



EXAMINATIONS FOR

**CERTIFIED
BIOMEDICAL EQUIPMENT TECHNICIAN**

**CERTIFIED
RADIOLOGY EQUIPMENT SPECIALIST**

**CERTIFIED
LABORATORY EQUIPMENT SPECIALIST**

Handbook for Applicants

Application Deadline Testing Window

March 24, 2012

May 5-19, 2012

April 28, 2012

**June 5, 2012
(Charlotte only)**

September 22, 2012

November 3-17, 2012



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NEW YORK, NY 10018
(212) 356-0660
WWW.PTCNY.COM

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International Certification Commission (ICC)
Phone (703) 525-4890
Fax (703) 276-0793
www.aami.org

Professional Testing Corporation (PTC)
Phone (212) 356-0660
Fax (212) 356-0678
www.ptcny.com

PSI
Phone (800) 211-2754

ANNOUNCEMENT

We are pleased to announce that, beginning with the Spring 2012 exam cycle, ICC examinations will be offered in a computerized format at more than 200 testing centers across the United States and in parts of Canada. Applicants also will be provided with an expanded choice of dates on which to take the examinations.

The examinations still will be available in paper-and-pencil format to applicants outside the United States.

For more details on these enhancements, please visit <http://www.aami.org/certification/announcement.html>

ICC CERTIFICATION

The Certification for Biomedical Equipment Technicians (BMET) is a formal recognition by the International Certification Commission for Clinical Engineering and Biomedical Technology (ICC) that individuals have demonstrated excellence in theoretical as well as practical knowledge of the principles of biomedical equipment technology.

PURPOSE OF CERTIFICATION

In today's health care market, technology is paramount. The need for a workforce knowledgeable in the theory of operation, underlying physiological principles, and safe application of biomedical equipment is a central concern of many hospitals and companies. Certification demonstrates that successful applicants have the knowledge to ensure a safe, reliable health care environment. It also demonstrates to employers a significant commitment to career and competence.

TYPES OF CERTIFICATION

The Board of Examiners for Biomedical Equipment Technicians, operating under the direction of the United States Certification Commission (USCC) and the ICC, maintains the certification programs for biomedical equipment technicians (CBET), radiology equipment specialists (CRES), and laboratory equipment specialists (CLES). One certification is not a prerequisite for another. Each certification (CBET, CRES, CLES) requires a separate, complete application and a separate examination. Applicants may test in only one discipline per testing window.

ELIGIBILITY REQUIREMENTS

FULL CERTIFICATION:

Certified Biomedical Equipment Technician (CBET), Certified Radiology Equipment Specialist (CRES)*, or Certified Laboratory Equipment Specialist (CLES)* :

Applicants must meet ONE of the following minimum eligibility requirements as of the application deadline:

1. Associate's degree in biomedical academic program and two years full-time BMET work experience; OR
2. Completion of a U.S. military biomedical equipment technology program and two years full-time BMET work experience; OR
3. Associate's degree in electronics technology and three years full-time BMET work experience; OR
4. Four years full-time BMET work experience.

Additional eligibility routes for CLES Applicants only:

5. Associate's degree in medical laboratory technology and three years full-time BMET work experience; OR
6. Bachelor's degree in medical laboratory technology and two years full-time BMET work experience.

***CRES and CLES Applicants for full certification:** At least 40% of work experience over the last two years or 25% over the last five years must be in the designated specialty area.

CANDIDATE STATUS:

Applicants desiring Full certification, but who do not yet meet the eligibility requirements (as listed above), have the opportunity to apply through candidate status. Successful candidates are given five years to meet the minimum eligibility requirements and be awarded Full certification.

To test as a candidate for any of the certifications, an applicant must meet ONE of the following minimum eligibility requirements as of the application deadline:

1. Associate's degree in biomedical academic program; OR
2. Completion of a U.S. military biomedical equipment technology program; OR
3. Associate's degree in electronics technology and one year full-time BMET work experience; OR
4. Two years of full-time BMET work experience.

Additional eligibility routes for CLES Applicants only:

5. Associate's degree in medical laboratory technology and one year full-time BMET work experience; OR
6. Bachelor's degree in medical laboratory technology.

IMPORTANT: If claiming eligibility based in full or in part on an Associate's or Bachelor's degree, a copy of the diploma MUST be included with the Application and fees. A copy of the diploma is required for individuals applying under the completion of a U.S. military biomedical program. Official college transcripts may be requested at the discretion of the application reviewer, but required from international applicants. NOTE: A Bachelor's degree does not replace work experience requirements.

APPLICATION PROCEDURE

To obtain additional Handbooks and Applications for the ICC Examinations contact Professional Testing Corporation at 1350 Broadway, 17th Floor, New York, NY 10018, (212) 356-0660, or www.ptcny.com.

Be sure to use the most current Application. Outdated Applications will be returned. Go to www.ptcny.com to download the most current versions of the Handbook and Application.

PART I

NOTE: The name you enter on your application must match exactly the name listed on your current, government-issued photo ID such as driver's license or passport. Do not use nicknames or abbreviations.

Complete all information requested unless noted as optional on the Application. Mark one response only unless otherwise indicated.

SIGNATURE: When you have completed all required information, obtain required signatures, date and sign the Application in the space provided.

PART II

Complete all information requested on the Application. Be sure to indicate the examination for which you are applying and the eligibility option under which you are applying. Complete Section C with the appropriate information and include all requested information.

APPLICATION CHECKLIST: Applicants **MUST** include the following:

- Completed and signed Application (Part I, Part II)
- Copy of diploma (if claiming eligibility based on an Associate's or Bachelor's degree)
- Copy of military diploma (if using completion of U.S. military biomedical program as eligibility route)
- Official college transcript (for international applicants)
- Required Fee(s)

NOTE: Applications will be returned if not submitted with the required documentation and fees.

Applications **MUST** be postmarked by the application deadline as noted on the front cover and mailed to:

ICC Examinations
Professional Testing Corporation
1350 Broadway – 17th Floor
New York, NY 10018

Applications postmarked after the application deadline cannot be guaranteed acceptance. Applications are valid *only* for the requested testing period.

Applications will be reviewed to verify that applicants meet the eligibility requirements.

Once reviewed, applicants will be notified of the following:

If eligible: Applicants will be notified by PTC within approximately two weeks confirming their registration.

If ineligible: Application and fees will be returned to applicant with a notice of ineligibility.

SCHEDULING YOUR EXAMINATION APPOINTMENT / EXAM ADMINISTRATION

Once your Application has been received and processed and your eligibility verified, you will be mailed an Eligibility Notice four weeks prior to the start of the testing period. **The Eligibility Notice plus current, government-issued photo identification must be presented in order to gain admission to the testing center.** A candidate not receiving an Eligibility Notice at least three weeks before the beginning of the testing period should contact the Professional Testing Corporation by telephone at (212) 356-0660 with their fax number.

The Eligibility Notice will indicate where to call to schedule your examination appointment as well as the dates during which testing is available. Appointment times are first-come, first-serve, so schedule your appointment as soon as you receive your Eligibility Notice in order to maximize your chance of testing at your preferred location and on your preferred date.

The Examinations for Certified Biomedical Equipment Technician, Certified Radiology Equipment Specialist, and Certified Laboratory Equipment Specialist are four hour examinations administered during an established two-week testing window on a daily basis, Monday through Saturday, excluding holidays, at computer-based testing facilities managed by PSI. PSI has several hundred testing sites in the United States, as well as Canada. Scheduling is done on a first-come, first-serve basis. To find a testing center near you visit: <http://www.ptcny.com/cbt/sites.htm> or call PSI at (800) 211-2754. Please note: Hours and days of availability vary at different centers. You will not be able to schedule your examination appointment until you have received an Eligibility Notice from PTC.

It is highly recommended that each candidate become familiar with the location of the testing site. Arrival at the testing site at the appointed time is the responsibility of the candidate. Please plan for weather, traffic, parking, and any security requirements that are specific to the testing location. Late arrival may prevent you from testing.

It is the candidate's responsibility to call PSI (the test administrators) to schedule the exam appointment.

TESTING SOFTWARE DEMONSTRATION

A Testing Software Demonstration can be viewed online.

- Go to <http://www.ptcny.com/cbt/demo.htm>

This online Testing Software Demonstration can give you an idea about the features of the testing software used for the examinations.

TESTING CENTER INFORMATION

To schedule your examination appointment, date, and time, follow the instructions on page 4 under Scheduling Your Examination Appointment/Exam Administration.

The June 5, 2012 examination is offered in conjunction with the AAMI 2012 Annual Conference and Expo in Charlotte, NC only.

SPECIAL TEST CENTERS EXCLUDING THE UNITED STATES AND PARTS OF CANADA

It may be possible to establish a special testing center to take a paper and pencil examination outside of the United States for an additional fee of \$100. A letter must be sent with your application and fees, specifying your preferred city and country and must be received eight weeks before the testing period begins. If there are no computer test centers in your province in Canada, you can follow this same procedure or travel to the closest computerized testing center in the United States to take the examination. You will be contacted by e-mail to confirm your test center. All of the applications for a group international test center must be submitted in one package, with all the fees and original documentation included, plus a cover letter specifying the city and country where the special test center is being requested. For groups submitting five or more applications, a group testing fee of \$250 must be submitted (rather than the \$100 per application). PTC is not responsible for following up on credit card payments – the candidate is responsible for paying the fees at the time his application is submitted.

MILITARY PERSONNEL

If an applicant is in the military, lives on a non-domestic US military base, and cannot leave that base to take the examination at an established testing center, special arrangements can be made for testing on base. However, examinations must take place in the testing window listed on the cover of the Handbook. Send a written request to Professional Testing Corporation with the name, address, phone number, and/or e-mail address of the Education Center on the base at least EIGHT weeks before the examination date. The Special Testing Center Fee is NOT required.

If you are requesting a group special test center at a military base, all the applications and required documentation must be submitted in one package with a cover letter providing the name and mailing address for the base education officer. All fees must be submitted with the applications.

SPECIAL NEEDS APPLICANTS

Special testing arrangements will be made for individuals with special needs. Submit the Application, fee(s), and a completed and signed Request for Special Accommodations Form, available from www.ptcny.com or by calling PTC at (212) 356-0660. Requests for special testing for individuals with special needs must be received at least EIGHT weeks before the testing date.

Please notify PTC at least two weeks prior to your test appointment if you need to bring a service dog, medicine, food, or beverages necessary for a medical condition with you to the test center.

FEES

Application Fee (Full Certification or Candidate Status)\$375
Special Testing Center Fee (for candidates outside the U.S. or Canada).....\$100
Group Testing Center Fee (for groups of 5 or more candidates)\$250
NOTE: Pay the Special Testing Fee ONLY if a Special Testing Center is being requested (see page 5 for instructions).

Payment Methods:

CHECKS: Make checks payable to: ICC Examinations. Complete Check Payment section on Part I, Page 2 of the Application.

CREDIT CARDS: To use Visa, MasterCard, or American Express, complete and sign the Credit Card Payment section on Part I, Page 2 of the Application.

Applications received without appropriate fees will be returned unprocessed!

RULES FOR THE EXAMINATION

1. Electronic devices including, but not limited to, cell phones, pagers, palm pilots, Blackberries, Bluetooth type devices, MP3 players (IPOD, I-Touch, etc.), cameras, and voice recorders cannot be operative during the examination.
2. No books or reference materials may be taken in or removed from the examination room.
3. Only calculators that are classified as simple based calculators that have 10 numbers (0,1,2,3,4,5,6,7,8,9), add (+), subtract (-), multiply (x), divide (/) and equals (=) functions, which have no programming options or preconfigured buttons with formulas or calculations (summations, financial computations, etc.) may be used. These calculators may have an "M" button which is for memory. It only memorizes numbers, not calculations, formulas, etc. It is the responsibility of the applicant to clear any information and/or programs stored before the examination. The use of any calculator with unacceptable features or for retrieval of information/programs during the examination is considered an act of cheating. Calculators which are included as part of cellular phones, blackberries, and other communication devices will not be permitted. Most formulas and any schematics that may be needed are provided. A calculator is also available on screen if needed.
4. No questions concerning content of the examination may be asked during the examination. The candidate should read carefully the directions that are provided on screen at the beginning of the examination session.
5. ICC prohibits certain behaviors, including but not limited to the activities listed below:
 - a. Copying test questions
 - b. Copying answers
 - c. Permitting another to copy answers
 - d. Sharing exam content with others
 - e. Falsifying information required for admission to an examination impersonating another examinee
 - f. Taking the examination for any reason other than the purpose of seeking certification
6. Applicants must bring several sharpened Number 2 pencils (with erasers) to the testing center (paper and pencil examination only).

CHEATING

Any applicant failing to adhere to the "Rules For The Examination" as listed on page 6 will be considered guilty of cheating and will not be allowed to continue the examination. Fees are forfeited and no grade will be given. The candidate may take the test again after six months.

REPORT OF RESULTS

Applicants will receive the results of the examination from PTC within four weeks after the close of the testing period. For information purposes, the results from PTC will include a total composite score and scores for each of the six subject areas. Applicants who successfully pass the examination will receive an additional package from the ICC office. **NOTE: Examination results will NOT be provided by PTC or ICC to any applicant for any circumstance over the telephone, by email, or by facsimile.** Applicants are responsible for promptly notifying the Professional Testing Corporation and the International Certification Commission of address or name changes.

ATTAINMENT OF CERTIFICATION

Score required to pass: The minimum score required to pass the ICC Examinations is 105 correct answers of 150 questions.

Passing the examination (full status): Applicants who pass for Full certification will receive their scores from PTC and a certification package from ICC. All certified individuals will be listed on the AAMI web site under the ICC/USCC Directory of Certificants and are authorized and encouraged to use the appropriate acronym (CBET, CRES, or CLES) to denote certification on business cards, letterheads, at signature, etc. Certification is initially considered valid through the remainder of the year in which certification is received plus the following full calendar year. At that time it becomes necessary to renew certification and upon renewal certificants are put on a triennial schedule. A renewal notice from ICC will be sent to all individuals when it is time to renew certification.

Passing the examination as a Candidate: Applicants who pass under Candidate status will receive their scores from PTC and a congratulatory letter from ICC. Candidates have five years in which to complete the remaining requirements and apply for upgrading to Full certification. Candidates are not eligible to represent themselves as certified but may use the congratulatory letter from ICC as proof of certifiee-in-training status.

Achieving certification does not constitute an AAMI membership.

REVOCATION OF CERTIFICATION

Certification can be revoked for any of the following reasons:

1. Misrepresentation of certification status.
2. Falsification of the Application, including any documentation submitted.
3. Non-compliance with the certification renewal requirements.

RETESTING PROCEDURES

Applicants who do not pass are eligible to retake the examination beginning with the next regularly scheduled examination period. There is no limit regarding the number of times the examination may be taken. With each examination taken, the full fee is required.

Individuals may not take the examination for a certification which they currently hold (active or inactive).

TRANSFERS/CANCELLATIONS/REFUNDS

Cancellations and requests for refunds *must* be in writing.

Applicants who choose not to take the examination may receive a partial refund of 50% of the application fee if the written request is received within 30 days after the original testing date. Requests for refunds will not be honored after the 30 days.

Applicants unable to take the examination as scheduled may request a transfer to another examination period. Requests must be submitted within 14 days of the testing period if submitted with the rescheduling fee of \$100 and may elect to reschedule to a date within one year of the originally scheduled date. Applicants who cannot attend the examination on the date for which they are registered and who fail to provide advance notification will have the application closed and must complete the Application process from the beginning in order to take the examination. Fees are forfeited.

*The rescheduling fee is based on cost, and is not punitive in nature. The rescheduling fee must be paid at the time the request for rescheduling is made. The \$100 rescheduling fee cannot be refunded. Once applicants choose to reschedule, they cannot request a refund of either the \$100 rescheduling fee or of the original fee(s).

Exams may only be rescheduled once, please plan carefully.

For last minute cancellations, please call (212) 356-0660 before the examination date, and follow up immediately with written notice. Please address written notification to ICC in care of Professional Testing Corporation, 1350 Broadway, 17th Floor, New York, NY 10018.

RENEWAL OF CERTIFICATION

Requirements for maintaining certification include the payment of renewal fees and the accumulation of at least fifteen points of continuing practice activities reported every three years. The initial period of certification includes the remainder of the year in which certified **plus** the full calendar year immediately following. At the end of that period individuals will receive a renewal invoice. Upon payment of renewal fees, certification is extended for a three year period. The first Continuing Practice Journal is not due until the *end* of that three year period. Journals are due every three years thereafter. The categories for obtaining points in the Journal are varied and well within the reach of any actively practicing BMET. Failure to comply with the renewal requirements will result in revocation of certification. To regain certification, a new Application must be submitted and the examination taken again.

APPEALS PROCEDURE

Upon notification of examination results, applicants wishing to appeal the outcome must submit a letter to the Board of Examiners requesting an appeal within 60 days of receiving the examination results. If challenging a particular item on the examination, provide as much detail as possible about the item. The appeal will be carefully reviewed by the Board of Examiners to determine the appropriate action. Applicants will be contacted if additional information is needed, or when a decision has been reached. Challenges made by way of notations on the examination booklet are **not** considered an appeal and will not be reviewed by the Board or taken into consideration. Send written appeals to the BMET Board of Examiners at the ICC, 4301 N. Fairfax Dr., Suite 301, Arlington, VA 22203-1633.

CONFIDENTIALITY

It is up to each individual to notify an employer or others as to whether you have passed or failed the examination. Upon inquiry, the ICC will release information regarding the **status** of an individual's certification only (i.e.-certified or not certified, active or inactive, date certification expires, date certification was granted, and certification number). Information regarding scores and whether an individual took the examination will **not** be released.

REVIEW COURSES

It is considered a conflict of interest for any certifying organization or commission to help individuals attain the credential it issues. The Board of Examiners, the USCC, and the ICC do **not** sponsor or endorse any refresher course. Contact local biomedical associations or ask colleagues about organizing study groups or arranging for review courses.

STUDY GUIDES

There are no study guides produced by the ICC, the USCC, or the Board of Examiners. NOTE: The ICC, the USCC, and the Board of Examiners assume no responsibility for the accuracy, content, or relevance of any study guide or review course.

CONTENT OF EXAMINATIONS

EXAMINATION FOR CERTIFIED BIOMEDICAL EQUIPMENT TECHNICIAN (CBET)

I. Anatomy and Physiology (Approximately 12%)

- A. Systems
 - 1. Respiratory
 - 2. Gastrointestinal
 - 3. Nervous
 - 4. Circulatory
 - 5. Musculoskeletal
 - 6. Endocrine
- B. Organs
 - 1. Heart
 - 2. Lungs
 - 3. Liver
 - 4. Kidneys
 - 5. Brain
 - 6. Gallbladder
 - 7. Pancreas
 - 8. Other
- C. Blood
 - 1. Components
 - 2. Metabolism
- D. Terminology

II. Public (employee, patient, visitor) Safety in the Healthcare Facility (Approximately 15%)

- A. Electrical
 - 1. Microshock/Electrical Safety Testing
 - 2. Other
- B. Chemical
 - 1. Material Safety Data Sheet
 - 2. Other
- C. Radiation Hazards
 - 1. Light Spectrum
 - 2. Types of Rays
- D. Biological
 - 1. Standard Precautions
 - 2. Other
- E. Fire
 - 1. Class
 - 2. Fire Extinguishers
- F. Codes and Standards
 - 1. Credentialing and Certification
 - a. Joint Commission Comprehensive Accreditation Manual
 - b. AABB
 - c. American College of Radiology
 - 2. NFPA 99
 - a. Gas and Vacuum Systems
 - b. Electrical Systems
 - 3. FDA
 - a. SMDA
 - b. Other
 - 4. OSHA
 - 5. Other (NEC, ANSI, FCC, etc.)

III. Fundamentals of Electricity and Electronics (Approximately 15%)

- A. Transducers
- B. Calculations and Conversions
 - 1. Hex/Decimal/Binary
 - 2. Other
- C. Circuits and Components
 - 1. Active Devices
 - a. Solid-State Devices
 - 1. Analog
 - 2. Digital
 - b. Other (CRTs, X-Ray tubes, photomultipliers, etc.)
 - 2. Power Supplies
 - 3. Passive Devices
- D. Power Distribution and Storage Systems
 - 1. Transformers
 - 2. Distribution
 - 3. Batteries
 - 4. UPS/Line Conditioning
- E. Terminology

IV. Healthcare Technology Function and Operation (Approximately 24%)

- A. Monitoring Systems (ECG, EEG, Blood Pressure, Pulse Oximetry, Fetal Monitor)
- B. Portable Equipment (Infusion Devices, Syringe Pumps, PCA Pumps, Hypo Hyperthermia)
- C. Life Support Equipment (Defibrillators, Anesthesia Machines, Critical Care Ventilators, Balloon Pumps)
- D. Therapeutic Equipment (Infant Warmers, Ultrasound Therapy)
- E. Laboratory Equipment (Centrifuges, Water Baths, Analyzers)
- F. Diagnostic Imaging (Ultrasound, Radiographic/Fluoroscopy)
- G. Operating Room (Electro Surgical Generators, Video Carts, Lasers, Tourniquets, Sterilizers, Warmers)
- H. Test Equipment (Electrical Safety, Defibrillator, Electro Surgical, Physiologic Simulators, Oscilloscopes, Meters)
- I. Diagnostic Equipment
- J. Terminology

V. Healthcare Technology Problem Solving (Approximately 24%)

- A. Electronic Component Level, Block Level
- B. Monitoring Systems (ECG, EEG, Blood Pressure, Pulse Oximetry, Fetal Monitor)
- C. Portable Equipment (Infusion Devices, Syringe Pumps, PCA Pumps, Hypo Hyperthermia)
- D. Life Support Equipment (Defibrillators, Hemodialysis, Anesthesia Machines, Critical Care Ventilators, Balloon Pumps)
- E. Therapeutic Equipment (Infant Warmers, Ultrasound Therapy)
- F. Laboratory Equipment (Centrifuges, Water Baths, Analyzers)
- G. Diagnostic Imaging (Ultrasound, Radiographic/Fluoroscopy)
- H. Operating Room (Electro Surgical Generators, Video Carts, Lasers, Tourniquets, Sterilizers, Warmers)
- I. Diagnostic Equipment
- J. Situational (User Error, User Training, Applications)

VI. Healthcare Information Technology (Approximately 10%)

- A. Regulatory and Safety
 - 1. Medical Device Data Systems (MDDS)
 - 2. IEC 80001 – Application of Risk Management for IT Networks
 - 3. Health Insurance Portability and Accountability Act (HIPAA)
 - 4. Digital Millennium Copyright Act (DMCA)
- B. Foundations
 - 1. Hardware
 - a. Topology
 - b. PCs/Laptops/Servers
 - c. Wiring/Structured Cabling/Connectors
 - d. Switches/Hubs/Routers
 - e. Wireless Communications
 - f. Other
 - 2. Software/Middleware/Applications
 - a. EMR/EHR
 - b. Healthcare Information Systems (PACs, LIS, RIS)
 - c. Network Protocols (IP, CCP, UDP)
 - d. Operating Systems
- C. Function and Operation
 - 1. Hardware
 - a. PCs, Switches, Patch Panels
 - b. Networks, Topology
 - c. Peripherals
 - d. Other
 - 2. Integration
 - a. Bedside Medical Device Integration (BMDI)
 - b. Medical Device Integration (MDI) (Labs, Printers, etc.)
 - c. Mobile Devices (Handhelds, Smart Phones, Tablets, etc.)
 - 3. Test Equipment
 - a. Cable Test Devices (Copper, Fiber)
 - b. Network Test Devices
 - 4. Security
- D. Problem Solving
 - 1. Computer Networks
 - 2. Integration
 - 3. PCs, Switches, Hubs
- E. Terminology

**EXAMINATION FOR CERTIFIED
RADIOLOGY EQUIPMENT SPECIALIST (CRES)**

I. Anatomy and Physiology (Approximately 12%)

- A. Systems
 - 1. Respiratory
 - 2. Gastrointestinal
 - 3. Nervous
 - 4. Circulatory
 - 5. Musculoskeletal
 - 6. Endocrine
- B. Organs
 - 1. Heart
 - 2. Lungs
 - 3. Liver
 - 4. Kidneys
 - 5. Brain
 - 6. Gallbladder
 - 7. Pancreas
 - 8. Other
- C. Blood
 - 1. Components
 - 2. Metabolism
- D. Terminology

II. Public (employee, patient, visitor) Safety in the Healthcare Facility (Approximately 15%)

- A. Electrical
 - 1. Microshock/Electrical Safety Testing
 - 2. Other
- B. Chemical
 - 1. Material Safety Data Sheet
 - 2. Other
- C. Radiation Hazards
 - 1. Light Spectrum
 - 2. Types of Rays
- D. Biological
 - 1. Standard Precautions
 - 2. Other
- E. Fire
 - 1. Class
 - 2. Fire Extinguishers
- F. Codes and Standards
 - 1. Credentialing and Certification
 - a. Joint Commission Comprehensive Accreditation Manual
 - b. American College of Radiology
 - 2. NFPA 99
 - a. Gas and Vacuum Systems
 - b. Electrical Systems
 - 3. FDA
 - a. MQSA
 - b. CFR Title 21
 - c. SMDA
 - 4. OSHA
 - 5. Other (NEC, ANSI, FCC, etc.)

III. Fundamentals of Electricity and Electronics (Approximately 15%)

- A. Transducers
- B. Calculations and Conversions
 - 1. Hex/Decimal/Binary
 - 2. Other
- C. Circuits and Components
 - 1. Active Devices
 - a. Solid-State Devices
 - 1. Analog
 - 2. Digital
 - b. Other (CRTs, X-Ray tubes, photomultipliers, etc.)
 - 2. Power Supplies
 - 3. Passive Devices
- D. Power Distribution and Storage Systems
 - 1. Transformers
 - 2. Distribution
 - 3. Batteries
 - 4. UPS/Line Conditioning
- E. Terminology

IV. Healthcare Technology Function and Operation (Approximately 24%)

- A. Equipment Types
 - 1. Test Equipment
 - 2. Film Processors
 - 3. X-Ray Tubes
 - 4. TV Camera
 - 5. Intensifying Screens

- 6. Image Intensifier
- 7. Other
- B. Systems
 - 1. X-Ray Machines
 - 2. Nuclear Medicine
 - 3. Magnetic Resonance Imaging
 - 4. Linear Tomography Systems
 - 5. Ultrasound – Diagnostics
 - 6. Mammography
 - 7. Digital Imaging
 - 8. CT
 - 9. Health Care Information Systems (PACS, LIS, RIS)
 - 10. Other (Support Equipment, EKG, Defibrillator)
- C. Quality Control
- D. Terminology

V. Healthcare Technology Problem Solving (Approximately 24%)

- A. Component Level (Electronic Circuit)
- B. Equipment Types
 - 1. Film Processors
 - 2. X-Ray Tubes
 - 3. TV Cameras/Displays
 - 4. Intensifying Screens
 - 5. Image Intensifier
 - 6. Digital Imaging
 - 7. CT
 - 8. Other (Support Equipment, EKG, Defibrillator)
- C. Systems
 - 1. X-Ray Machines
 - 2. Nuclear Medicine
 - 3. Magnetic Resonance Imaging
 - 4. Linear Tomography Systems
 - 5. Ultrasound – Diagnostic
 - 6. Mammography
 - 7. Other
- D. Situational
 - 1. Prioritizing Work
 - 2. Operator vs. Equipment
 - 3. Applications
 - 4. Other

VI. Healthcare Information Technology (Approximately 10%)

- A. Regulatory and Safety
 - 1. Medical Device Data Systems (MDDS)
 - 2. IEC 80001 – Application of Risk Management for IT Networks
 - 3. Health Insurance Portability and Accountability Act (HIPAA)
 - 4. Digital Millennium Copyright Act (DMCA)
- B. Foundations
 - 1. Hardware
 - a. Topology
 - b. PCs/Laptops/Servers
 - c. Wiring/Structured Cabling/Connectors
 - d. Switches/Hubs/Routers
 - e. Wireless Communications
 - f. Other
 - 2. Software/Middleware/Applications
 - a. EMR/EHR
 - b. Healthcare Information Systems (PACs, LIS, RIS)
 - c. Network Protocols (IP, CCP, UDP)
 - d. Operating Systems
 - e. Other
- C. Function and Operation
 - 1. Hardware
 - a. PCs, Switches, Patch Panels
 - b. Networks, Topology
 - c. Peripherals
 - d. Other
 - 2. Integration
 - a. Bedside Medical Device Integration (BMDI)
 - b. Medical Device Integration (MDI) (Labs, Printers, etc.)
 - c. Mobile Devices (Handhelds, Smart Phones, Tablets, etc.)
 - 3. Test Equipment
 - a. Cable Test Devices (Copper, Fiber)
 - b. Network Test Devices
 - 4. Security
- D. Problem Solving
 - 1. Computer Networks
 - 2. Integration
 - 3. PCs, Switches, Hubs
- E. Terminology

**EXAMINATION FOR CERTIFIED
LABORATORY EQUIPMENT SPECIALIST (CLES)**

I. Anatomy and Physiology (Approximately 12%)

- A. Systems
 - 1. Respiratory
 - 2. Gastrointestinal
 - 3. Nervous
 - 4. Circulatory
 - 5. Musculoskeletal
 - 6. Endocrine
- B. Organs
 - 1. Heart
 - 2. Lungs
 - 3. Liver
 - 4. Kidneys
 - 5. Brain
 - 6. Gallbladder
 - 7. Pancreas
 - 8. Other
- C. Blood
 - 1. Components
 - 2. Metabolism
- D. Terminology

II. Public (employee, patient, visitor) Safety in the Healthcare Facility (Approximately 15%)

- A. Electrical
 - 1. Microshock/Electrical Safety Testing
 - 2. Other
- B. Chemical
 - 1. Material Safety Data Sheet
 - 2. Other
- C. Radiation Hazards
 - 1. Light Spectrum
 - 2. Types of Rays
- D. Biological
 - 1. Standard Precautions
 - 2. Other
- E. Fire
 - 1. Class
 - 2. Fire Extinguishers
- F. Codes and Standards
 - 1. Credentialing and Certification
 - a. Joint Commission Comprehensive Accreditation Manual
 - b. College of American Pathologists
 - c. Clinical Laboratory Improvement Amendments
 - d. COLA (formerly known as Commission on Laboratory Accreditation)
 - e. AABB (formerly known as American Association of Blood Banks)
 - 2. NFPA 99
 - a. Gas and Vacuum Systems
 - b. Electrical Systems
 - 3. FDA
 - a. SMDA
 - b. Other
 - 4. OSHA
 - 5. Other (NEC, ANSI, FCC, etc.)

III. Fundamentals of Electricity and Electronics (Approximately 15%)

- A. Transducers
- B. Calculations and Conversions
 - 1. Hex/Decimal/Binary
 - 2. Other
- C. Circuits and Components
 - 1. Active Devices
 - a. Solid-State Devices
 - 1. Analog
 - 2. Digital
 - b. Other (CRTs, X-ray tubes, photomultipliers, etc.)
 - 2. Power Supplies
 - 3. Passive Devices
- D. Power Distribution and Storage Systems
 - 1. Transformers
 - 2. Distribution
 - 3. Batteries
 - 4. UPS/Line Conditioning
- E. Terminology

IV. Healthcare Technology Function and Operation (Approximately 24%)

- A. Equipment Types
 - 1. Test Equipment
 - 2. Common Lab Equipment
 - a. Centrifuges
 - b. Microscopes
 - c. Blood Gas Analyzers
 - d. Refrigerators
 - 3. Chemistry Equipment
 - 4. Hematology Equipment
 - 5. Microbiology Equipment
 - 6. Blood Bank Equipment
 - 7. Urinalysis Equipment
 - 8. Histology Equipment
 - 9. Other
- B. Systems
 - 1. Lab Information
 - 2. Other
- C. Quality Control
- D. Terminology

V. Healthcare Technology Problem Solving (Approximately 24%)

- A. Component Level (Electronic Circuit)
- B. Equipment Types
 - 1. Common Lab Equipment
 - a. Centrifuges
 - b. Microscopes
 - c. Blood Gas Analyzers
 - d. Refrigerators
 - 2. Chemistry Equipment
 - 3. Hematology Equipment
 - 4. Microbiology Equipment
 - 5. Blood Bank Equipment
 - 6. Urinalysis Equipment
 - 7. Histology Equipment
 - 8. Other
- C. Systems
 - 1. Lab Information
 - 2. Other
- D. Situational
 - 1. Prioritizing Work
 - 2. Operator vs. Equipment
 - 3. Applications
 - 4. Other

VI. Healthcare Information Technology (Approximately 10%)

- A. Regulatory and Safety
 - 1. Medical Device Data Systems (MDDS)
 - 2. IEC 80001 – Application of Risk Management for IT Networks
 - 3. Health Insurance Portability and Accountability Act (HIPAA)
 - 4. Digital Millennium Copyright Act (DMCA)
- B. Foundations
 - 1. Hardware
 - a. Topology
 - b. PCs/Laptops/Servers
 - c. Wiring/Structured Cabling/Connectors
 - d. Switches/Hubs/Routers
 - e. Wireless Communications
 - f. Other
 - 2. Software/Middleware/Applications
 - a. EMR/EHR
 - b. Healthcare Information Systems (PACs, LIS, RIS)
 - c. Network Protocols (IP, CCP, UDP)
 - d. Operating Systems
 - e. Other
- C. Function and Operation
 - 1. Hardware
 - a. PCs, Switches, Patch Panels
 - b. Networks, Topology
 - c. Peripherals
 - d. Other
 - 2. Integration
 - a. Bedside Medical Device Integration (BMDI)
 - b. Medical Device Integration (MDI) (Labs, Printers, etc.)
 - c. Mobile Devices (Handhelds, Smart Phones, Tablets, etc.)
 - 3. Test Equipment
 - a. Cable Test Devices (Copper, Fiber)
 - b. Network Test Devices
 - 4. Security
- D. Problem Solving
 - 1. Computer Networks
 - 2. Integration
 - 3. PCs, Switches, Hubs
- E. Terminology

SAMPLE QUESTIONS

I. Anatomy & Physiology

The biomedical equipment technician (BMET) must be able to communicate intelligently with physicians and hospital staff members. To fulfill the BMET's responsibilities in safety, calibration, and related areas, the BMET must have a reasonable knowledge of anatomy and physiology. The knowledge should include familiarity with terminology and body functions.

1. In fresh, normal human blood, the volume of cells is what percent of the total volume?
 1. 25%
 2. 45%
 3. 80%
 4. 90%

II. Public Safety in the Health Care Facility

This area includes all aspects of safety relating to the health care facility. Each specialist examination (Radiology & Laboratory) emphasizes safety in the specialty.

2. What are the three components of an ordinary fire?
 1. Gas, liquid, vapor
 2. Smoke, flame, heat
 3. Fuel, heat, oxygen
 4. Flames, sparks, explosions

III. Fundamentals of Electricity and Electronics

Fundamental to many functions of the BMET is knowledge of basic electricity and electronics. Test items in this area call for:

- a. An understanding of current and voltage relationships in AC and DC circuits.
 - b. The ability to apply fundamental mathematical formulae to circuitry.
 - c. An understanding of semiconductor theory and the principles of solid-state circuitry.
 - d. An understanding of electronic test and measuring equipment function.
3. In a single-stage amplifier with a transistor in common-emitter configuration featuring a purely resistive load, the emitter voltage and the collector voltage are
 1. in phase.
 2. not related.
 3. 90° out of phase.
 4. 180° out of phase.

IV. Healthcare Technology Function and Operation

The BMET should possess a broad knowledge of equipment and instrumentation in the medical environment. The BMET's knowledge should include the theory of operation, clinical application, and unique safety requirements relating to items such as: (1) coronary and critical care equipment; (2) spectrophotometers, colometers, centrifuges, and other instruments in a clinical laboratory; (3) suction and pressure units; (4) anesthesia machines, ventilators, intra-aortic balloon pumps, and infusion devices; (5) diathermy and ultrasound units; (6) X-ray equipment; and (7) sterilizers.

4. A sphygmomanometer is used for
 1. measuring blood pressure.
 2. collecting urine for analysis.
 3. measuring respiration rate.
 4. high-speed counting of erythrocytes.

V. Healthcare Technology Problem Solving

The BMET must be able to perform theoretical troubleshooting using schematics ranging from the simple, serologic water bath to one for an electrocardiograph.

5. A dampened waveform on an invasive blood pressure monitor is usually caused by
 1. a defective monitor.
 2. air bubbles in the fluid system.
 3. the transducer being above the patient.
 4. the transducer being below the patient.

VI. Healthcare Information Technology

A BMET must have a fundamental knowledge of computer based systems, used in conjunction with modern medical systems. The BMET's knowledge should include the theory and operation of microprocessor circuits, computer interfaces and networking devices and LAN topography.

6. Which of the following devices automatically assigns IP addresses?
 1. Router
 2. Switch
 3. Repeater
 4. DHCP server

CORRECT ANSWERS TO SAMPLE QUESTIONS:

1. 2 2. 3 3. 4 4. 1 5. 2 6. 4

EDUCATIONAL RESOURCES

The following list is not intended to be a complete listing of every source available, nor should applicants feel they must purchase and study every item on this list. Most texts in a particular category are redundant. The list is purposely long to increase the probability that everyone will have access to at least some of the sources listed. Other generally accepted texts may be of equal value in preparation for the examinations.

Anatomy, Physiology, and Medical Terminology

(General/Radiology/Laboratory)

Martini, Frederick and Bartholomew, Edwin: *Structure & Function of the Human Body*, Prentice Hall, Upper Saddle River, NJ, 1999.

Patton, Kevin T. and Thibodeau, Gary A.: *Anthony's Textbook of Anatomy & Physiology*, Mosby Yearbook Co., St. Louis, MO (ISBN: 0-323-01630-8) 17th Edition, 2002.

Stedman, Thomas: *Stedman's Medical Dictionary*, Lippicott, Williams & Wilkins, NY (ISBN: 0-7817-4494-6) 27th Edition, 2002.

Tortora, Gerard J. and Grabowski, Sandra Reynolds: *Principles of Anatomy and Physiology*, Wiley Publishing (ISBN: 0-471-41501-4) 10th Edition, 2002.

Safety and Regulatory-Public and Patient Safety in the Health

Care Facility (General/Radiology/Laboratory)

AABB: *American Association Blood Banks*
<http://www.aabb.org/>

ANSI: *American National Standards Institute*
<http://webstore.ansi.org/ansidocstore/default.asp>

CLIA: *Clinical Laboratory Improvement Amendments*
<http://www.fda.gov/cdrh/clia/>

Code of Federal Regulations, *Title 21, Subchapter J*.
<http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfCFR/CFRSearch.cfm>

Comprehensive Accreditation Manual of Hospitals: *The Joint Commission*
<http://www.jointcommission.org/>

Health Care Abbreviations and Acronyms
https://www.aami.org/certification/download/Healthcare_Abbreviations.pdf

MQSA: *Mammography Quality Standards Act*
<http://www.fda.gov/cdrh/mammography/>

NCRP (Report 99, 102): *National Council on Radiation Protection and Measurements*
<http://www.ncrponline.org/>

NEMA Standards (Publication No. XR 8, XR9, XR11, XR12): *National Electrical Manufacturers Association*
<http://nema.org/>

NFPA (70, 99, 101): *National Fire Protection Association*
<http://www.nfpa.org/>

OSHA: *Occupational Safety & Health Administration*
<http://www.osha.gov/>

Electronics and Devices
(General/Radiology/Laboratory)

- Beyda, William J.: Data Communications, from Basics to Broadband, Prentice-Hall, Englewood Cliffs, NJ (ISBN: 0-1309-6139-6) 3rd Edition, 2000.
- Floyd, Thomas L.: Digital Fundamentals, Prentice Hall, Englewood Cliffs, NJ (ISBN: 0-1308-08540-4) 7th Edition, 2000.
- Floyd, Thomas L.: Electronic Devices, Prentice Hall, Englewood Cliffs, NJ (ISBN: 0-1364-3138-3) 5th Edition, 1999.
- Grob, Bernard and Schultz, Mitchel: Basic Electronics, Macmillan/McGraw-Hill, Westerville, OH (ISBN: 0-0782-7124-X) 9th Edition, 2003.
- Malvino, Albert Paul, PhD: Electronic Principles, McGraw-Hill Book Co., New York, NY (ISBN: 0-0280-2833-3) 6th Edition, 1999.
- Paynter, Robert T.: Introductory Electronic Devices and Circuits, Prentice Hall, Englewood Cliffs, NJ (ISBN: 0-1392-7203-8) 5th Edition, 2000.
- Williams, Joseph: An Introduction to Computing Infrastructure: Hardware and Opening Systems, Que Education and Training (ISBN: 1-5757-6355-9) 1997.

Biomedical Instrumentation (General)

- Atles, Leslie, R.: A Practicum for Biomedical Engineering Technology Management Issues, 2008.
- Carr, Joseph J. and Brown, John M.: Introduction to Biomedical Equipment Technology, John Wiley & Sons, Inc., NY (ISBN: 0-1301-0492-2) 4th Edition, 2001.
- Chan, Anthony: Biomedical Device Technology: Principles and Design, Charles C Thomas Publisher, Ltd., Springfield, IL (ISBN: 978-0-398-07699) 2008.
- Christe, Barbara: Introduction to Biomedical Instrumentation: The Technology of Patient Care, Cambridge University Press, New York (ISBN: 978-0-521-5152-2) 2009.
- Cromwell, and Others: Biomedical Instrumentation and Measurements, Prentice-Hall, Inc., Englewood Cliffs, NJ (ISBN: 0-1307-6448-5) 2nd Edition, 1980.
- Khandpur, Raghbir: Biomedical Instrumentation: Technology and Applications, McGraw-Hill, New York (ISBN: 0-07-144784-9) 2005.
- MacIntyre, Neil R. and Branson, Richard D.: Mechanical Ventilation, W.B. Saunders Company (ISBN: 0-7216-7361-9) 1st Edition, 2001.
- Robbins, Allan and Miller, Willhelm: Circuit Analysis: Theory and Practice, Thomson Delmar Learning, New York, 2nd edition, 2006.
- Street, Laurence: Introduction to Biomedical Engineering Technology, CRC Press, Boca Raton, FL, 2008.

Health Care Information Technology

- Arnold, Steven: Guide to the Wireless Medical Practice. Himss (ISBN: 0-9777903-8-X) 2008.
- Benson, Tim: Principles of Health Interoperability HL7 & SNOMED: Health Informatics Series (ISBN: 978-1-84882-802-5) 2010.
- ECRI Institute: Medical Technology for the IT Professional (ISBN: 978-0-9819241-1-3).

Radiology

Bushong, Stewart: Radiologic Science for Technologists: Physics, Biology, and Protection, Mosby Yearbook Co., St. Louis, MO (ISBN: 0-323-01337-6) 7th Edition, 2001.

Callaway, W. J.: Mosby's Comprehensive Review of Radiography: The Complete Study Guide and Planner, Elsevier Science (ISBN: 0-3230-1839-4) 3rd Edition, 2002.

Papp, J.: Quality Management in the Imaging Sciences, Elsevier Science (ISBN: 0-3230-1624-3) 2nd Edition, 2002.

Saia, D. A.: Appleton & Lange's Review for the Radiography Examination, McGraw Hill (ISBN: 0-8385-0389-6) 4th Edition, 2000.

Laboratory

Estridge, Barbara H., Reynolds, Anna P., & Walters, Norma J. PhD: Basic Medical Laboratory Techniques, Delmar (Thomas Learning), Albany, NY (ISBN: 0-7668-1206-5) 4th Edition, 2000.

Fischbach, Francis RN, BSN, MSN: A Manual of Laboratory & Diagnostic Tests, Lippincott Williams & Wilkins, Philadelphia, PA (ISBN: 0-7817-1969-0) 6th Edition, 2000.

Lehman, PhD, Craig A., Leiken, Alan, Ward, PhD., Kory M.: Clinical Laboratory Instrumentation and Automation: Principles, Applications, and Selection, W.B. Saunders Co., Philadelphia, PA (ISBN: 0-7216-4218-7) 1st Edition, 1994.

Mahon, C., Smith, L., Burno, C.: An Introduction to Clinical Laboratory Science, W.B. Saunders Co., Philadelphia, PA (ISBN: 0-7216-4990-4) 1st Edition, 1998.

Mangle, James I., Nortica, PhD., Solomon, Petit, MD, J.E.: Alba's Medical Technology: Board Examination Review and Complete Clinical Laboratory Text, Berkeley Scientific Publications (ISBN: 0-91024-18-8) 12th Edition, 1996.

Segen, Joseph C. MD and Stauffe, Joseph PhD: The Patient's Guide to Medical Tests, Facts on File, Inc., New York, NY (ISBN: 0-8160-4652-2) 2nd Edition, 2002.

PTC11092
Revised DCHI11

Administered by:
U.S. Board of Examiners for Biomedical Equipment Technicians
International Certification Commission
United States Certification Commission
for Clinical Engineering and Biomedical Technology