

Technologist Certification Exam Handbook Fundamentals of Technology

Offered by:



CTTAM
*Certified Technicians & Technologists
Association of Manitoba*

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Introduction

The Fundamentals of Technology Certification Exam Handbook has been prepared for engineering and applied science technologists who are required to pass a certification exam to achieve registration as a Certified Engineering Technologist or Applied Science Technologist. The handbook is designed to provide candidates with essential information regarding the certification examination.

Examination Information

Purpose of Examination

The purpose of the Fundamentals of Technology Certification Examination is to identify capable engineering and applied science technologists who possess technical competencies in their discipline of practice (**see Appendix A**). The ultimate goal is to protect the public by granting designations only to those professionals who have the skill and knowledge necessary to perform their job in a safe and competent manner.

Examination Development Process

The Fundamentals of Technology Certification Examination consists of 100 multiple-choice questions, which assess knowledge of fundamental sciences relevant to practice of engineering and applied science technology at the entry level. The exam includes questions with graphs, diagrams, and schematics and questions that require calculations. Each multiple-choice question has four answer options, only one of which is correct. Exam questions vary in the level of cognitive difficulty.

A rigorous exam development process was implemented to ensure that the resultant exam meets professional testing standards as specified in the Standards for Educational and Psychological Testing. Exam development involved numerous consultations with experienced engineering and applied science technologists, as well as education providers and industry representatives. These individuals contributed their expertise to seven stages of exam development, including: 1) competency development; 2) exam blueprinting; 3) item writing; 4) group item review; 5) pilot testing; 6) standard setting; and 7) exam form assembly.

Examination Content

The Fundamentals of Technology Certification Examination questions are divided into four modules, including mathematics, statistics, chemistry, and physics. **Table 1** provides the weighting of each module on the examination, as well as topics, which are tested within each module. **See Appendix A for a detailed breakdown of the competencies that are tested on the examination.**

Table 1. Description of Fundamentals of Technology Examination by Topic

| Topic | Percentage of Questions | Number of Questions |
|----------------|-------------------------|---------------------|
| 1. Mathematics | 35-45% | 35-45 |
| 2. Statistics | 5-15% | 5-15 |
| 3. Chemistry | 15-25% | 15-25 |
| 4. Physics | 20-30% | 20-30 |
| Total | 100% | 100 |

Table 2 provides the breakdown of exam questions by cognitive level. “Knowledge” questions require that candidates recall information and provide its interpretation. “Application” questions require that candidates apply their knowledge to practical situations, while “Critical thinking” questions require that candidates analyze complex situations and provide solutions.

Table 2. Description of Fundamentals of Technology Examination by Cognitive Level

| Cognitive Level | Percentage of Questions | Number of Questions |
|-------------------|-------------------------|---------------------|
| Knowledge | 60-70% | 60-70 |
| Application | 20-30% | 20-30 |
| Critical Thinking | 5-15% | 5-15 |
| Total | 100% | 100 |

As can be seen in Table 3, from 15% to 25% of exam questions have an image (e.g., a graphic, figure, table, or a schematic).

Table 3. Description of Fundamentals of Technology Examination by Image-based Questions

| Cognitive Level | Percentage of Questions | Number of Questions |
|--------------------------|-------------------------|---------------------|
| Questions with Images | 15-25% | 15-25 |
| Questions without Images | 75-85% | 75-85 |
| Total | 100% | 100 |

Examination Registration

Applicants who are required to complete the Fundamentals of Technology Certification Examination will be required to register for the examination at the time of application. Please see the ASET website or CTTAM website for current information on examination dates, fees, and policies.

Study Resources for Examination

The following resources may be of use to candidates interested in refreshing their knowledge prior to writing the examination. Candidates are not expected to study each of these resources. Rather, candidates may wish to review particular content areas in which they feel

they would like to update their current knowledge. For detailed information on the content areas covered on the exam, candidates should refer to **Appendix A**.

Gibilisco, S. (2011). *Geometry demystified*.

Giordano, N. (2012). *College physics* (Vol. 1).

Hewitt, P. G. (2002). *Conceptual Physics*.

Kenkel, J. (2011). *Basic chemistry: Concepts and exercises*.

Mahaffy, P. G. (2014). *Chemistry: Human activity, chemical reactivity*.

Mott, R. L. (2006). *Applied fluid mechanics* (6th ed.).

Mott, R. L. (2008). *Applied strength of materials* (5th ed.).

Newman, J. (2010). *Physics of the Life Sciences*.

Northrop, R. B. (2014). *Introduction to Instrumentation and Measurements* (3rd ed.).

Platt, D. (2010). *Applied mechanics*.

Steege, R., & Bailey, K. (2010). *Intermediate algebra* (2nd ed.).

Triola, M. (2014). *Elementary statistics* (12th ed.).

Walker, K. M. (2008). *Applied mechanics for engineering technology* (8th ed.).

Washington, A. (2014). *Basic technical mathematics with calculus* (10th ed.).

Whitten, K., Davis, R., Peck, M. L., & Stanley, G. (2014). *Chemistry* (10th ed.).

Zumdahl, S., & DeCoste, D. J. (2014). *Basic chemistry*.

Exam Accommodations for Candidate with Disabilities

According to Canadian human rights legislation and test industry standards, exam developers are responsible for providing candidates with disabilities with exam accommodations where appropriate and feasible. Exam accommodations are designed to remove barriers related to individual characteristics of candidates that may prevent them from demonstrating their technical competencies on the exam. “An appropriate accommodation is one that that responds to specific individual characteristics but does so in a way that does not change the construct the test is measuring or the meaning of scores.”¹

Candidates with disabilities should request accommodations to write the certification exam at the time of application. To protect the integrity of the examination, documented evidence of

¹ American Educational Research Association (2014). *Standards for Educational and Psychological Testing*. Washington, DC (p. 67).

the candidate's disability must be submitted to ASET or CTTAM along with the application form. Such evidence includes a formal detailed diagnosis of the specific disability from an appropriate professional (e.g., physician, psychologist, rehabilitation counsellor) and supporting documentation citing the need for exam accommodations and what accommodations the candidate received in the past.

ASET or CTTAM will review the candidate's written request for accommodation and determine if it can be supported. Depending on the candidate's individual needs, ASET or CTTAM may modify exam material or exam administration conditions, including exam setting, exam presentation, or the addition of individuals to the exam (e.g., readers, scribes). Each request will be reviewed on a case-by-case basis.

Below is a list of reasonable exam accommodations for candidates with a disability.

1. *Separate Room*

A separate room is provided to candidates who due to the nature of their disability require an exam environment that minimizes distractions resulting from noise or movement or process information by talking aloud.

2. *Additional Time*

Extending additional time to candidates is a frequently used exam accommodation that is used with a variety of disability-related conditions. Often candidates are offered time-and-one-half to complete the exam (e.g., a 3-hour exam is extended to 4.5 hours).

3. *Interpreter*

Candidates with hearing impairment may request an interpreter who has proficiency in sign language.

4. *Reader*

A reader is an individual who reads exam instructions and/or exam questions to a candidate. Candidates with visual impairment or those with a learning disability may benefit from services of a reader during the examination.

5. *Recorder*

A recorder is an individual who fills in the answers for a candidate who has difficulty writing independently.

Costs related to exam accommodations will be the responsibility of the candidate.

Examination Administration

The Fundamentals of Technology Certification Examination will be administered on a computer in one of Yardstick's exam centers in Alberta or Manitoba. Generally, exam centers are located in colleges and universities. An experienced proctor will oversee the examination.

Admissions to the Exam Centre

ASET and CTTAM provide Yardstick with a list of examination candidates for each exam sitting. When an exam appointment is made, candidates will receive a booking confirmation

email from Yardstick. **It is important that candidates bring this email with them to an examination center on the day of the examination.**

Upon entering the examination center, candidates will be asked to register with the proctor. The following information will need to be provided to the proctor.

- Candidate's first and last name
- Valid government-issued photo ID
- Candidate's booking email as provided by Yardstick

After the initial verification of identity, candidates will be asked to sign a roster. Candidates' personal belongings, such as bags and jackets, will be stored in a designated area. Electronic devices, including but not limited to cell phones, tablets, and reference books, may not under any circumstances be brought into the exam center. The only exception to this rule is personal calculators. The proctor is responsible for inspecting candidate's calculators prior to the exam.

Candidates may bring with them into the exam center water, juice, coffee or another drink in a spill proof container with no label and, only if approved by the proctor, a sweater without pockets, and disposable ear plugs.

The use of scratch paper is permitted. The proctor will provide scratch paper to the candidates before the exam and collect it after the exam.

Taking the Exam

At the beginning of the examination, candidates will hear verbal examination instructions from the proctor and read the Candidate's Statement of Understanding and/or Non-disclosure Agreement in the software. Failure to comply with the regulations outlined in these documents will result in the candidate's results being invalidated. Candidates will not be able to begin the examination without agreeing to the conditions outlined in the document.

Next, exam candidates will be given written exam instructions in the software. These exam instructions will emphasize the fact that some exam questions contain images and/or require calculations. If the images appear too small on the screen, candidates will be advised to hover their mouse over them to get an expanded view.

Following exam instructions, there will be a tutorial available to candidates before they proceed to the exam.

After the Examination

Upon submitting their exam responses, candidates will be offered an opportunity to provide feedback on exam material and exam administration conditions by completing a short online survey. Then, candidates will submit their scrap paper to the proctor, sign out from the candidate roster, and leave the examination center.

Examination Scoring and Reporting

Multiple-choice examination questions are scored dichotomously, using a score of “0” for an incorrect response and a score of “1” for a correct response. The Technologist Certification Examinations are criterion-referenced exams, which means that a candidate should obtain a score that is equal or higher than an exam pass mark to pass the examination.

Each Certification Examination has its own pass mark. The pass mark for the Fundamentals of Technology Certification Examination was determined by the Exam Committee, which took into account the difficulty of exam questions and the expected level of performance for a minimally competent engineering technologist. A psychometrically acceptable standard-setting methodology was used to set examination pass marks.

The examinations are electronically scored. Candidates can expect to obtain their exam score and the associated pass/fail decision within four to six weeks after the date of exam administration. Unsuccessful candidates will also receive a performance report indicating a failure to pass, their score, and areas of strength and weakness in the four tested competency areas. The unsuccessful candidates will be able to retake the exam.

Review and Appeal Process

A candidate who failed the Certification Examination may request that their exam score be verified. Due to the automated scoring and extensive quality control procedures, errors in scoring are extremely unlikely. However, candidates may request that ASET or CTTAM manually rescore their exam to verify the original score. The candidate will be responsible for any expenses incurred during the review and appeals process.

Appendix A: Fundamentals of Technology Exam Competencies

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| 1. Mathematics |
| 1.1 Basic Mathematics and Linear Algebra |
| 1.1.1 Solve algebraic equations using the basic laws of algebra |
| 1.1.2 Analyze and solve systems of linear equations, including simultaneous linear equations |
| 1.1.3 Explain the application of matrices |
| 1.1.4 Solve inequalities in one and two variables |
| 1.1.5 Explain the relationship between accuracy and significant digits |
| 1.1.6 Perform calculations using the proper order of mathematical operations |
| 1.1.7 Perform unit conversion using imperial units and SI units |
| 1.2 Calculus |
| 1.2.1 Identify a slope of a tangent to a curve |
| 1.2.2 Compute functional values |
| 1.2.3 Numerically approximate the area under a curve |
| 1.3 Differential Equations |
| 1.3.1 Perform basic mathematical operations with complex numbers |
| 1.4 Analytical Geometry and Trigonometry |
| 1.4.1 Describe various coordinate systems |
| 1.4.2 Solve geometry problems on a coordinate plane |
| 1.4.3 Determine distances between points and ratios of lengths of segments between points |
| 1.4.4 Apply equations of parallel and perpendicular lines |
| 1.4.5 Identify intersections of geometric objects |
| 1.4.6 Apply trigonometric functions in solving technology problems |
| 1.4.7 Solve right-angle triangles using trigonometry |
| 1.4.8 Solve trigonometric equations |
| 1.4.9 Carry out the simplification of trigonometric expressions using trigonometric identities |
| 2. Statistics |
| 2.1 Measures of Central Tendency and Variability |
| 2.1.1 Differentiate between sample statistics and population parameters |
| 2.1.2 Define measures of central tendency and variability |
| 2.1.3 Calculate the mean, median, and mode |
| 2.1.4 Calculate the range, variance, and standard deviation |
| 2.1.5 Compute percentiles and standard scores |
| 2.2 Probability |
| 2.2.1 Explain the basic tenants of the probability theory* |
| 2.2.2 Calculate simple conditional probabilities |
| 2.3 Sampling |
| 2.3.1 Explain the concepts of random, stratified, and clustered sampling |
| 2.3.2 Apply the appropriate sampling techniques to problems |

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| 3. Chemistry |
| 3.1 Periodic Table |
| 3.1.1 Explain the nomenclature of the periodic table |
| 3.1.2 Discuss basic concepts of atomic structure |
| 3.1.3 Predict the behaviour of elements from their positions on the periodic table and their electronic configurations |
| 3.2 Oxidation and Reduction |
| 3.2.1 Explain the principles of oxidation and reduction |
| 3.3 Acids and Bases |
| 3.3.1 Describe the properties of acids and bases |
| 3.3.2 Interpret pH indicators in aqueous solutions |
| 3.4 Gas Laws |
| 3.4.1 Explain how gas adapts in response to changes in volume and pressure |
| 3.4.2 Explain how gas adapts in response to changes in temperature and volume |
| 3.5 Liquids, Solids, and Gases |
| 3.5.1 Describe the properties of liquids, solids, and gases |
| 3.5.2 Determine the concentration of solutions |
| 3.6 Material Science |
| 3.6.1 Describe the properties of common materials found in engineering applications (e.g., ferrous alloys, polymers, ceramics) |
| 3.6.2 Recognize stress and strain caused by axial loads, bending loads, torsion, or shear |
| 3.6.3 Explain the application of common non-destructive material testing methods |
| 3.6.4 Describe common forms of material degradation |
| 4. Physics |
| 4.1 Thermodynamics |
| 4.1.1 Explain the concepts of energy, heat, and thermal expansion and contraction |
| 4.1.2 Define thermodynamic properties and processes |
| 4.1.3 Explain the concept of thermodynamic equilibrium |
| 4.1.4 Describe methods of heat transfer (e.g., conduction, convection, and radiation) |
| 4.1.5 Solve problems involving the transfer of thermal energy and heat loss |
| 4.2 Electricity, Power, and Magnetism |
| 4.2.1 Apply the concepts of electrical charge, current, voltage, resistance, and power |
| 4.2.2 Apply electrical current and voltage laws (Kirchhoff and Ohm) |
| 4.2.3 Explain the principles of operation of DC and AC circuits |
| 4.2.4 Describe the properties of electrical and magnetic fields |
| 4.3 Statics |
| 4.3.1 Recognize resultants of force systems and vector analysis |
| 4.3.2 Calculate dimensional properties |
| 4.3.3 Apply Newton's laws to static problems |
| 4.4 Dynamics |
| 4.4.1 Explain the concepts of speed, velocity, and acceleration |

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| 4.4.2 Describe Newton's first, second, and third laws of motion |
| 4.4.3 Apply Newton's laws to dynamic problems |
| 4.4.4 Calculate mass and weight |
| 4.4.5 Determine the individual forces acting upon an object |
| 4.4.6 Define the concepts of work, kinetic and potential energy, and power |
| 4.5 Fluid Dynamics |
| 4.5.1 Describe physical properties of fluids |
| 4.5.2 Distinguish between laminar and turbulent flow |
| 4.5.3 Define hydrostatic pressure |
| 4.5.4 Perform calculations for a flow rate |
| 4.5.5 Identify friction losses |
| 4.6 Measurement and Instrumentation |
| 4.6.1 Analyze the principles of operation of instruments |
| 4.6.2 Select measurement instruments for specific applications |