



EXAMINATIONS FOR

CERTIFIED
BIOMEDICAL EQUIPMENT TECHNICIAN

CERTIFIED
RADIOLOGY EQUIPMENT SPECIALIST

CERTIFIED
LABORATORY EQUIPMENT SPECIALIST

Handbook for Applicants

Application Deadline Examination Date

March 20, 2010

May 1, 2010

May 18, 2010

June 29, 2010
(Tampa, FL only)

September 25, 2010

November 6, 2010

PTC
PROFESSIONAL TESTING CORPORATION®

1350 BROADWAY • 17th FLOOR
NEW YORK, NY 10018
(212) 356-0660
WWW.PTCNY.COM

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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 examination.

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:

1. Associate's degree in biomedical academic program and two years full-time BMET work experience; OR
2. Associate's degree in electronics technology and three years full-time BMET work experience; OR
3. Four years full-time BMET work experience.

Additional eligibility routes for CLES Applicants only:

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

*CRES and CLES Applicants: 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:

1. Associate's degree in biomedical academic program; OR
2. Associate's degree in electronics technology and one year full-time BMET work experience; OR
3. Completion of a U.S. military biomedical equipment technology program. (Applicants qualifying under this route must still complete one of the three eligibility requirements for certification in addition to the U.S. military biomedical equipment technology course before being awarded certification.); 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, an official college transcript MUST be included with the Application and fees. A copy of the diploma is required for individuals applying under the completion of a military program. If appropriate transcripts are not included, the Application will be returned unprocessed. 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.

COMPLETION OF APPLICATION

PART I

Complete all information requested unless noted as optional on the Application. Mark one response only unless otherwise indicated. For Testing Center Number, city, and state see page 4.

SIGNATURE: When you have completed all required information, 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. Under Section C, complete with the appropriate information and include all requested information.

APPLICATION CHECKLIST: Applicants MUST include the following:

- Completed and signed Application (Part I, Part II)
- Official transcript (if using degree as eligibility route)
- Copy of military diploma (if using completion of military program as eligibility route)
- 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 examination date.

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.

TESTING CENTER INFORMATION

The following cities will serve as testing centers for the examinations. Indicate your choice of center on the Application in the space provided.

ARKANSAS 234 - Little Rock	KENTUCKY 434 - Lexington	NORTH CAROLINA 703 - Greensboro
CALIFORNIA 255 - Los Angeles area 262 - San Francisco area	LOUISIANA 452 - New Orleans	OHIO 732 - Columbus
COLORADO 276 - Denver area	MARYLAND 477 - College Park	PENNSYLVANIA 788 - Philadelphia
FLORIDA 100 - Tampa* 313 - Orlando	MASSACHUSETTS 486 - Boston	SOUTH CAROLINA 823 - Columbia
GEORGIA 334 - Savannah	MICHIGAN 508 - Detroit area	TENNESSEE 851 - Memphis
ILLINOIS 368 - Chicago	MINNESOTA 534 - Minneapolis	TEXAS 867 - Dallas 890 - San Antonio
INDIANA 388 - Indianapolis	MISSOURI 566 - St. Louis	VIRGINIA 912 - Richmond
IOWA 405 - Des Moines	NEBRASKA 594 - Lincoln	WASHINGTON 929 - Spokane
	NEVADA 607 - Las Vegas	WISCONSIN 962 - Madison
	NEW YORK 668 - New York City	

* June 29, 2010 only in conjunction with the AAMI 2010 Annual Conference and Expo.

SPECIAL TESTING CENTERS

If an applicant lives over 250 miles from an established testing center, special arrangements for a closer testing center may be possible for the nonrefundable Special Testing Center Fee of \$100. A written request must accompany the Application specifying the preferred location and must be received EIGHT weeks before the examination date. If there is a group of five or more applicants who want an additional testing center, they may request one for the Special Testing Center Fee of \$250 (per group), regardless of distance from established test centers. This can be done provided all Applications and Fees are sent in one package at least EIGHT weeks before the examination date. A written request must accompany the Application package specifying the preferred location. Examinations must take place on the dates listed on the cover of the Handbook.

MILITARY PERSONNEL

If an applicant is in the military, lives on a 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 on the date listed on the cover of the Handbook, or within 3 business days of this test date. 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.

SUNDAY TESTING REQUEST

Sunday testing is permitted ONLY for those applicants submitting satisfactory evidence that their religious convictions prevent them from taking the examination on Saturday. The test will be given on the Sunday immediately following the regular Saturday testing date. Requests for Sunday testing must be made in writing and submitted with the Application and Fees, and must be received EIGHT weeks before the testing date.

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.

INTERNATIONAL APPLICANTS

Please submit a letter with your Application, fee(s), and documentation requesting a special test center in your city and country. 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. PTC is not responsible for following up on credit card payments – the candidate is responsible for paying the fees at the time their application is submitted.

FEES

Application Fee (Full Certification or Candidate Status) \$295

Special Testing Center Fee \$100

Special Group Testing Center Fee \$250

NOTE: Pay the Special Testing Fee or Special Group Testing Center Fee ONLY if a Special Testing Center or Special Group Testing Center is being requested (See Special Testing Centers on page 4 for instructions.).

Payment Methods:

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

TIME ALLOCATION FOR THE EXAMINATIONS

Applicants are allowed up to 4 hours to answer 150 multiple choice questions. The following schedule will be observed at all testing centers:

- 8:30 A.M. - Report to testing center
- 9:00 A.M. - Examination begins
- 1:00 P.M. - Examination ends

Applicants should report to their assigned centers by 8:30 A.M. on the examination date. Latecomers may be admitted to the examination at the discretion of the Examiner but will NOT be permitted to continue testing beyond the time scheduled for completion of the examination.

ADMISSION TO TESTING

Admission Notice: The Professional Testing Corporation will notify applicants approximately three weeks before the testing date of final assignments for testing centers by means of an Admission Notice showing exact address to which applicants should report. **Save this notice** and bring it when reporting for testing. In addition to the Admission Notice, a **current government-issued photo identification** (such as a driver's license, passport, etc.) must be presented in order to gain admission to the testing site.

Failure to receive Admission Notice: An applicant not receiving an Admission Notice at least ten days before the test date should contact the Professional Testing Corporation by calling (212) 356-0660.

Changes: Changes in assignments to testing centers can NOT be made later than four weeks before the examination date.

RULES FOR THE EXAMINATION

1. Applicants must bring several sharpened Number 2 pencils (with erasers) to the testing center.
2. The use of programmable calculators is not permitted. However, in such cases should an applicant arrive with a programmable calculator, 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.
3. No signaling devices, including pagers, cellular phones, and alarms, may be operative during the examination.
4. No test materials, documents, or memoranda of any sort are to be taken from the examination room.
5. Absolutely no books or other reference material may be taken into the examination room.
6. No questions concerning content of the examination may be asked during the testing period. The applicant should listen carefully to the instructions given by the Examiner and should read carefully the directions in the test booklet.
7. Talking is not allowed in the examination room once the examination has started (except with the proctor).

CHEATING

Any applicant failing to adhere to numbers 2 - 7 of the "Rules For The Examination," as listed above, will be considered guilty of cheating and will not be allowed to continue the examination. Fees are forfeited and no grade will be given. Testing may be applied for again after six months.

REPORT OF RESULTS

Applicants will receive the results of the examination from PTC within six weeks after the examination. For information purposes, the results from PTC will include a total composite score and scores for each of the five subject areas. If the applicant has successfully passed the examination, they 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 Directory of Active 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.

REVOCAION 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 date. 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).

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 -- which will be supplied by the ICC -- 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.

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% 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 date up to 14 days after the testing date 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 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.

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 90 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. Each appeal is handled individually depending upon its nature. 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, 1110 N Glebe Road, Suite 220, Arlington, VA 22201.

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. The Association for the Advancement of Medical Instrumentation (AAMI) offers a course entitled "BMET Evaluation and Review" every year at its Annual Meeting. Call AAMI at (703) 525-4890, [ext. 217](#) for more information.

STUDY GUIDES

There are no study guides produced by the ICC, the USCC, or the Board of Examiners. The Association for the Advancement of Medical Instrumentation (AAMI) offers a Study Guide for BMET Certification. This guide has been developed to give an indication of the scope and range of topics covered on the BMET certification examination and to help users identify areas that require additional study. It is NOT intended as sufficient preparation for the certification examination. Call AAMI Publications at (877) 249-8226 for more information.

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 EXAMINATION

EXAMINATION FOR CERTIFIED BIOMEDICAL EQUIPMENT TECHNICIAN (CBET)

- I. **Anatomy and Physiology (Approximately 13%)**
 - 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 Health Care Facility (Approximately 17%)**
 - 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. Joint Commission Comprehensive Accreditation Manual
 2. AABB
 3. NFPA 99
 - a. Gas and Vacuum Systems
 - b. Electrical Systems
 4. FDA
 5. SMDA
 6. OSHA
 7. Other
- III. **Fundamentals of Electricity, Electronics, and Solid-State Devices (Approximately 17%)**
 - A. Transducers
 - B. Calculations and Conversions
 1. Hex/Decimal/Binary
 2. Other
 - C. Devices
 1. Passive
 2. Active
 3. Digital
 - D. Circuits
 1. Operational Amplifier
 2. Power Supplies
 3. Common Base/Emitter/ Collector Transistor Circuits
 4. AC Power
 - a. Transformer
 - b. Distribution
 - E. Test Equipment
- F. Batteries
- G. Terminology
- IV. **Medical Equipment Function and Operation (Approximately 26%)**
 - A. Monitoring Systems (i.e. ECG, EEG, Blood Pressure, Pulse Oximetry, Fetal Monitor)
 - B. Portable Equipment (i.e. Infusion Devices Syringe Pumps, PCA Pumps, Hypo Hyperthermia)
 - C. Life Support Equipment (i.e. Defibrillators, Hemodialysis, Anesthesia Machines, Critical Care Ventilators, Balloon Pumps)
 - D. Therapeutic Equipment (i.e. Infant Warmers, Ultrasound Therapy)
 - E. Laboratory Equipment (i.e. Centrifuges, Water Baths, Analyzers)
 - F. Diagnostic Imaging (i.e. Ultrasound, Radiographic/Fluoroscopy)
 - G. Operating Room (i.e. Electro Surgical Generators, Video Carts, Lasers, Tourniquets, Sterilizers, Warmers)
 - H. Information Systems (i.e. Computers, Networks, Topology)
 - I. Test Equipment (i.e. Electrical Safety, Defibrillator, Electro Surgical, Physiologic Simulators, Oscilloscopes, Meters)
 - J. Terminology
- V. **Medical Equipment Problem Solving (Approximately 27%)**
 - A. Electronic Component Level, Block Level
 - B. Monitoring Systems (i.e. ECG, EEG, Blood Pressure, Pulse Oximetry, Fetal Monitor)
 - C. Portable Equipment (i.e. Infusion Devices Syringe Pumps, PCA Pumps, Hypo Hyperthermia)
 - D. Life Support Equipment (i.e. Defibrillators, Hemodialysis, Anesthesia Machines, Critical Care Ventilators, Balloon Pumps)
 - E. Therapeutic Equipment (i.e. Infant Warmers, Ultrasound Therapy)
 - F. Laboratory Equipment (i.e. Centrifuges, Water Baths, Analyzers)
 - G. Diagnostic Imaging (i.e. Ultrasound, Radiographic/Fluoroscopy)
 - H. Operating Room (i.e. Electro Surgical Generators, Video Carts, Lasers, Tourniquets, Sterilizers, Warmers)
 - I. Information Systems (i.e. Computers, Networks, Topology)
 - J. Situational (i.e. User error, user training, applications)

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

I. Anatomy and Physiology (Approximately 13%)	IV. Medical Equipment Function and Operation (Approximately 26%)
<ul style="list-style-type: none"> A. Systems <ul style="list-style-type: none"> 1. Respiratory 2. Gastrointestinal 3. Nervous 4. Circulatory 5. Musculoskeletal 6. Endocrine B. Organs <ul style="list-style-type: none"> 1. Heart 2. Lungs 3. Liver 4. Kidneys 5. Brain 6. Gallbladder 7. Pancreas 8. Other C. Blood <ul style="list-style-type: none"> 1. Components 2. Metabolism D. Terminology 	<ul style="list-style-type: none"> A. Equipment Types <ul style="list-style-type: none"> 1. Test Equipment 2. Film Processors 3. X-Ray Tubes 4. TV Camera 5. Intensifying Screens 6. Image Intensifier 7. Other B. Systems <ul style="list-style-type: none"> 1. X-Ray Machines <ul style="list-style-type: none"> a. Diagnostic b. Therapy c. Portable d. Fluoroscopy 2. Nuclear Medicine 3. Magnetic Resonance Imaging 4. Linear Tomography Systems 5. Ultrasound - Diagnostics 6. Mammography 7. Digital Imaging 8. CT 9. PACS 10. Other C. Information Technology <ul style="list-style-type: none"> 1. Computers <ul style="list-style-type: none"> a. Hardware b. Software 2. Networks <ul style="list-style-type: none"> a. Topologies b. Operating Systems D. Quality Control E. Terminology
II. Public (employee, patient, visitor) Safety In The Health Care Facility (Approximately 17%)	V. Medical Equipment Problem Solving(Approximately 27%)
<ul style="list-style-type: none"> A. Electrical <ul style="list-style-type: none"> 1. Microshock/Electrical Safety Testing 2. Other B. Chemical <ul style="list-style-type: none"> 1. Material Safety Data Sheet 2. Other C. Radiation Hazards <ul style="list-style-type: none"> 1. Light Spectrum 2. Types of Rays D. Biological <ul style="list-style-type: none"> 1. Standard Precautions 2. Other E. Fire <ul style="list-style-type: none"> 1. Class 2. Fire Extinguishers F. Codes and Standards <ul style="list-style-type: none"> 1. Joint Commission Comprehensive Accreditation Manual 2. NFPA 99 <ul style="list-style-type: none"> a. Gas and Vacuum Systems b. Electrical Systems 3. FDA <ul style="list-style-type: none"> a. MQSA b. Title 21 4. SMDA 5. OSHA 6. Other 	<ul style="list-style-type: none"> A. Component Level (Electronic Circuit) B. Equipment Types <ul style="list-style-type: none"> 1. Film Processors 2. X-Ray Tubes 3. TV Camera/Displays 4. Intensifying Screens 5. Image Intensifier 6. Digital Imaging 7. CT 8. PACS 9. Other C. Systems <ul style="list-style-type: none"> 1. X-Ray Machines <ul style="list-style-type: none"> a. Diagnostic b. Therapy c. Portable d. Fluoroscopy 2. Nuclear Medicine 3. Magnetic Resonance Imaging 4. Linear Tomography Systems 5. Ultrasound - Diagnostic 6. Mammography 7. Other D. Situational <ul style="list-style-type: none"> 1. Prioritizing Work 2. Operator vs. Equipment 3. Applications 4. Other
III. Fundamentals of Electricity, Electronics, and Solid-State Devices (Approximately 17%)	
<ul style="list-style-type: none"> A. Transducers B. Calculations and Conversions <ul style="list-style-type: none"> 1. Hex/Decimal/Binary 2. Other C. Devices <ul style="list-style-type: none"> 1. Passive 2. Active 3. Digital D. Circuits <ul style="list-style-type: none"> 1. Operational Amplifier 2. Power Supplies 3. Common Base/Emitter/ Collector Transistor Circuits 4. AC Power <ul style="list-style-type: none"> a. Transformer b. Distribution E. Test Equipment F. Batteries G. Terminology 	

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

**I. Anatomy and Physiology
(Approximately 13%)**

- 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 Health Care Facility
(Approximately 17%)**

- A. Electrical
 - 1. Microshock/Electrical Safety Testing
 - 2. Other
- B. Chemical
 - 1. Material Safety Data Sheet
 - 2. Other
- C. Radiation Hazards
- D. Biological
 - 1. Standard Precautions
 - 2. Other
- E. Fire
 - 1. Class
 - 2. Fire Extinguishers
- F. Codes and Standards
 - 1. Joint Commission Comprehensive Accreditation Manual
 - 2. AABB
 - 3. NFPA 99
 - a. Gas and Vacuum Systems
 - b. Electrical Systems
 - 4. FDA
 - 5. SMDA
 - 6. OSHA
 - 7. CLIA
 - 8. Other

**III. Fundamentals of Electricity, Electronics,
and Solid-State Devices
(Approximately 13%)**

- A. Transducers
- B. Calculations and Conversions
 - 1. Hex/Decimal/Binary
 - 2. Other
- C. Devices
 - 1. Passive
 - 2. Active
 - 3. Digital
- D. Circuits
 - 1. Operational Amplifier
 - 2. Power Supplies
 - 3. Common Base/ Emitter/Collector Transistor Circuits
 - 4. AC Power
 - a. Transformer
 - b. Distribution
- E. Test Equipment
- F. Batteries
- G. Terminology

**IV. Medical Equipment Function and
Operation (Approximately 39%)**

- 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. Computer
 - a. Hardware
 - b. Software
 - 3. Networks
 - a. Topologies
 - b. Operating Systems
 - 4. Other
- C. Quality Control
- D. Terminology

**V. Medical Equipment Problem Solving
(Approximately 18%)**

- 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. Computer
 - a. Hardware
 - b. Software
 - 3. Networks
 - a. Topologies
 - b. Operating Systems
 - 4. Other
- D. Situational
 - 1. Prioritizing Work
 - 2. Operator vs. Equipment
 - 3. Applications
 - 4. Other

SAMPLE QUESTIONS

I. Anatomy & Physiology

The biomedical equipment technician 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, Electronics, and Solid-State Devices

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. Medical Equipment 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. Medical Equipment 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.

CORRECT ANSWERS TO SAMPLE QUESTIONS:

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

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)

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

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

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.

Safety and Regulatory-Public and Patient Safety in Health Care Facility (General/Radiology/Laboratory)

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/>

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/>

MQSA: *Mammography Quality Standards Act*

<http://www.fda.gov/cdrh/mammography/>

ANSI: *American National Standards Institute*

<http://webstore.ansi.org/ansidocstore/default.asp>

AABB: *American Association Blood Banks*

<http://www.aabb.org/>

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

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)

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.

Cromwell, and Others: Biomedical Instrumentation and Measurements, Prentice-Hall, Inc. Englewood Cliffs, NJ (ISBN: 0-1307-6448-5) 2nd Edition, 1980.

MacIntyre, Neil R. and Branson, Richard D.: Mechanical Ventilation, W.B. Saunders Company (ISBN: 0-7216-7361-9) 1st Edition, 2001.

Radiology

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.

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

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

Laboratory

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

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

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

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.

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.

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