INCLUDES:

- General information about the Architect Registration Examination
- Specifications and references for each multiple-choice division
- Frequently asked questions
- Sample questions and answers for each division
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The format of this book assumes that users of this guide are prepared to take the ARE and that they want more information on the format of the examination. The book will familiarize you with the testing environment, the software used to take the test, and the scoring and score reporting process. This book is not to be used as the only source for preparing for the exam as it is not intended to “teach” the architectural content of the exam’s separate test divisions. The questions included in this guide are presented to illustrate the types of graphic vignettes delivered within each division.

This study guide includes sample questions for the six multiple-choice divisions of the ARE. These multiple-choice sample questions are presented in a format similar to the way questions appear in the actual examination; however, during the administration of the exam, the computer presents only one question on the screen at a time. Graphics have been reduced to fit in this book; they appear in a larger format in the exam. Answers to the sample tests are found at the end of the guide.

Prior to taking the ARE, you must be made eligible by one of NCARB’s member registration boards or by one of the Canadian provincial architectural associations. It is not possible to “sign-up” for the exam with NCARB or NCARB’s testing consultant. Only individuals who have been made eligible for the ARE will be permitted to take the exam.

While the Architect Registration Examination has been designed to be taken by candidates who do not use this study guide to prepare themselves, we hope that you will find it useful in your preparations for this important stage in your career.

This guide does not contain sample solutions for the three graphic divisions of the ARE. Please see the companion book, ARE Study Guide: Graphic Divisions.
The development of the Architect Registration Examination is a lengthy process that involves thousands of hours of work by hundreds of volunteer architects. Most of these volunteers are appointed to serve on various NCARB committees by NCARB’s president. Other architects volunteer their time when they complete surveys that are sent out periodically to validate exam content. The examination has been written and reviewed by architects who practice in many different settings. In addition, specialists in test development have guided the writing of new questions, the revisions to existing questions, and the formatting of the ARE. This process merges the expert judgment of architects with the expertise of test developers.

The ARE is designed to measure minimum competence of the knowledge, skills, and abilities that architects must possess in order to safely practice architecture independently. In order to best determine the content of the ARE, NCARB employs a number of procedures that are widely used in the testing of professionals such as accountants, physicians, lawyers, and others. Periodically, NCARB surveys thousands of architects to determine what knowledge, skills, and abilities are used by newly registered architects in their practice. This survey, known as a “practice analysis,” identifies tasks performed by architects that are the most important in protecting the public health, safety, and welfare. It is important to keep in mind that the ARE is not intended to be a test covering all possible tasks an architect may be called on to perform; rather, it focuses on those tasks deemed most important from a public-protection point of view.

NCARB uses the results of the practice analysis survey as the basis for developing specifications for each division of the ARE. The architects who volunteer their time and expertise to write test questions and graphic vignettes follow these specifications. Checks and balances in the development process prevent volunteers from interjecting their own personal perspectives into the ARE. Just as in the development of construction specifications, these test specifications are strictly followed and are not changed without significant research and analysis.

Several times a year, the ARE Subcommittee, a group of approximately 60 architects, meets to write new multiple-choice questions, create graphic vignettes, and review and pretest existing questions and vignettes. These architects are first trained in writing test questions for a registration examination, which differs greatly from writing questions for other types of exams. This training is conducted by NCARB’s consultant, Thomson Prometric. During each committee meeting, staff members from Thomson Prometric work with the architects and guide them through the process. Following the subcommittee’s work, NCARB’s staff architects and Thomson Prometric’s staff format and prepare the questions and vignettes for delivery on computer. The ARE Subcommittee reviews the packaged exams before they are delivered to candidates.

One of the most important things to understand about this process is that the test is designed by architects and prepared by architects. Therefore, it is a practice-based exam and not a test of book knowledge or material learned in the academic environment. There is no substitute for a well-rounded internship to help prepare you for the ARE.

**Multiple-Choice Divisions**

The ARE includes six multiple-choice divisions administered in a fixed-length format. The six divisions test architectural content in the areas of Pre-Design, General Structures, Lateral Forces, Mechanical & Electrical Systems, Building Design / Materials & Methods, and Construction Documents & Services.

The multiple-choice divisions contain varying numbers of questions. See the chart on page 12 for a breakdown of questions and test times for each division. The question number and your remaining test time will be displayed on the computer screen throughout your exam.

For each test question, you will be presented with four choices, one of which is clearly the best answer. Questions will be presented one at a time, and you will have the ability to skip the question, answer the question, or answer the question and mark it for later review. You can move backward and forward through the exam using arrow icons that appear on the screen, or you can navigate from a specific point in the exam by choosing the “Review” feature.

Regardless of your approach, it is important to answer every question. Any question not answered will be counted as incorrect; therefore, guessing may help your overall score.

Benefits of NCARB Certification

After successful completion of the examination and licensure process, many newly registered architects find it necessary to become registered in other jurisdictions. Typically, this means completing new forms from the second registration board documenting your education, employment, references, and exam scores because boards do not accept copies of other boards’ application forms. NCARB has developed a certification system that makes this process much easier.

Almost half of the 55 NCARB member registration boards require an NCARB Certificate for interstate registration. NCARB certification is also used to facilitate reciprocity between U.S. and Canadian jurisdictions. The Certificate is granted to those architects who are registered by an NCARB member board or Canadian provincial association, and whose NCARB Council Record has been compiled and evaluated to ensure that NCARB’s standards for certification have been met.

Maintaining a record of your qualifications is one of many services that NCARB provides. The Council Record is a detailed, authenticated record of your education, training, examination, registration, and character. This confidential record consists...
Benefits of NCARB Certification (cont’d.)

of school transcripts, employment verifications, architect verifications, and examination and registration history. In order to be issued an NCARB Certificate, you must comply with the Council’s standards as set collectively by NCARB’s member boards.

As long as your Certificate is in good standing, and the transmittal fee has been paid, NCARB will transmit your Certificate Record to any member board or foreign registration authority in support of your application for registration. The Certificate Record—your Council Record along with certification—signifies to registration authorities that you have met NCARB’s certification standards.

In order to request a transmittal of your Council Record, you should call the Council, visit NCARB’s web site (www.ncarb.org), or write the NCARB office. Please include your file number, daytime phone number, fax number, and the name of the jurisdiction(s) to which you are requesting a transmittal of your Council Record.

Unlike a license, an NCARB Certificate does not entitle you to practice architecture in a jurisdiction. It also does not indicate membership in NCARB; rather, it stands as a testimony to your qualifications as an architect. The Certificate carries the recommendation that you should be registered as an architect without additional submissions or examination, although a few states may require you to demonstrate your competency in additional areas such as arctic construction or local laws. These additional requirements may be found in additional requirements may be found in the registration authority in support of your application for registration. The Certificate Record—your Council Record along with certification—signifies to registration authorities that you have met NCARB’s certification standards.

Within each of the six multiple-choice divisions of the ARE, the test questions you receive will differ from those your colleagues receive. Since the ARE is administered year-round, test questions are issued randomly to preserve the test’s security. Therefore, the test questions are organized to allow each administration to cover the same test content as all other administrations and to be of the same average difficulty as all other administrations.

In order for NCARB to know the average difficulty of a test, each question must have been administered to a large number of candidates. These “pre-test” questions are scattered throughout each test so that statistical information can be collected on the questions for use in future exams. These questions do not count toward your final score.

When your test is complete, the electronic record of your examination will be sent to NCARB’s testing consultant to undergo quality-control procedures. Following these checks, a score report will be provided to the registration board that made you eligible for the ARE. The board then will forward the score report to you.

Graphic Divisions

The ARE includes three divisions administered in a graphic format. The three divisions test architectural content in the areas of Site Planning, Building Planning, and Building Technology. Each is composed of a series of vignettes. The Site Planning division consists of three vignettes, the Building Planning division has two vignettes, and the Building Technology division has six vignettes.

Each of the three graphic divisions will be administered within a fixed maximum time limit. Every candidate will take all of the vignettes within a division, and every candidate will have the same amount of time for each division. Your scheduled appointment time is longer than your actual test time in order to accommodate checking in at the test center, answering demographic questions, and taking a scheduled break.

The practice software is available for downloading from NCARB’s web site at www.ncarb.org. It allows you to practice using the test-delivery software on all of the vignettes within the three graphic divisions.

As is the case with the multiple-choice divisions, the graphic divisions are administered year-round; therefore, many versions of each vignette are available to draw from to assemble each candidate’s particular exam. When you take your exam, one of each different vignette type will be selected randomly from the pool of available vignettes. Each vignette is similar and equal in difficulty to all others of its type so that you will not be asked to do more or less work than any other candidate on a particular vignette. This is achieved through tight control of the test specification during development.

The graphic divisions are administered in sections to allow for a brief break during the testing process. A section comprises a group of vignettes or a single vignette that you are able to view and work on at a given time. For sections containing multiple vignettes you may work on the vignettes within that section in any order you choose, and you may take as much time as you need on each vignette up to the maximum time allotted for that section. Vignettes within a section may be reviewed; however, when the allotted time for the section is up, or if you exit the section, you will not be able to return to any vignette in that section.

After you complete all vignettes within a division, the electronic record of your examination will be sent to NCARB’s testing consultant for grading. After your test is graded and all quality-control procedures have been completed, a score report is provided to your registration board who will then forward it to you.

All Divisions

You will receive a separate score report for each ARE division in the mail. Test scores are not available at the test center. The score report will indicate whether you passed or failed the division; no numeric scores are reported. In the event a failing score is reported, your score report will indicate relative strengths and weaknesses in each portion of the test specification. The ARE is not a test of luck. If you fail a division, you will need to increase your knowledge and experience level in those areas determined to be weakest before you take the test again. The limited diagnostic information provided can be used to plan for additional training and study before repeating the division.

If you do not pass a division you must wait six months before you repeat that division. You will receive a new Authorization to Test for each failed division approximately two months before the end of the mandatory waiting period so that you may schedule a new appointment.
Maintaining Exam Eligibility

You are responsible for maintaining your exam eligibility with your registration board. Consequently, you should be aware of the specific rules your board has for maintaining eligibility. Some boards require you to pay an annual maintenance fee so they do not cancel scores for divisions you passed should your eligibility expire.

Because the rules vary from board to board and are subject to frequent change, NCARB cannot be responsible if you take a division of the ARE at a time when your board has canceled your eligibility. Your scores may be canceled for the divisions taken when your eligibility has expired, and you will not be eligible for a refund of test fees. Therefore, it is important for you to stay informed of your individual registration board’s policies and procedures. This includes notifying them of any address changes so they can contact you about eligibility renewals or any other important licensure information and so that NCARB can contact you regarding any updates about the exam.

Rolling Clock

During NCARB’s 2004 Annual Meeting, the Council passed a resolution officially creating a “rolling clock” requirement for the ARE. Under the terms of the Rolling Clock, which will be officially implemented on January 1, 2006, candidates for the ARE must pass all divisions within five years. Three transitional rules, which are noted below, will guide the process.

Rules

Three basic rules will guide the implementation of the Rolling Clock:

- For applicants who have passed all divisions of the ARE by January 1, 2006, regardless of the time taken, such applicants will have passed the ARE.
- For applicants who have passed one or more but not all divisions of the ARE by January 1, 2006, such applicants will have five years from the date of the first (non-exempt) passed division to pass all remaining divisions. [Exams passed prior to January 1, 2006, are exempt and will NOT have to be retaken.] If a candidate fails to pass all remaining divisions within the initial five-year period, the candidate is given a new five-year period from the date of the second oldest passed division. The five-year period shall commence after January 1, 2006, on the date when the first passed division is administered.
- For applicants who have passed no divisions of the ARE by January 1, 2006, such applicants shall be governed by the above five-year requirement. The five-year period shall commence on the date when the first passed division is administered.

Adherence to these rules is required for NCARB Certification.

Units of Measurement

The ARE includes both inch-pound and SI (Système International) units commonly referred to as metric units. References to applicable Canadian documents, standards, and terms are also included.

For most questions in the six multiple-choice divisions, SI units and Canadian standards and terms appear in brackets immediately following the inch-pound units and U.S. standards and terms. Conversions to SI units are approximate and have been rounded for simplicity and clarity. You must complete your work in either inch-pound units or metric (SI) units, where appropriate. Converting from one system to another may result in wrong answers.

You will be given the opportunity to choose to work in either inch-pound units or metric units at the beginning of each graphic division. Once you have made a choice and confirmed your selection, your decision is final and cannot be changed during your examination. All of the dimensions and references to standards on the drawings and in the written materials will be displayed in the measurement system selected.

French-Language Examinations

If you are seeking initial registration with one of the Canadian provincial or territorial architectural associations, you have the option of writing the ARE in either French or English.

If you want to write the ARE in French, you must notify your provincial or territorial association. If, in the future, you wish to change your language preference, you must notify your provincial or territorial association. French-language examinations are ONLY available at test centers in Canada. The French-language graphic divisions use metric units only. Candidates seeking initial registration with any U.S. board of architecture must complete the ARE in English.

Benefits of NCARB Certification (cont’d.)

There are many reasons to begin compiling your Council Record early in your career. Relevant employment must be verified in order to be eligible for certification. By starting the record compilation process now, you can document your experience as it is earned and take advantage of special cost-saving options for the program.

If, after receiving your initial registration, you are interested in applying for NCARB certification, you can obtain the necessary forms and information by calling NCARB’s Council Records Department at 202/879-0520 or by visiting the Council’s web site (www.ncarb.org).
The Architect Registration Examination, like other professional registration examinations, is administered for local jurisdictions (states, provinces, and territories) as partial fulfillment of the requirements for professional registration. As such, there is no national or multi-national process for signing up to take the exam. Candidates must contact the registration board where they wish to be initially registered and meet that board’s requirements for registration. Many boards currently require applicants to hold an accredited professional degree in architecture and have at least three years of experience in the offices of registered architects before they are allowed to begin the examination process. However, this is not the case in all jurisdictions. These requirements vary by jurisdiction, so it is wise to learn about them as early as possible. A brief summary of jurisdictional requirements is available on the Council’s web site at www.ncarb.org.

In many cases, candidates in the United States will be required to complete the Intern Development Program (IDP) prior to becoming eligible to sit for the ARE. Canadian provinces require completion of the Canadian Intern Architect Program training requirements before taking the ARE.

It is, unfortunately, all too common for candidates to wait until they have completed five or more years of education and three years of internship to ask about the requirements for their jurisdiction, only to find they do not have the required degree or experience to become licensed.

The typical application process consists of documenting transcripts, work experience, and professional references. This process can take many months to complete, especially if you have attended more than one university and/or had many employers. If you have completed the IDP or the Canadian IAP, you will find the exam-application process is relatively easy since most of the required documents have been compiled over the course of your internship. Please see NCARB’s most recent edition of the IDP Guidelines or go to www.ncarb.org to learn more about IDP.

When you have met all of your registration board's requirements, your board will submit your eligibility information to NCARB’s testing consultant, Thomson Prometric. Thomson Prometric will then send you all the information you need to begin scheduling your examinations, including your Authorization to Test form, a listing of test centers, and the ARE Guidelines. The practice program may be downloaded, free of charge, at www.ncarb.org. Candidates are encouraged to frequently check NCARB’s web site in order to download the latest version of the practice program.

Individuals with disabilities who may require special testing accommodations should contact their registration board directly, or NCARB if your registration board participates in the Direct Registration Program. Please refer to the ARE Guidelines to determine if your jurisdiction participates in the program.

Direct Registration
The Direct Registration program is a service provided to Member Boards. For those Boards participating in the program, NCARB temporarily serves as an intermediary and manages all candidate eligibility and score reporting processes. Please refer to the inside back cover of this publication to determine if your jurisdiction participates in the program.
How many divisions make up the ARE?
The ARE consists of nine divisions - six multiple-choice divisions and three graphic divisions. The multiple-choice divisions are: Pre-Design, General Structures, Lateral Forces, Mechanical & Electrical Systems, Building Design / Materials & Methods, and Construction Documents & Services. The graphic divisions are Site Planning, Building Planning, and Building Technology.

Who writes the ARE?
The exam is written by dozens of licensed architects from NCARB’s member registration boards, consulting engineers, and code officials. Canadian architects from the Committee of Canadian Architectural Councils (CCAC) representing the architectural associations of the Canadian provinces also serve on exam-writing committees. Individual exam-writing committees for each division of the exam meet several times a year to revise and write questions and vignettes used in the exam.

How do I register to take the ARE?
Contact the registration board in your state/province to apply to take the exam. Your board will provide you with all application requirements. Although NCARB prepares the ARE, it does not register candidates to take the exam. If your board requires documentation of the IDP (Intern Development Program), they will instruct you to establish an IDP record with NCARB.

How do I start taking the ARE?
1. If you began taking the exam in paper-and-pencil format, your registration board may or may not require you to apply to them to continue taking the ARE; you need to contact them to determine this.

2. Once you are eligible to take the ARE, your registration board will submit your name to NCARB’s eligibility database. If your board participates in the Direct Registration program, NCARB temporarily serves as an intermediary and manages all candidate eligibility and score reporting processes. Please refer to the ARE Guidelines to determine if your jurisdiction participates in the program. This publication can be downloaded from the Council’s web site at www.ncarb.org.

3. NCARB’s consultant, Thomson Prometric, will send you a test information package that includes: the ARE Guidelines, which describes test content, timing for each division, test fees, and payment information for the exam; a list of test centers where you can take the exam; and your Authorization to Test form.

4. The practice program may be downloaded, free of charge, from the Council’s web site (www.ncarb.org). Candidates are encouraged to frequently check NCARB’s web site to download the latest version of the practice program.

5. After you receive the ARE Guidelines, decide when and where you want to take your exams and call to schedule a test appointment.

When is the computer-based exam given?
You have the opportunity to take the exam in any order at any time you choose once you have been approved to take the exam. Test centers are open Monday through Saturday, but hours vary from test center to test center. Contact the test center of your choice to determine their hours of operation.

Where are the test centers located?
The ARE is administered at more than 300 standardized test centers across North America. Once your eligibility information has been processed, Thomson Prometric will send you a listing of test centers and contact information.

Do I have to take all nine divisions of the ARE within one week, as was the case with the paper-and-pencil ARE?
No. You can take the divisions at any time during your eligibility period.

Do I have to take the exam at a test center within the borders of the state or province where I am seeking my initial license (registration)?
No. NCARB’s computer-based format removes geographical barriers. For instance, a candidate who started taking the exam in Texas, and now lives in New York, will be able to take the exam at any conveniently located test center, rather than having to return to Texas. Scores will be forwarded to the initial jurisdiction where you are seeking registration.
What is the Rolling Clock?

Beginning January 1, 2006, NCARB will implement a “Rolling Clock.” Under the “Rolling Clock,” candidates must pass all ARE divisions within five years. For further details, please refer to NCARB’s website, www.ncarb.org.

Will a calculator be provided at the test center?

Calculators will not be provided at the test center. However, the graphic divisions have a calculator built into the software interface.

For multiple-choice divisions, you must bring your own scientific calculator to the test center. ONLY non-programmable, non-communicating, non-printing calculators are allowed. It must NOT have pre-loaded formulas or have the capability to store formulas. The test center administrator reserves the right to refuse the use of any other calculators and is not responsible for providing a replacement calculator.

For the graphic divisions of the exam, will I be able to stop working on one vignette and move to another, then come back to the first vignette?

Yes. You are able to stop working on one vignette, move to a second or third vignette, come back to the first, etc., within each section of vignettes. However, once you choose to exit that section of vignettes, you cannot return to them. You do not need to save your work, as it is automatically saved approximately every minute. Every time you leave a vignette to move to another vignette your work is also saved.

Will I be able to print out my solutions as I go to check them?

You are not able to print out your work. In order to offer the ARE six days a week, year-round, NCARB has developed a large library of equivalent vignettes. These vignettes must remain secure, so printouts are not allowed.

What software will be used, and how can I get it to practice?

The software used to take the exam is not commercially available. NCARB did this for two reasons. First, the exam might unfairly advantage one group of candidates that was familiar with the software and disadvantage the remaining candidates. Second, the software NCARB has developed is designed for testing and not for the creation of construction documents. The software is much more intuitive than CAD packages. The practice program includes tutorials to teach you how to use the various tools, plus one of each of the vignettes to practice. You may download the current version, free of charge, at www.ncarb.org. Candidates are encouraged to frequently check NCARB’s web site to download the latest version of the practice program. Make sure you allow sufficient time prior to testing to become familiar with the software you will be using.

For the vignettes in the three graphic divisions, how will we “draw” on the computer?

You will use a mouse to record your solutions. The computer screen contains icons that are selected using the mouse, to allow you to draw, move, rotate, erase, etc.

How will the multiple-choice divisions be given on a computer?

A brief tutorial is delivered before each division to explain how to move from one question to the next. Each multiple-choice division consists of a fixed number of questions delivered within a maximum time limit. Within each division, some questions are being pretested and do not affect your actual test score. These pretest questions are being evaluated and may be included in future editions of the test.

For the multiple-choice questions, I’ve heard that I will only be able to look at one question at a time and I will not be able to go back to previous questions to change answers. Is this true?

It is true that you will only see one question at a time; however, you can go back to review and/or change answers. You will have tools (icons) available to maneuver through the test. It is possible to look at each question, answer it, and move on without going back. It is also possible to answer a question and mark it for later review. Additionally, you will have the option to skip a question and come back to it later.

How are the vignettes scored?

The vignettes are scored by computer.

How can the subjective vignettes be graded by computer? Does this mean that there is only one right answer to each vignette?

There have been many common misconceptions about the ARE. One of the biggest was that the paper-and-pencil vignettes were graded using “subjective” criteria. In the past, NCARB developed very specific objective grading criteria and trained the architects who volunteered to grade exams in using this objective criteria. NCARB never allowed the graders to apply their own subjective criteria to exams. With computer grading, the only real change is that committees of architects have already determined the objective grading criteria, and that criteria has been transferred to a computer program instead of human graders.

The computer-delivered vignettes, like the paper-and-pencil vignettes, are designed to allow for many correct answers. There is no one right answer, with the exception of some very technical Site Planning
vignettes, such as laying out setbacks. Just as in the paper-and-pencil versions, the vignette scoring procedures allow for errors to occur without automatically assigning a failing score. The scoring engines evaluate the solutions to the vignettes in a holistic manner where minor errors are compensated for by overall compliance with the programmatic and technical aspects of each vignette.

**How long after I take the exam will I receive my scores?**
Results for multiple-choice divisions are typically processed within two to four weeks of your test date. Graphic division scores are typically processed within four to six weeks of your test date. After processing, your score is forwarded directly to your Board of Architecture or NCARB if your board participates in the Direct Registration Program. Your board then completes any additional processing and forwards the score report to you. Test results are not released at the test center and are not available through NCARB.

**If I fail a division of the exam, why do I have to wait six months until I can retake that division?**
This rule was established for two reasons. First, the exams are not a test of luck. It is important to spend the time between test administrations gaining additional knowledge and experience in the particular areas being tested. Second, NCARB is developing a large library of test questions and vignettes, but the library is not of sufficient size to offer each division of the exam more than once every six months.

**For the last two administrations of a particular division, I received the same failing diagnostics. What can I do to improve my score and pass?**
Receiving similar score reports indicates that the exam has accurately assessed your ability level at the time. In order to pass, you will have to gain additional knowledge in the subject area before trying again. Repeating a division without increasing your knowledge of the subject through more experience will not likely result in a higher score.

**I failed the paper-and-pencil Building Design exam. Do I have to take one or two tests in the new format?**
Two. The old Division C: Building Design exam is now two separate divisions—Building Planning and Building Technology. NCARB made this change because sitting at a computer for 11 or 12 hours is much more difficult than sitting at a drawing table for that amount of time. You must pass these two divisions completely independent of each other.

**I failed the Site Design graphic portion in paper-and-pencil, but passed the written portion. Do I get credit for the written portion?**
No. Since you did not pass both sections of the previous Division B: Site Design, you must take the new Site Planning division.

**If I pass all divisions of the ARE, does that mean I am certified by NCARB?**
No. Passing the exam is usually (but not always) the final step in receiving a license to practice in a particular jurisdiction. If you wish to become certified by NCARB, you must apply for NCARB certification after you have passed the exam, or contact NCARB’s Council Records Department if you have already established an IDP Council Record. Your state board will not notify NCARB. For more information on the certification process, contact NCARB’s Council Records Department at 202/879-0520. You also can get more information or request an application by visiting NCARB’s web site.

**Review and Challenge**
A review procedure is available to you ONLY if your Board of Architecture permits reviews of failed examinations. It is at the sole discretion of each Board of Architecture whether or not to administer the review process. If you wish to pursue the review process, immediately contact your Board of Architecture to better understand the procedures and fees involved. The application for review must be completed within four months of the administration of your test date, and the review process must be completed within six months of your test date.

Only those questions you answered incorrectly or those vignettes marked with an asterisk (*) on your score report can be reviewed. The correct answer or proper solution will not be revealed.

During the review process, you may only challenge a question answered incorrectly for a multiple-choice division. A representative from your board will forward your challenge to a multiple-choice question to NCARB for review and response. Any challenge to a graphic vignette will not be reviewed by NCARB.

Depending on the laws of the jurisdiction where you are seeking registration, you may be able to challenge the score received on any ARE division. If your Board of Architecture (or a court with jurisdiction) changes your score from fail to pass, ONLY that jurisdiction is required to accept the new score. NCARB will not recognize the new score for purposes of NCARB certification.
TAKING THE MULTIPLE-CHOICE DIVISIONS

**TEST TIMING**
Pages 5-7 of this book describe the format used to administer the multiple-choice divisions of the ARE. The chart to the right shows the number of questions in each multiple-choice division, the amount of actual time allowed to answer the questions, and the total scheduled appointment time. The scheduled appointment time includes time for general instructions and an exit evaluation survey.

<table>
<thead>
<tr>
<th>MULTIPLE-CHOICE DIVISIONS</th>
<th>NUMBER OF QUESTIONS</th>
<th>TESTING TIME</th>
<th>SCHEDULED APPOINTMENT TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-DESIGN</td>
<td>105</td>
<td>2.5 HOURS</td>
<td>3 HOURS</td>
</tr>
<tr>
<td>GENERAL STRUCTURES</td>
<td>85</td>
<td>2.5 HOURS</td>
<td>3 HOURS</td>
</tr>
<tr>
<td>LATERAL FORCES</td>
<td>75</td>
<td>2 HOURS</td>
<td>2.5 HOURS</td>
</tr>
<tr>
<td>MECHANICAL &amp; ELECTRICAL SYSTEMS</td>
<td>105</td>
<td>2 HOURS</td>
<td>2.5 HOURS</td>
</tr>
<tr>
<td>BUILDING DESIGN / MATERIALS &amp; METHODS</td>
<td>105</td>
<td>2 HOURS</td>
<td>2.5 HOURS</td>
</tr>
<tr>
<td>CONSTRUCTION DOCUMENTS &amp; SERVICES</td>
<td>115</td>
<td>3 HOURS</td>
<td>3.5 HOURS</td>
</tr>
</tbody>
</table>

Score reports are processed multiple-choice divisions → 2-4 weeks
EXAM CONTENT CONFIDENTIALITY

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NCARB staff and Legal Counsel are authorized to investigate alleged cheating and attempts to disclose the substance of ARE questions and to take appropriate action. Such action may include holding scores and suspension of future ARE testing privileges pending resolution of the matter and, with the approval of the president, commencing legal action against any person threatening the integrity of the ARE.

Further action may include referral of the matter to the Council’s Committee on Professional Conduct for its recommendation to the Board of Directors. Such recommendations may include the cancellation of ARE scores and the suspension of future ARE testing for up to 3 years from NCARB’s discovery of the incident, or such longer period as may be warranted in exceptional circumstances; and in appropriate circumstances seeking recovery of costs and civil damages in a court of law.

The Member Board making the individual eligible for the ARE shall be informed of NCARB’s action and that such action shall be retained in records maintained by NCARB.
SAMPLE UNANSWERED QUESTION

The question shown to the right represents a typical unanswered question from one of the multiple-choice divisions as it appears on the computer screen.

Unlike sample questions in this book, only one question appears at a time on the screen. The tools along the bottom portion of the screen allow you to navigate through the questions.

Before you begin the timed portion of your examination, a brief instructional tutorial is administered. This will allow you the opportunity to become familiar with the navigation icons and to practice using the mouse to select your answer.
### SAMPLE ANSWERED QUESTION

The question shown to the left represents a typical answered question from one of the multiple-choice divisions as it appears on the computer screen. To select an answer from the list of four available choices, position the mouse pointer over the circle that corresponds to your selection and press to click. The circle will become solid.

After selecting an answer, you can change your selection by clicking on a different selection, or you can unanswer the question by clicking again on the choice previously selected. The circle will appear empty.

---

**General Structures**

<table>
<thead>
<tr>
<th>A deflection of 1.0 inches [25 mm] is calculated for a steel beam during design. If the yield strength of the steel is raised by 29 percent with no change of load or section, what will the calculated deflection be?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2 in [30 mm]</td>
</tr>
<tr>
<td>1.6 in [40 mm]</td>
</tr>
<tr>
<td>0.99 in [25 mm]</td>
</tr>
<tr>
<td>0.89 in [21 mm]</td>
</tr>
</tbody>
</table>

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Click on the circle to select your answer.
REVIEW SCREEN

Clicking on the “Review” icon on the question screen will take you to a screen similar to the one shown. This review screen indicates the status of each question and enables you to move to any specific question within the division. You may have to use the scroll bar on the right to see those questions that do not appear in the display. To move to a specific question, double-click the question number.

While answering the test questions, you can mark questions that you’d like to go back to and review by clicking on the “Mark” button. If you’ve clicked “Mark” on any question, a red “✓” appears to the left of the question number on the review screen. Therefore, it is possible to answer all the questions, mark a few for review, and then use the review screen after you have seen all of the questions in the division to return to those you want to see again. It is not necessary to undo the “Mark” icon before you end your test.

If you do not answer a question, or choose to skip to the next question without selecting an answer, a green “i” appears to the left of the incomplete question number. It is possible to skip a question and “Mark” it for later review. In this instance, both the green “i” and the red “✓” appear on the review screen.

If you click on the “End Exam” icon, a warning screen will appear asking you to confirm that you intend to quit your examination. If you click on the “Yes” button on the warning screen, your test will end and you will not be able to return.

MARKED FOR REVIEW
If you click the “Mark” icon on any question, a red “✓” will appear in this column.

INCOMPLETE
If you do not answer or choose to skip a question, a green “i” will appear in this column.

REVIEW ALL
Selecting this icon will sequentially deliver all questions.

REVIEW INCOMPLETE
Selecting this icon will sequentially deliver all “Incomplete” questions.

END EXAMINATION
Selecting this icon will terminate your examination.
The specifications for each division of the ARE are organized to include a statement of intent and a list of various content areas. This structure assists the examination writers in developing specific questions and problems aimed at assessing whether a candidate for registration is capable of providing specific professional services.

The test specifications are the heart of the ARE, and candidates should give them primary attention. Test questions for each division are developed from the content areas listed.

The references listed for each division are presented as a guide in preparing for the examination. The lists were developed by the committee that prepares the examination. They are not intended to be an exhaustive list of all possible reference materials for the subject area of any given division. NCARB makes no guarantee that the various references are currently in print.

Both specifications and references are provided for each division on the following pages. Candidates should be familiar with the latest edition of the model code listed to the left.

**This information is applicable to all multiple-choice divisions.**

**International Code Council, Inc. (ICC)**

**National Fire Protection Association (NFPA)**
- Life Safety Code (NFPA 101)
- National Electrical Code (NFPA 70)

**National Research Council of Canada**
- National Building Code of Canada
- National Plumbing Code of Canada
- National Fire Code of Canada

Candidates should also be familiar with the Standard on Accessible and Usable Buildings and Facilities (ICC/ANSI A117.1-98).
DIVISION STATEMENT
The application of project development knowledge and skills relating to architectural programming; environmental, social, and economic issues; codes and regulations; project and practice management; and site planning and design.

Content Areas
1. Programming & Analysis
   Assess client needs and requirements to develop master plan and program. Document design objectives including site characteristics, spatial and functional relationships, and building systems considerations. Establish preliminary project scope, phasing, budget, and schedule.

2. Environmental, Social, & Economic Issues
   Obtain and review site and building surveys. Assess physical, environmental, social, and economic issues and project impact. Develop project concepts utilizing sustainable principles, alternative energy systems, and new material technologies. Apply basic design principles and historic precedent.

3. Codes & Regulations
   Identify, analyze, and incorporate building codes, specialty codes, zoning, and other regulatory requirements. Manage regulatory approval process.

4. Project & Practice Management
   Develop scope of services and project delivery method. Assess project budget and financing. Identify project team members including consultants. Document project meetings. Manage project schedule and design process. Assist with construction procurement. Manage legal issues relating to practice including fees, insurance, and professional services contracts.

5. Site Planning & Design
   A. Principles: Review and assess sites. Incorporate the implication of human behavior, historic precedent, and design theory in the selection of systems, materials, and methods related to site design and construction.

   B. Environmental Issues: Interpret site and environmental conditions. Assess design impact on human behavior.
PRE-DESIGN
The references listed here are presented as a guide in preparing for the examination. The list was developed by the committee that writes questions for the exam. Since the examination is practice-based, it should not be considered an exhaustive list of all possible reference materials used to prepare for the examination. NCARB makes no guarantee that the various references are currently in print.

REFERENCES
The Architect's Handbook of Professional Practice
Joseph A. Demkin, AIA, Executive Editor
The American Institute of Architects
John Wiley & Sons, latest edition

Architectural Graphic Standards
Charles G. Ramsey and Harold R. Sleeper
The American Institute of Architects
John Wiley & Sons, latest edition

Canadian Handbook of Practice for Architects,
Committee of Canadian Architectural Councils and The Royal Architectural Institute of Canada, latest edition

Design Office Management Handbook
Fred A. Stitt, Editor
Arts & Architecture Press, 1986

Design With Climate
Victor Olgyay
Van Nostrand Reinhold, 1992

Design With Nature
Ian L. McHarg
John Wiley & Sons, 1992

Designing Places for People
C. M. Deasy, FAIA
Whitney Library of Design, 1985

A History of Architecture: Settings & Rituals
Spiro Kostof
Oxford University Press, 1995

The Image of the City
Kevin Lynch
MIT Press, 1960

Modern Architecture: A Critical History
Kenneth Frampton
Thames and Hudson, Ltd., 1992

The New Urbanism
Peter Katz
McGraw-Hill, 1994

A Pattern Language: Towns, Buildings, Construction
Christopher Alexander, Sarah Ishikawa, and Murray Silverstein
Oxford University Press, 1977

Sir Banister Fletcher's A History of Architecture
John Musgrove, Editor
Butterworths-Heinmann, 1996

Site Planning, Third Edition
Kevin Lynch and Gary Hack
MIT Press, 1984

Suburban Nation: The Rise of Sprawl and the Decline of the American Dream
Andres Duany, Elizabeth Plater-Zybeck, and Jeff Speck
North Point Press, 2001

Sustainable Design Fundamentals for Buildings
National Practice Program
Canada, 2001

The Ultimate Project Management Manual
Frank Stasiowski and David Stone
PSMJ, 1994
PRE-DESIGN SAMPLE QUESTIONS

1. Buildings more than 40 years old are most likely to be at variance with present-day standards in which of the following areas?
   I. Dead-end corridor lengths
   II. Size of toilet-room stalls
   III. Ceiling heights
   IV. Adequacy of insulation
   - I and III only
   - II, III, and IV only
   - I, II, and IV only
   - I, II, III, and IV

2. Which type of educational facility encompasses the largest service area or population?
   - Primary school
   - Magnet school
   - Middle school
   - High school

3. Among the sites being considered for a new main library are those adjacent to the following areas or services. The most appropriate site is one that is adjacent to
   - a residential neighborhood and recreation facilities
   - churches and governmental offices
   - public schools
   - shopping and public transportation

4. The density of a metropolitan neighborhood would be increased dramatically by a proposed high-rise housing development, with resultant overloading of mass transit and other local service capacities. The first concession that the community board will likely request of the developers will be to
   - downsize the proposed project
   - increase the size of subway platforms
   - develop more open space on the site
   - include a new public school on the site

5. In preparing the specifications for an unusual building type that has special equipment and construction requirements, it would be most reasonable to use all of the following resources EXCEPT
   - project drawings
   - reference material pertaining to products and construction methods
   - outline specifications prepared for an earlier project
   - applicable laws and building codes

6. A small suburban town has a “ridge ordinance” that prohibits any building taller than the ridges of its contained hills. An architect has been hired to design a two-story house with a view of the valley. In this situation, which of the sites shown on the diagram below is most appropriate?

   - Site A
   - Site B
   - Site C
   - Site D

7. The urban structure shown in the drawings below, which serves as a marketplace, meeting place, and pedestrian route, is

   - the Crystal Palace in London
   - King’s Cross Station in London
   - Les Halles Centrales in Paris
   - La Galleria in Milan
8. Programming refers to all of the following EXCEPT
   - turning raw data into useful information
   - evaluating data for design and analyzing their influence on major design elements
   - designing an aesthetically pleasing building
   - abstracting all program requirements to find the project’s “uniqueness”

9. Several sites in suburban residential areas are being considered for a planned unit development of dwelling units in 10 clusters, a recreation facility, and a convenience shopping center. The developer wishes to find a wooded, rolling site whose sylvan character could be preserved by building structures that would be visible but would not dominate the landscape. For preliminary planning, these elements are diagrammed below.

   If it is assumed that the entire site is generally suitable for development, what is the minimum size for a site that could accommodate the development described above?
   - 10 acres [4 hectares]
   - 30 acres [12 hectares]
   - 60 acres [24 hectares]
   - 90 acres [36 hectares]

10. A good public sidewalk should be designed in which of the following ways?
   - Wide enough to eliminate congestion
   - Without large trees that block pleasing vistas
   - Without seating that would encourage street vendors, entertainers, and litter
   - Wide enough to be slightly crowded at peak periods

11. The restoration of a 100-year-old neglected public landmark will include new windows, electrical and elevator modernization, murals conservation, and exterior masonry stabilization. Which of the following construction sequences is most appropriate?
   - Masonry, windows, elevators, murals
   - Windows, elevators, masonry, murals
   - Elevators, murals, windows, masonry
   - Murals, elevators, windows, masonry

12. “Contextualism” insists that new buildings “refer and defer” to existing buildings around them. The expression and concept was first developed by
   - Robert Venturi
   - Robert Stern
   - Frank Lloyd Wright
   - Le Corbusier

13. High water table, loose silt, rock, and expansive, collapsing, or organic soils are examples of which of the following?
   - Site problems that affect the materials that can be used to surface the building
   - Site conditions that are frequently found and can be easily overcome
   - Subsurface conditions that affect site utilization
   - Site conditions that only affect the depth of foundation to be used

14. Environmental sensitivity of development to a site is best exemplified by which of the following?
   - The Barcelona Pavilion
   - Sea Ranch, California
   - University of Lethbridge, Alberta
   - Brasilia, Brazil
15. In the plan-sketch shown below, the starred elements help to achieve

- architectural scale
- solar radiation
- spatial transition
- materials selection

16. A developer is considering the construction of a center-city shopping mall. In evaluating the cost/benefit of public ownership and management of common areas, appropriate questions to ask about the city’s ability to respond to the business needs of major commercial tenants include which of the following?

I. Does the city have both the desire and the financial resources to undertake long-term management of the common areas?
II. Can the city maintain and enhance the common areas’ appearance and character to attract shoppers and tenants?
III. Can the city respond to the profit incentive of others when it does not itself operate for profit?
IV. In light of the city’s salary structure, would the cost of services provided by the city be far in excess of the cost of services provided by the private sector?

- IV only
- I and III only
- I, II, III, and IV only
- I, II, III, and IV

17. What would be the minimum required width of a bypassing sliding glass door, 6’8” high [2030 mm] located at Y on plan B, if required ventilation is 5 percent of floor area, and living room/dining area is 313 sq. ft. [29 m²]?

- 4 ft [1200 mm]
- 5 ft [1500 mm]
- 6 ft [1800 mm]
- 10 ft [3000 mm]

18. Which two of the following are of prime importance in a metes-and-bounds description?

I. Roads, fences, and utilities must be documented.
II. The description must begin at some identifiable, known point.
III. The elevation described must be above sea level.
IV. The description must close.

- I and II
- I and III
- II and IV
- III and IV

19. Funding for public projects can be accomplished by all of the following EXCEPT

- bonding
- appropriation
- mortgaging
- referendum
20. Which of the following statements are true of the project schedule below?

<table>
<thead>
<tr>
<th>ACTIVITIES</th>
<th>SEPT</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
<th>JAN</th>
<th>FEB</th>
<th>MARCH</th>
<th>APR</th>
<th>MAY</th>
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<tr>
<td>Schematics - layout &amp; design</td>
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<td>Final review &amp; coordination</td>
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<td>Tender period (bidding)</td>
<td></td>
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</tbody>
</table>

I. Mechanical, electrical, and structural drawings and specs must be finished by the end of February.
II. Structural preliminary design can start when architectural design development begins.
III. Owner’s approval has no effect on overall design schedule.
IV. Mechanical and electrical preliminary design cannot begin until structural design is started.

- I and IV only
- II and III only
- I, II, and III only
- I, II, III, and IV

21. Frequently, the determining factor in sizing exit ways and exits is the occupant load of spaces. Sizing is calculated by using the:
- number of occupants expected to utilize the space and/or facility
- architect’s projected occupancy rate as derived from personal studies and calculations
- density factors established by industry or agency standards
- criteria set forth by the building code

22. A mechanical engineer would typically perform HVAC calculations and load calculations and do single-line duct layouts in which phase of basic services?
- Pre-design
- Schematic design
- Design development
- Construction documents

23. With respect to model building code requirements, which of the following is correct concerning the diagram below?

- The stair does not meet code requirements.
- The mezzanine meets code requirements.
- The mezzanine area is too small.
- The mezzanine area is too large.

24. Which of the following is a common method by which communities finance capital improvements?
- General obligation bonds
- General sales tax
- Eminent domain
- Comprehensive planning

25. In topographic surveys, the line connecting points of equal elevation is called a
- base line
- property line
- fall line
- contour line

26. Due to poor soil-bearing conditions on a site, the documents call for over-excavation and engineered fill. Which of the following could create additional problems on the project?
- Spread footings
- Stepped foundations
- Subsurface water
- Gravel strata
27. For the remote site below, which of the four locations indicated is most suitable for development of a naturally fed fire-protection pond?
- A
- B
- C
- D

28. Which of the following sites would best suit a nursery for intense and varied cultivation, botanical tours, educational purposes, and experiments with planting combinations of flowers, shrubs, and trees?
- A
- B
- C
- D

29. An architectural firm is commissioned to design a 500-seat auditorium and a 50-seat seminar area for a high school campus. The primary resource for determining the exit travel distance would be
- zoning ordinances [bylaws]
- applicable building codes
- Architectural Graphic Standards
- seating and design standards

30. Which of the following types of schedules is most likely to be developed as part of the programming process?
- Schedule of latest dates for ordering key building subsystems
- Proposed overall project schedule
- Owner's partial occupancy schedule
- Room finish schedule

31. Which of the following is a correct statement about space perception?
- Light walls combined with light ceilings maximize spaciousness.
- Dark side walls and light end walls shorten a long room.
- Light ceilings lower a room's apparent height.
- Light ceilings and floors set off dark objects most effectively.

32. After the building program has been determined, which of the following would have the greatest impact on the building area requirements?
- Functional relationships
- Site utilities
- Topographic survey
- Building codes

Answers to this division may be found on page 69.
DIVISION STATEMENT
The identification and incorporation of general structural principles in
the design and construction of buildings.

Content Area
1. General Structures
   A. Principles: Apply general structural principles to building design
      and construction.
   B. Codes & Regulations: Incorporate building codes, specialty
codes, and other regulatory requirements in the design of gener-
   al structure systems.
   C. Materials & Technology: Analyze the implications of design deci-
      sions in the selection of systems, materials, and construction
details related to general structural design.
   D. Environmental Issues: Consider site and environmental charac-
teristics in the selection, design, and construction of building
structural systems.

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American Concrete Institute, 1995
-OR-
CAN/CSA-A23.1-94 (Concrete Materials and Methods of Concrete
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Structures for Buildings)
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James Ambrose
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Ronald E. Shaeffer
Prentice Hall, 2002

Introduction to Design in Wood
Canadian Wood Council, 1991

American Institute of Steel Construction, 1989
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Canadian Institute of Steel Construction

Parts 1, 3, 4, 9; Appendix A
Supplement
Chapters 1, 2, 4; Commentaries A, D, F, H, I
**GENERAL STRUCTURES**

The references listed here are presented as a guide in preparing for the examination. The list was developed by the committee that writes questions for the exam. Since the examination is practice-based, it should not be considered an exhaustive list of all possible reference materials used to prepare for the examination. NCARB makes no guarantee that the various references are currently in print.

**REFERENCES (CONT’D.)**

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James Underwood and Michele Chiuini
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**Understanding Structures**
Fuller Moore
McGraw-Hill, 1999

**Wood Design Manual and CAN/CSA-086.1-94 and Commentary**
Canadian Wood Council
1. The purpose of prestressing concrete members is to
   ○ transfer loads to nonstructural members
   ○ respond to the creep characteristics of concrete
   ○ eliminate beam deflection
   ○ reduce tensile stresses resulting from loads

2. For the existing wood roof structure shown to the right, which of the following alter-
   nations will most increase the load-bearing capacity of the roof assembly? (Assume
   that all new members are identical in materials and cross section, and all are pin-connected.)

   ○ A
   ○ B
   ○ C
   ○ D

3. Which of the following considerations has the greatest influence on the deci-
   sion in favor of a pre-engineered structural system such as that shown
   below for a warehouse facility?

   - Fire resistance
   - Construction time
   - Support reactions
   - Maintenance

4. The radius of gyration relates directly to a member’s resistance to
   ○ bending stress
   ○ buckling
   ○ shear stress
   ○ deflection

5. With respect to soil, “friable” means
   ○ crumbly
   ○ gummy
   ○ extremely hard
   ○ plastic

6. When concrete structural members are sized for economic construction, which of
   the following should be done?
   I. Use constant beam sizes from span to span and vary reinforcement as required.
   II. Use narrow, deep concrete beams with beam widths less than column width.
   III. Vary the size of reinforcing steel from beam-to-beam according to the
        design calculation, to minimize the rebar weight.
   ○ I only
   ○ III only
   ○ I and II only
   ○ II and III only
7. The total load created by rainfall on a long-span roof is influenced by which of the following?
   I. Area of the roof
   II. Size of the roof drains
   III. Rainfall rate
   IV. Distance to the roof drains
   ○ I and II only
   ○ I and III only
   ○ II and IV only
   ○ I, II, III, and IV

8. For a multistory warehouse building with heavy floor loads (400 psf [20 kN/m²] or more) and moderate spans (to 30 feet [10 m]), which of the following types of reinforced-concrete slab would likely be most appropriate? (Distance LN is identical in all cases.)
   ○ A
   ○ B
   ○ C
   ○ D

9. Which of the following is true concerning a curtain wall in a framed building?
   ○ It is supported by the building framework.
   ○ It does not resist wind loads.
   ○ It is generally more than 12" [300 mm] thick.
   ○ It gives vertical support to floors and ceilings.

10. What is the purpose of crossribs in concrete joist construction?
   ○ To provide lateral bracing for the joists
   ○ To make forming easier
   ○ To act as purlins
   ○ To decrease slab spans

11. In the design of the retaining wall below, the angle of repose for the soil influences which of the following conditions?
   ○ Active lateral soil pressure
   ○ Surcharge pressure
   ○ Allowable soil pressure [factored bearing capacity]
   ○ Optimum moisture content
12. After construction completion, the owner requests the installation of a dumbwaiter that requires an opening to be made through the existing floor system. Which of the following opening locations and structural systems would accommodate the opening with LEAST effect on the structural integrity of the system?

<table>
<thead>
<tr>
<th>Structural System</th>
<th>Opening Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete waffle system</td>
<td>Adjacent to the column</td>
</tr>
<tr>
<td>Two-way concrete slab beam system</td>
<td>At the center of the bay</td>
</tr>
<tr>
<td>One-way concrete slab/beam/girder system</td>
<td>Between two beams</td>
</tr>
<tr>
<td>Precast, prestressed, hollow-core concrete planks</td>
<td>At the center of the span</td>
</tr>
</tbody>
</table>

13. Maximum deflection limits for roof and floor systems of structural steel are established by which of the following?

- The applicable building code [NBCC]
- AISC Specification [CAN/CSA-S16.1]
- The local building inspector
- The project architect

14. Which of the following soils has the smallest angle of repose and produces the largest lateral force against a retaining wall?

- Gravel
- Hardpan
- Saturated silt
- Dense, moist sand

15. A two-story library is planned with overall dimensions of 96 feet by 84 feet [30 m x 24 m]. The structural system is a beam-column-girder having a standard bay size of 24 feet by 28 feet [7.5 m x 8 m]. There are no special soil problems. The cost of the structure (footings, foundations, columns, beams, girders, and decks) should be approximately what percentage of the total construction costs?

- 5%
- 25%
- 50%
- 70%

16. For the steel lintel shown below, what is the maximum bending moment induced by the masonry wall alone if the unit dead load of the wall = 90 psf [5.4 kN/m², factored]?

- 94 ft-lb [0.152 kN-m]
- 235 ft-lb [0.380 kN-m]
- 469 ft-lb [0.759 kN-m]
- 938 ft-lb [1.520 kN-m]

17. An open-web steel roof joist has been half-cleared of snow, resulting in the load diagram shown below. What is the load in the diagonal web member that is cut by section x - x ?

- 1.0 compression
- 1.0 tension
- 1.4 compression
- 1.4 tension
18. If the two wood joists shown below are of the same species and grade, then the 2-inch by 12-inch [50 mm x 300 mm] joist is about how many times as strong as the 2-inch by 6-inch [50 mm x 150 mm] joist in bending?

- 2
- 4
- 8
- 16

19. In addition to aesthetics, brick masonry veneers provide which of the following benefits for structural masonry or light wood-frame construction?

I. Increased thermal performance
II. Sound penetration resistance
III. Increased fire resistance
IV. Increased overall structural performance

- I and IV only
- II and IV only
- I, II, and III only
- I, II, III, and IV

20. Loads associated with all of the following are calculated as impact loads EXCEPT

- elevator machinery
- cab-operated traveling cranes
- hangers for floors supporting machinery
- automobiles parked in garages

21. An investigation of the existing church roof structure shown below revealed deflection and lateral movement problems of an exposed truss. The structural engineer stated that a vertical member, at the location of the dashed line in the diagram, was required to improve the structural integrity of the truss. What would be the primary stress characteristic on such a new vertical member?

- Shear
- Torsion
- Compression
- Tension

22. For the block shown below, what is the factor against sliding if the coefficient of friction is 0.5?

- 2.5
- 5
- 25
- 50

23. All of the following are advantages of welded trusses over bolted trusses EXCEPT

- the truss is stronger
- tension members may be designed on the basis of cross section
- there is a saving in material
- there is generally less detailing required
24. Which of the following materials requires the greatest allowance for thermal expansion and contraction when used in the construction of a building?
- Cast iron
- Wrought iron
- Mild steel
- Aluminum

25. What is the reaction $R_1$ in the truss shown below?

![Planar Truss Diagram](image)

26. Bending stress is a function of the bending moment and
- modulus of elasticity
- cross-sectional area
- section modulus
- radius of gyration

27. The structural action of a folded-plate system of reinforced concrete is analogous to that of a
- solid, one-way concrete slab
- formed sheet-steel deck
- steel open-web joist
- plywood deck

28. The tension in member B shown below is 1,500 pounds [1,500 kN]. If the resultant of the forces exerted by members B and C is to be horizontal, what is the tension in member C? [SI load already factored]
- 388 lb [388 kN]
- 604 lb [604 kN]
- 1,919 lb [1,919 kN]
- 2,334 lb [2,334 kN]

29. The section modulus, $S$, of a wood beam with the section shown below is
- $bh/4$
- $bh^3/12$
- $bh^2/6$
- $bh^2/4$
30. The diagram below shows a wood post in a balustrade. What is the allowable load \( P \) (factored load \( P_f \)), based on the bending capacity of the post? (Section modulus = 7.15 in\(^3\) [117.49 x 10\(^3\) mm\(^3\)]; allowable bending stress = 1,100 psi [factored resisting stress = 7.7 MPa])

![Diagram of wood post in balustrade](image)

- 0.154 kip [0.701 kN]
- 0.175 kip [0.794 kN]
- 0.293 kip [1.33 kN]
- 1.310 kips [6.03 kN]

31. The strength of a short steel column loaded at its centroid is governed by the

- radius of gyration
- yield strength
- moment of inertia
- section modulus

32. For the figure shown, what is the horizontal force at the left reaction?

![Figure of steel column](image)

- 3 kips [3 kN]
- 4 kips [4 kN]
- 5 kips [5 kN]
- 9 kips [9 kN]

33. The plan section below represents a connection used to accommodate

![Plan section of connection](image)

- expansion and contraction
- bending and shear
- longitudinal force
- diagonal and horizontal shear stress
34. For the framing plan for the freestanding drive-up canopy shown below, which of the following is the ratio of dimension A to B which produces maximum two-way structural efficiency?

- 0.50 to 1
- 0.75 to 1
- 1 to 1
- 1.33 to 1

35. Which of the following wood truss designs is used where the roof is required to slope in only one direction?
- Common
- Mono
- Scissors
- Flat

36. The primary structural concept that is expressed in the architecture of Fallingwater, designed by Frank Lloyd Wright, is the use of
- post-and-beam
- cantilever
- arch
- load-bearing unit masonry

37. The welds shown in the drawing below are called
- plug welds
- fillet welds
- complete-penetration groove welds
- partial-penetration groove welds

38. To determine the proper installation of bolts in wood trusses, the nuts should be
- welded to the washers
- tensioned by the “turn of the nut” method
- tight and the washers in uniform contact with the surface of the wood
- tight and the washers embedded in the wood to a depth equal to the washer thickness

39. The test to determine the adequacy of soil preparation and moisture content prior to installing a concrete slab-on-grade is called a
- compaction test
- slump test
- Windsor probe
- boring log
40. The diagrams below show three types of retaining walls. Which of the following sequences correctly identifies each type?

I  II  III

- Cantilever
- Counterfort
- Gravity

○ I  II  III
○ I  III  II
○ III  I  II
○ III  II  I

41. Which of the following is NOT a primary objective of the use of hand-operated tampers for soil compaction?

- Reduce soil compressibility
- Increase soil moisture content
- Reduce soil permeability
- Increase soil strength

Answers to this division may be found on page 70.
**LATERAL FORCES**

**Division Statement/Content Areas**

1. **Content Areas**

   **1. Seismic Forces**
   
   **A. Principles:** Apply lateral forces principles to the design and construction of buildings to resist seismic forces.
   
   **B. Codes & Regulations:** Incorporate building codes and other regulatory requirements related to seismic forces.
   
   **C. Materials & Technology:** Analyze the implications of design decisions in the selection of systems, materials, and construction details related to seismic forces.
   
   **D. Environmental Issues:** Consider site and environmental characteristics in the selection, design, and construction of building structural systems to resist seismic forces.

2. **Wind Forces**

   **A. Principles:** Apply lateral forces principles to the design and construction of buildings to resist wind forces.
   
   **B. Codes & Regulations:** Incorporate building codes and other regulatory requirements related to wind forces.
   
   **C. Materials & Technology:** Analyze the implications of design decisions in the selection of systems, materials, and construction details related to wind forces.
   
   **D. Environmental Issues:** Consider site and environmental characteristics in the selection, design, and construction of building structural systems to resist wind forces.

3. **Lateral Forces—General**

   **A. Principles:** Apply lateral forces principles to the design and construction of buildings.
   
   **B. Materials & Technology:** Analyze the implications of design decisions in the selection of systems, materials, and construction details related to lateral forces.
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LATERAL FORCES

The references listed here are presented as a guide in preparing for the examination. The list was developed by the committee that writes questions for the exam. Since the examination is practice-based, it should not be considered an exhaustive list of all possible reference materials used to prepare for the examination. NCARB makes no guarantee that the various references are currently in print.
1. The figure below represents a section through a rigid structure that has a uniformly distributed total [specified, unfactored] weight (W). The [specified, unfactored] lateral force applied at mid-height that will cause the overturning moment to equal the stabilizing moment is
   - 0.333 W
   - 1.000 W
   - 1.333 W
   - 3.000 W

2. Which of the following light wood-frame construction types would be most likely to have configuration discontinuity?
   - Two-story residence on grade
   - Two-story residence with full basement on a sloping site
   - One-story residence with partial basement
   - Split-level residence on grade

3. Which of the following terms best describes the property that causes a freely vibrating structure to come to rest eventually?
   - Period
   - Damping
   - Resonance
   - Vibration

4. The diagram below shows an exterior exit door, 3’ 0” x 7’ 0” [910 x 2100], subject to a net positive wind pressure of 20 psf [1.0 kN/m², unfactored]. What force must be exerted at the center of the door to open it?
   - 210 lb [0.95 kN]
   - 420 lb [1.9 kN]
   - 630 lb [2.9 kN]
   - 840 lb [3.8 kN]

5. In order to provide for wind resistance in a new earthquake-resistant, low-rise structure in a region of high seismic risk, the owner’s cost would be most nearly what percent more than that for the earthquake resistance alone?
   - 0%
   - 20%
   - 50%
   - 100%

6. True statements concerning the use of shear walls to resist wind-induced horizontal loadings include which of the following?
   - Forces are resisted in a direction parallel to the shear walls.
   - Diagonal bracing in the plane of the shear wall must be provided, regardless of the type of material or assembly.
   - Shear walls must be positioned at right angles in plan for all types of structural systems.
   - Connections of shear walls to roof or floor diaphragms must develop 67 percent of the applied force.
   - I only
   - IV only
   - I and II only
   - II and III only

7. The additional construction cost required to enhance structural systems and components for seismic resistance is generally what percentage of the total new building cost?
   - 9% or less
   - 10%-15%
   - 16%-20%
   - 21% or more

8. The Modified Mercalli Scale is a measurement of the
   - energy released in an earthquake
   - probable acceleration relative to the distance from a major fault
   - probable focal depth relative to the magnitude of the seismic event
   - earthquake intensity based on the observed damage

9. Which of the following are all basic parameters for calculating the dynamic motion of a structure?
   - Base shear, deflection, frequency of vibration
   - Base shear, acceleration, fundamental period
   - Mass, acceleration, fundamental period
   - Mass, deflection, stiffness of structure
10. Which of the following is NOT a potential problem in the design of reinforced concrete buildings for earthquake resistance?
   - Weight of the structure
   - Ductile yielding of reinforcing
   - Compression bar ties
   - Difficulty of achieving effective diaphragms

11. The steel structural frame shown in the diagram below has become increasingly popular over the past decade as a means of resisting earthquake damage, permitting flexibility in incorporation of architectural features and reducing cost. What is the name of this framing system?
   - Concentrically braced frame
   - Zee-braced frame
   - Longitudinally braced frame
   - Eccentrically braced frame

12. For the structural frames shown below, which of the following statements concerning damping of earthquake-induced motion is true?
   - All frames have damping.
   - Only frame I is undamped.
   - Only frame III is undamped.
   - Only frames II and III are undamped.

13. The photograph below, showing damage to a suspended ceiling caused by the 1994 Northridge, California, earthquake reveals which of the following regarding seismic performance of the ceiling system?
   - Absence of partitions to provide edge restraint for the ceiling grid
   - Absence of diagonal tie wires between the structure and the ceiling grid
   - Lay-in ceiling tiles that are too large for the grid system used
   - Suspended light fixtures shown dangling properly attached to prevent complete displacement

14. Minor interior alterations are proposed for an existing “nonseismically designed” building located in a seismic zone. Construction consists of a light wood-framed roof supported by unreinforced brick bearing walls. Changes in use, occupancy, or floor loads are not involved in the alterations. Which of the following statements correctly indicates what must be done structurally to the building to meet code requirements?
   - The roof construction must satisfy the requirements of a seismic-zone diaphragm.
   - Unreinforced masonry bearing walls must be reinforced to meet the seismic-zone requirements.
   - New shear walls must be added to meet the seismic-zone requirements.
   - No changes in the primary structural system are required.
15. Good seismic design practice recognizes which of the following conditions as vertical irregularities in the design of seismic-resistive buildings?
   I. Reentrant corner
   II. Weight irregularity
   III. In-plane discontinuity in vertical bracing
   IV. Soft story
   ○ I and IV only
   ○ I, II, and III only
   ○ II, III, and IV only
   ○ I, II, III, and IV

16. Which of the following economic factors should NOT be an expected consequence for a building that has been designed and constructed in compliance with the seismic provisions of a typical building code?
   ○ Lower earthquake insurance rates
   ○ Increased construction cost
   ○ Increased work in design services
   ○ Elimination of future seismic damage

17. Which of the following factors need to be considered for a building that is subjected to seismic forces?
   I. Size of the building (plan dimensions and height)
   II. Location of the site
   III. Orientation of the building
   IV. Shape of the building
   ○ I and III only
   ○ I, II, and IV only
   ○ II, III, and IV only
   ○ I, II, III, and IV

18. All of the following affect the seismic design of buildings EXCEPT
   ○ acceptable damage level
   ○ underlying geological conditions
   ○ climatic conditions
   ○ dynamic behavior of soil

19. Which of the following facilities would be in Seismic Hazard Exposure Group III?
   ○ Day-care center
   ○ Emergency vehicle garage
   ○ Police station
   ○ Office

20. Which two of the following statements concerning the cost for meeting wind and earthquake code requirements are correct?
   I. The cost for compliance with code requirements for wind and seismic design of a building can be influenced by the choice of configuration.
   II. For the same total load on a roof caused by either earthquake or wind, the structural costs for the load-resisting structural system will be identical.
   III. For the same load on a braced-framed vertical structural element caused by either earthquake or wind, the cost of the vertical element is the same.
   IV. For a wind load on the windward wall of a one-story structure and an earthquake load of the same total magnitude applied at the center of mass of the roof of the same structure, the cost to resist the overturning moment will be the same.
   ○ I and IV
   ○ II and IV
   ○ I and III
   ○ III and IV

21. For wood truss-plate trusses spanning 24 feet [7 m] clear, spaced at 2 feet [600 mm] on center with a single-pitched top chord of 6:12 [1 in 2], adequate lateral support is provided by which of the following?
   ○ 5-ply, 5/8” [15.5 mm] plywood decking alone
   ○ 5 rows of 2 x 4 [38 x 89] blocking between bottom chords
   ○ Linear horizontal 2 x 4’s [38 x 89] at top chord panel points
   ○ Vertical diagonal bracing with 2 x 4’s [38 x 89] from top chords to bottom chords at maximum 20-foot [6 m] intervals

22. Which of the following methods is recommended to determine the in-plane shear capacity of an existing brick wall?
   ○ Obtain shear values for coursed brick from design tables prepared by the brick industry for new construction.
   ○ Obtain mortar shear values from design tables prepared by a mortar manufacturer.
   ○ Obtain shear values from an in-plane compression test of the existing wall by laterally displacing a single brick relative to adjacent bricks in the wythe.
   ○ Obtain shear values from laboratory compression testing of a core sample of the brick taken from the existing wall.
23. For which of the following situations involving modification of existing buildings do model codes require that seismic requirements be met?
   - Only modifications for which the total cost exceeds 50 percent of the replacement value of the building
   - Only modifications that include alteration of the primary structural system
   - Any modification, except where the risk to life safety is not increased
   - Any modification of a building located in Seismic Zone 3 or 4

24. In the design of buildings and building appurtenances to resist the effects of wind, model codes allow reduction in wind pressure for which of the following?
   - The shielding effect of adjacent structures
   - Buildings with a height-width ratio greater than 5
   - Buildings with a height-width ratio less than 5
   - No reduction in wind pressure is allowed

25. In addition to consideration of direct wind pressure on a building’s surface, model building codes require consideration of which of the following?
   - A 50 percent increase of pressure on windward walls in which windows occur
   - A negative pressure of 4 times the positive pressure when the windward wall is open
   - A roof uplift force of approximately 50 to 75 percent of the lateral pressure
   - A vibration load equal to the lateral force at a frequency equal to the building frequency

26. The renovation of existing buildings frequently requires upgrading the performance of a structure or various components to meet the more stringent codes of today. Such upgrading most frequently affects
   - footings
   - floor diaphragms
   - roof diaphragm
   - parapets

27. An existing cable-supported single-curvature roof is found to flutter under wind load. The structural solution to the problem will most likely be to
   - increase cable tension
   - decrease cable tension
   - increase the roof dead load
   - install tie-down cables

28. Which of the following are required when an addition is designed as a rigid attachment to an existing building?
   - Investigating the existing building’s lateral load resisting system to support additional wind loads
   - Providing independent lateral load resisting systems in both primary directions for the addition
   - Investigating the combined buildings for torsion
   - Determining new story drift due to increased loads and stiffening the building if drift is excessive
   - III and IV only
   - I, II, and III only
   - I, III, and IV only
   - II, III, and IV only

29. The Great Pyramid at Giza, Egypt, demonstrates all of the following ideal characteristics for seismic design of modern buildings EXCEPT
   - direct load paths
   - a broad base
   - a large mass
   - a symmetrical plan

30. In seismic design, the net sum of all lateral seismic forces is called
   - inertial vector
   - base shear
   - dynamic analysis
   - importance factor

31. Which of the following is produced by wind blowing against a building?
   - Negative pressure on the leeward side
   - Positive pressure on the leeward side
   - Negative pressure on the windward side
   - No pressure on the sides parallel to the wind direction

32. Post-and-beam structural systems must be braced for lateral loads. Which of the following is NOT considered to be lateral bracing for post-and-beam systems?
   - Moment connections
   - Pinned connections
   - Trussing
   - Shear panels

Answers to this division may be found on page 71.
DIVISION STATEMENT
The evaluation, selection, and integration of mechanical, electrical, plumbing, conveying, and specialty systems in building design and construction.

Content Areas
1. Codes & Regulations
   Incorporate building codes, specialty codes, and other regulatory requirements in the design of mechanical, electrical, plumbing, conveying, and other specialty systems.

2. Environmental Issues
   A. Building Design: Apply sustainable design principles to the selection, design, and construction of building systems.
   B. Site Planning & Design: Apply sustainable design principles to the selection and design of the site.

3. Plumbing
   A. Principles: Analyze and design plumbing systems.
   B. Materials & Technology: Evaluate and select materials and construction details related to plumbing systems.
   C. Calculations: Perform calculations for plumbing systems.

4. HVAC
   A. Principles: Analyze and design heating, ventilating, and air conditioning systems.
   B. Materials & Technology: Evaluate and select materials and construction details related to heating, ventilating, and air conditioning systems.
   C. Calculations: Perform calculations for HVAC systems.

5. Electrical
   A. Principles: Analyze and design electrical systems.
   B. Materials & Technology: Evaluate and select materials and construction details related to electrical systems.
   C. Calculations: Perform calculations for electrical systems.

6. Lighting
   A. Principles: Analyze and design natural and artificial lighting systems.
   B. Materials & Technology: Evaluate and select materials and construction details related to natural and artificial lighting systems.
   C. Calculations: Perform calculations for lighting systems.

7. Specialities
   A. Acoustics: Evaluate, select, and design acoustical systems.
   B. Communications & Security: Evaluate, select, and design communications and security systems.
   C. Conveying Systems: Evaluate, select, and design elevators, escalators, moving walkways, and other conveying systems.
   D. Fire Detection & Suppression: Evaluate, select, and design fire detection and suppression systems.
   E. Calculations: Perform calculations for specialty systems.
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MECHANICAL & ELECTRICAL SYSTEMS

The references listed here are presented as a guide in preparing for the examination. The list was developed by the committee that writes questions for the exam. Since the examination is practice-based, it should not be considered an exhaustive list of all possible reference materials used to prepare for the examination. NCARB makes no guarantee that the various references are currently in print.
1. The advantage of a flow-control sprinkler head is that it
   - increases water flow in proportion to the increase in ceiling temperature
   - uses an IR sensor to aim water at the flame
   - can be painted to match the room ceiling
   - closes automatically when ceiling temperatures are sufficiently reduced

2. The installation of an air compressor is required by which of the following types of sprinkler systems?
   - I. Wet system
   - II. Dry system
   - III. Halon system
   - I only
   - II only
   - I and III only
   - II and III only

3. Mechanically regulated smoke control is accomplished by employing fans and dampers. If it is to be an effective means of preventing the spread of smoke, which of the following must be true in case of fire?
   - I. Exhaust dampers in the fire zone change from normal to fully open.
   - II. Supply dampers in the fire zone change from normal to fully closed.
   - III. Supply fans serving the fire zone increase their speed.
   - I and II only
   - I and III only
   - II and III only
   - I, II, and III

4. Burning a 135-volt incandescent lamp at 115 volts rather than 135 volts results in which of the following?
   - I. Less light (lumens)
   - II. Less power consumption (watts)
   - III. Lower bulb temperature
   - IV. Less life (hours)
   - I only
   - I and IV only
   - II and III only
   - I, II, and III only

5. To which of the following occupancies do the model codes ascribe the most stringent life-safety requirements?
   - Church
   - Residence
   - Hospital
   - Office building

6. Which would be best to specify for use as the drain in a laundry room?
   - A
   - B
   - C
   - D

7. Why are thermostatically controlled shower valves used?
   - To minimize the use of hot water
   - To decrease water consumption
   - To prevent discharge of water at dangerously high temperatures
   - To ensure that water is shut off automatically

8. When mechanical equipment is mounted resiliently for sound control, all of the following should be flexibly connected to the equipment EXCEPT
   - water and steam piping
   - electrical connections
   - duct systems
   - flues
9. Which of the following building air distribution systems should provide the lowest annual operating cost for heating and cooling a 20,000-square-foot [1 800 m²] office building?
   ○ Constant volume, low velocity
   ○ Constant volume, high velocity
   ○ Variable volume, low velocity
   ○ Variable volume, high velocity

10. Economizer-cycle equipment conserves building energy by
   ○ using outdoor air to cool the building
   ○ using capacitors to increase the power factor
   ○ reducing artificial lighting as daylight increases
   ○ reducing ventilation air quality when building occupancy drops

11. In which of the following spaces would the highest coefficient of utilization (CU) be obtained for most luminaire types?
   ○ High white ceiling, small floor area
   ○ High dark ceiling, small floor area
   ○ Low dark ceiling, large floor area
   ○ Low white ceiling, large floor area

12. The diagram below represents a 120/208-volt, 3-phase, four wire electrical service. A 208-volt, 3-phase motor would be connected as

   PHASE LEG A
   PHASE LEG B
   PHASE LEG C
   NEUTRAL
   ○ A
   ○ B
   ○ C
   ○ D

13. In large buildings with principally fluorescent lighting, it is desirable to utilize a 277/480V [347/600V], 3-phase, 4-wire system rather than the more conventional 120/208V [120/208V], 3-phase, 4-wire system because
   ○ higher voltage is required to reach the extremities of large buildings
   ○ utility companies charge lower monthly rates for higher voltage
   ○ higher voltage permits the use of smaller feeder, conduit, and switchgear sizes
   ○ higher voltage makes it easier to detect short circuits and eliminate fires caused by arcing

14. Aluminum is frequently selected instead of copper for large electrical cables because
   ○ aluminum has less electrical resistance than copper has
   ○ aluminum is nonmagnetic
   ○ PVC conduit can be used with aluminum cables but not with copper
   ○ aluminum provides lower installation cost

15. The electrical symbol shown below represents a

   ○ junction box
   ○ phone outlet
   ○ computer outlet
   ○ floor receptacle

16. Which of the following are used to calculate the average illumination level within a room?
   I. Total lumens
   II. Floor area
   III. U-value of walls
   IV. Coefficient of utilization
   V. Maintenance factor
   ○ I, III, and V only
   ○ II, IV, and V only
   ○ I, II, III, and IV only
   ○ I, II, IV, and V only

17. Indoor air quality is adversely affected by which four of the following?
   I. Solar gain
   II. Occupant activity
   III. Building materials
   IV. Smoking
   V. Communications networking
   VI. Ventilation rate
   ○ I, II, IV, and V
   ○ I, III, V, and VI
   ○ II, III, IV, and VI
   ○ III, IV, V, and VI
18. The schematic section of the auditorium below shows the cause and remedies for which of the following acoustical problems?

- Diffusion
- Focusing
- Echoes
- Flutter

19. At which location in the diagram below would the listener best hear the whispering speaker?

- A
- B
- C
- D

20. The primary purpose of the element labeled X in the conveying system shown is to

- house the hydraulic cylinders
- increase power requirements
- dampen hoist-cable vibration
- counterbalance the load

21. Inadequate venting of concealed spaces in walls can cause which of the following?

- Condensation in the insulation
- Dry-rotting of structural members
- Staining and blistering of paint

- I and II only
- I and III only
- II and III only
- I, II, and III
22. Indoor air pollution, commonly caused by formaldehyde, carbon dioxide, or methanol, is worsened by which of the following design practices?
   - Design of supertight buildings that have low outside air ventilation and that use materials with these by-products
   - Design of new buildings with restaurants that use food products containing these pollutants
   - Specification of building materials with these by-products in order to lower construction costs
   - Conformance to building codes that require materials with these by-products

23. When designing task lighting, the designer should consider which of the following in determining the illumination type and level?
   I. Visual difficulty of the task
   II. Task duration
   III. Age of task performer
   IV. Cost of performance errors due to improper lighting
   - I and III only
   - I, II, and IV only
   - II, III, and IV only
   - I, II, III, and IV

24. Which of the following functions of dumbwaiters is prohibited?
   - Movement between more than two levels
   - Transport of people
   - Transport of liquids
   - Electronic operation

25. Which central heating/cooling system, configured as a collection of single-zone systems served by a single supply fan, permits simultaneous heating of some zones and cooling of others?
   - Single-duct variable air volume
   - Single duct with reheat
   - Multi-zone system
   - Double-duct system

26. Which would be the best design strategy for summer comfort in Phoenix, Arizona?
   - South facing glass and thermal mass
   - Evaporative coolers
   - Air movement
   - Increased insulation to resist heat flow

27. Which component in this diagram of hydronic and electrical controls for an oil-fired boiler for heating by hot water represents the expansion tank?

28. In illumination calculations, the number that is related to the length and width of a room and to the height between the work surface and the light fixtures is called the
   - ceiling cavity ratio
   - floor cavity ratio
   - room cavity ratio
   - room brightness ratio
29. The diagram below illustrates a converter connected to steam supply and equipped with all devices necessary for a complete hot-water heating system. Which of the following components of the diagram represents the relief valve?

- A
- B
- C
- D

30. What is the name for the ductwork air control illustrated below?

- Opposed-blade damper
- Splitter damper
- Fire damper
- Turning vane

31. Based on the following diagram of all-air HVAC system variations, which system refers to multi-zone?

- A
- B
- C
- D
32. The diagram below depicts a typical overhead electric service to a small apartment building. Which of the following parts of the diagram represents the ground rod?

- A
- B
- C
- D

33. The purpose of the check valve in the diagram below is to

- prevent backflow during fire-department pumper connection
- prevent penthouse flooding
- protect the building fire pump
- protect the city water supply from contamination

34. Which of the following materials are suitable for sewer systems?

I. ABS
II. PVC
III. EMT

- I only
- III only
- I and II only
- II and III only

35. Manual pull stations are used to

- notify fire departments
- trigger (release) automatic fire sprinkler systems
- activate fire alarm systems
- close fire-rated doors and return elevators to the main floor
36. In the following illustration of a typical overhead electrical service to a small apartment building, which represents the meter socket or meter base?

- A
- B
- C
- D

37. Which of the following buildings introduced natural lighting by means of an atrium?

- Reliance Building, Chicago, Daniel Burnham and John Root
- Philadelphia Savings Fund Society Building, William Lescaze
- Larkin Building, Buffalo, Frank Lloyd Wright
- Chicago Tribune Building, Raymond Hood and John Howells

38. The chart below is used to establish all of the following EXCEPT

- Sun position on an architectural model
- Sun penetration patterns
- Sun shadows on a model
- Azimuth and altitude of the Sun

39. Electrical floor-plan drawings show all of the following EXCEPT

- Conduit
- Switches
- Fixtures
- Wall devices

40. Given equal amounts of solar radiation, which of the following will absorb the least?

- Red brick
- Galvanized steel
- Slate
- Polished aluminum
41. The room-space condition is 72 degrees F [22.2 degrees C] D.B. and 50% RH. The point of condensation on the building wall is represented by which letter in the psychrometric chart below?

- A
- B
- C
- D

42. Which of the wall assemblies shown below allows the most sound transmission?

- A
- B
- C
- D

43. Which of the following piped heating/cooling systems uses a common return line for heating and cooling?

- 2-pipe, fan-coil
- 3-pipe, fan-coil
- 4-pipe, fan-coil
- 2-pipe, water-to-air heat-pump

Answers to this division may be found on page 72.
DIVISION STATEMENT
The application of knowledge and skills relating to evaluation and selection of building systems and related environmental issues; application of codes and regulations; use of materials and related technologies; and project and practice management during the schematic design and design development phases.

Content Areas

1. Principles
   Incorporate client needs and requirements in the development of schematic design and design development documents. Consider the implications of design decisions, human behavior, historic precedent, and design theory. Also consider building systems selection; adaptive reuse; and furnishings and equipment.

2. Environmental Issues
   Understand hazardous material mitigation, indoor air quality, sustainability, energy conservation, and alternative systems and their application during schematic design and design development.

3. Codes & Regulations
   Understand and incorporate building and specialty codes, zoning, and other regulatory requirements in the selection of materials and construction systems.

4. Materials & Technology
   Analyze the implication of design decisions during schematic design and design development in relation to the selection of systems, materials, and methods incorporated into the design and construction.
   
   A. Masonry: Identify the properties and characteristics of structural masonry and masonry veneer applications.
   
   B. Metals: Identify the properties and characteristics of structural and miscellaneous metals.
   
   C. Wood: Identify the properties and characteristics of wood structures, rough carpentry, finish carpentry, and millwork assemblies.
   
   D. Concrete: Identify the properties and characteristics of concrete structures and finishes.
   
   E. Other: Identify the properties and characteristics of miscellaneous systems, assemblies, membranes, cladding, coatings, and finish materials (e.g., plastics, composites, glass, tensile, pneumatic, EIFS, etc.).
   
   F. Specialties: Analyze and select accessories, equipment, and other specialty items.
   
   G. Site Planning & Design: Identify the properties and characteristics of site-related structures and materials.

5. Project & Practice Management
   Assess the implications of construction sequencing, scheduling, cost, and risk management regarding building size and configuration, and in the selection of systems, materials, and methods.
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McGraw-Hill, latest edition

Time-Saver Standards for Building Materials & Systems: Design Criteria and Selection Data
Donald Watson, Editor
McGraw-Hill, 2000

Time-Saver Standards for Building Types, Fourth Edition
Joseph De Chiara and Michael J. Crosbie, Editors
McGraw-Hill, 2001

Time-Saver Standards for Interior Design and Space Planning
Joseph De Chiara, Editor, Julius Panero, Editor, and Martin Zelnik
McGraw-Hill, 2001
1. According to model building codes, the time that materials or assemblies must withstand exposure to a fire is called
   - flame-spread rating
   - fire-resistance rating
   - critical radiant flux
   - flash point

2. If concrete remains in a transit mixer longer than is recommended by ASTM C94, what should be done?
   - Five gallons [19 L] of water should be added to the concrete.
   - A plasticizer should be added to the concrete.
   - Air should be entrained in the concrete.
   - The concrete should be rejected.

3. Which of the following would most likely be caused by differential settlement of the interior and exterior wythes of a brick and concrete masonry unit cavity wall?
   - spalling of the brick face
   - pulling away of the exterior brick veneer from the concrete masonry backup
   - stairstep cracking along the brick mortar joints
   - forming of efflorescence on the exterior of the brick veneer

4. The dimension labeled X in the diagram below refers to a
   - rabbet
   - soffit
   - stop
   - backbend

5. Which of the following includes the four major types of ceramic tile as grouped by the Tile Council of America (TCA)?
   - Glazed wall, mosaic, glazed brick, and paving
   - Glazed wall, mosaic, paving, and structural glazed
   - Glazed wall, mosaic, quarry, and paving
   - Glazed concrete soap, mosaic, quarry, and paving

6. Which of the following is true concerning fire-retardant treatment of wood?
   - It is a requirement for heavy timber construction.
   - It reduces flame-spread rating.
   - It makes the wood noncombustible.
   - It increases wood strength.

7. The plan detail below illustrates a vertical concrete masonry control joint used in an exterior wall to allow for all of the following EXCEPT
   - thermal expansion
   - thermal contraction
   - building settlement
   - shrinkage

8. Which illustration represents modular brick veneer with CMU backup?

9. Truck-mixed concrete governed by ASTM C94 is delivered to a job site for use in a reinforced concrete slab. The concrete should be delivered and discharged within what time limit after the introduction of water?
   - 30 min.
   - 60 min.
   - 90 min.
   - 120 min.
10. In the precast-concrete floor assembly illustrated below, if all the other elements remain the same, the item that may vary and provide the difference between a fire-resistance rating of two hours rather than three hours is which of the following?

- (A) Concrete topping
- (B) Fire-rated unit
- (C) Minimum bearing
- (D) Grout

11. Which of the following is the LEAST desirable sealant for metal-panel curtain-wall construction?

- Oil-base compounds (caulking)
- Nonskinning compounds (polybutenes)
- Rubber-base compounds (polysulfides)
- Elastic compounds (butyls, acrylics, and vinyls)

12. Which of the following correctly identifies the hand of the door shown below?

- Left hand
- Right hand
- Left-hand reverse
- Right-hand reverse

13. The critical radiant flux rating of a carpet indicates which of the following?

- The static-electricity rating of the carpet
- The suitability of installing the carpet on a radiant-heated floor slab
- The suitability of installing the carpet in an X-ray room
- The minimum radiant energy required to sustain combustion

14. To provide assistance for visually impaired persons, textured surfaces are applied to door-operating hardware at

- public rest rooms
- emergency exits only
- hazardous areas only
- both emergency exits and hazardous areas

15. Which of the mortar joints illustrated below provides the maximum protection against water penetration?

- Raked
- Flush
- Struck
- Concave

16. What is the maximum time period that mixed mortar can be used before hydration has a damaging effect on its final strength?

- ½ to 1½ hours
- 2 to 3½ hours
- 3½ to 4½ hours
- 4½ to 6 hours

17. If 2 x 12s are priced at $255/1,000 board feet, what is the price for one 10-foot-long 2 x 12?

- $ 2.55
- $ 5.10
- $10.20
- $20.40

18. In a steel-framed structure, which of the following does NOT generally provide for required lateral force resistance?

- Steel bracing
- Pile caps
- Shear walls
- Rigid frame

19. Edges of fire-resistant, interior-finish gypsum wallboard are

- tapered
- beveled
- square
- tongue and groove
20. Which of the following are design strategies for sustainable architecture?
   I. Design for energy transition
   II. Design with a combination of materials and components
   III. Design for building recycling
   IV. Design for building expansion
   ○ II and IV only
   ○ I, II, and III only
   ○ I, III, and IV only
   ○ I, II, III, and IV

21. Which of the following is the appropriate waterproofing to use on the exposed interior side of a foundation wall?
   ○ Membrane
   ○ Hydrolytic
   ○ Acrylic sealer
   ○ Sheet metal

22. When renovating an existing building, which of the following materials may contain asbestos?
   ○ Asphalt tile
   ○ Rubber tile
   ○ Linoleum
   ○ Vinyl composition tile

23. Which of the following is the recommended depth of saw-cut control joints relative to slab thickness?
   ○ 10%
   ○ 25%
   ○ 30%
   ○ 40%

24. Tactile signage requirements established by ANSI A117.1 [Barrier Free], include which of the following?
   I. Contrasting background surface textures
   II. Width-to-height ratio limitations for letters
   III. Sans serif uppercase letters
   IV. Raised letters and symbols
   ○ I and III only
   ○ I, II, and IV only
   ○ II, III, and IV only
   ○ I, II, III, and IV

25. Which of the following is an advantage of posttensioned concrete over pretensioned and precast concrete?
   ○ Quality can be verified before installation.
   ○ Construction time may be reduced.
   ○ Heavy abutments are not required.
   ○ Cured sections can be sawed to desired lengths.

26. Which of the following factory finish treatments is commonly specified for aluminum storefront sections?
   ○ Bonderizing
   ○ Metallizing
   ○ Anodizing
   ○ Aluminizing

27. The masonry unit illustrated below is which of the following types?
   ○ Jumbo brick
   ○ Structural glazed tile
   ○ CMU stretcher
   ○ CMU bond block

28. An architect is working on the restoration of a Greek Revival building. One of the columns in the classical portico is in need of replacement. The architect should inform the company that is going to replace the column that it is in which of the following orders?
   ○ Greek
   ○ Doric
   ○ Tuscan
   ○ Composite

29. The appearance of waterborne salts on the face of masonry is called
   ○ laitance
   ○ efflorescence
   ○ effluence
   ○ permeance
30. Which of the following is NOT a characteristic of cold-formed metal framing sections?
   - They have configurations similar to those of heavy structural members.
   - They are made from a single piece of material.
   - They are made by braking, rolling, or crimping sheet material.
   - They are frequently used as structural components in high-rise buildings.

31. The construction methods illustrated below are examples of which of the following types of construction?
   - Composite
   - Filled
   - Integral
   - Underlaid

32. Which of the following window types provides the LEAST amount of natural ventilation area for a given rough-opening size?
   - Double-hung
   - Casement
   - Jalousie
   - Pivot

33. To which of the following elements does the term “flame-spread rating” refer?
   - Structural elements
   - Finish materials
   - Exit distances
   - Fire detectors

34. Which paint contains binders of oil-modified resins which dry by oxidation?
   - Alkyd
   - Latex
   - Oil
   - Urethane

35. Which of the following types of paint gloss is referred to as “low sheen”?
   - Eggshell
   - High gloss
   - Low gloss
   - Semi gloss

36. According to model codes, which of the following conditions in the drawing below is a violation?
   - The slope of 1:12
   - The 4-foot [1.3 m] width
   - The horizontal projection of 30 feet [9 m]
   - The landing length of 3 feet [0.9 m]

37. Which of the following building types typically has the highest mechanical and electrical construction costs?
   - General care hospital
   - Career technical school
   - Medical office building
   - Correctional facility

38. Which of the following is NOT a type of toilet partition?
   - Ceiling hung
   - Floor braced
   - Wall braced
   - Wall cantilevered

39. Which of the following materials is no longer used for manufacturing chalkboards?
   - Baked enamel on steel
   - Integrally colored cement asbestos
   - Natural slate
   - Painted composition board

40. OSHA regulates which of the following?
   - Project safety procedures
   - Fire sprinkler systems
   - Roofing warranty provisions
   - Steel structures
41. What is the term for the stair element indicated at X in the drawing below?

○ Riser
○ Stringer
○ Baseboard
○ Barge board

42. The finish of toilet accessories is best identified in the

○ shop drawings
○ project specifications
○ project details
○ finish schedule

43. The maximum recommended spacing for masonry veneer anchors is NOT to exceed

○ 16” o.c. vertically and 24” o.c. horizontally
○ 24” o.c. vertically and 16” o.c. horizontally
○ 24” o.c. vertically and 36” o.c. horizontally
○ 36” o.c. vertically and 24” o.c. horizontally

44. Which of the following is a nonstandard width for metal lockers?

○ 10 in
○ 12 in
○ 15 in
○ 18 in

45. After the architect receives the client’s written approval of the Design Development Phase documents, the client requests that the mechanical engineer consider a new energy-efficient mechanical system; however, this new system requires more clearance for the equipment and ductwork than what was originally allowed. The result is that the building height must be increased and extensive structural changes must be made. The architect should inform the owner of which of the following?

I. Changes to the design can no longer be made since the Design Development Phase documents have already been approved.
II. The design changes will result in higher construction costs and project schedule delays.
III. The project may require further planning department review.
IV. The architect will proceed with the requested design changes at an increased fee.

○ I only
○ II and III only
○ III and IV only
○ II, III, and IV only

Answers to this division may be found on page 73.
DIVISION STATEMENT
The application of project management and professional practice knowledge and skills, including the preparation of contract documents and contract administration.

Content Areas

1. Codes & Regulations
   A. Building Design: Incorporate building codes, specialty codes, zoning, and other regulatory requirements in construction documents and services.
   B. Site Planning & Design: Incorporate zoning ordinances and other regulatory requirements in construction documents and services.

2. Environmental Issues
   A. Building Design: Incorporate sustainable design principles, adaptive reuse concepts, alternative energy systems, new material technologies, and hazardous material mitigation in construction documents.
   B. Site Planning & Design: Incorporate sustainable design principles, new material technologies, and hazardous material mitigation in construction documents.

   Prepare and coordinate construction drawings including building systems, product selection, and constructability. Prepare, coordinate, and review general and supplementary conditions and technical specifications.

4. Project & Practice Management
   A. Cost: Prepare estimates of probable construction cost. Consider cost implications of design decisions.
   B. Scheduling & Coordination: Prepare and manage project schedule and coordinate all contract documents including those of consultants.
   C. Project Delivery (including Submittals): Establish project delivery method. Provide contract administration documentation and services.
   D. Contracts & Legal Issues: Review and administer professional services and construction contracts. Consider issues pertaining to practice including risk management and professional and business ethics.
   E. Site Planning & Design: Provide project and practice management services related to site planning and design including: cost estimating; scheduling and coordination; project delivery; and contracts and legal issues.
CONSTRUCTION DOCUMENTS & SERVICES
The references listed here are presented as a guide in preparing for the examination. The list was developed by the committee that writes questions for the exam. Since the examination is practice-based, it should not be considered an exhaustive list of all possible reference materials used to prepare for the examination. NCARB makes no guarantee that the various references are currently in print.

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Canadian Handbook of Practice for Architects
Committee of Canadian Architectural Councils and
The Royal Architectural Institute of Canada, latest edition

CSI Manual of Practice
Construction Specifications Institute, latest edition

Rules of Conduct
National Council of Architectural Registration Boards, latest edition
1. The bidding documents require the successful bidder to submit a performance bond and a payment bond or the equivalent to the owner. At what time must these documents be delivered to the owner?
   - With the contractor’s first request for payment
   - Prior to the commencement of work on site
   - Within 3 days following the commencement of work on site
   - Within 14 days of receipt of the owner’s intent to award the contract

2. A Change Order requires that the owner, the architect, and the contractor agree on which of the following?
   - The contract sum only
   - The contract time only
   - The contract sum and the contract time only
   - A change to the work, the contract sum, and the contract time

3. A key plan is a
   - part of the hardware schedule
   - small-scale outline of a building complex
   - masonry term used in the construction of arches or vaults
   - grooving applied to a surface to improve its bond with another surface

4. Which of the following is an appropriate construction drawing symbol for detectable warnings on walking surfaces?
   - A
   - B
   - C
   - D

5. According to AIA Document A201 [CCDC 2], General Conditions, if, during the course of construction, the local building official requires additional testing, it is the architect’s responsibility to do which of the following?
   - Upon written authorization from the owner, instruct the contractor to make arrangements for such additional testing.
   - Upon written authorization from the owner, observe the additional testing.
   - Instruct the owner to make arrangements for such additional testing.
   - Bear the cost of the additional testing.

6. In order to determine and record the condition of the work immediately prior to partial occupancy or use, the area to be occupied or the portion of the work to be used shall be inspected by the
   - architect only
   - owner only
   - architect and the owner only
   - architect, the owner, and the contractor

7. While coordinating a set of construction documents, the mechanical engineer submits the drawing below. The drawing is a portion of
   - a reflected ceiling plan
   - an HVAC floor plan
   - a plumbing floor plan
   - a floor register layout
8. Midway through construction, the building official notifies the architect that all exhaust fans must be tested for operation at a minimum of 260 cubic feet per minute [120 cubic liters per second]. The building official requests that these tests be conducted immediately and that reports be filed within 30 days. Who is responsible for paying for the test?
   ○ The owner
   ○ The architect
   ○ The contractor
   ○ The mechanical subcontractor

9. On reviewing the construction documents, the owner does not approve of the lighting design in the lobby. The owner should communicate the request for changes to the
   ○ contractor
   ○ architect
   ○ electrical subcontractor
   ○ electrical consultant

10. During construction, the contractor has advised the architect that the contract drawings show a special brick shape; however, the specifications do not mention the special brick. The contractor has asked for an extra for the special shapes. The architect should do which of the following?
    ○ Issue a change order.
    ○ Reject the request for a change order.
    ○ Delete the special brick from the project.
    ○ Refer the request for arbitration.

11. The architect has specified that the contractor build a sample brick wall using a running bond. Which of the following walls satisfies the specifications?
    ○ A
    ○ B
    ○ C
    ○ D

12. Clarity of construction documents and the avoidance of problems and extra costs during construction are best achieved by which of the following?
    ○ Copious notes on the drawings
    ○ Frequent use of “or equal” clauses
    ○ Repetition of clauses and details
    ○ Simple language in the specifications

13. Which of the following symbols shown on the drawings indicates private telephone system devices?

14. In order to comply with corridor-width egress and accessibility requirements in a public building, which of the following plan details for the water cooler must be used?

15. The contract requires the construction of three elevators in a large turn-of-the-century railway station. The contractor encounters existing unknown services in each elevator excavation, bringing the project to a full stop while the architect prepares designs for the relocation of these services. Knowing that the owner is captive for daily delay charges until the work is able to start again, the contractor prices the contemplated Change Orders unjustifiably high. Under AIA [CCDC] standard forms of contract, the owner can cut losses in this situation by
   ○ having the work proceed on a cost-plus basis
   ○ terminating the contract
   ○ going to mediation/arbitration
   ○ instructing counsel to sue for damages to offset losses
16. The contractor has proposed a substitution on a project. According to AIA
document B141 [CCAC Document 6], Owner-Architect Agreement, the provision
of services by the architect in connection with evaluating and documenting the
substitution is
○ a basic service
○ a direct personal service
○ an additional [other] service
○ a matter for negotiation

17. During a routine site observation [review] of the work on a large renovation proj-
et, the architect observes a tradesperson core drilling the existing concrete floor
preparatory to installing a mechanical sprinkler riser. The architect's primary con-
cern should be to
○ inspect the hole to see if reinforcing steel is being severed or whether the
  contractor is or will be drilling through a structural beam
○ check the diameter of the hole to ensure it is large enough to accommodate
  insulation, sleeving, and firestopping
○ check the drawings to see if the sprinkler line is in the correct location in rela-
tion to partition locations and room finishes
○ make sure the sprinkler shop drawings have been reviewed

18. According to AIA Document B141/CMa, Owner-Architect Agreement–Construc-
tion Manager-Adviser Edition [Construction Management Contract Form], construction
cost estimates [updates] at the end of the construction documents phase are to be
provided by the
○ architect alone
○ construction manager alone
○ construction manager and the architect independently
○ architect in consultation with the construction manager

19. A subcontractor has advised the architect that the contractor has failed to pay the
subcontractor his portion of monies for work approved in the certificate for pay-
ment. In this situation, according to AIA Document A201 [CCDC 2], General
Conditions, the owner or architect
○ should refer the request for payment to the lending company
○ should arbitrate the dispute between the contractor and the subcontractor
○ has no obligation to see that payment is made
○ has an obligation to hold the certificate for payment

20. After walking off the job and refusing to continue, the contractor is terminated
under the provisions of AIA Document A201 [CCDC 2], General Conditions.
Which of the following is a true statement about this situation?
○ The architect must prepare a construction change directive directing the
  subcontractors to continue.
○ The work cannot continue unless the contractor continues.
○ Litigation is the only recourse for the owner.
○ The subcontractors have an obligation to finish their portion of the work.

21. When the architect authorizes the work to proceed via a construction change
directive on a cost-plus basis, which of the following are recognized as costs of the
work?
I. Benefits paid for labor and the contractor's personnel
II. Monies paid to all field office personnel
III. Monies paid to those head office personnel who spend time
    on the work
IV. Legal costs incurred by the contractor that result from the
    execution of the work
○ I and II only
○ I and III only
○ II and IV only
○ I, II, III, and IV

22. The roofing specifications call for a UL Class-A roof. This classification refers to
○ smoke-contribution characteristics of the membrane
○ smoke-contribution characteristics of the roof assembly
○ fire-retardancy characteristics of the roof assembly
○ fire-retardancy characteristics of the membrane against fire from outside
  sources

23. The architect has recommended to the owner that several construction alters
[alternatives] be included in the bidding documents to enable the owner to keep
the construction cost within the budget. In accordance with AIA Document B141
[CCAC Document 6], Owner-Architect Agreement, the services required to docu-
ment these alternates [alternatives] are the responsibility of
○ the contractor, as part of the bid proposal
○ each subcontractor, as part of the bid proposal
○ the architect, as additional [other] services
○ the architect, as part of basic services
24. On a local YMCA project, a gym floor is to be donated by one of the members and installed by the contractor. When the time for installation arrives, the floor does not. The contractor requests an extension of time plus reimbursement for builder’s risk insurance. The architect should do which of the following?
- Reject the request.
- Prepare a Change Order for an extension of time but no reimbursement.
- Prepare a Change Order for both an extension of time and reimbursement.
- Prepare a construction change directive requiring the contractor to install the floor when it arrives.

25. At the preconstruction meeting with the architect, the owner, and the construction manager, a contractor asks who will review and certify applications for payment, including final payment. According to AIA Document A201/CMa, General Conditions–Construction Manager–Adviser Edition [CCA 5, Management Contract Form Between Owner and Construction Manager], the contractor should be advised that this will be done by the
- architect only
- construction manager only
- architect and the construction manager
- architect and the owner

26. The structural consultant has requested that certain procedures be followed by the contractor prior to loading the structure. The architect should include these procedures in the
- working drawings
- specifications
- bidding instructions
- general conditions

27. Which of the following are NOT included as part of the contract documents?
- Specifications
- Performance bonds
- Shop drawings
- Supplementary conditions

28. When reviewing shop drawings, the architect is responsible for checking which of the following?
- Fabrication
- Design intent
- Coordination
- Erection

29. On an elementary school project, the architect secured a sample of a window before preparing the specification. After the award of the contract, the contractor, before submitting a sample of a substitute window, noticed that the window has a thinner sill section than the specified window. How should the contractor handle this revision?
- Telephone the architect.
- Notify the architect in writing.
- Consult the owner.
- Ask the window supplier to call the architect.

30. The architect determines after a site visit [field review] that the project work is behind schedule. The architect should
- advise the building inspector
- advise the owner
- revise the construction schedule
- order overtime

31. Specifications generally give all of the following information EXCEPT
- quantities of components
- identification of alternates [alternatives]
- methods of installation
- types of materials

32. For a building constructed in cold weather, which of the following operations require winter protection?
- Structural-steel frame
- Membrane roof and ballast
- Concrete footings and foundation
- Metal roof-deck and siding

33. Who is responsible for determining whether a completed assembly, achieved through specific construction means, methods, and techniques, meets the design intent of the contract documents?
- The contractor
- The contractor’s superintendent
- The owner
- The architect

34. Discussion of construction delivery methods starts at the
- beginning of the project
- time construction documents are prepared
- time bid documents are prepared
- time the prebid conference is held
35. The shop drawings for HVAC equipment, which are at a site construction office, do not have an architect's or engineer's review stamp on them. The contractor's explanation is that the subcontractor is under a tight schedule and that the equipment to be provided conforms to specifications and is on its way from the factory. The architect should
○ feel assured that the project is moving along well and that the owner will get what the owner is paying for
○ have the contractor tell the subcontractor that all items needing shop drawings must be reviewed
○ call the factory to see whether what the subcontractor had indicated about compliance is correct
○ call the engineer and report the problem

36. A change order may include which of the following items?
   I. Time extensions
   II. Labor costs
   III. Material costs
   IV. Insurance and bond costs
   ○ I only
   ○ II and III only
   ○ I, II, and III only
   ○ I, II, III, and IV

37. During final closeout of a project, the contractor submits a claim for costs for additional compacted fill placed at the beginning of construction. The contractor had forgotten about the work and had not submitted a claim when the fill was placed. According to AIA Document A201 [CCDC 2], the architect should
○ review the work, and if the work is complete, prepare a change order
○ notify the owner and wait for instructions
○ reject the request because it was not presented in a timely manner
○ negotiate a lower amount and issue a purchase order

38. On certificates for payment, material and labor costs are paid according to the
   ○ materials stored at the site
   ○ schedule of values
   ○ cash flow projection
   ○ superintendent's daily log

39. According to AIA Document A201 [CCDC 2], the warranty period starts on the date
○ the contractor specifies
○ of substantial completion [substantial performance]
○ the owner occupies the building
○ the mechanical systems are started

40. Final payment on a construction project constitutes a waiver of all claims by the owner except those arising from which of the following?
   I. Liens, claims, security interests, or encumbrances arising out of the contract and unsettled
   II. Failure of the work to comply with the requirements of the contract documents
   III. Terms of special warranties required by the contract documents
   IV. Claims of consultants employed by the architect
   ○ III only
   ○ I and IV only
   ○ I, II, and III only
   ○ I, II, III, and IV

41. Work found to be not in accordance with the contract documents, AIA Document A201 [CCDC 2], General Conditions, requires a minimum warranty period of
   ○ 3 months
   ○ 6 months
   ○ 1 year
   ○ 2 years

42. The contractor has issued a written request that the owner furnish evidence of financing for the project. The owner responds that he has the financing but will not provide a letter to that effect. The best option available to the contractor is to
○ issue a notice of intent to stop work in 7 days [5 working days] if evidence of financing is not provided
○ issue a notice of intent to stop work for a period of 30 days [20 working days]
○ continue work but issue a letter reserving the right to suspend work immediately
○ stop work immediately and indefinitely until the issue is resolved

43. The contractor should provide a schedule of values of the work at which of the following times?
○ Shortly after the award of the construction contract
○ Prior to submitting the bid to or negotiating with the owner
○ With the bid or during negotiations with the owner
○ With each change order request

Answers to this division may be found on page 74.
1. I, II, and IV only
2. Magnet school
3. shopping and public transportation
4. downsize the proposed project
5. outline specifications prepared for an earlier project
6. Site B
7. La Galleria in Milan
8. designing an aesthetically pleasing building
9. 30 acres [12 hectares]
10. Wide enough to be slightly crowded at peak periods
11. Masonry, windows, elevators, murals
12. Robert Stern
13. Subsurface conditions that affect site utilization
14. Sea Ranch, California
15. spatial transition
16. I, II, III, and IV
17. 5 ft [1 500 mm]
18. II and IV
19. mortgaging
20. I and IV only
21. criteria set forth by the building code
22. Design development
23. The mezzanine area is too large.
24. General obligation bonds
25. contour line
26. Subsurface water
27. Location B
28. Site C
29. applicable building codes
30. Proposed overall project schedule
31. Light walls combined with light ceilings maximize spaciousness.
32. Building codes
1. reduce tensile stresses resulting from loads
2. A
3. Construction time
4. buckling
5. crumbly
6. I only
7. I, II, III, and IV
8. C
9. It is supported by the building framework.
10. To provide lateral bracing for the joists
11. Active lateral soil pressure
12. Structural System
   Opening Location
   One-way concrete
   Between two beams
   slab/beam/girder system
13. The applicable building code [NBCC]
14. Saturated silt
15. 25%
16. 469 ft-lb [0.759 kN-m]
17. 1.4 compression
18. 4
19. I, II, and III only
20. automobiles parked in garages
21. Tension
22. 2.5
23. the truss is stronger
24. Aluminum
25. 2,500 lb [2,500 kN]
26. section modulus
27. formed sheet-steel deck
28. 604 lb [604 kN]
29. bh²/6
30. 0.175 kip [0.794 kN]
31. yield strength
32. 4 kips [4 kN]
33. expansion and contraction
34. 1 to 1
35. Mono
36. cantilever
37. fillet welds
38. tight and the washers in uniform contact with the surface of the wood
39. compaction test
40. III (Cantilever), II (Counterfort), and I (Gravity)
41. Increase soil moisture content
1. 0.333 W
2. Split-level residence on grade
3. Damping
4. 420 lb [1.9 kN]
5. 0%
6. I only
7. 9% or less
8. earthquake intensity based on the observed damage
9. Mass, acceleration, fundamental period
10. Difficulty of achieving effective diaphragms
11. Eccentrically braced frame
12. Only frames II and III are undamped.
13. Absence of diagonal tie wires between the structure and the ceiling grid
14. No changes in the primary structural system are required.
15. II, III, and IV only
16. Elimination of future seismic damage
17. I, II, and IV only
18. climatic conditions
19. Police station
20. I and III
21. Vertical diagonal bracing with 2 x 4's [38 x 89] from top chords to bottom chords at maximum 20-foot [6 m] intervals
22. Obtain shear values from an in-plane compression test of the existing wall by laterally displacing a single brick relative to adjacent bricks in the wythe.
23. Any modification, except where the risk to life safety is not increased
24. No reduction in wind pressure is allowed
25. A roof uplift force of approximately 50 to 75 percent of the lateral pressure
26. parapets
27. install tie-down cables
28. I, III, and IV only
29. a large mass
30. base shear
31. Negative pressure on the leeward side
32. Pinned connections
1. closes automatically when ceiling temperatures are sufficiently reduced
2. II only
3. I and II only
4. I, II, and III only
5. Hospital
6. B

7. To prevent discharge of water at dangerously high temperatures
8. flues
9. Variable volume, low velocity
10. using outdoor air to cool the building
11. Low white ceiling, large floor area
12. C
13. higher voltage permits the use of smaller feeder, conduit, and switchgear sizes
14. aluminum provides lower installation cost
15. floor receptacle
16. I, II, IV, and V only
17. II, III, IV, and VI
18. Echoes
19. Location D
20. counterbalance the load
21. I, II, and III
22. Design of supertight buildings that have low outside air ventilation and that use materials with these by-products
23. I, II, III, and IV
24. Transport of people
25. Multi-zone system
26. Evaporative coolers
27. Component B
28. room cavity ratio
29. Component B

30. Splitter damper
31. B

32. Part C
33. prevent backflow during fire-department pumper connection
34. I and II only
35. activate fire alarm systems
36. Part B
37. Larkin Building, Buffalo, Frank Lloyd Wright
38. azimuth and altitude of the Sun
39. conduit
40. Polished aluminum
41. D
42. B

43. 3-pipe, fan-coil
1. fire-resistance rating
2. The concrete should be rejected.
3. stairstep cracking along the brick mortar joints
4. stop
5. Glazed wall, mosaic, quarry, and paving
6. It reduces flame-spread rating.
7. building settlement
8. A
9. 90 min.
10. (A) Concrete topping
11. Oil-base compounds (caulking)
12. Right-hand reverse
13. The minimum radiant energy required to sustain combustion
14. hazardous areas only
15. Concave
16. 2 to 3½ hours
17. $5.10
18. Pile caps
19. tapered
20. I, III, and IV only
21. Hydrolytic
22. Asphalt tile
23. 25%
24. II, III, and IV only
25. Heavy abutments are not required.
26. Anodizing
27. CMU stretcher
28. Doric
29. efflorescence
30. They are frequently used as structural components in high-rise buildings.
31. Composite
32. Double-hung
33. Finish materials
34. Alkyd
35. Eggshell
36. The landing length of 3 feet [0.9 m]
37. General care hospital
38. Wall cantilevered
39. Integrially colored cement asbestos
40. Project safety procedures
41. Stringer
42. project specifications
43. 16" o.c. vertically and 24" o.c. horizontally
44. 10 in
45. II, III, and IV only
1. Prior to the commencement of work on site
2. A change to the work, the contract sum, and the contract time
3. small-scale outline of a building complex
4. A

5. Upon written authorization from the owner, instruct the contractor to make arrangements for such additional testing.
6. architect, the owner, and the contractor
7. an HVAC floor plan
8. The owner
9. architect
10. Reject the request for a change order.
11. C

12. Simple language in the specifications
13. C

14. B

15. having the work proceed on a cost-plus basis
16. an additional [other] service
17. inspect the hole to see if reinforcing steel is being severed or whether the contractor is or will be drilling through a structural beam
18. construction manager alone
19. has no obligation to see that payment is made
20. The subcontractors have an obligation to finish their portion of the work.
21. I, II, III, and IV
22. fire-retardancy characteristics of the membrane against fire from outside sources
23. the architect, as additional [other] services
24. Prepare a Change Order for both an extension of time and reimbursement.
25. architect and the construction manager
26. specifications
27. Shop drawings
28. Design intent
29. Notify the architect in writing.
30. advise the owner
31. quantities of components
32. Concrete footings and foundation
33. The architect
34. beginning of the project
35. have the contractor tell the subcontractor that all items needing shop drawings must be reviewed
36. I, II, III, and IV
37. reject the request because it was not presented in a timely manner
38. schedule of values
39. of substantial completion [substantial performance]
40. I, II, and III only
41. 1 year
42. issue a notice of intent to stop work in 7 days [5 working days] if evidence of financing is not provided
43. Shortly after the award of the construction contract