CollegeBoard

2015
AP® Computer Science A

Released Exam

Secured for Teacher Use

Contents

Note: This publication shows the page numbers that appeared in the *2014–15 AP Exam Instructions* book and in the actual exam. This publication was not repaginated to begin with page 1.

AP® Computer Science A Exam

Regularly Scheduled Exam Date: Thursday morning, May 7, 2015

Late-Testing Exam Date: Thursday morning, May 21, 2015

Section I Total Time: 1 hr. 15 min. Section II Total Time: 1 hr. 45 min.

Section I

Total Time: 1 hour 15 minutes
Number of Questions: 40*
Percent of Total Score: 50%
Writing Instrument: Pencil required

**The number of questions may vary slightly depending on the form of the exam.*

Section II

Total Time: 1 hour 45 minutes
Number of Questions: 4
Percent of Total Score: 50%
Writing Instrument: Pencil required

Note: The language used on the exam will be Java. The Java Quick Reference is included in the exam booklets.

What Proctors Need to Bring to This Exam

- Exam packets
- Answer sheets
- AP Student Packs
- *2014-15 AP Coordinator's Manual*
- This book — *AP Exam Instructions*
- AP Exam Seating Chart template(s)
- School Code and Home-School/Self-Study Codes
- Pencil sharpener
- Container for students' electronic devices (if needed)
- Extra No. 2 pencils with erasers
- Extra pens with black or dark blue ink
- Extra paper
- Stapler
- Watch
- Signs for the door to the testing room
  - "Exam in Progress"
  - "Cell phones are prohibited in the testing room"

SECTION I: Multiple Choice

Do not begin the exam instructions below until you have completed the appropriate General Instructions for your group.

Make sure you begin the exam at the designated time. Remember: You must complete a seating chart for this exam. See pages 279–280 for a seating chart template and instructions. See the *2014-15 AP Coordinator's Manual* for exam seating requirements (pages 48–50, 88).

If you are giving the regularly scheduled exam, say:

It is Thursday morning, May 7, and you will be taking the AP Computer Science A Exam.

If you are giving the alternate exam for late testing, say:

It is Thursday morning, May 21, and you will be taking the AP Computer Science A Exam.

In a moment, you will open the packet that contains your exam materials. By opening this packet, you agree to all of the AP Program's policies and procedures outlined in the *2014-15 Bulletin for AP Students and Parents*. You may now remove the shrinkwrap from your exam packet and take out the Section I booklet, but do not open the booklet or the shrinkwrapped Section II materials. Put the white seals aside. . . .

Carefully remove the AP Exam label found near the top left of your exam booklet cover. Now place it on page 1 of your answer sheet on the light blue box near the top right-hand corner that reads "AP Exam Label."

If students accidentally place the exam label in the space for the number label or vice versa, advise them to leave the labels in place. They should not try to remove the label; their exam will be processed correctly.

Read the statements on the front cover of Section I and look up when you have finished. . . .

Sign your name and write today's date. Look up when you have finished. . . .

Now print your full legal name where indicated. Are there any questions? . . .

Turn to the back cover and read it completely. Look up when you have finished. . . .

Are there any questions? . . .

You will now take the multiple-choice portion of the exam. You should have in front of you the multiple-choice booklet and your answer sheet. You may never discuss these specific multiple-choice questions at any time in any form with anyone, including your teacher and other students. If you disclose these questions through any means, your AP Exam score will be canceled. . . .

You must complete the answer sheet using a No. 2 pencil only. Mark all of your responses beginning on page 2 of your answer sheet, one response per question. Completely fill in the circles. If you need to erase, do so carefully and completely. No credit will be given for anything written in the exam booklet. Scratch paper is not allowed, but you may use the margins or any blank space in the exam booklet for scratch work. Are there any questions? . . .

The Java Quick Reference is located at the back of the booklet. You have 1 hour and 15 minutes for Section I. Open your Section I booklet and begin.

Note Start Time here _____. Note Stop Time here _____. Check that students are marking their answers in pencil on their answer sheets, and that they are not looking at their shrinkwrapped Section II booklets. After 1 hour and 5 minutes, say:

There are 10 minutes remaining.

After 10 minutes, say:

Stop working. Close your exam booklet and put your answer sheet on your desk, face up. Make sure you have your AP number label and an AP Exam label on page 1 of your answer sheet. Sit quietly while I collect your answer sheets.

Collect an answer sheet from each student. Check that each answer sheet has an AP number label and an AP Exam label. After all answer sheets have been collected, say:

Now you must seal your exam booklet using the white seals you set aside earlier. Remove the white seals from the backing and press one on each area of your exam booklet cover marked "PLACE SEAL HERE." Fold each seal over the back cover. When you have finished, place the booklet on your desk, face up. . . .

I will now collect your Section I booklet.

Collect a Section I booklet from each student. Check that each student has signed the front cover of the sealed Section I booklet.

There is a 10-minute break between Sections I and II. When all Section I materials have been collected and accounted for and you are ready for the break, say:

Please listen carefully to these instructions before we take a 10-minute break. All items you placed under your chair at the beginning of this exam must stay there, and you are not permitted to open or access them in any way. Leave your shrinkwrapped Section II packet on your desk during the break. You are not allowed to consult teachers, other students, or textbooks during the break. You may not make phone calls, send text messages, check email, use a social networking site, or access any electronic or communication device. Remember, you may never discuss the multiple-choice questions at any time in any form with anyone, including your teacher and other students. If you disclose these questions through any means, your AP Exam score will be canceled. Are there any questions? . . .

 **You may begin your break. Testing will resume at _____.**

SECTION II: Free Response

After the break, say:

May I have everyone's attention? Place your Student Pack on your desk. . . .

You may now remove the shrinkwrap from the Section II packet, but do not open the exam booklet until you are told to do so. . . .

Read the bulleted statements on the front cover of the exam booklet. Look up when you have finished. . . .

Now place an AP number label on the shaded box. If you don't have any AP number labels, write your AP number in the box. Look up when you have finished. . . .

Read the last statement. . . .

Using your pen, print the first, middle and last initials of your legal name in the boxes and print today's date where indicated. This constitutes your signature and your agreement to the statements on the front cover. . . .

Turn to the back cover and complete Item 1 under "Important Identification Information." Print the first two letters of your last name and the first letter of your first name in the boxes. Look up when you have finished. . . .

In Item 2, print your date of birth in the boxes. . . .

In Item 3, write the school code you printed on the front of your Student Pack in the boxes. . . .

Read Item 4. . . .

Are there any questions? . . .

I need to collect the Student Pack from anyone who will be taking another AP Exam. You may keep it only if you are not taking any other AP Exams this year. If you have no other AP Exams to take, place your Student Pack under your chair now. . . .

While Student Packs are being collected, read the information on the back cover of the exam booklet. Do not open the booklet until you are told to do so. Look up when you have finished. . . .

Collect the Student Packs. Then say:

Are there any questions? . . .

You have 1 hour and 45 minutes for Section II. You must write your answers in the exam booklet using a No. 2 pencil. You are responsible for pacing yourself, and may proceed freely from one question to the next. If you need more paper during the exam, raise your hand. At the top of each sheet of paper you use, be sure to write only your AP number and the number of the question you are working on. Do not write your name. The Java Quick Reference is located at the back of the booklet. Are there any questions? . . .

You may begin.

Note Start Time here _____. Note Stop Time here _____. After 1 hour and 35 minutes, say:

There are 10 minutes remaining.

After 10 minutes, say:

Stop working and close your exam booklet. Place it on your desk, face up. . . .

If any students used extra paper for the free-response section, have those students staple the extra sheet(s) to the first page corresponding to that question in their exam booklets. Complete an Incident Report and include any exam booklets with extra sheets of paper in an Incident Report return envelope (see page 57 of the *AP Coordinator's Manual* for details). Then say:

Remain in your seat, without talking, while the exam materials are collected. . . .

Collect a Section II booklet from each student. Check for the following:

- Exam booklet front cover: The student placed an AP number label on the shaded box, and printed his or her initials and today's date.
- Exam booklet back cover: The student completed the "Important Identification Information" area.

When all exam materials have been collected and accounted for, return to students any electronic devices you may have collected before the start of the exam.

If you are giving the regularly scheduled exam, say:

You may not discuss or share these specific free-response questions with anyone unless they are released on the College Board website in about two days. Your AP Exam score results will be available online in July.

If you are giving the alternate exam for late testing, say:

None of the questions in this exam may ever be discussed or shared in any way at any time. Your AP Exam score results will be available online in July.

If any students completed the AP number card at the beginning of this exam, say:

Please remember to take your AP number card with you. You will need the information on this card to view your scores and order AP score reporting services online.

Then say:

You are now dismissed.

All exam materials must be placed in secure storage until they are returned to the AP Program after your school's last administration. Before storing materials, check the "School Use Only" section on page 1 of the answer sheet and:

- Fill in the appropriate section number circle in order to access a separate AP Instructional Planning Report (for regularly scheduled exams only) or subject score roster at the class section or teacher level. See "Post-Exam Activities" in the *2014-15 AP Coordinator's Manual*.
- Check your list of students who are eligible for fee reductions and fill in the appropriate circle on their registration answer sheets.

Be sure to give the completed seating chart to the AP Coordinator. Schools must retain seating charts for at least six months (unless the state or district requires that they be retained for a longer period of time). Schools should not return any seating charts in their exam shipments unless they are required as part of an Incident Report.

AP Answer Sheet 2015

AP Number Label
(from Student Pack)

B123456789T

AP Exam Label
(from Section I Booklet)

CollegeBoard

COMPLETE THIS AREA AT EVERY EXAM. **USE NO. 2 PENCIL ONLY**

To maintain the security of the exam and the validity of my AP score, I will allow no one else to see the multiple-choice questions. I will seal the multiple-choice booklet when asked to do so, and I will not discuss these questions with anyone at any time after completing the section. I am aware of and agree to the AP Program's policies and procedures as outlined in the *2014-15 Bulletin for AP Students and Parents*, including using testing accommodations (e.g., extended time, computer, etc.) only if I have been preapproved by College Board Services for Students with Disabilities.

A. SIGNATURE Sign your legal name as it will appear on your college applications. Date

B. LEGAL NAME Omit apostrophes, Jr., II.

Legal Last Name — First 15 Letters | Legal First Name — First 12 Letters | MI

C. YOUR AP NUMBER

D. EXAM DATE Month | Day

E. EXAM START TIME AM | PM

F. MULTIPLE-CHOICE BOOKLET SERIAL NUMBER S

G. ONLINE PROVIDER CODE

COMPLETE THIS AREA ONLY ONCE.

I. AREA CODE AND PHONE NUMBER

INTERNATIONAL PHONE

J. SCHOOL YOU ATTEND

SCHOOL CODE | School Name | City | State | Country

K. DATE OF BIRTH

Month (Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec) | Day | Year

L. SOCIAL SECURITY NUMBER (Optional)

M. COLLEGE TO RECEIVE YOUR AP SCORE REPORT

COLLEGE CODE

Using the college code listed in the AP Student Pack, indicate the **ONE** college that you want to receive your AP score report.

College Name | City | State | Country

N. CURRENT GRADE LEVEL

- Not yet in 9th grade
- 9th
- 10th
- 11th
- 12th
- No longer in high school

H. AP EXAM I AM TAKING USING THIS ANSWER SHEET Exam Name: | Form: | Form Code:

779934

SCHOOL USE ONLY

Section Number: 1 2 3 4 5 6 7 8 9

Fee Reduction Granted: 1 Option 1 2 Option 2

104246-00657 • UNLWEB315

Q3914/1-4

COMPLETE THIS AREA AT EACH EXAM (IF APPLICABLE).

O. SURVEY QUESTIONS — Answer the survey questions in the AP Student Pack. Do not put responses to exam questions in this section.

1 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ Ⓖ Ⓗ Ⓘ	4 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ Ⓖ Ⓗ Ⓘ	7 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ Ⓖ Ⓗ Ⓘ
2 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ Ⓖ Ⓗ Ⓘ	5 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ Ⓖ Ⓗ Ⓘ	8 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ Ⓖ Ⓗ Ⓘ
3 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ Ⓖ Ⓗ Ⓘ	6 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ Ⓖ Ⓗ Ⓘ	9 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ Ⓖ Ⓗ Ⓘ

P. LANGUAGE — Do not complete this section unless instructed to do so.

If this answer sheet is for the French Language and Culture, German Language and Culture, Italian Language and Culture, Spanish Language and Culture, or Spanish Literature and Culture Exam, please answer the following questions. Your responses will not affect your score.

1. Have you lived or studied for one month or more in a country where the language of the exam you are now taking is spoken?

◯ Yes ◯ No

2. Do you regularly speak or hear the language at home?

◯ Yes ◯ No

QUESTIONS 1–75

Indicate your answers to the exam questions in this section (pages 2 and 3). Mark only one response per question for Questions 1 through 120. If a question has only four answer options, do not mark option E. Answers written in the multiple-choice booklet will not be scored.

COMPLETE MARK ● EXAMPLES OF INCOMPLETE MARKS 

You must use a No. 2 pencil and marks must be complete. Do not use a mechanical pencil. It is very important that you fill in the entire circle darkly and completely. If you change your response, erase as completely as possible. Incomplete marks or erasures may affect your score.

1 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	26 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	51 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
2 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	27 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	52 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
3 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	28 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	53 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
4 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	29 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	54 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
5 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	30 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	55 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
6 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	31 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	56 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
7 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	32 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	57 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
8 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	33 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	58 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
9 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	34 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	59 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
10 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	35 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	60 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
11 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	36 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	61 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
12 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	37 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	62 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
13 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	38 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	63 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
14 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	39 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	64 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
15 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	40 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	65 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
16 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	41 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	66 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
17 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	42 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	67 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
18 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	43 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	68 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
19 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	44 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	69 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
20 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	45 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	70 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
21 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	46 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	71 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
22 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	47 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	72 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
23 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	48 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	73 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
24 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	49 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	74 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
25 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	50 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	75 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ

ETS USE ONLY

Exam		⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
		⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
Exam		⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
		⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

SELECTED MEDIA EXAMS	R	W	O	OTHER EXAMS	R	W	O
PT02				TOTAL			
PT03				Subscore (if applicable)			
PT04				Subscore (if applicable)			

DO NOT WRITE IN THIS AREA

QUESTIONS 76–120

Be sure each mark is dark and completely fills the circle. If a question has only four answer options, do not mark option E.

76	A B C D E	91	A B C D E	106	A B C D E
77	A B C D E	92	A B C D E	107	A B C D E
78	A B C D E	93	A B C D E	108	A B C D E
79	A B C D E	94	A B C D E	109	A B C D E
80	A B C D E	95	A B C D E	110	A B C D E
81	A B C D E	96	A B C D E	111	A B C D E
82	A B C D E	97	A B C D E	112	A B C D E
83	A B C D E	98	A B C D E	113	A B C D E
84	A B C D E	99	A B C D E	114	A B C D E
85	A B C D E	100	A B C D E	115	A B C D E
86	A B C D E	101	A B C D E	116	A B C D E
87	A B C D E	102	A B C D E	117	A B C D E
88	A B C D E	103	A B C D E	118	A B C D E
89	A B C D E	104	A B C D E	119	A B C D E
90	A B C D E	105	A B C D E	120	A B C D E

QUESTIONS 121–126

For Students Taking AP Biology

Write your answer in the boxes at the top of the griddable area and fill in the corresponding circles. Mark only one circle in any column. You will receive credit only if the circles are filled in correctly.

121 122 123 124 125 126

QUESTIONS 131–142

For Students Taking AP Physics 1 or AP Physics 2

Mark two responses per question. You will receive credit only if both correct responses are selected.

131	A B C D	135	A B C D	139	A B C D
132	A B C D	136	A B C D	140	A B C D
133	A B C D	137	A B C D	141	A B C D
134	A B C D	138	A B C D	142	A B C D

DO NOT WRITE IN THIS AREA

COMPLETE THIS AREA ONLY ONCE.

Q. YOUR MAILING ADDRESS Use the address abbreviations from your AP Student Pack. Fill in only one circle per column. Indicate a space in your address by leaving a blank box; do not grid that column.

STREET ADDRESS (include street number, street name, apartment number, etc.)

CITY

ZIP OR POSTAL CODE

COUNTRY CODE

STATE

AK	HI	MI	NY	VT
AL	IA	MN	OH	WA
AR	ID	MO	OK	WI
AZ	IL	MS	OR	WV
CA	IN	MT	PA	WY
CO	KS	NC	RI	Puerto Rico
CT	KY	ND	SC	
DC	LA	NE	SD	AA
DE	MA	NH	TN	AE
FL	MD	NJ	TX	AP
GA	ME	NM	UT	Other
		NV	VA	

U. STUDENT SEARCH SERVICE®

Colleges and scholarship programs may request your information to inform you of educational opportunities and financial aid.

Would you like us to supply your information?

- Yes
- No

If you don't answer and previously chose to participate in this service, we will continue providing your information.

V. SEX

- Female
- Male

W. WHICH LANGUAGE DO YOU KNOW BEST?

- English
- English and another language about the same
- Another language

X. ETHNICITY/RACE

- American Indian or Alaska Native
- Asian, Asian American or Pacific Islander
- Black or African American
- Mexican or Mexican American
- Puerto Rican
- Other Hispanic, Latino or Latin American
- White
- Other

Y. PARENTAL EDUCATION LEVEL

In the first column, indicate the highest level of education of your parent/guardian. If you have two parents/guardians, indicate the level of education for your other parent/guardian in the second column. In the appropriate column for each parent/guardian, indicate whether this is your mother or female guardian or your father or male guardian.

	Grade school
	Some high school
	High school diploma or equivalent
	Vocational or trade school
	Some college
	Associate or two-year degree
	Bachelor's or four-year degree
	Some graduate or professional school
	Graduate or professional degree
Mother or female guardian	
Father or male guardian	

R. FOR STUDENTS OUTSIDE THE UNITED STATES ONLY

- If your address does not fit in the spaces provided in Item Q, fill in as many circles as you can, then fill in the circle in Item R and print the remainder of your address in the spaces provided.

Address	City	State or Province	Country	ZIP or Postal Code

S. STUDENT IDENTIFIER (Student ID Number)

T. EMAIL ADDRESS By providing your email address, you are granting the College Board permission to use your email in accordance with the policies in the *2014-15 Bulletin for AP Students and Parents*.

AP® Computer Science A Exam

SECTION I: Multiple Choice

2015

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

At a Glance

Total Time
1 hour, 15 minutes
Number of Questions
40
Percent of Total Score
50%
Writing Instrument
Pencil required
Electronic Device
None allowed

Instructions

The Java Quick Reference is located at the back of this booklet.

Section I of this exam contains 40 multiple-choice questions. Fill in only the circles for numbers 1 through 40 on your answer sheet.

Indicate all of your answers to the multiple-choice questions on the answer sheet. No credit will be given for anything written in this exam booklet, but you may use the booklet for notes or scratch work. After you have decided which of the suggested answers is best, completely fill in the corresponding circle on the answer sheet. Give only one answer to each question. If you change an answer, be sure that the previous mark is erased completely. Here is a sample question and answer.

Sample Question	Sample Answer
Chicago is a (A) state (B) city (C) country (D) continent (E) village	Ⓐ ● Ⓒ Ⓓ Ⓔ

Use your time effectively, working as quickly as you can without losing accuracy. Do not spend too much time on any one question. Go on to other questions and come back to the ones you have not answered if you have time. It is not expected that everyone will know the answers to all of the multiple-choice questions.

Your total score on the multiple-choice section is based only on the number of questions answered correctly. Points are not deducted for incorrect answers or unanswered questions.

Form O
Form Code 4LBP

COMPUTER SCIENCE A
SECTION I
Time—1 hour and 15 minutes
Number of questions—40
Percent of total score—50

Directions: Determine the answer to each of the following questions or incomplete statements, using the available space for any necessary scratch work. Then decide which is the best of the choices given and fill in the corresponding circle on the answer sheet. No credit will be given for anything written in the examination booklet. Do not spend too much time on any one problem.

Notes:
- Assume that the classes listed in the Java Quick Reference have been imported where appropriate.
- Assume that declarations of variables and methods appear within the context of an enclosing class.
- Assume that method calls that are not prefixed with an object or class name and are not shown within a complete class definition appear within the context of an enclosing class.
- Unless otherwise noted in the question, assume that parameters in method calls are not `null` and that methods are called only when their preconditions are satisfied.

1. Consider the following incomplete method, which is intended to return the number of integers that evenly divide the integer `inputVal`. Assume that `inputVal` is greater than 0.

```
public static int numDivisors(int inputVal)
{
  int count = 0;
  for (int k = 1; k <= inputVal; k++)
  {
    if ( /* condition */ )
    {
      count++;
    }
  }
  return count;
}
```

Which of the following can be used to replace `/* condition */` so that `numDivisors` will work as intended?

(A) `inputVal % k == 0`

(B) `k % inputVal == 0`

(C) `inputVal % k != 0`

(D) `inputVal / k == 0`

(E) `k / inputVal > 0`

GO ON TO THE NEXT PAGE.

2. Consider the following code segment.

```
for (int r = 3; r > 0; r--)
{
  int c;

  for (c = 1; c < r; c++)
  {
    System.out.print("-");
  }
  for (c = r ; c <= 3; c++)
  {
    System.out.print("*");
  }

  System.out.println();
}
```

What is printed as a result of executing the code segment?

(A)
```
--*
-**
***
```

(B)
```
*--
**-
***
```

(C)
```
***
-**
--*
```

(D)
```
***
**-
*--
```

(E)
```
--*
***
--*
```

3. Consider the following two classes.

```
public class A
{
  public void show()
  {
    System.out.print("A");
  }
}


public class B extends A
{
  public void show()
  {
    System.out.print("B");
  }
}
```

What is printed as a result of executing the following code segment?

```
A obj = new B();
obj.show();
```

(A) `A`

(B) `B`

(C) `AB`

(D) `BA`

(E) The code results in a runtime error.

4. Consider the following instance variable and method.

```
private int[] arr;

/** Precondition: arr.length > 0
 *  @return the largest value in array arr
 */
public int findMax()
{
  int maxVal = 0;

  for (int val : arr)
  {
    if (val > maxVal)
    {
      maxVal = val;
    }
  }

  return maxVal;
}
```

Method `findMax` is intended to return the largest value in the array `arr`. Which of the following best describes the conditions under which the method `findMax` will not work as intended?

(A) The largest value in `arr` occurs only once and is in `arr[0]`.

(B) The largest value in `arr` occurs only once and is in `arr[arr.length - 1]`.

(C) The largest value in `arr` is negative.

(D) The largest value in `arr` is zero.

(E) The largest value in `arr` occurs more than once.

5. Assume that `x` and `y` are `boolean` variables and have been properly initialized.

```
(x || y) && x
```

Which of the following always evaluates to the same value as the expression above?

(A) `x`

(B) `y`

(C) `x && y`

(D) `x || y`

(E) `x != y`

---

6. Consider the following method, which is intended to return `true` if at least one of the three strings `s1`, `s2`, or `s3` contains the substring "`art`". Otherwise, the method should return `false`.

```
public static boolean containsArt(String s1, String s2, String s3)
{

  String all = s1 + s2 + s3;

  return (all.indexOf("art") != -1);

}
```

Which of the following method calls demonstrates that the method does not work as intended?

(A) `containsArt("rattrap", "similar", "today")`

(B) `containsArt("start", "article", "Bart")`

(C) `containsArt("harm", "chortle", "crowbar")`

(D) `containsArt("matriculate", "carat", "arbitrary")`

(E) `containsArt("darkroom", "cartoon", "articulate")`

GO ON TO THE NEXT PAGE.

7. Consider the following code segment.

```
for (int outer = 1; outer <= 6; outer++)
{
  for (int inner = outer; inner <= 6; inner++)
  {
    if (inner % 2 == 0)
    {
      System.out.print(inner + "  ");
    }
  }
  System.out.println();
}
```

What will be printed as a result of executing the code segment?

(A)
```
2  4  6
4  6
6
```

(B)
```
2  4  6
2  4  6
2  4  6
```

(C)
```
2  4  6
2  4  6
4  6
4  6
6
6
```

(D)
```
2  4  6
2  4  6
2  4  6
2  4  6
2  4  6
2  4  6
```

(E)
```
2  4
2  4
4
4
```


GO ON TO THE NEXT PAGE.

8. Consider the following method.

```
public static int[] operation(int[][] matrix, int r, int c)
{
  int[] result = new int[matrix.length];

  for (int j = 0 ; j < matrix.length ; j++)
  {
    result[j] = matrix[r][j] * matrix[j][c];
  }
  return result;
}
```

The following code segment appears in another method in the same class.

```
int[][] mat = {{3, 2, 1, 4},
               {1, 2, 3, 4},
               {2, 2, 1, 2},
               {1, 1, 1, 1}};

int[] arr = operation(mat, 1, 2);
```

Which of the following represents the contents of `arr` as a result of executing the code segment?

(A) `{6, 4, 2, 4}`

(B) `{1, 6, 3, 4}`

(C) `{4, 3, 6, 1}`

(D) `{4, 4, 2, 2}`

(E) `{2, 2, 4, 4}`

9. A pair of number cubes is used in a game of chance. Each number cube has six sides, numbered from 1 to 6, inclusive, and there is an equal probability for each of the numbers to appear on the top side (indicating the cube's value) when the number cube is rolled. The following incomplete statement appears in a program that computes the sum of the values produced by rolling two number cubes.

```
int sum = /* missing code */ ;
```

Which of the following replacements for `/* missing code */` would best simulate the value produced as a result of rolling two number cubes?

(A) `2 * (int) (Math.random() * 6)`

(B) `2 * (int) (Math.random() * 7)`

(C) `(int) (Math.random() * 6) + (int) (Math.random() * 6)`

(D) `(int) (Math.random() * 13)`

(E) `2 + (int) (Math.random() * 6) + (int) (Math.random() * 6)`

10. Consider the following interface and class declarations.

```
public interface Student
{  /* implementation not shown */  }

public class Athlete
{  /* implementation not shown */  }

public class TennisPlayer extends Athlete implements Student
{  /* implementation not shown */  }
```

Assume that each class has a zero-parameter constructor. Which of the following is NOT a valid declaration?

(A) `Student a = new TennisPlayer();`

(B) `TennisPlayer b = new TennisPlayer();`

(C) `Athlete c = new TennisPlayer();`

(D) `Student d = new Athlete();`

(E) `Athlete e = new Athlete();`

11. Consider the following method.

```
public static boolean mystery(String str)
{
  String temp = "";

  for (int k = str.length(); k > 0; k--)
  {
    temp = temp + str.substring(k - 1, k);
  }

  return temp.equals(str);
}
```

Which of the following calls to `mystery` will return `true`?

(A) `mystery("no")`

(B) `mystery("on")`

(C) `mystery("nnoo")`

(D) `mystery("nono")`

(E) `mystery("noon")`

12. Assume that `x` and `y` are `boolean` variables and have been properly initialized.

```
(x && y) && !(x || y)
```

Which of the following best describes the result of evaluating the expression above?

(A) `true` always

(B) `false` always

(C) `true` only when `x` is `true` and `y` is `true`

(D) `true` only when `x` and `y` have the same value

(E) `true` only when `x` and `y` have different values

13. Consider the following instance variable and method.

```
private int[] numbers;

public void mystery(int x)
{
  for (int k = 1; k < numbers.length; k = k + x)
  {
    numbers[k] = numbers[k - 1] + x;
  }
}
```

Assume that `numbers` has been initialized with the following values.

```
{17, 34, 21, 42, 15, 69, 48, 25, 39}
```

Which of the following represents the order of the values in `numbers` as a result of the call `mystery(3)` ?

(A) `{17, 20, 21, 42, 45, 69, 48, 51, 39}`

(B) `{17, 20, 23, 26, 29, 32, 35, 38, 41}`

(C) `{17, 37, 21, 42, 18, 69, 48, 28, 39}`

(D) `{20, 23, 21, 42, 45, 69, 51, 54, 39}`

(E) `{20, 34, 21, 45, 15, 69, 51, 25, 39}`

GO ON TO THE NEXT PAGE.

14. Consider the following method, `biggest`, which is intended to return the greatest of three integers. It does not always work as intended.

```
public static int biggest(int a, int b, int c)
{
  if ((a > b) && (a > c))
  {
    return a;
  }
  else if ((b > a) && (b > c))
  {
    return b;
  }
  else
  {
    return c;
  }
}
```

Which of the following best describes the error in the method?

(A) `biggest` always returns the value of `a`.

(B) `biggest` may not work correctly when `c` has the greatest value.

(C) `biggest` may not work correctly when `a` and `b` have equal values.

(D) `biggest` may not work correctly when `a` and `c` have equal values.

(E) `biggest` may not work correctly when `b` and `c` have equal values.

15. Consider the following method.

```
public static void showMe(int arg)
{
  if (arg < 10)
  {
    showMe(arg + 1);
  }
  else
  {
    System.out.print(arg + " ");
  }
}
```

What will be printed as a result of the call `showMe(0)` ?

(A) `10`

(B) `11`

(C) `0 1 2 3 4 5 6 7 8 9`

(D) `9 8 7 6 5 4 3 2 1 0`

(E) `0 1 2 3 4 5 6 7 8 9 10`

16. Consider the following method.

```
/** Precondition: values has at least one row */
public static int calculate(int[][] values)
{
  int found = values[0][0];
  int result = 0;
  for (int[] row : values)
  {
    for (int y = 0; y < row.length; y++)
    {
      if (row[y] > found)
      {
        found = row[y];
        result = y;
      }
    }
  }
  return result;
}
```

Which of the following best describes what is returned by the `calculate` method?

(A) The largest value in the two-dimensional array

(B) The smallest value in the two-dimensional array

(C) The row index of an element with the largest value in the two-dimensional array

(D) The row index of an element with the smallest value in the two-dimensional array

(E) The column index of an element with the largest value in the two-dimensional array

17. Consider the following method.

```
//* Precondition: num > 0 */
public static int doWhat(int num)
{
  int var = 0;

  for (int loop = 1; loop <= num; loop = loop + 2)
  {
    var += loop;
  }

  return var;
}
```

Which of the following best describes the value returned from a call to `doWhat` ?

(A) `num`

(B) The sum of all integers between `1` and `num`, inclusive

(C) The sum of all even integers between `1` and `num`, inclusive

(D) The sum of all odd integers between `1` and `num`, inclusive

(E) No value is returned because of an infinite loop.

---

18. What is printed as a result of executing the following statement?

```
System.out.println(404 / 10 * 10 + 1);
```

(A) `4`

(B) 5

(C) `41`

(D) `401`

(E) `405`

19. Consider the following code segment.

```
int x = 1;
while ( /* condition */ )
{
  if (x % 2 == 0)
  {
    System.out.print(x + " ");
  }
  x = x + 2;
}
```

The following conditions have been proposed to replace `/* condition */` in the code segment.

I. `x < 0`

II. `x <= 1`

III. `x < 10`

For which of the conditions will nothing be printed?

(A) I only

(B) II only

(C) I and II only

(D) I and III only

(E) I, II, and III

20. Consider the following method.

```
/** Precondition: arr.length > 0 */
public static int mystery(int[] arr)
{
  int index = 0;
  int count = 0;
  int m = -1;

  for (int outer = 0; outer < arr.length; outer++)
  {
    count = 0;
    for (int inner = outer + 1; inner < arr.length; inner++)
    {
      if (arr[outer] == arr[inner])
      {
        count++;
      }
    }

    if (count > m)
    {
      index = outer;
      m = count;
    }
  }

  return index;
}
```

Assume that `nums` has been declared and initialized as an array of integer values. Which of the following best describes the value returned by the call `mystery(nums)` ?

(A) The maximum value that occurs in `nums`

(B) An index of the maximum value that occurs in `nums`

(C) The number of times that the maximum value occurs in `nums`

(D) A value that occurs most often in `nums`

(E) An index of a value that occurs most often in `nums`

21. Consider the following recursive method.

```
public static void whatsItDo(String str)
{
  int len = str.length();
  if (len > 1)
  {
    String temp = str.substring(0, len - 1);
    System.out.println(temp);
    whatsItDo(temp);
  }
}
```

What is printed as a result of the call `whatsItDo("WATCH")` ?

(A)
```
H
```

(B)
```
WATC
```

(C)
```
ATCH
ATC
AT
A
```

(D)
```
WATC
WAT
WA
W
```

(E)
```
WATCH
WATC
WAT
WA
```

22. Consider the following definition.

```
int[][] numbers = {{1, 2, 3},
                   {4, 5, 6}};
```

Which of the following code segments produces the output `123456` ?

(A)
```
for (int[] row : numbers)
{
  for (int n : row)
  {
    System.out.print(n);
  }
}
```

(B)
```
for (int[] row : numbers)
{
  for (int n : row)
  {
    System.out.print(row[n]);
  }
}
```

(C)
```
for (int rc = 0; rc < numbers.length; rc++)
{
  System.out.print(numbers[rc]);
}
```

(D)
```
for (int r = 0; r < numbers[0].length; r++)
{
  for (int c = 0; c < numbers.length; c++)
  {
    System.out.print(numbers[r][c]);
  }
}
```

(E)
```
for (int c = 0; c < numbers[0].length; c++)
{
  for (int r = 0; r < numbers.length; r++)
  {
    System.out.print(numbers[r][c]);
  }
}
```


GO ON TO THE NEXT PAGE.

23. Consider the following code segment from an insertion sort program.

```
for (int j = 1; j < arr.length; j++)
{
  int insertItem = arr[j];
  int k = j - 1;

  while (k >= 0 && insertItem < arr[k])
  {
    arr[k + 1] = arr[k];
    k--;
  }

  arr[k + 1] = insertItem;

  /* end of for loop */
}
```

Assume that array `arr` has been defined and initialized with the values `{5, 4, 3, 2, 1}`. What are the values in array `arr` after two passes of the `for` loop (i.e., when `j = 2` at the point indicated by `/* end of for loop */`) ?

(A) `{2, 3, 4, 5, 1}`

(B) `{3, 2, 1, 4, 5}`

(C) `{3, 4, 5, 2, 1}`

(D) `{3, 5, 2, 3, 1}`

(E) `{5, 3, 4, 2, 1}`

24. Consider the following class.

```
public class SomeMethods
{
  public void one(int first)
  {  /* implementation not shown */  }

  public void one(int first, int second)
  {  /* implementation not shown */  }

  public void one(int first, String second)
  {  /* implementation not shown */  }
}
```

Which of the following methods can be added to the `SomeMethods` class without causing a compile-time error?

I.
```
public void one(int value)
{  /* implementation not shown */  }
```

II.
```
public void one(String first, int second)
{  /* implementation not shown */  }
```

III.
```
public void one(int first, int second, int third)
{  /* implementation not shown */  }
```

(A) I only

(B) I and II only

(C) I and III only

(D) II and III only

(E) I, II, and III

25. Consider the following code segment.

```
int count = 0;

for (int x = 0; x < 4; x++)
{
  for (int y = x; y < 4; y++)
  {
    count++;
  }
}
System.out.println(count);
```

What is printed as a result of executing the code segment?

(A) 4

(B) 8

(C) 10

(D) 16

(E) 20

26. Consider the following two methods, which appear within a single class.

```
public static void changeIt(int[] arr, int val, String word)
{
  arr = new int[5];
  val = 0;
  word = word.substring(0, 5);

  for (int k = 0; k < arr.length; k++)
  {
    arr[k] = 0;
  }
}


public static void start()
{
  int[] nums = {1, 2, 3, 4, 5};
  int value = 6;
  String name = "blackboard";

  changeIt(nums, value, name);

  for (int k = 0; k < nums.length; k++)
  {
    System.out.print(nums[k] + " ");
  }

  System.out.print(value + " ");
  System.out.print(name);
}
```

What is printed as a result of the call `start()` ?

(A) `0 0 0 0 0 0 black`

(B) `0 0 0 0 0 6 blackboard`

(C) `1 2 3 4 5 6 black`

(D) `1 2 3 4 5 0 black`

(E) `1 2 3 4 5 6 blackboard`

Questions 27-28 refer to the following information.

Consider the following `sort` method. This method correctly sorts the elements of array `data` into increasing order.

```
public static void sort(int[] data)
{
  for (int j = 0; j < data.length - 1; j++)
  {
    int m = j;
    for (int k = j + 1; k < data.length; k++)
    {
      if (data[k] < data[m])     /* Compare values */
      {
        m = k;
      }
    }
    int temp = data[m];          /* Assign to temp */
    data[m] = data[j];
    data[j] = temp;

    /* End of outer loop */
  }
}
```

27. Assume that `sort` is called with the array `{6, 3, 2, 5, 4, 1}`. What will the value of `data` be after three passes of the outer loop (i.e., when `j = 2` at the point indicated by `/* End of outer loop */`) ?

(A) `{1, 2, 3, 4, 5, 6}`

(B) `{1, 2, 3, 5, 4, 6}`

(C) `{1, 2, 3, 6, 5, 4}`

(D) `{1, 3, 2, 4, 5, 6}`

(E) `{1, 3, 2, 5, 4, 6}`

---

28. Assume that `sort` is called with the array `{1, 2, 3, 4, 5, 6}`. How many times will the expression indicated by `/* Compare values */` and the statement indicated by `/* Assign to temp */` execute?

	Compare values	*Assign to temp*
(A)	15	0
(B)	15	5
(C)	15	6
(D)	21	5
(E)	21	6

29. Consider the following recursive method.

```
/** Precondition: num ≥ 0 */
public static int what(int num)
{
  if (num < 10)
  {
    return 1;
  }
  else
  {
    return 1 + what(num / 10);
  }
}
```

Assume that `int val` has been declared and initialized with a value that satisfies the precondition of the method. Which of the following best describes the value returned by the call `what(val)` ?

(A) The number of digits in the decimal representation of `val` is returned.

(B) The sum of the digits in the decimal representation of `val` is returned.

(C) Nothing is returned. A run-time error occurs because of infinite recursion.

(D) The value 1 is returned.

(E) The value `val/10` is returned.

30. The price per box of ink pens advertised in an office supply catalog is based on the number of boxes ordered. The following table shows the pricing.

Number of Boxes	Price per Box
1 up to but not including 5	$5.00
5 up to but not including 10	$3.00
10 or more	$1.50

The following incomplete method is intended to return the total cost of an order based on the value of the parameter `numBoxes`.

```
/** Precondition: numBoxes > 0 */
public static double getCost(int numBoxes)
{
  double totalCost = 0.0;

  /* missing code */

  return totalCost;
}
```


GO ON TO THE NEXT PAGE.

Which of the following code segments can be used to replace `/* missing code */` so that method `getCost` will work as intended?

I.
```
if (numBoxes >= 10)
{
  totalCost = numBoxes * 1.50;
}
if (numBoxes >= 5)
{
  totalCost = numBoxes * 3.00;
}
if (numBoxes > 0)
{
  totalCost = numBoxes * 5.00;
}
```

II.
```
if (numBoxes >= 10)
{
  totalCost = numBoxes * 1.50;
}
else if (numBoxes >= 5)
{
  totalCost = numBoxes * 3.00;
}
else
{
  totalCost = numBoxes * 5.00;
}
```

III.
```
if (numBoxes > 0)
{
  totalCost = numBoxes * 5.00;
}
else if (numBoxes >= 5)
{
  totalCost = numBoxes * 3.00;
}
else if (numBoxes >= 10)
{
  totalCost = numBoxes * 1.50;
}
```

(A) I only

(B) II only

(C) III only

(D) I and II

(E) II and III

31. Consider the following code segment.

```
String[][] board = new String[5][5];

for (int row = 0; row < 5; row++)
{
  for (int col = 0; col < 5; col++)
  {
    board[row][col] = "O";
  }
}

for (int val = 0; val < 5; val++)
{
  if (val % 2 == 1)
  {
    int row = val;
    int col = 0;
    while (col < 5 && row >= 0)
    {
      board[row][col] = "X";
      col++;
      row--;
    }
  }
}
```

Which of the following represents `board` after this code segment is executed?

(A)

	0	1	2	3	4
0	X	O	X	O	X
1	O	X	O	X	O
2	X	O	X	O	X
3	O	X	O	X	O
4	X	O	X	O	X

(B)

	0	1	2	3	4
0	O	X	O	X	O
1	X	O	X	O	X
2	O	X	O	X	O
3	X	O	X	O	X
4	O	X	O	X	O

(C)

	0	1	2	3	4
0	X	O	O	O	X
1	O	X	O	X	O
2	O	O	X	O	O
3	O	X	O	X	O
4	X	O	O	O	X

(D)

	0	1	2	3	4
0	O	X	O	O	O
1	O	O	X	O	O
2	X	O	O	X	O
3	O	X	O	O	X
4	O	O	X	O	O

(E)

	0	1	2	3	4
0	O	X	O	X	O
1	X	O	X	O	O
2	O	X	O	O	O
3	X	O	O	O	O
4	O	O	O	O	O

GO ON TO THE NEXT PAGE.

32. Consider the following class declaration.

```
public class StudentInfo
{
  private String major;
  private int age;

  public String getMajor()
  {  return major;  }

  public int getAge()
  {  return age;  }

  // There may be instance variables, constructors, and methods that are not shown.
}
```

The following instance variable and method appear in another class.

```
private List<StudentInfo> students;

/** @return the average age of students with the given major;
 *          -1.0 if no such students exist
 */
public double averageAgeInMajor(String theMajor)
{
  double sum = 0.0;
  int count = 0;
  for (StudentInfo k : students)
  {
    /* missing code */
  }

  if (count > 0)
  {
    return sum / count;
  }
  else
  {
    return -1.0;
  }
}
```

Which of the following could be used to replace `/* missing code */` so that `averageAgeInMajor` will compile without error?

(A)
```
if (theMajor.equals(k.major))
{
  sum += k.age;
  count++;
}
```

(B)
```
if (theMajor.equals(k.getMajor()))
{
  sum += k.getAge();
  count++;
}
```

(C)
```
if (theMajor.equals(k.major))
{
  sum += k.getAge();
  count++;
}
```

(D)
```
if (theMajor.equals(students[k].getMajor()))
{
  sum += students[k].getAge();
  count++;
}
```

(E)
```
if (theMajor.equals(getMajor(k)))
{
  sum += getAge(k);
  count++;
}
```

---

33. Which of the following statements regarding interfaces is FALSE?

(A) All methods in an interface are public.

(B) An interface cannot be instantiated.

(C) An interface can declare an instance variable.

(D) A non-abstract class can implement an interface.

(E) An abstract class can implement an interface.

34. Consider the problem of finding the maximum value in an array of integers. The following code segments are proposed solutions to the problem. Assume that the variable `arr` has been defined as an array of `int` values and has been initialized with one or more values.

I.
```
int max = Integer.MIN_VALUE;
for (int value : arr)
{
  if (max < value)
  {
    max = value;
  }
}
```

II.
```
int max = 0;
boolean first = true;
for (int value : arr)
{
  if (first)
  {
    max = value;
    first = false;
  }
  else if (max < value)
  {
    max = value;
  }
}
```

III.
```
int max = arr[0];
for (int k = 1; k < arr.length; k++)
{
  if (max < arr[k])
  {
    max = arr[k];
  }
}
```

Which of the code segments will always correctly assign the maximum element of the array to the variable `max` ?

(A) I only

(B) II only

(C) III only

(D) II and III only

(E) I, II, and III

35. Consider the following instance variable and method. Method `wordsWithCommas` is intended to return a string containing all the words in `listOfWords` separated by commas and enclosed in braces.
For example, if `listOfWords` contains `["one", "two", "three"]`, the string returned by the call `wordsWithCommas()` should be `"{one, two, three}"`.

```
private List<String> listOfWords;

public String wordsWithCommas()
{
  String result = "{";

  int sizeOfList = /* expression */ ;

  for (int k = 0; k < sizeOfList; k++)
  {
    result = result + listOfWords.get(k);

    if ( /* condition */ )
    {
      result = result + ", ";
    }
  }

  result = result + "}";
  return result;
}
```

Which of the following can be used to replace `/* expression */` and `/* condition */` so that `wordsWithCommas` will work as intended?

	`/* expression */`	*`/* condition */`*
(A)	`listOfWords.size() - 1`	`k != 0`
(B)	`listOfWords.size()`	`k != 0`
(C)	`listOfWords.size() - 1`	`k != sizeOfList - 1`
(D)	`listOfWords.size()`	`k != sizeOfList - 1`
(E)	`result.length()`	`k != 0`

Questions 36-37 refer to the following information.

Consider the following `binarySearch` method. The method correctly performs a binary search.

```
/** Precondition: data is sorted in increasing order. */
public static int binarySearch(int[] data, int target)
{
  int start = 0;
  int end = data.length - 1;
  while (start <= end)
  {
    int mid = (start + end) / 2;      /* Calculate midpoint */
    if (target < data[mid])
    {
      end = mid - 1;
    }
    else if (target > data[mid])
    {
      start = mid + 1;
    }
    else
    {
      return mid;
    }
  }
  return -1;
}
```

36. Consider the following code segment.

```
int[] values = {1, 2, 3, 4, 5, 8, 8, 8};
int target = 8;
```

What value is returned by the call `binarySearch(values, target)` ?

(A) -1

(B) 3

(C) 5

(D) 6

(E) 8

---

37. Suppose the `binarySearch` method is called with an array containing 2,000 elements sorted in increasing order. What is the maximum number of times that the statement indicated by `/*` *Calculate midpoint* `*/` could execute?

(A) 2,000

(B) 1,000

(C) 20

(D) 11

(E) 1

38. Consider the following incomplete method that is intended to return a string formed by concatenating elements from the parameter `words`. The elements to be concatenated start with `startIndex` and continue through the last element of `words` and should appear in reverse order in the resulting string.

```
/** Precondition: words.length > 0;
 *                startIndex >= 0
 */
public static String concatWords(String[] words, int startIndex)
{
  String result = "";

  /* missing code */

  return result;
}
```

For example, the following code segment uses a call to the `concatWords` method.

```
String[] things = {"Bear", "Apple", "Gorilla", "House", "Car"};
System.out.println(concatWords(things, 2));
```

When the code segment is executed, the string `"CarHouseGorilla"` is printed.

The following three code segments have been proposed as replacements for `/* missing code */`.

I.
```
for (int k = startIndex; k < words.length; k++)
{
  result += words[k] + words[words.length - k - 1];
}
```

II.
```
int k = words.length - 1;
while (k >= startIndex)
{
  result += words[k];
  k--;
}
```

III.
```
String[] temp = new String[words.length];
for (int k = 0; k <= words.length / 2; k++)
{
  temp[k] = words[words.length - k - 1];
  temp[words.length - k - 1] = words[k];
}

for (int k = 0; k < temp.length - startIndex; k++)
{
  result += temp[k];
}
```

Which of these code segments can be used to replace `/* missing code */` so that `concatWords` will work as intended?

(A) I only

(B) II only

(C) III only

(D) I and II

(E) II and III

39. Consider the following method.

```
/** Precondition: 0 < numVals <= nums.length */
public static int mystery(int[] nums, int v, int numVals)
{
  int k = 0;

  if (v == nums[numVals - 1])
  {
    k = 1;
  }

  if (numVals == 1)
  {
    return k;
  }
  else
  {
    return k + mystery(nums, v, numVals - 1);
  }
}
```

Which of the following best describes what the call `mystery(numbers, val, numbers.length)` does? You may assume that variables `numbers` and `val` have been declared and initialized.

(A) Returns 1 if the last element in `numbers` is equal to `val`; otherwise, returns 0

(B) Returns the index of the last element in `numbers` that is equal to `val`

(C) Returns the number of elements in `numbers` that are equal to `val`

(D) Returns the number of elements in `numbers` that are not equal to `val`

(E) Returns the maximum number of adjacent elements that are not equal to `val`

40. Consider the following code segment.

```
List<String> students = new ArrayList<String>();

students.add("Alex");
students.add("Bob");
students.add("Carl");

for (int k = 0; k < students.size(); k++)
{
  System.out.print(students.set(k, "Alex") + "   ");
}

System.out.println();

for (String str : students)
{
  System.out.print(str + "   ");
}
```

What is printed as a result of executing the code segment?

(A)
```
Alex  Alex  Alex
Alex  Alex  Alex
```

(B)
```
Alex  Alex  Alex
Alex  Bob  Carl
```

(C)
```
Alex  Bob  Carl
Alex  Alex  Alex
```

(D)
```
Alex  Bob  Carl
Alex  Bob  Carl
```

(E) Nothing is printed because the first print statement will cause a runtime exception to be thrown.

END OF SECTION I

IF YOU FINISH BEFORE TIME IS CALLED,
YOU MAY CHECK YOUR WORK ON THIS SECTION.

DO NOT GO ON TO SECTION II UNTIL YOU ARE TOLD TO DO SO.

MAKE SURE YOU HAVE DONE THE FOLLOWING.

- **PLACED YOUR AP NUMBER LABEL ON YOUR ANSWER SHEET**
- **WRITTEN AND GRIDDED YOUR AP NUMBER CORRECTLY ON YOUR ANSWER SHEET**
- **TAKEN THE AP EXAM LABEL FROM THE FRONT OF THIS BOOKLET AND PLACED IT ON YOUR ANSWER SHEET**

Java Quick Reference

Accessible Methods from the Java Library That May Be Included on the Exam

class java.lang.Object

- `boolean equals(Object other)`
- `String toString()`

class java.lang.Integer

- `Integer(int value)`
- `int intValue()`
- `Integer.MIN_VALUE` // minimum value represented by an `int` or `Integer`
- `Integer.MAX_VALUE` // maximum value represented by an `int` or `Integer`

class java.lang.Double

- `Double(double value)`
- `double doubleValue()`

class java.lang.String

- `int length()`
- `String substring(int from, int to)` // returns the substring beginning at `from`
  // and ending at `to-1`
- `String substring(int from)` // returns `substring(from, length())`
- `int indexOf(String str)` // returns the index of the first occurrence of `str`;
  // returns `-1` if not found
- `int compareTo(String other)` // returns a value < 0 if `this` is less than `other`
  // returns a value = 0 if `this` is equal to `other`
  // returns a value > 0 if `this` is greater than `other`

class java.lang.Math

- `static int abs(int x)`
- `static double abs(double x)`
- `static double pow(double base, double exponent)`
- `static double sqrt(double x)`
- `static double random()` // returns a `double` in the range [0.0, 1.0)

interface java.util.List<E>

- `int size()`
- `boolean add(E obj)` // appends `obj` to end of list; returns `true`
- `void add(int index, E obj)` // inserts `obj` at position `index` (0 ≤ `index` ≤ size),
  // moving elements at position `index` and higher
  // to the right (adds 1 to their indices) and adjusts size
- `E get(int index)`
- `E set(int index, E obj)` // replaces the element at position `index` with `obj`
  // returns the element formerly at the specified position
- `E remove(int index)` // removes element from position `index`, moving elements
  // at position `index + 1` and higher to the left
  // (subtracts 1 from their indices) and adjusts size
  // returns the element formerly at the specified position

class java.util.ArrayList<E> implements java.util.List<E>

AP® Computer Science A Exam

SECTION II: Free Response

2015

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

At a Glance

Total Time
1 hour, 45 minutes
Number of Questions
4
Percent of Total Score
50%
Writing Instrument
Pencil
Electronic Device
None allowed
Weight
The questions are weighted equally.

IMPORTANT Identification Information

PLEASE PRINT WITH PEN:

1. First two letters of your last name ☐☐
   First letter of your first name ☐
2. Date of birth
   ☐☐ ☐☐ ☐☐☐☐
   Month Day Year
3. Six-digit school code
   ☐☐☐☐☐☐
4. Unless I check the box below, I grant the College Board the unlimited right to use, reproduce, and publish my free-response materials, both written and oral, for educational research and instructional purposes. My name and the name of my school will not be used in any way in connection with my free-response materials. I understand that I am free to mark "No" with no effect on my score or its reporting.
   No, I do not grant the College Board these rights. ☐

Instructions

The questions for Section II are printed in this booklet. You may use any of the blank pages to organize your answers and for scratch work, but you must write your answers on the pages that correspond with the questions.

The Java Quick Reference is located at the back of this booklet.

Write your answer to each question in the space provided for the question in this booklet. Some questions require you to write program segments, and these must be written in Java. Show all your work. Credit for partial solutions will be given. Write clearly and legibly. Cross out any errors you make. Erased or crossed-out work will not be scored.

Manage your time carefully. Do not spend too much time on any one question. You may proceed freely from one question to the next. You may review your responses if you finish before the end of the exam is announced.

Form O
Form Code 4LBP

COMPUTER SCIENCE A
SECTION II
Time—1 hour and 45 minutes
Number of questions—4
Percent of total score—50

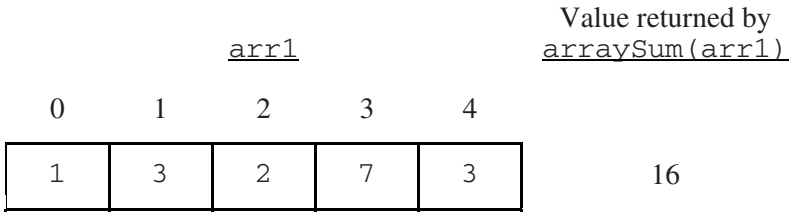
Directions: SHOW ALL YOUR WORK. REMEMBER THAT PROGRAM SEGMENTS ARE TO BE WRITTEN IN JAVA.

Notes:

- Assume that the classes listed in the Java Quick Reference have been imported where appropriate.
- Unless otherwise noted in the question, assume that parameters in method calls are not `null` and that methods are called only when their preconditions are satisfied.
- In writing solutions for each question, you may use any of the accessible methods that are listed in classes defined in that question. Writing significant amounts of code that can be replaced by a call to one of these methods will not receive full credit.

1. This question involves reasoning about one-dimensional and two-dimensional arrays of integers. You will write three static methods, all of which are in a single enclosing class, named `DiverseArray` (not shown). The first method returns the sum of the values of a one-dimensional array; the second method returns an array that represents the sums of the rows of a two-dimensional array; and the third method analyzes row sums.

   (a) Write a `static` method `arraySum` that calculates and returns the sum of the entries in a specified one-dimensional array. The following example shows an array `arr1` and the value returned by a call to `arraySum`.



WRITE YOUR SOLUTION ON THE NEXT PAGE.

Complete method `arraySum` below.

```
/** Returns the sum of the entries in the one-dimensional array arr.
 */
public static int arraySum(int[] arr)
```

Part (b) begins on page 6.

(b) Write a `static` method `rowSums` that calculates the sums of each of the rows in a given two-dimensional array and returns these sums in a one-dimensional array. The method has one parameter, a two-dimensional array `arr2D` of `int` values. The array is in row-major order: `arr2D[r][c]` is the entry at row `r` and column `c`. The method returns a one-dimensional array with one entry for each row of `arr2D` such that each entry is the sum of the corresponding row in `arr2D`. As a reminder, each row of a two-dimensional array is a one-dimensional array.

For example, if `mat1` is the array represented by the following table, the call `rowSums(mat1)` returns the array `{16, 32, 28, 20}`.

`mat1`

	0	1	2	3	4
0	1	3	2	7	3
1	10	10	4	6	2
2	5	3	5	9	6
3	7	6	4	2	1

Methods written in this question

```
public static int arraySum(int[] arr)
public static int[] rowSums(int[][] arr2D)
public static boolean isDiverse(int[][] arr2D)
```

WRITE YOUR SOLUTION ON THE NEXT PAGE.

Assume that `arraySum` works as specified, regardless of what you wrote in part (a). You must use `arraySum` appropriately to receive full credit.

Complete method `rowSums` below.

```
/** Returns a one-dimensional array in which the entry at index k is the sum of
 *  the entries of row k of the two-dimensional array arr2D.
 */
public static int[] rowSums(int[][] arr2D)
```

Part (c) begins on page 8.

(c) A two-dimensional array is *diverse* if no two of its rows have entries that sum to the same value. In the following examples, the array `mat1` is diverse because each row sum is different, but the array `mat2` is not diverse because the first and last rows have the same sum.

`mat1`

	0	1	2	3	4	Row sums
0	1	3	2	7	3	16
1	10	10	4	6	2	32
2	5	3	5	9	6	28
3	7	6	4	2	1	20

`mat2`

	0	1	2	3	4	Row sums
0	1	1	5	3	4	14
1	12	7	6	1	9	35
2	8	11	10	2	5	36
3	3	2	3	0	6	14

Write a `static` method `isDiverse` that determines whether or not a given two-dimensional array is diverse. The method has one parameter: a two-dimensional array `arr2D` of `int` values. The method should return `true` if all the row sums in the given array are unique; otherwise, it should return `false`. In the arrays shown above, the call `isDiverse(mat1)` returns `true` and the call `isDiverse(mat2)` returns `false`.

Methods written in this question

```
public static int arraySum(int[] arr)
public static int[] rowSums(int[][] arr2D)
public static boolean isDiverse(int[][] arr2D)
```

WRITE YOUR SOLUTION ON THE NEXT PAGE.

Assume that `arraySum` and `rowSums` work as specified, regardless of what you wrote in parts (a) and (b). You must use `rowSums` appropriately to receive full credit.

Complete method `isDiverse` below.

```
/** Returns true  if all rows in arr2D have different row sums;
 *         false otherwise.
 */
public static boolean isDiverse(int[][] arr2D)
```

2. Consider a guessing game in which a player tries to guess a hidden word. The hidden word contains only capital letters and has a length known to the player. A guess contains only capital letters and has the same length as the hidden word.

   After a guess is made, the player is given a hint that is based on a comparison between the hidden word and the guess. Each position in the hint contains a character that corresponds to the letter in the same position in the guess. The following rules determine the characters that appear in the hint.

If the letter in the guess is …	**the corresponding character in the hint is**
also in the same position in the hidden word,	the matching letter
also in the hidden word, but in a different position,	`"+"`
not in the hidden word,	`"*"`

   The `HiddenWord` class will be used to represent the hidden word in the game. The hidden word is passed to the constructor. The class contains a method, `getHint`, that takes a guess and produces a hint.

   For example, suppose the variable `puzzle` is declared as follows.

```
HiddenWord puzzle = new HiddenWord("HARPS");
```

   The following table shows several guesses and the hints that would be produced.

Call to `getHint`	**String returned**
`puzzle.getHint("AAAAA")`	`"+A+++"`
`puzzle.getHint("HELLO")`	`"H****"`
`puzzle.getHint("HEART")`	`"H*++*"`
`puzzle.getHint("HARMS")`	`"HAR*S"`
`puzzle.getHint("HARPS")`	`"HARPS"`

   Write the complete `HiddenWord` class, including any necessary instance variables, its constructor, and the method, `getHint`, described above. You may assume that the length of the guess is the same as the length of the hidden word.

ADDITIONAL WORK SPACE

GO ON TO THE NEXT PAGE.

3. A two-dimensional array of integers in which most elements are zero is called a *sparse array*. Because most elements have a value of zero, memory can be saved by storing only the non-zero values along with their row and column indexes. The following complete `SparseArrayEntry` class is used to represent non-zero elements in a sparse array. A `SparseArrayEntry` object cannot be modified after it has been constructed.

```
public class SparseArrayEntry
{
  /** The row index and column index for this entry in the sparse array */
  private int row;
  private int col;

  /** The value of this entry in the sparse array */
  private int value;

  /** Constructs a SparseArrayEntry object that represents a sparse array element
   *  with row index r and column index c, containing value v.
   */
  public SparseArrayEntry(int r, int c, int v)
  {
    row = r;
    col = c;
    value = v;
  }

  /** Returns the row index of this sparse array element. */
  public int getRow()
  {  return row;  }

  /** Returns the column index of this sparse array element. */
  public int getCol()
  {  return col;  }

  /** Returns the value of this sparse array element. */
  public int getValue()
  {  return value;  }
}
```

The `SparseArray` class represents a sparse array. It contains a list of `SparseArrayEntry` objects, each of which represents one of the non-zero elements in the array. The entries representing the non-zero elements are stored in the list in no particular order. Each non-zero element is represented by exactly one entry in the list.

```
public class SparseArray
{
  /** The number of rows and columns in the sparse array. */
  private int numRows;
  private int numCols;

  /** The list of entries representing the non-zero elements of the sparse array. Entries are stored in the
   *  list in no particular order. Each non-zero element is represented by exactly one entry in the list.
   */
  private List<SparseArrayEntry> entries;

  /** Constructs an empty SparseArray. */
  public SparseArray()
  {  entries = new ArrayList<SparseArrayEntry>();  }

  /** Returns the number of rows in the sparse array. */
  public int getNumRows()
  {  return numRows;  }

  /** Returns the number of columns in the sparse array. */
  public int getNumCols()
  {  return numCols;  }

  /** Returns the value of the element at row index row and column index col in the sparse array.
   *  Precondition: 0 ≤ row < getNumRows()
   *                0 ≤ col < getNumCols()
   */
  public int getValueAt(int row, int col)
  {  /* to be implemented in part (a) */  }

  /** Removes the column col from the sparse array.
   *  Precondition: 0 ≤ col < getNumCols()
   */
  public void removeColumn(int col)
  {  /* to be implemented in part (b) */  }

  // There may be instance variables, constructors, and methods that are not shown.
}
```

The following table shows an example of a two-dimensional sparse array. Empty cells in the table indicate zero values.

	0	1	2	3	4
0					
1		5			4
2	1				
3		-9			
4					
5					

The sample array can be represented by a `SparseArray` object, `sparse`, with the following instance variable values. The items in `entries` are in no particular order; one possible ordering is shown below.

```
numRows: 6

numCols: 5

entries: [ row: 1 col: 4 value: 4 ] [ row: 2 col: 0 value: 1 ] [ row: 3 col: 1 value: -9 ] [ row: 1 col: 1 value: 5 ]
```

(a) Write the `SparseArray` method `getValueAt`. The method returns the value of the sparse array element at a given row and column in the sparse array. If the list `entries` contains an entry with the specified row and column, the value associated with the entry is returned. If there is no entry in `entries` corresponding to the specified row and column, 0 is returned.

In the example above, the call `sparse.getValueAt(3, 1)` would return -9, and `sparse.getValueAt(3, 3)` would return 0.

WRITE YOUR SOLUTION ON THE NEXT PAGE.

Complete method `getValueAt` below.

```
/** Returns the value of the element at row index row and column index col in the sparse array.
 *  Precondition: 0 ≤ row < getNumRows()
 *                0 ≤ col < getNumCols()
 */
public int getValueAt(int row, int col)
```

Part (b) begins on page 16.

(b) Write the `SparseArray` method `removeColumn`. After removing a specified column from a sparse array:

- All entries in the list `entries` with column indexes matching `col` are removed from the list.
- All entries in the list `entries` with column indexes greater than `col` are replaced by entries with column indexes that are decremented by one (moved one column to the left).
- The number of columns in the sparse array is adjusted to reflect the column removed.

The sample object `sparse` from the beginning of the question is repeated for your convenience.

	0	1	2	3	4
0					
1		5			4
2	1				
3		-9			
4					
5					

The shaded entries in `entries`, below, correspond to the shaded column above.

```
numRows: 6

numCols: 5

entries: [ row: 1 col: 4 value: 4 ] [ row: 2 col: 0 value: 1 ] [ row: 3 col: 1 value: -9 ] [ row: 1 col: 1 value: 5 ]
```

When `sparse` has the state shown above, the call `sparse.removeColumn(1)` could result in `sparse` having the following values in its instance variables (since `entries` is in no particular order, it would be equally valid to reverse the order of its two items). The shaded areas below show the changes.

```
numRows: 6

numCols: 4

entries: [ row: 1 col: 3 value: 4 ] [ row: 2 col: 0 value: 1 ]
```

GO ON TO THE NEXT PAGE.

Class information repeated from the beginning of the question

```
public class SparseArrayEntry

public SparseArrayEntry(int r, int c, int v)
public int getRow()
public int getCol()
public int getValue()

public class SparseArray

private int numRows
private int numCols
private List<SparseArrayEntry> entries
public int getNumRows()
public int getNumCols()
public int getValueAt(int row, int col)
public void removeColumn(int col)
```

Complete method `removeColumn` below.

```
/** Removes the column col from the sparse array.
 *  Precondition: 0 ≤ col < getNumCols()
 */
public void removeColumn(int col)
```


GO ON TO THE NEXT PAGE.

ADDITIONAL WORK SPACE

GO ON TO THE NEXT PAGE.

4. This question involves the design of an interface, writing a class that implements the interface, and writing a method that uses the interface.

   (a) A *number group* represents a group of integers defined in some way. It could be empty, or it could contain one or more integers.

   Write an interface named `NumberGroup` that represents a group of integers. The interface should have a single `contains` method that determines if a given integer is in the group. For example, if `group1` is of type `NumberGroup`, and it contains only the two numbers `-5` and `3`, then `group1.contains(-5)` would return `true`, and `group1.contains(2)` would return `false`.

   Write the complete `NumberGroup` interface. It must have exactly one method.

Part (b) begins on page 21.

(b) A *range* represents a number group that contains all (and only) the integers between a minimum value and a maximum value, inclusive.

Write the `Range` class, which is a `NumberGroup`. The `Range` class represents the group of `int` values that range from a given minimum value up through a given maximum value, inclusive. For example, the declaration

```
NumberGroup range1 = new Range(-3, 2);
```

represents the group of integer values -3, -2, -1, 0, 1, 2.

Write the complete `Range` class. Include all necessary instance variables and methods as well as a constructor that takes two `int` parameters. The first parameter represents the minimum value, and the second parameter represents the maximum value of the range. You may assume that the minimum is less than or equal to the maximum.

Part (c) begins on page 22.

(c) The `MultipleGroups` class (not shown) represents a collection of `NumberGroup` objects and is a `NumberGroup`. The `MultipleGroups` class stores the number groups in the instance variable `groupList` (shown below), which is initialized in the constructor.

```
private List<NumberGroup> groupList;
```

Write the `MultipleGroups` method `contains`. The method takes an integer and returns `true` if and only if the integer is contained in one or more of the number groups in `groupList`.

For example, suppose `multiple1` has been declared as an instance of `MultipleGroups` and consists of the three ranges created by the calls `new Range(5, 8)`, `new Range(10, 12)`, and `new Range(1, 6)`. The following table shows the results of several calls to `contains`.

Call	Result
`multiple1.contains(2)`	`true`
`multiple1.contains(9)`	`false`
`multiple1.contains(6)`	`true`

Complete method `contains` below.

```
/** Returns true if at least one of the number groups in this multiple group contains num;
 *          false otherwise.
 */
public boolean contains(int num)
```

ADDITIONAL WORK SPACE

GO ON TO THE NEXT PAGE.

STOP

END OF EXAM

THE FOLLOWING INSTRUCTIONS APPLY TO THE COVERS OF THE SECTION II BOOKLET.

- **MAKE SURE YOU HAVE COMPLETED THE IDENTIFICATION INFORMATION AS REQUESTED ON THE FRONT AND BACK COVERS OF THE SECTION II BOOKLET.**
- **CHECK TO SEE THAT YOUR AP NUMBER LABEL APPEARS IN THE BOX ON THE COVER.**
- **MAKE SURE YOU HAVE USED THE SAME SET OF AP NUMBER LABELS ON ALL AP EXAMS YOU HAVE TAKEN THIS YEAR.**

Java Quick Reference

Accessible Methods from the Java Library That May Be Included on the Exam

class java.lang.Object

- `boolean equals(Object other)`
- `String toString()`

class java.lang.Integer

- `Integer(int value)`
- `int intValue()`
- `Integer.MIN_VALUE` // minimum value represented by an `int` or `Integer`
- `Integer.MAX_VALUE` // maximum value represented by an `int` or `Integer`

class java.lang.Double

- `Double(double value)`
- `double doubleValue()`

class java.lang.String

- `int length()`
- `String substring(int from, int to)` // returns the substring beginning at `from`
  // and ending at `to-1`
- `String substring(int from)` // returns `substring(from, length())`
- `int indexOf(String str)` // returns the index of the first occurrence of `str`;
  // returns `-1` if not found
- `int compareTo(String other)` // returns a value < 0 if `this` is less than `other`
  // returns a value = 0 if `this` is equal to `other`
  // returns a value > 0 if `this` is greater than `other`

class java.lang.Math

- `static int abs(int x)`
- `static double abs(double x)`
- `static double pow(double base, double exponent)`
- `static double sqrt(double x)`
- `static double random()` // returns a `double` in the range [0.0, 1.0)

interface java.util.List<E>

- `int size()`
- `boolean add(E obj)` // appends `obj` to end of list; returns `true`
- `void add(int index, E obj)` // inserts `obj` at position `index` (0 ≤ `index` ≤ size),
  // moving elements at position `index` and higher
  // to the right (adds 1 to their indices) and adjusts size
- `E get(int index)`
- `E set(int index, E obj)` // replaces the element at position `index` with `obj`
  // returns the element formerly at the specified position
- `E remove(int index)` // removes element from position `index`, moving elements
  // at position `index + 1` and higher to the left
  // (subtracts 1 from their indices) and adjusts size
  // returns the element formerly at the specified position

class java.util.ArrayList<E> implements java.util.List<E>

Answer Key for AP Computer Science A Released Exam, Section I

Question 1: A
Question 2: A
Question 3: B
Question 4: C
Question 5: A
Question 6: A
Question 7: C
Question 8: B
Question 9: E
Question 10: D
Question 11: E
Question 12: B
Question 13: A
Question 14: C
Question 15: A
Question 16: E
Question 17: D
Question 18: D
Question 19: E
Question 20: E
Question 21: D
Question 22: A
Question 23: C
Question 24: D
Question 25: C
Question 26: E
Question 27: B
Question 28: B
Question 29: A
Question 30: B
Question 31: E
Question 32: B
Question 33: C
Question 34: E
Question 35: D
Question 36: C
Question 37: D
Question 38: E
Question 39: C
Question 40: C

AP® COMPUTER SCIENCE A
2015 GENERAL SCORING GUIDELINES

Apply the question assessment rubric first, which always takes precedence. Penalty points can only be deducted in a part of the question that has earned credit via the question rubric. No part of a question (a, b, c) may have a negative point total. A given penalty can be assessed only once for a question, even if it occurs multiple times, or in multiple parts of that question. A maximum of 3 penalty points may be assessed per question.

1-Point Penalty

(v) Array/collection access confusion (`[] get`)

(w) Extraneous code that causes side effect (*e.g., writing to output, failure to compile*)

(x) Local variables used but none declared

(y) Destruction of persistent data (*e.g., changing value referenced by parameter*)

(z) Void method or constructor that returns a value

No Penalty

- Extraneous code with no side effect (*e.g., precondition check, no-op*)
- Spelling/case discrepancies where there is no ambiguity*
- Local variable not declared provided other variables are declared in some part
- `private` or `public` qualifier on a local variable
- Missing `public` qualifier on class or constructor header
- Keyword used as an identifier
- Common mathematical symbols used for operators (× • ÷ ≤ ≥ <> ≠)
- `[]` vs. `()` vs. `<>`
- `=` instead of `==` and vice versa
- `length/size` confusion for array, `String`, `List`, or `ArrayList`, with or without `( )`
- Extraneous `[]` when referencing entire array
- `[i,j]` instead of `[i][j]`
- Extraneous size in array declaration (*e.g.,* `int[size] nums = new int[size];`)
- Missing `;` where structure clearly conveys intent
- Missing `{ }` where indentation clearly conveys intent
- Missing `( )` on parameter-less method or constructor invocations
- Missing `( )` around `if` or `while` conditions

Spelling and case discrepancies for identifiers fall under the "No Penalty" category only if the correction can be **unambiguously inferred from context; for example, "`ArayList`" instead of "`ArrayList`". As a counterexample, note that if the code declares "`Bug bug;`", then uses "`Bug.move()`" instead of "`bug.move()`", the context does **not** allow for the reader to assume the object instead of the class.*

AP® COMPUTER SCIENCE A
2015 SCORING GUIDELINES

Question 1: Diverse Array

Part (a)	`arraySum`	**2 points**

Intent: *Compute and return sum of elements in 1D array* `arr`, *passed as parameter*

+1 Accesses all elements of `arr`, (*no bounds errors on* `arr`)

+1 Initializes, computes, and returns sum of elements

Part (b)	`rowSums`	**4 points**

Intent: *Compute and return 1D array containing sums of each row in the 2D array* `arr2D`, *passed as parameter*

+1 Constructs correctly-sized 1D array of ints

+1 Accesses all rows in `arr2D` (*no bounds errors on* `arr2D`)

+1 Computes sum of row in `arr2D` using `arraySum` and assigns to element in 1D array

+1 Returns 1D array where kth element is computed sum of corresponding row in 2D array for all rows

Part (c)	`isDiverse`	**3 points**

Intent: *Determine whether* `arr2D`, *passed as parameter, is diverse*

+1 Computes and uses array of row sums from `arr2D` using `rowSums`

+1 Compare all and only pairs of row sums for equality (*No bounds errors on row sums array; point not awarded if no adjustment when compares any row sum with itself*)

+1 Returns `true` if all compared row sums are different and `false` otherwise (*point not awarded for immediate return*)

Question-Specific Penalties

-1 (g) Uses `getLength/getSize` for array size

-1 (y) Destruction of persistent data (`arr` *or* `arr2D`)

AP® COMPUTER SCIENCE A
2015 CANONICAL SOLUTIONS

Question 1: Diverse Array

Part (a):

```
public static int arraySum(int[] arr){
       int sum=0;
       for (int elem : arr){
            sum += elem;
       }
       return sum;
}
```

Part (b):

```
public static int[] rowSums(int[][] arr2D){
        int [] sums=new int[arr2D.length];
        int rowNum=0;
        for(int[] row : arr2D){
            sums[rowNum]=arraySum(row);
            rowNum++;
        }
        return sums;
    }
```

Part (c):

```
public static boolean isDiverse(int[][] arr2D){
        int [] sums=rowSums(arr2D);
        for (int i=0; i < sums.length; i++){
            for (int j=i+1; j < sums.length; j++){
                if (sums[i]==sums[j]){
                    return false;
                }
            }
        }
        return true;
    }
```

AP® COMPUTER SCIENCE A
2015 SCORING GUIDELINES

Question 2: Guessing Game

Class:	`HiddenWord`	**9 points**

Intent: *Define implementation of class to represent hidden word in guessing game*

+1 Uses correct class, constructor, and method headers

+1 Declares appropriate `private` instance variable

+1 Initializes instance variable within constructor using parameter

+6 Implement `getHint`

- **+1** Accesses all letters in both guess and hidden word in loop (*no bounds errors in either*)
- **+4** Process letters within loop
  - **+1** Extracts and compares corresponding single letters from guess and hidden word
  - **+1** Tests whether guess letter occurs in same position in both guess and hidden word
  - **+1** Tests whether guess letter occurs in hidden word but not in same position as in guess
  - **+1** Adds correct character exactly once to the hint string based on the test result
- **+1** Declares, initializes, and returns constructed hint string

Question-Specific Penalties

-1 (t) Uses `get` to access letters from strings

-2 (u) Consistently uses incorrect name instead of instance variable name for hidden word

AP® COMPUTER SCIENCE A
2015 CANONICAL SOLUTIONS

Question 2: Guessing Game

```
public class HiddenWord
{
    private String word;

    public HiddenWord(String hWord)
    {
        word = hWord;
    }

    public String getHint(String guess){
        String hint = "";
        for (int i = 0; i < guess.length(); i++){
          if (guess.substring(i,i+1).equals(word.substring(i,i+1))){
                hint += guess.substring(i,i+1);
          } else if (word.indexOf(guess.substring(i,i+1))!= -1){
                hint += "+";
          } else {
                hint += "*";
          }
        }
        return hint;
    }

}
```

AP® COMPUTER SCIENCE A
2015 SCORING GUIDELINES

Question 3: Sparse Array

Part (a)	`getValueAt`	**3 points**

Intent: *Return the value at row index* `row` *and column index* `col` *in sparse array*

+1 Accesses all necessary elements of `entries` (*No bounds errors*)

+1 Identifies element of `entries` at row index `row` and column index `col`, if exists

+1 Returns identified value or returns 0 if no entry exists in `entries` with row index `row` and column index `col`

Part (b)	`removeColumn`	**6 points**

Intent: *Remove column* `col` *from sparse array*

+1 Decrements `numCols` exactly once

+1 Accesses all elements of `entries` (*No bounds errors*)

+1 Identifies and removes entry with column index `col`

+2 Process entries with column index `> col` within loop

- **+1** Creates new `SparseArrayEntry` with current row index, column index -1, current value
- **+1** Identifies and replaces entry with column index `> col` with created entry

+1 On exit: All and only entries with column index `col` have been removed and all and only entries with column index `> col` have been changed to have column index -1. All other entries are unchanged. (*Minor loop errors ok*)

Question-Specific Penalties

-2 (t) Consistently uses incorrect name instead of `entries`

-1 (u) Directly accesses private instance variables in `SparseArrayEntry` object

AP® COMPUTER SCIENCE A
2015 CANONICAL SOLUTIONS

Question 3: Sparse Array

Part (a):

```
public int getValueAt(int row, int col){
       for (SparseArrayEntry e : entries){
          if (e.getRow() == row && e.getCol() == col){
             return e.getValue();
          }
       }
       return 0;
}
```

Part (b):

```
public void removeColumn(int col){
       int i=0;
       while (i < entries.size()){
            SparseArrayEntry e = entries.get(i);
            if (e.getCol() == col){
                entries.remove(i);
            } else if (e.getCol() > col){
                entries.set(i, new SparseArrayEntry(e.getRow(),
                                                    e.getCol()-1,
                                                    e.getValue()));
                i++;
            } else {
                i++;
            }
      }
      numCols--;
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

AP® COMPUTER SCIENCE A
2015 SCORING GUIDELINES

Question 4: Number Group

Part (a)	**Interface: `NumberGroup`**	**2 points**

Intent: *Define interface to represent a number group*

+1 `interface NumberGroup` (*point lost if visibility private*)

+1 `boolean contains(int num);`
(*point lost if visibility not public or extraneous code present*)

Part (b)	**Class: `Range`**	**5 points**

Intent: *Define implementation of* `NumberGroup` *representing a range of numbers*

+1 `class Range implements NumberGroup` (*point lost if visibility private*)

+1 Declares appropriate `private` instance variable(s)

+1 Uses correct constructor header

+1 Initializes instance variables within constructor using parameters
(*point lost if bounds errors occur in container use*)

+1 Computes and returns correct value from `contains`
(*point lost for incorrect method header*)

Part (c)	`contains`	**2 points**

Intent: *Determine whether integer is part of any of the member number groups*

+1 Calls `contains` on elements of `groupList` in context of loop *(no bounds errors)*

+1 Computes and returns correct value

Question-Specific Penalties

-1 (s) Inappropriate use of `static`

AP® COMPUTER SCIENCE A
2015 CANONICAL SOLUTIONS

Question 4: Number Group

Part (a):

```
public interface NumberGroup
{
    boolean contains(int num);
}
```

Part (b):

```
public class Range implements NumberGroup
{
    private int min;
    private int max;

    public Range(int min, int max)
    {
        this.min=min;
        this.max=max;
    }

    public boolean contains(int num){
        return num >= min && num <= max;
    }
}
```

Part (c):

```
public boolean contains(int num){
       for (NumberGroup group : groupList){
           if (group.contains(num)){
               return true;
           }
       }
       return false;
}
```

2015 AP Computer Science A Scoring Worksheet

Section I: Multiple Choice

_____	× 1.0000 =	_____
Number Correct (out of 40)		Weighted Section I Score (Do not round)

Section II: Free Response

Question 1	_____ (out of 9)	× 1.1111 =	_____ (Do not round)
Question 2	_____ (out of 9)	× 1.1111 =	_____ (Do not round)
Question 3	_____ (out of 9)	× 1.1111 =	_____ (Do not round)
Question 4	_____ (out of 9)	× 1.1111 =	_____ (Do not round)

Sum = _____
Weighted Section II Score (Do not round)

Composite Score

_____	+	_____	=	_____
Weighted Section I Score		Weighted Section II Score		Composite Score (Round to nearest whole number)

AP Score Conversion Chart
Computer Science A

Composite Score Range	AP Score
62-80	5
44-61	4
31-43	3
25-30	2
0-24	1