explain the relationships among them.		Physics
3.C.53	4.5	Interpret and be able to apply the laws of reflection and refraction (qualitatively) to all waves.		Physics
3.C.54	4.6	Recognize the effects of polarization, wave interaction, and the Doppler effect.		Physics
3.C.55	4.7	Explain, graph, and interpret graphs of constructive and destructive interference of waves.		Physics
3.C.56		Identify chemical forces important to biomolecules.		Voc
3.C.57		Name hydrocarbon molecules using IUPAC standard for given structural formulas.		Voc
3.C.58		Recognize organic groups when given structure.		Voc
3.C.59		Identify how cellular respiration is important for the production of ATP.		Voc
3.C.60		Explain genetic mutations.		Voc

Strand 4: Employability Knowledge and Skills

4.A Develop employability skills to secure and keep employment in chosen field.

- 4.A.01a Evaluate industries, organizations, and careers based on multiple sources of research and information.
- 4.A.02a Assess interest areas to determine potential career pathways, including career ladders.
- 4.A.03a Develop a career plan with alternatives.
- 4.A.04a Complete job applications and related employment documents (e.g. W-4).
- 4.A.05a Create professional cover letters, resumes, and portfolios in a variety of formats (print and electronic) .
- 4.A.06a Apply job search skills to seek, evaluate, apply for, and accept employment.
- 4.A.07a Demonstrate good interviewing skills.
- 4.A.08a Demonstrate employability skills needed to get and keep a job.
- 4.A.09a Assess alternative occupational choices (e.g. working conditions, benefits, and opportunities to change).

Performance Examples:

1. Research positions open within a variety of companies and compare/contrast their descriptions, duties, and expectations.
2. Prepare responses to standard interview questions.
3. Participate in a mock-interview with industry professionals.

4.B Communicate in multiple modes to address needs within the career and technical field.

- 4.B.01a Apply strategies to enhance effectiveness of all types of communications in the workplace.
- 4.B.02a Apply reading skills and strategies to work-related documents.
- 4.B.03a Locate information from books, journals, magazines, and the Internet.
- 4.B.04a Apply basic writing skills to work-related communication.
- 4.B.05a Write work-related materials.
- 4.B.06a Explain information presented graphically.
- 4.B.07a Use writing/publishing/presentation applications.
- 4.B.08a Apply basic skills for work-related oral communication.
- 4.B.09a Explain proper telephone etiquette and skills.
- 4.B.10a Lead formal and informal group discussions.
- 4.B.11a Demonstrate effective negotiation and conflict management.
- 4.B.12a Apply active listening skills to obtain and clarify information.
- 4.B.13a Communicate with others in a diverse workforce.

Performance Examples:

1. Review a professional journal; choose one article to summarize.
2. Call the publisher for free products in journal.
3. Develop an oral presentation regarding an article in a journal.
4. Summarize trends presented in a graph.

4.C Solve problems using critical thinking.

- 4.C.01a Demonstrate skills used to define and analyze a given problem.

- 4.C.02a Explain the importance and dynamics of individual and teamwork approaches of problem solving.
- 4.C.03a Describe methods of researching and validating reliable information relevant to the problem.
- 4.C.04a Explain strategies used to formulate ideas, proposals and solutions to problems.
- 4.C.05a Select potential solutions based on reasoned criteria.
- 4.C.06a Implement and evaluate solution(s).

4.D Demonstrate positive work behaviors.

- 4.D.01a Identify time management and task prioritization skills.
- 4.D.02a Explain the importance of following workplace etiquette/protocol.
- 4.D.03a Demonstrate willingness to learn and further develop skills.
- 4.D.04a Demonstrate self-management skills.
- 4.D.05a List causes of stress and effective stress management techniques.
- 4.D.06a Describe the importance of having a positive attitude and techniques that boost morale.
- 4.D.07a Show initiative by coming up with unique solutions and taking on extra responsibilities.
- 4.D.08a Explain the importance of setting goals and demonstrate the ability to set, reach, and evaluate goals.
- 4.D.09a Explain the importance of taking pride in work accomplished and extrinsic and intrinsic motivators that can be used to increase pride.
- 4.D.10a Value the importance of professionalism, including reliability, honesty, responsibility, and ethics.
- 4.D.11a Demonstrate a respect for diversity and its benefit to the workplace.

Strand 5: Management and Entrepreneurship Knowledge and Skills

5.A Analyze basic business practices required to start and run a company/organization.

- 5.A.01a Define entrepreneurship .
- 5.A.02a Describe the relationship between suppliers, producers, and consumers.
- 5.A.03a Compare and contrast types of businesses, including sole proprietorships, small businesses, companies, corporations, governmental agencies, and non-profit organizations.
- 5.A.04a Describe practices that ensure quality customer service.
- 5.A.05a Explain the value of competition in business/field.
- 5.A.06 Describe why industries respond to customer wants and expectations.
- 5.A.07 List differences in how companies deliver products versus delivering services.
- 5.A.08 Describe ways a worker can influence company decision-making.

Performance Examples:

1. Prepare a business plan for a new company in your community.
2. Participate in a discussion with members of a local small-business incubator or chamber of commerce, identifying opportunities and summarizing best practices of new companies.
3. Create an equipment list, with costs, of equipment required for doing specific tasks.
4. Identify local zoning and environmental laws that apply to businesses in your industry.

5.B Manage all resources related to a business/organization.

- 5.B.01a Identify a company's/organization's chain of command and organizational structure.
- 5.B.02a Define and demonstrate leadership and teamwork skills.
- 5.B.03a Explain ways a company or organization can market itself, including choosing a name, designing logos and promotional materials, advertising, and the importance of word-of-mouth.
- 5.B.04a Identify methods to track inventory, productivity, income, expenses, and personnel .
- 5.B.05a Explain the importance of written operating procedures and policies.
- 5.B.06a Identify professional organizations and their benefits.
- 5.B.07a Explain methods to effectively run a meeting.
- 5.B.08 Identify key components of a company "mission statement".
- 5.B.09 Describe the significance of a company's "corporate culture".
- 5.B.10 List typical ways company departments communicate.
- 5.B.11 Cite examples of why a worker should adjust to different management styles.
- 5.B.12 Cite an example of how companies are dependent on the national economy.
- 5.B.13 Cite an example of how a company is dependent upon the local economy.
- 5.B.14 Describe the importance of achieving internal and external customer satisfaction.

Performance Examples:

1. Create a plan to keep track of tools and supplies in your classroom/shop.
2. Work as a team to complete a project, including running and participating in problem-solving meetings.
3. Contact a relevant professional organization and request information about its benefits, membership requirements, and costs.
4. Clip print advertisements from local companies, identifying common themes and contrasting different styles.

5.C Describe methods for managing, organizing, retrieving and reporting financial data.

- 5.C.01a Explain the role of small businesses in the economy.
- 5.C.02a Extract and extrapolate data from financial documents, such as a pay-stub, budget, tax statement, and financial report.
- 5.C.03 Describe key implications for a company that grants credit.
- 5.C.04 Describe how a company estimates and bids for a contract.
- 5.C.05 Describe how paycheck deductions affect a worker.
- 5.C.06 Describe the importance of cost containment in a company.

Performance Examples:

1. Create and follow a budget for an in-class project.
2. Identify equipment in your shop/lab that are considered as capital.
3. From a pay-stub, determine gross salary, deductions, and net pay for a calendar year.
4. Create a rate card or other list of standardized costs for services provided, based on research of local rates and practices.

5.D Apply labor and civil rights law and guidelines to business practice and decisions.

- 5.D.01a List federal and state mandated employee rights.
- 5.D.02a Describe proper working conditions for your industry.
- 5.D.03a Explain the role of labor organizations.
- 5.D.04a Discuss the importance of diversity and list methods of encouraging diversity in the workplace.
- 5.D.05a Describe standard forms of employment contracts applicable to your industry.
- 5.D.06a State the current minimum wage, as well as wages for common jobs found within the field.
- 5.D.07a List opportunities for continual professional development.
- 5.D.08 List differences between being a self-employed worker and a worker employed by a company.
- 5.D.09 Describe the importance of participating in quality enhancement programs.
- 5.D.10 Describe the need for flex scheduling and erratic hours in the biotechnical field.

Performance Examples:

1. Participate in and summarize a discussion with a member of a labor organization.
2. Participate in and summarize a discussion with a member of a civil rights organization.

3. While participating in a group project, write and follow job descriptions for each member of the team.
4. Evaluate a shop/lab in terms of safety, ergonomics, and workflow.

5.E Evaluate the effects of community relations on companies and the industry.

- 5.E.01a Describe the role that the industry/organization plays in different communities.
- 5.E.02a Describe the role that community interests play in a company's/organization's decision-making process.
- 5.E.03 Identify an impact of buying outside the community.
- 5.E.04 Describe the importance of providing for the access needs of the physically challenged.

Performance Example:

1. Participate in a service project or community-centered event.

5.F Apply legal requirements and ethical considerations to business practice and decisions.

- 5.F.01a Identify laws that regulate businesses/organizations in your field.
- 5.F.02a Define the requirements for and protections given by copyright and trademark law.
- 5.F.03a Define the impact of the Americans with Disabilities Act and other civil rights legislation on your business/organization, employees, and customers.
- 5.F.04a Define ethical business practices for your field.
- 5.F.05a Identify trade-specific practices that support clean energy technologies and encourage environmental sustainability.
- 5.F.06c Recognize organizational and legal consequences of aiding and participating in illegal or inappropriate behavior.
- 5.F.07 List pros and cons of genetically modified foods.
- 5.F.08 Make an argument for or against DNA data banking.
- 5.F.09 Describe personalized medicine.
- 5.F.10 Describe the origin of stem cells and potential applications.
- 5.F.11 Describe the ethical considerations of cloning research (ownership).
- 5.F.12 Identify the need for confidentiality in the biotechnical industry.

Performance Examples:

1. Research the ethical guidelines set forth by a professional organization related to your industry and participate in a debate over how to apply these guidelines to a variety of situations.
2. Create a portfolio of a variety of completed contracts and their uses.
3. Participate in and summarize a discussion with a lawyer, consumer advocate, or other legal professional.
4. Create a quick reference outline listing legal topics and related resources.

Strand 6: Technological Knowledge and Skills

6.A Demonstrate proficiency in the use of computers and applications as well as an understanding of concepts underlying hardware, software, and connectivity.

- 6.A.01a Select and utilize the appropriate technology to solve a problem or complete a task.
- 6.A.02a Demonstrate file management skills (e.g., install new software, compress and expand files as needed, download files as appropriate).
- 6.A.03a Differentiate between different operating systems and demonstrate use of at least one to open and switch between programs and files.
- 6.A.04a Identify and demonstrate resolutions to simple hardware and software problems as they occur (e.g., frozen screen, disk error, printing problems).
- 6.A.05a Save, retrieve, load, format, and import data into, and export a variety of electronic documents (word processing, spreadsheet, database, AND desktop publishing).
- 6.A.06a Demonstrate the proper use of a variety of external peripherals and how they connect to a computer.
- 6.A.07a Illustrate methods of selecting and using search engines.
- 6.A.08a Send, receive, and manage electronic correspondence and files, in accordance with school policy.
- 6.A.09a Demonstrate proper use of electronic proofreading tools and explain reasons why these shouldn't be relied upon solely.

Performance Example:

1. In the development of work-based projects, students demonstrate computer skills inherent in the word processing techniques used, the organization of data, use of photographic representation, research projects, and other relevant project based activities.

6.B Demonstrate responsible use of technology and an understanding of ethics and safety issues in using electronic media.

- 6.B.01a Identify ways in which technology is used in the workplace and in society.
- 6.B.02a Summarize the rights and responsibilities of the school's Acceptable Use Policy.
- 6.B.03a Explain laws restricting use of copyrighted materials on the Internet.
- 6.B.04a Discuss the concerns about electronic communications, privacy and security, including protection from spyware and viruses.

Performance Example:

1. Describe how computers are used to increase efficiency, accuracy, and professionalism in the industry.

6.C Demonstrate ability to use technology for research, problem solving, and communication.

- 6.C.01a Locate, evaluate, collect, and process information from a variety of electronic sources.
- 6.C.02a Demonstrate the use of telecommunications and other media to interact or collaborate with peers, experts, and other audiences.

- 6.C.03a Demonstrate the use of appropriate electronic sources to conduct research (e.g., Web sites, online periodical databases, and online catalogs).
- 6.C.04a Demonstrate proper style (with correct citations) when integrating electronic research results into a research project.
- 6.C.05a Collect, organize, analyze, and graphically present data using the most appropriate tools.
- 6.C.06a Present information, ideas, and results of work using any of a variety of communications technologies (e.g., multimedia presentations, Web pages, videotapes, desktop-published documents).
- 6.C.07a Identify capabilities of technology resources and describe how they can be used for lifelong learning.
- 6.C.08a Demonstrate the proper use of electronic tools and office communications equipment (telephone, fax, copier, etc).

Performance Example:

1. Student is able to effectively use various technologies in the work place.

6.D Demonstrate the effects a new technology might have on the society.

- 6.D.01c Describe how new technology in manufacturing, engineering and technology has local, state, federal and global impact.
- 6.D.02c Discuss the role of society in the development and use of technology.

Performance Example:

1. Research and write on one technological device describing the history and evolution of the equipment line, effects both positive and negative on society and the environment and develop a closing argument for the existence or removal of this technology based on the facts gathered.