

# Notes on the AP Computer Science Principles Practice Exam

## Multiple-Choice Section

### Course Framework Alignment and Rationales

#### Question 1

Skill	Learning Objective	Topic
5.E: Evaluate the use of computing based on legal and ethical factors.	IOC-2.C: Explain how unauthorized access to computing resources is gained.	5.6: Safe Computing
(A)	Incorrect. The act of installing malware on a computer is not in itself a phishing attack.	
(B)	Incorrect. Overwhelming a system in an attempt to deny service is not a phishing attack.	
(C)	Incorrect. Gaining remote access to a computer is not a phishing attack.	
(D)	<b>Correct.</b> Phishing is a technique that attempts to trick a user into providing personal information. In this case, the user is tricked by a fraudulent e-mail.	

#### Question 2

Skill	Learning Objective	Topic
Skill 2.B: Implement and apply an algorithm.	AAP-2.F.a: For relationships between Boolean values, write expressions using logical operators.	3.5: Boolean Expressions
(A)	<b>Correct.</b> For a person to be eligible for the ride, <code>age</code> must be greater than or equal to 12 and <code>height</code> must be greater than or equal to 50 and less than or equal to 80. Therefore, all three of the conditions <code>(age ≥ 12)</code> , <code>(height ≥ 50)</code> , and <code>(height ≤ 80)</code> must be true for a person to be eligible for the ride.	
(B)	Incorrect. This expression will always evaluate to <code>false</code> because it is not possible for <code>height</code> to be less than or equal to 50 and also greater than or equal to 80.	
(C)	Incorrect. This expression may evaluate to <code>true</code> when the person is not eligible for the ride. For example, this expression will evaluate to <code>true</code> when <code>age</code> is 12 and <code>height</code> is 40, even though the person is not tall enough to be eligible.	
(D)	Incorrect. This expression may evaluate to <code>true</code> when the person is not eligible for the ride. For example, this expression will evaluate to <code>true</code> when <code>age</code> is 11 and <code>height</code> is 55, even though the person is not old enough to be eligible.	

Question 3

Skill	Learning Objective	Topic
4.B: Determine the result of code segments.	AAP-1.B: Determine the value of a variable as a result of an assignment.	3.1: Variables and Assignments
(A)	<b>Correct.</b> The variable <code>first</code> is initially assigned the value 100 and the variable <code>second</code> is initially assigned the value 200. Next, <code>temp</code> is assigned the value of <code>first</code> , which is 100. Next, <code>second</code> is assigned the value of <code>temp</code> , which is 100. Last, <code>first</code> is assigned the value of <code>second</code> , which is 100. After execution, both <code>first</code> and <code>second</code> have the value 100.	
(B)	Incorrect. The variable <code>second</code> , while initially assigned the value 200, is later assigned the value of <code>temp</code> , which is 100.	
(C)	Incorrect. The variable <code>first</code> is initially assigned the value 100, and then later assigned the value of <code>second</code> , which at that point in the code segment is also 100.	
(D)	Incorrect. The variable <code>second</code> , while initially assigned the value 200, is later assigned the value of <code>temp</code> , which is 100. The variable <code>first</code> is initially assigned the value 100, and then later assigned the value of <code>second</code> , which at that point in the code segment is also 100.	

Question 4

Skill	Learning Objective	Topic
5.A: Explain how computing systems work.	CSN-1.D: Describe the differences between the Internet and the World Wide Web.	4.1: The Internet
(A)	Incorrect. The Internet is a network of interconnected networks, but the World Wide Web is an information system that is accessed via the Internet.	
(B)	Incorrect. The Internet is a network of interconnected networks, but the World Wide Web is an information system that is accessed via the Internet.	
(C)	Incorrect. The Internet is a network of interconnected networks, but the World Wide Web is an information system that is accessed via the Internet.	
(D)	<b>Correct.</b> The Internet is the global system of interconnected computer networks that uses protocols to connect devices worldwide. The World Wide Web is an information system (of pages, programs, and files) that is accessible over the Internet.	

Question 5

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	AAP-2.K.a: For iteration, write iteration statements.	3.8: Iteration
(A)	<b>Correct.</b> For each iteration of the outer loop, "up" is displayed once and then "down" is displayed three times. The outer loop iterates two times, so "up down down down" is displayed two times as intended.	
(B)	Incorrect. This code segment produces the output "up down down up down down up down down".	
(C)	Incorrect. This code segment produces the output "up up up down up up up down".	
(D)	Incorrect. This code segment produces the output "up up down up up down up up down".	

Question 6

Skill	Learning Objective	Topic
5.E: Evaluate the use of computing based on legal and ethical factors.	IOC-2.B: Explain how computing resources can be protected and can be misused.	5.6: Safe Computing
(A)	Incorrect. Users are usually asked to enter a new password twice to help them avoid making an error when typing a new password. This is not an example of multifactor authentication.	
(B)	Incorrect. Having each user of a shared account create a unique password may help protect the account, but this is not an example of multifactor authentication.	
(C)	<b>Correct.</b> Multifactor authentication is a method of computer access control in which a user is only granted access after successfully presenting several separate pieces of evidence to an authentication mechanism. In this case, the user provided a password and showed evidence of having the phone associated with the user account.	
(D)	Incorrect. While having users update their password regularly and avoid reusing old passwords may be helpful in protecting an account, this is not an example of multifactor authentication.	

Question 7

Skill	Learning Objective	Topic
2.A: Represent algorithmic processes without using a programming language.	AAP-2.J: Express an algorithm that uses iteration without using a programming language.	3.8: Iteration
(A)	Incorrect. The counter is incremented once for each time the game piece moves. The game piece makes four moves before ending in the red space.	
(B)	Incorrect. The counter is incremented once for each time the game piece moves. The game piece makes four moves before ending in the red space.	
(C)	<b>Correct.</b> The game piece begins at the rightmost black space. The piece moves one space to the left to a yellow space, and the counter is incremented to 1. The piece then moves three spaces to the left to another yellow space, and the counter is incremented to 2. The piece then moves three spaces to the left to a green space, and the counter is incremented to 3. The piece then moves two spaces to the right to the red space, and the counter is incremented to 4. The algorithm terminates now that the piece is in the red space.	
(D)	Incorrect. The counter is incremented once for each time the game piece moves. The game piece makes four moves before ending in the red space.	

Question 8

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	CSN-1.E.a: For fault-tolerant systems, like the Internet, describe the benefits of fault tolerance.	4.2: Fault Tolerance
(A)	Incorrect. Redundancy on the Internet allows packets to be transmitted along multiple paths, but does not reduce the number of packets needed to transmit a particular message.	
(B)	Incorrect. Redundancy within a system usually requires additional resources, not fewer. A path within a redundant system may be longer than the shortest possible path.	
(C)	<b>Correct.</b> If a particular device or connection on the Internet fails, subsequent data will be sent via a different route, if possible. This is supported by redundancy in the network.	
(D)	Incorrect. Redundancy on the Internet does not protect against communications being intercepted. Having multiple paths can increase the number of places that an unauthorized individual can intercept communications.	

Question 9

Skill	Learning Objective	Topic
3.C: Explain how abstraction manages complexity.	DAT-1.A: Explain how data can be represented using bits.	2.1: Binary Numbers
(A)	Incorrect. While some programs or procedures take audio data as input, this is not how audio data are represented digitally. At the lowest level, all digital data are represented as sequences of bits.	
(B)	<b>Correct.</b> Analog signals are sampled digitally at discrete intervals over time. These samples, like all digital data, are represented at the lowest level as a sequence of bits.	
(C)	Incorrect. While some programming languages can be used to manipulate audio data, this is not how audio data are represented digitally. At the lowest level, all digital data are represented as sequences of bits.	
(D)	Incorrect. While some programs transform audio data into text, this is not how audio data are represented digitally. At the lowest level, all digital data are represented as sequences of bits.	

Question 10

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	DAT-1.C.a: For binary numbers, calculate the binary (base 2) equivalent of a positive integer (base 10) and vice versa.	2.1: Binary Numbers
(A)	Incorrect. The binary equivalent of 3 is 00011.	
(B)	Incorrect. The binary equivalent of 12 is 01100.	
(C)	<b>Correct.</b> The binary value 11000 is equal to $2^4 + 2^3$ , which is equal to 24.	
(D)	Incorrect. The binary equivalent of 48 is 110000.	

Question 11

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	DAT-1.C.a: For binary numbers, calculate the binary (base 2) equivalent of a positive integer (base 10) and vice versa.	2.1: Binary Numbers
(A)	Incorrect. The decimal value for $\leftarrow$ is equal to $2^3$ , or 8.	
(B)	Incorrect. The decimal value for $\uparrow$ is equal to $2^3 + 2^0$ , or 9.	
(C)	Incorrect. The decimal value for $\rightarrow$ is equal to $2^3 + 2^1 + 2^0$ , or 11.	
(D)	<b>Correct.</b> The decimal number 15 is equal to $2^3 + 2^2 + 2^1 + 2^0$ , which is represented in binary as 01111. Therefore, the decimal value 15 represents the $\downarrow$ control.	

Question 12

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	AAP-2.H.a: For selection, write conditional statements.	3.6: Conditionals
(A)	Incorrect. For each iteration of the loop, if there is an open square to the left of the robot, this code segment rotates the robot left and then attempts to move the robot forward one square. The robot does not have an open square to its left at its initial location; therefore, the code segment continues in an infinite loop and the robot never moves.	
(B)	Incorrect. For each iteration of the loop, if there is an open square in front of the robot, this code segment moves the robot forward one square and then rotates it left. After the first iteration, the robot has moved forward one square and has rotated left. For all other iterations, there is not an open square in front of the robot; therefore, the code segment continues in an infinite loop and the robot does not make any additional moves.	
(C)	<b>Correct.</b> For each iteration of the loop, this code segment rotates the robot left if there is an open square to its left. Then, whether or not the robot rotates left, the code segment attempts to move the robot forward one square. In the first three iterations of the loop, the robot moves forward three squares from its initial location. In the next iteration of the loop, it rotates left. In the next three iterations of the loop, it moves forward three squares. In the next iteration of the loop, it rotates left. In the last three iterations of the loop, it moves forward three squares to the gray square at the bottom left corner of the grid.	
(D)	Incorrect. For each iteration of the loop, this code segment moves the robot forward if there is an open square in front of the robot. Otherwise, the robot rotates left. In the first five iterations of the loop, the robot moves forward five squares to the top of the grid. In the next two iterations of the loop, the robot rotates left two times. In the next five iterations of the loop, the robot moves forward five squares to the bottom of the grid. In the next two iterations of the loop, the robot rotates left two times. The robot continues in an infinite loop, repeatedly moving from the bottom of the grid to the top of the grid and back.	

Question 13

Skill	Learning Objective	Topic
1.C: Explain how collaboration affects the development of a solution.	CRD-1.A: Explain how computing innovations are improved through collaboration.	1.1: Collaboration
(A)	Incorrect. Collaboration often allows teams to break a complex problem into smaller parts, decreasing the size and complexity of tasks required of each team member.	
(B)	Incorrect. Having multiple team members review components of the innovation throughout the process can help in the identifying and correcting errors.	
(C)	<b>Correct.</b> While effective collaboration often benefits from a diversity of talents and perspectives, collaborators still need to develop strategies to resolve differences of opinion.	
(D)	Incorrect. Effective collaborative teams draw on the diverse perspectives, skills, and backgrounds of team members.	

Question 14

Skill	Learning Objective	Topic
4.C: Identify and correct errors in algorithms and programs, including error discovery through testing.	CRD-2.I.b: For errors in an algorithm or program, correct the error.	1.4: Identifying and Correcting Errors
(A)	Incorrect. By making this change, an invalid list index of 0 will be used. This will not correct the error in the procedure.	
(B)	Incorrect. By making this change, the procedure will immediately return <code>true</code> any time it encounters a value that is greater than or equal to the preceding value. It will not check any subsequent values in the list.	
(C)	<b>Correct.</b> As is, the procedure traverses <code>numberList</code> from left to right and returns <code>true</code> whenever it encounters a value that is less than the preceding value. If it never encounters such a value, <code>false</code> is returned. This has the effect of returning <code>true</code> whenever the list is not increasing and returning <code>false</code> whenever the list is increasing, which is the opposite of what is intended. By interchanging lines 8 and 12, the procedure will return <code>true</code> or <code>false</code> appropriately.	
(D)	Incorrect. By making this change, an infinite loop will occur if the second element in the list is greater than or equal to the first element in the list. In that case, the variable <code>count</code> will never be updated and the subsequent values in the list will never be checked. This will not correct the error in the procedure.	

Question 15

Skill	Learning Objective	Topic
3.B: Use abstraction to manage complexity in a program.	AAP-3.A.a: For procedure calls, write statements to call procedures.	3.12: Calling Procedures
(A)	<b>Correct.</b> This code segment starts at the coordinate $(1, 0)$ . Inside the loop, a call to <code>drawLine</code> draws a vertical line segment of length <code>len</code> . By increasing <code>xVal</code> by 1 inside the loop, the next line segment will be drawn one position to the right. By increasing <code>len</code> by 1 inside the loop, the next line segment drawn will have its length increased by one. This has the effect of drawing the line segments shown in the figure from left to right.	
(B)	Incorrect. This code segment draws five horizontal line segments, starting with the segment from $(1, 0)$ to $(2, 0)$ and ending with the segment from $(1, 4)$ to $(6, 4)$ .	
(C)	Incorrect. This code segment draws five vertical line segments that are all 5 units long, starting with the segment from $(5, 0)$ to $(5, 5)$ and ending with the segment from $(1, 0)$ to $(1, 5)$ .	
(D)	Incorrect. This code segment draws five horizontal line segments, starting with the segment from $(5, 0)$ to $(10, 0)$ and ending with the segment from $(5, -4)$ to $(6, -4)$ .	

Question 16

Skill	Learning Objective	Topic
5.E: Evaluate the use of computing based on legal and ethical factors.	IOC-1.F: Explain how the use of computing can raise legal and ethical concerns.	5.5: Legal and Ethical Concerns
(A)	Incorrect. Publishing an e-book with a Creative Commons license does not encrypt the e-book.	
(B)	<b>Correct.</b> A no-rights-reserved Creative Commons license is used when the creator of a published work wants the work to be made freely available to everyone.	
(C)	Incorrect. Publishing an e-book with a no-rights-reserved Creative Commons license enables people to freely distribute it.	
(D)	Incorrect. Publishing an e-book with a no-rights-reserved Creative Commons license enables people to freely make use of its content.	



Question 17

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	CSN-1.E.c: For fault-tolerant systems, like the Internet, identify vulnerabilities to failure in a system.	4.2: Fault Tolerance
(A)	Incorrect. Removing any three connections will not prevent devices B and C from communicating. For example, if connections A-C, C-D, and B-D are removed, then devices B and C can still communicate along the path B-E-F-C.	
(B)	<b>Correct.</b> Devices B and C must be completely cut off from each other for them to no longer communicate. Removing any three connections will not prevent devices B and C from communicating. However, if connections B-A, B-D, B-E, and B-G are removed (or C-A, C-D, C-F, and C-I), then devices B and C can no longer communicate.	
(C)	Incorrect. While it is possible to disconnect devices B and C by removing five connections, it can be done by removing only four connections.	
(D)	Incorrect. While it is possible to disconnect devices B and C by removing six connections, it can be done by removing only four connections.	

Question 18

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	CSN-1.E.c: For fault-tolerant systems, like the Internet, identify vulnerabilities to failure in a system.	4.2: Fault Tolerance
(A)	Incorrect. There are many possible paths between devices A and D, including A-B-D, A-C-D, A-C-F-D, and A-B-E-F-D.	
(B)	Incorrect. It is possible for a message to be routed from device A to device I through more than four other devices. One possible path is A-B-G-E-H-F-I.	
(C)	Correct. If devices B and F fail, then devices E, G, and H will become isolated from devices A, C, D, and I. Therefore, device A will be unable to communicate with device G.	
(D)	Incorrect. If devices C and F fail, then device D can still communicate with device H. One possible path is D-B-E-H.	

Question 19

Skill	Learning Objective	Topic
5.E: Evaluate the use of computing based on legal and ethical factors.	IOC-2.B: Explain how computing resources can be protected and can be misused.	5.6: Safe Computing
(A)	Incorrect. Overwhelming a system with requests in order to deny service can be done regardless of password strength.	
(B)	Incorrect. Keylogging software can be used to obtain passwords regardless of password strength.	
(C)	Incorrect. The exploitation of encryption algorithms is not related to password strength.	
(D)	<b>Correct.</b> A strong password is something that is easy for a user to remember but would be difficult for someone else to guess based on knowledge of that user. Weak passwords can often be guessed based on publicly available information about a user. Other weak passwords (such as "password" or "1234") can often be guessed because they are commonly used.	

Question 20

Skill	Learning Objective	Topic
5.A: Explain how computing systems work.	CSN-1.A: Explain how computing devices work together in a network.	4.1: The Internet
(A)	Incorrect. Limiting the bandwidth of a connection is likely to increase the amount of time it takes to send and receive files.	
(B)	Incorrect. The number of packets used to transmit data is related to the size of the data, not to the bandwidth of the connection.	
(C)	Incorrect. Internet routing is fault-tolerant, regardless of the bandwidth of a local connection.	
(D)	<b>Correct.</b> The bandwidth of a computer network is the maximum amount of data that can be sent in a fixed amount of time. With limited bandwidth, guest users will be restricted in the amount of data transmitted per second.	

Question 21

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	DAT-1.B: Explain the consequences of using bits to represent data.	2.1: Binary Numbers
(A)	<b>Correct.</b> This situation is consistent with the behavior of an overflow error. When the value of the count exceeded the maximum value that can be represented by a fixed number of bits, the count overflowed and wrapped around to a negative number.	
(B)	Incorrect. This situation is consistent with the behavior of an overflow error, not a rounding error. A rounding error would lead to imprecision in the count, rather than increasing to the point of wrapping around to a negative number.	
(C)	Incorrect. This situation is consistent with the behavior of an overflow error. If the software used to update the count failed, it would not increase to the point of wrapping around to a negative number.	
(D)	Incorrect. This situation is consistent with the behavior of an overflow error. The count is not an approximation of an analog measurement.	

Question 22

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	AAP-2.L: Compare multiple algorithms to determine if they yield the same side effect or result.	3.9: Developing Algorithms
(A)	<p><b>Correct.</b> The given code segment initializes <code>count</code> to <code>1</code> and increments <code>count</code> at the end of the outer loop. This causes the robot to move 1 square forward, then rotate left, then move 2 squares forward, then rotate left, then move 3 squares forward, then rotate left, then move 4 squares forward, then rotate left. The robot ends in the lower-right corner of the grid, facing toward the top of the grid. This code segment initializes <code>count</code> to <code>0</code> and increments <code>count</code> at the beginning of the outer loop. Because <code>count</code> is initialized to <code>0</code> and then immediately incremented inside the loop, the inner loop iterates the same number of times for each iteration of the outer loop as in the given code segment. The robot ends in the lower-right corner of the grid, facing toward the top of the grid.</p>	
(B)	<p>Incorrect. The given code segment causes the robot to end in the lower-right corner of the grid, facing toward the top of the grid. This code segment causes the robot to rotate left before moving forward, causing the robot to follow a different path. The robot ends in the upper-right corner of the grid, facing toward the top of the grid.</p>	
(C)	<p>Incorrect. The given code segment causes the robot to end in the lower-right corner of the grid, facing toward the top of the grid. In this code segment, since <code>MOVE_FORWARD</code> is outside the inner loop, the robot moves forward 1 time for each iteration of the outer loop and rotates left <code>count</code> number of times for each iteration of the inner loop. The robot ends in the center square of the grid, facing toward the bottom of the grid.</p>	
(D)	<p>Incorrect. The given code segment causes the robot to end in the lower-right corner of the grid, facing toward the top of the grid. In this code segment, <code>count</code> is <code>0</code> in the first iteration of the outer loop, so the robot rotates left, but does not move forward. The robot ends in the upper-right corner of the grid, facing toward the top of the grid.</p>	

Question 23

Skill	Learning Objective	Topic
5.A: Explain how computing systems work.	CSN-1.B: Explain how the Internet works.	4.1: The Internet
(A)	Incorrect. The Internet uses standardized, open (nonproprietary) communication protocols.	
(B)	<b>Correct.</b> The Internet was designed to be scalable, using open protocols to easily connect additional computing devices to the network.	
(C)	Incorrect. The Internet was not designed to be completely secure. Encryption is not required for communications.	
(D)	Incorrect. Routing on the Internet is usually dynamic; it is not specified in advance, nor is it controlled from a central location.	

Question 24

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	DAT-1.D: Compare data compression algorithms to determine which is best in a particular context.	2.2: Data Compression
(A)	Incorrect. In situations where quality is maximally important, lossless compression algorithms are typically chosen.	
(B)	Incorrect. In situations where the ability to reconstruct an original is maximally important, lossless compression algorithms are typically chosen.	
(C)	<b>Correct.</b> In situations where minimizing data size or transmission time is maximally important, lossy compression algorithms are typically chosen.	
(D)	Incorrect. In situations where quality is maximally important, lossless compression algorithms are typically chosen.	

Question 25

Skill	Learning Objective	Topic
4.B: Determine the result of code segments.	AAP-2.K.b: For iteration, determine the result or side effect of iteration statements.	3.8: Iteration
(A)	Incorrect. The procedure will run without error and return a value.	
(B)	Incorrect. The procedure does not return the value of $2 * n$ . For a procedure to return $2 * n$ , it could initialize <code>result</code> to 0 and then repeatedly add 2 to <code>result</code> a total of $n$ times.	
(C)	Incorrect. The procedure does not return the value of $n * n$ . For a procedure to return $n * n$ , it could initialize <code>result</code> to 0 and then repeatedly add $n$ to <code>result</code> a total of $n$ times.	
(D)	<b>Correct.</b> The procedure initially sets <code>result</code> to 1 and <code>j</code> to 2. In the REPEAT UNTIL loop, <code>result</code> is first assigned the sum of <code>result</code> and <code>j</code> , or $1 + 2$ . The value of <code>j</code> is then increased to 3. In each subsequent iteration of the loop, <code>result</code> is increased by each successive value of <code>j</code> (3, 4, 5, etc.) until <code>j</code> exceeds $n$ . Therefore, the procedure returns the sum of the integers from 1 to $n$ .	

Question 26

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	CSN-2.B: Describe benefits and challenges of parallel and distributed computing.	4.3: Parallel and Distributed Computing
(A)	<b>Correct.</b> The efficiency of a parallel computing solution is limited by the sequential portion of the solution. If each step is dependent on the preceding step, then each step must wait for the previous step to complete before executing. Therefore, the solution is completely sequential and does not benefit from parallel computing.	
(B)	Incorrect. If the same formula can be applied to every data element, then the computations can be done in parallel on multiple processors.	
(C)	Incorrect. If an algorithm is broken down into small independent tasks, then each task can be executed in parallel on multiple processors.	
(D)	Incorrect. Searching for a key word in multiple documents can be done in parallel, where each processor performs a search on a different document (or part of a document).	

Question 27

Skill	Learning Objective	Topic
5.E: Evaluate the use of computing based on legal and ethical factors.	IOC-1.D: Explain how bias exists in computing innovations.	5.3: Computing Bias
(A)	Incorrect. A group of users who use the application at least ten hours per week is unlikely to be representative of all users of the application. Using data from only this group may lead to bias.	
(B)	<b>Correct.</b> Testing the new algorithm on a random sample of users will help ensure that the data gathered are from a group that is representative of all users of the application. Gathering data and perspectives from a representative sample can help the developers avoid bias.	
(C)	Incorrect. Teenage users are not likely to be representative of all users of the application. Using data from only this group may lead to bias.	
(D)	Incorrect. A group of users from only one geographic location is unlikely to be representative of all users of the application. Using data from only this group may lead to bias.	

Question 28

Skill	Learning Objective	Topic
2.A: Represent algorithmic processes without using a programming language.	AAP-2.J: Express an algorithm that uses iteration without using a programming language.	3.8: Iteration
(A)	Incorrect. For these values, <code>-5</code> will be added to <code>result</code> five times and <code>-25</code> will be displayed.	
(B)	Incorrect. For these values, <code>0</code> will be added to <code>result</code> five times and <code>0</code> will be displayed.	
(C)	Incorrect. For these values, <code>k</code> is initially <code>0</code> , so the algorithm will never enter into the loop and <code>0</code> will be displayed.	
(D)	<b>Correct.</b> The value of <code>k</code> is repeatedly decremented by <code>1</code> inside the loop until <code>k = 0</code> . If <code>k</code> is initially negative, it will continue to decrease without ever reaching <code>0</code> .	

Question 29

Skill	Learning Objective	Topic
2.A: Represent algorithmic processes without using a programming language.	AAP-2.J: Express an algorithm that uses iteration without using a programming language.	3.8: Iteration
(A)	Incorrect. The algorithm in the flowchart calculates the product of $j$ and $k$ rather than the sum of $j$ and $k$ .	
(B)	Incorrect. The value 9 represents the result that would be displayed if the loop iterated one less time.	
(C)	Incorrect. The value 10 represents the result that would be displayed if the assignment statement <code>result ← result + j</code> was changed to <code>result ← result + k</code> .	
(D)	<b>Correct.</b> The algorithm represented in the flowchart calculates $j * k$ by repeatedly adding $j$ to <code>result</code> a total of $k$ times. The value displayed is 12.	

Question 30

Skill	Learning Objective	Topic
5.A: Explain how computing systems work.	CSN-1.C: Explain how data are sent through the Internet via packets.	4.1: The Internet
(A)	Incorrect. Data packets may travel along different paths, arriving at the destination in order, out of order, or not at all.	
(B)	<b>Correct.</b> Data transmitted on the Internet is broken into packets and then reassembled upon arrival. Packets may travel along different paths, arriving at the destination in order, out of order, or not at all.	
(C)	Incorrect. Data is broken into packets and then reassembled upon arrival.	
(D)	Incorrect. Data is broken into packets and then reassembled upon arrival.	



Question 31

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	DAT-1.C.b: For binary numbers, compare and order binary numbers.	2.1: Binary Numbers
(A)	Incorrect. Appending three 0s to the end of a binary number multiplies it by $2^3$ , not by 3.	
(B)	Incorrect. Appending three 0s to the end of a binary number multiplies it by $2^3$ , not by 4.	
(C)	<b>Correct.</b> Appending a 0 to the end of a binary number multiplies the number by 2. Therefore, appending three 0s to the end of a binary number multiplies the number by 2 three times, which is the same as multiplying the number by 8.	
(D)	Incorrect. Appending three 0s to a decimal number multiplies it by 1,000. Appending three 0s to the end of a binary number multiplies it by $2^3$ .	

Question 32

Skill	Learning Objective	Topic
5.E: Evaluate the use of computing based on legal and ethical factors.	IOC-2.B: Explain how computing resources can be protected and can be misused.	5.6: Safe Computing
(A)	<b>Correct.</b> Public-key encryption is considered a secure way of encoding data to prevent unauthorized access.	
(B)	Incorrect. A public key is used to encrypt messages, while a private key is used to decrypt messages. Public key encryption is still considered secure even if a public key is obtained by an unauthorized individual.	
(C)	Incorrect. Public key encryption can be used to encrypt any type of digital data.	
(D)	Incorrect. Public key encryption uses a public key for encryption and a private key for decryption. Symmetric encryption is a method that uses a single key for both encryption and decryption.	

Question 33

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	AAP-4.A.b: For determining the efficiency of an algorithm, identify situations where a heuristic solution may be more appropriate.	3.17: Algorithmic Efficiency
(A)	Incorrect. The problem described is not undecidable, as it is possible to find an exact solution using algorithm I.	
(B)	<b>Correct.</b> Algorithm II runs in time proportional to $n^2$ , which is considered reasonable time because $n^2$ is a polynomial. This is considered a heuristic approach because it finds an approximate solution in reasonable time when the technique that finds an exact solution (algorithm I) does not run in reasonable time.	
(C)	Incorrect. Algorithm II runs in time proportional to $n^2$ , which is considered reasonable time because $n^2$ is a polynomial.	
(D)	Incorrect. An algorithm that runs in reasonable time can show significant improvement over an algorithm that does not run in reasonable time, even on a slower computer.	

Question 34

Skill	Learning Objective	Topic
4.C: Identify and correct errors in algorithms and programs, including error discovery through testing.	CRD-2.I.b: For errors in an algorithm or program, correct the error.	1.4: Identifying and Correcting Errors
(A)	Incorrect. An incorrect trial count occurs because there are two calls to <code>RANDOM</code> for each iteration of the loop instead of one. Replacing line 9 with <code>IF (RANDOM(1, 4) ≥ 2)</code> will not correct this error.	
(B)	<b>Correct.</b> An incorrect trial count occurs because there are two calls to <code>RANDOM</code> for each iteration of the loop instead of one. By replacing line 9 with an <code>ELSE</code> statement, the code segment will increment <code>xCount</code> approximately 25% of the time and will increment <code>yCount</code> otherwise.	
(C)	Incorrect. An incorrect trial count occurs because there are two calls to <code>RANDOM</code> for each iteration of the loop instead of one. Interchanging lines 5 and 9 will not correct this error.	
(D)	Incorrect. An incorrect trial count occurs because there are two calls to <code>RANDOM</code> for each iteration of the loop instead of one. Interchanging lines 7 and 11 will not correct this error.	

Question 35

Skill	Learning Objective	Topic
5.B: Explain how knowledge can be generated from data.	DAT-2.A: Describe what information can be extracted from data.	2.3: Extracting Information from Data
(A)	Incorrect. This information can be determined by counting the total number of tickets issued each year.	
(B)	<b>Correct.</b> The database only tracks the month and year that each ticket was issued. There is no information about whether the tickets were issued on weekends or weekdays.	
(C)	Incorrect. This information can be determined by counting the number of moving and nonmoving violations that occurred each month.	
(D)	Incorrect. This information can be determined by counting the total number of moving violations that occurred each year.	

Question 36

Skill	Learning Objective	Topic
5.D: Describe the impact of gathering data.	IOC-2.A: Describe the risks to privacy from collecting and storing personal data on a computer system.	5.6: Safe Computing
(A)	Incorrect. Personal information found online can be redistributed via social media posts, e-mail, and other methods.	
(B)	Incorrect. Personal information found online can be redistributed via social media posts, e-mail, and other methods. Through this redistribution, it can end up on a large number of devices.	
(C)	Incorrect. Search engines, social media sites, and other data aggregators can automatically collect personal information that is posted online.	
(D)	<b>Correct.</b> Personal information can be found in a variety of places where authentication measures may not be used, including social media sites. Personal information placed online can be collected, aggregated, distributed, and exploited.	

Question 37

Skill	Learning Objective	Topic
4.B: Determine the result of code segments.	AAP-2.I.b: For nested selection, determine the result of nested conditional statements.	3.7: Nested Conditionals
(A)	Incorrect. The string "artichoke" is displayed for values of $n$ that are greater than 100.	
(B)	Incorrect. The string "broccoli" is displayed for values of $n$ that are greater than 10 but less than or equal to 100.	
(C)	<b>Correct.</b> The string "carrot" can be displayed only when the expression $(n > 10)$ is false and the expression $(n > 100)$ is true. If $n$ is not greater than 10, it cannot be greater than 100, and so "carrot" can never be displayed.	
(D)	Incorrect. The string "daikon" is displayed for values of $n$ that are less than or equal to 10.	

Question 38

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	AAP-3.F.b: For simulations, compare simulations with real-world contexts.	3.16: Simulations
(A)	Incorrect. Simulations are well-suited to situations where real-world events are impractically slow.	
(B)	Incorrect. Simulations are simplified abstractions of more-complex objects or phenomena.	
(C)	Incorrect. Simulations are well-suited to situations where real-world events are impractically expensive or dangerous.	
(D)	<b>Correct.</b> Simulations are most useful when real-world events are impractical. A simulation is unlikely to be appropriate if continuous real-world data is needed.	

Question 39

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	DAT-1.C.a: For binary numbers, calculate the binary (base 2) equivalent of a positive integer (base 10) and vice versa.	2.1: Binary Numbers
(A)	Incorrect. Using 5 bits will only allow for up to 32 sequences because $2^5 = 32$ .	
(B)	Incorrect. Using 6 bits will only allow for up to 64 sequences because $2^6 = 64$ .	
(C)	<b>Correct.</b> Using 6 bits will only allow for up to 64 sequences because $2^6 = 64$ . Using 7 bits will allow for up to 128 sequences because $2^7 = 128$ . Therefore, a minimum of 7 bits are needed.	
(D)	Incorrect. Using 8 bits will allow for up to 256 sequences because $2^8 = 256$ . However, a unique bit sequence can be assigned using only 7 bits because $2^7 = 128$ .	

Question 40

Skill	Learning Objective	Topic
5.C: Describe the impact of a computing innovation.	IOC-1.C: Describe issues that contribute to the digital divide.	5.2: Digital Divide
(A)	Incorrect. Some individuals are unable to use computing devices effectively due to lack of education and experience with these devices. Offering educational programs focusing on these skills may help reduce the digital divide for these individuals.	
(B)	<b>Correct.</b> The digital divide describes the differences in access to computing devices and the Internet. Requiring job applicants to apply online serves only individuals who already have access to computing devices and the Internet. It does not help reduce the divide.	
(C)	Incorrect. Some individuals lack access to computing devices because the devices are prohibitively expensive. Offering low-cost devices may help reduce the digital divide for these individuals.	
(D)	Incorrect. Some individuals lack access to the Internet due to lack of network infrastructure. Building new infrastructure in remote areas may help reduce the digital divide for these individuals.	

Question 41

Skill	Learning Objective	Topic
1.C: Explain how collaboration affects the development of a solution.	IOC-1.E: Explain how people participate in problem-solving processes at scale.	5.4: Crowdsourcing
(A)	<b>Correct.</b> Crowdsourcing is the practice of using input or information obtained from a large number of people via the Internet. In this case, input on a player is provided by other players of the game.	
(B)	Incorrect. While this solution may reduce disrespectful communication between players, it does not make use of input from a large number of users.	
(C)	Incorrect. While this solution may reduce disrespectful communication between players, it does not make use of input from a large number of users.	
(D)	Incorrect. While this solution may reduce disrespectful communication between players, it does not make use of input from a large number of users.	

Question 42

Skill	Learning Objective	Topic
4.B: Determine the result of code segments.	AAP-2.O.b: For algorithms involving elements of a list, determine the result of an algorithm that includes list traversals.	3.10: Lists
(A)	<b>Correct.</b> The expression <code>(item MOD 2)</code> evaluates to 1 for odd values and evaluates to 0 for even values. As a result, the code segment adds 1 to <code>result</code> for each odd value in <code>integerList</code> . There are three odd values in the list, so 3 is displayed.	
(B)	Incorrect. This result would be displayed if the code segment counted the number of even values in the list rather than the number of odd values.	
(C)	Incorrect. This result would be displayed if the code segment computed the sum of the odd values in the list rather than counting the number of odd values in the list.	
(D)	Incorrect. This result would be displayed if the code segment computed the sum of the even values in the list rather than counting the number of odd values in the list.	

Question 43

Skill	Learning Objective	Topic
5.E: Evaluate the use of computing based on legal and ethical factors.	IOC-2.C: Explain how unauthorized access to computing resources is gained.	5.6: Safe Computing
(A)	<b>Correct.</b> Keylogging is the use of a program to record every keystroke made by a computer to gain fraudulent access to passwords and other confidential information.	
(B)	Incorrect. This is an example of a weak password. While a weak password may enable an unauthorized user to gain access to a computer system, it is not an example of keylogging.	
(C)	Incorrect. This is an example of intercepted network data. While intercepted network data may enable an unauthorized user to gain access to a computer system, it is not an example of keylogging.	
(D)	Incorrect. This is an example of phishing. While phishing may enable an unauthorized user to gain access to a computer system, it is not an example of keylogging.	

Question 44

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	DAT-1.B: Explain the consequences of using bits to represent data.	2.1: Binary Numbers
(A)	Incorrect. An overflow occurs when a value exceeds the maximum representable value. This type of error does not typically lead to imprecision of values.	
(B)	<b>Correct.</b> The fixed number of bits used to represent real numbers limits the range of these values; this limitation can result in round-off errors. Round-off errors typically result in imprecise values or results.	
(C)	Incorrect. Programming languages typically represent numbers with a fixed number of bits. The use of a fixed number of bits can lead to overflow or round-off errors.	
(D)	Incorrect. Programming languages typically represent numbers with a fixed number of bits. The use of a fixed number of bits can lead to overflow or round-off errors.	

Question 45

Skill	Learning Objective	Topic
3.B: Use abstraction to manage complexity in a program.	AAP-3.A.a: For procedure calls, write statements to call procedures.	3.12: Calling Procedures
(A)	Incorrect. In this code segment, the first call to <code>botStepper</code> moves the robot forward two squares, rotates it left so that it faces toward the top of the grid, moves it forward two squares, and rotates it right so that it faces right. The second call to <code>botStepper</code> moves the robot forward three squares, rotates it left so that it faces toward the top of the grid, moves it forward three squares, and rotates it right so that it faces right. The robot ends one square to the left of the gray square.	
(B)	Incorrect. In this code segment, the first call to <code>botStepper</code> moves the robot forward three squares, rotates it left so that it faces toward the top of the grid, moves it forward three squares, and rotates it right so that it faces right. The second call to <code>botStepper</code> attempts to moves the robot forward four squares, off the edge of the grid, causing execution to terminate.	
(C)	<b>Correct.</b> In this code segment, the first call to <code>botStepper</code> moves the robot forward two squares, rotates it left so that it faces toward the top of the grid, moves it forward two squares, and rotates it right so that it faces right. The code segment then moves the robot forward one square. The second call to <code>botStepper</code> moves the robot forward three squares, rotates it left so that it faces toward the top of the grid, moves it forward three squares, and rotates it right so that it faces right. The robot ends in the gray square.	
(D)	Incorrect. In this code segment, the first call to <code>botStepper</code> moves the robot forward three squares, rotates it left so that it faces toward the top of the grid, moves it forward three squares, and rotates it right so that it faces right. The code segment then moves the robot forward one square. The second call to <code>botStepper</code> attempts to moves the robot forward four squares, off the edge of the grid, causing execution to terminate.	



Question 46

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	DAT-2.D: Extract information from data using a program.	2.4: Using Programs with Data
(A)	Incorrect. Any ordering of the three steps will identify the correct restaurant. Sequence III will work. Sorting by rating will put the greatest customer rating at the top of the list. Then filtering by number of ratings will remove restaurants without any ratings. Then filtering by payment type will remove the restaurants that do not accept credit cards.	
(B)	Incorrect. Any ordering of the three steps will identify the correct restaurant. Sequence II will work. Filtering by number of ratings will remove restaurants without any ratings. Then sorting by rating will put the greatest customer rating at the top of the list. Then filtering by payment type will remove the restaurants that do not accept credit cards.	
(C)	Incorrect. Any ordering of the three steps will identify the correct restaurant. Sequence I will work. Filtering by number of ratings will remove restaurants without any ratings. Then filtering by payment type will remove the restaurants that do not accept credit cards. Then sorting by rating will put the greatest customer rating at the top of the list.	
(D)	<b>Correct.</b> Because the relative order of the rows is not changed when the filters are applied, the order in which the actions are performed does not matter. The filtering can occur either before or after the spreadsheet is sorted by rating.	

Question 47

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	DAT-2.D: Extract information from data using a program.	2.4: Using Programs with Data
(A)	Incorrect. This expression will always evaluate to <code>false</code> because <code>prcRange</code> cannot be equal to both <code>"lo"</code> and <code>"med"</code> .	
(B)	<b>Correct.</b> This expression evaluates to <code>true</code> only for restaurants with the correct price range (when <code>prcRange</code> equals <code>"lo"</code> or <code>"med"</code> ) and the correct customer rating (when <code>avgRating</code> $\geq$ 4.0).	
(C)	Incorrect. This expression will evaluate to <code>true</code> for restaurants with a correct customer rating and will evaluate to <code>false</code> for restaurants with an incorrect customer rating, regardless of the price range. The intent is to return <code>true</code> for restaurants with the correct price range and the correct customer rating.	
(D)	Incorrect. This expression will evaluate to <code>true</code> for restaurants with the correct price range or with the correct customer rating. The intent is for the expression to evaluate to <code>true</code> only for restaurants with the correct price range and the correct customer rating.	

Question 48

Skill	Learning Objective	Topic
5.E: Evaluate the use of computing based on legal and ethical factors.	IOC-2.C: Explain how unauthorized access to computing resources is gained.	5.6: Safe Computing
(A)	<b>Correct.</b> A rogue access point is a wireless access point that gives unauthorized access to secure networks. Data sent over public networks can be intercepted, analyzed, and modified. One way that this can happen is through a rogue access point.	
(B)	Incorrect. While disconnecting a router can be disruptive to users, it does not allow unauthorized individuals to intercept information transmitted on a network.	
(C)	Incorrect. Tricking a user into providing personal information is an example of a phishing attack. While this type of attack can be used to obtain personal information, it does not allow unauthorized individuals to intercept information transmitted on a network.	
(D)	Incorrect. While overwhelming a router can be disruptive to users, it does not allow unauthorized individuals to intercept information transmitted on a network.	

Question 49

Skill	Learning Objective	Topic
1.A: Investigate the situation, context, or task.	AAP-4.B: Explain the existence of undecidable problems in computer science.	3.18: Undecidable Problems
(A)	Incorrect. While some solutions benefit from being validated by a human, not all problems can be solved with an algorithm.	
(B)	Incorrect. While some solutions benefit from parallel computation, not all problems can be solved with an algorithm.	
(C)	Incorrect. While some solutions require a large amount of data storage, not all problems can be solved with an algorithm.	
(D)	<b>Correct.</b> An undecidable problem is one for which no algorithm can be constructed that is always capable of providing a correct yes-or-no answer. Some instances of an undecidable problem may have an algorithmic solution, but there is no algorithmic solution that could solve all instances of the problem.	

Question 50

Skill	Learning Objective	Topic
5.E: Evaluate the use of computing based on legal and ethical factors.	IOC-2.B: Explain how computing resources can be protected and can be misused.	5.6: Safe Computing
(A)	<b>Correct.</b> Symmetric encryption uses a single key for both encryption and decryption of data. Since the key can be used to unlock the data, it should be kept secret.	
(B)	Incorrect. Since symmetric encryption uses the same key to encrypt and decrypt data, it should be kept secret.	
(C)	Incorrect. Symmetric encryption uses a single key.	
(D)	Incorrect. Symmetric encryption uses a single key. Public key encryption uses a public key for encryption and a private key for decryption.	

Question 51

Skill	Learning Objective	Topic
1.C: Explain how collaboration affects the development of a solution.	IOC-1.E: Explain how people participate in problem-solving processes at scale.	5.4: Crowdsourcing
(A)	<b>Correct.</b> Citizen science is scientific research conducted in whole or part by distributed individuals, many of whom may not be scientists, who contribute relevant data to research using their own computing devices. This project would benefit from using a citizen science model for gathering photographs of birds from amateur photographers around the world.	
(B)	Incorrect. This project can be done by a small team of researchers and is not likely to require a distributed approach.	
(C)	Incorrect. A simulation is run on a computer and is not likely to require input from individuals distributed around the world.	
(D)	Incorrect. This project requires specialized equipment that is unlikely to be available to individuals distributed around the world.	

## Question 52

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	AAP-2.P: For binary search algorithms— a. Determine the number of iterations required to find a value in a data set. b. Explain the requirements necessary to complete a binary search.	3.11: Binary Search
(A)	Incorrect. After 2 binary search iterations on a list of length 128, there will still be 32 elements remaining.	
(B)	<b>Correct.</b> The binary search algorithm starts at the middle of the list and repeatedly eliminates half the elements until the desired value is found or all elements have been eliminated. For a list with 128 elements, the list will be cut in half a maximum of 7 times (causing 8 elements to be examined). The list will start with 128 elements, then 64 elements, then 32 elements, then 16 elements, then 8 elements, then 4 elements, then 2 elements, then 1 element.	
(C)	Incorrect. While a binary search on a list of length 128 will eliminate 64 elements on the first iteration, fewer than 64 iterations are needed to eliminate all elements.	
(D)	Incorrect. A linear search of a list of length 128 may examine all 128 elements. A binary search requires fewer elements to be examined.	

## Question 53

Skill	Learning Objective	Topic
2.A: Represent algorithmic processes without using a programming language.	AAP-2.J: Express an algorithm that uses iteration without using a programming language.	3.8: Iteration
(A)	<b>Correct.</b> Step 4 checks every element of the list, incrementing <code>count</code> each time <code>target</code> appears. Step 5 prints <code>true</code> if and only if <code>count</code> appears multiple times in the list.	
(B)	Incorrect. This algorithm will only display <code>true</code> if every element in the list is equal to <code>target</code> . In step 5, it is not possible for <code>count</code> to be greater than <code>position</code> , and <code>count</code> will only be equal to <code>position</code> if <code>count</code> was incremented for every element in the list.	
(C)	Incorrect. If <code>target</code> appears two or fewer times in the list, <code>count</code> will never be greater than 2. Steps 2 and 3 will be continually repeated until the algorithm eventually attempts to access a list element at an index beyond the end of the list.	
(D)	Incorrect. It is not possible for <code>count</code> to be greater than <code>n</code> . Steps 2 and 3 will be continually repeated until the algorithm eventually attempts to access a list element at an index beyond the end of the list.	

Question 54

Skill	Learning Objective	Topic
5.B: Explain how knowledge can be generated from data.	DAT-2.A: Describe what information can be extracted from data.	2.3: Extracting Information from Data
(A)	Incorrect. This information can be determined by analyzing the dates and times that trucks entered and left the depot.	
(B)	<b>Correct.</b> The data captured each time a truck enters or leaves the depot do not include any information about the number of customers or deliveries associated with the truck.	
(C)	Incorrect. This information can be determined by comparing the weight of a truck when it last entered the depot to its weight when it last left the depot.	
(D)	Incorrect. This information can be determined by analyzing the dates and times that trucks entered and left the depot.	

Question 55

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	AAP-2.N.a: For list operations, write expressions that use list indexing and list procedures.	3.10: Lists
(A)	Incorrect. This code segment assigns the value of the last element of the list to the variable <code>temp</code> , then removes the last element of the list, then appends <code>temp</code> to the end of the list. The resulting list is the same as the original list.	
(B)	Incorrect. This code segment removes the last element of the list, then attempts to access an element at index <code>len</code> . This causes an error because there is no longer an element at index <code>len</code> .	
(C)	<b>Correct.</b> This code segment assigns the value of the last element of the list to the variable <code>temp</code> , then removes the last element of the list, then inserts <code>temp</code> as the first element of the list.	
(D)	Incorrect. This code segment removes the last element of the list, then attempts to access an element at index <code>len</code> . This causes an error because there is no longer an element at index <code>len</code> .	

Question 56

Skill	Learning Objective	Topic
5.B: Explain how knowledge can be generated from data.	DAT-2.A: Describe what information can be extracted from data.	2.3: Extracting Information from Data
(A)	<b>Correct.</b> The desired information can be determined by using the student IDs in spreadsheet II to identify the students who play a sport. Once the students who play a sport are identified, the grade point averages of students who play sports in spreadsheet I can be compared to the grade point averages of all other students in spreadsheet I.	
(B)	Incorrect. The desired information cannot be determined with these two spreadsheets because students who play a single sport cannot be identified.	
(C)	Incorrect. The desired information cannot be determined with these two spreadsheets because students with grade point averages of 3.5 or less cannot be identified.	
(D)	Incorrect. The desired information cannot be determined with these two spreadsheets because students who play a single sport and students with grade point averages of 3.5 or less cannot be identified.	

Question 57

Skill	Learning Objective	Topic
1.D: Evaluate solution options.	CSN-2.A.b: For sequential, parallel, and distributed computing, determine the efficiency of solutions.	4.3: Parallel and Distributed Computing
(A)	<b>Correct.</b> With two processors running in parallel, execution time is minimized when the processors take on as close to an equal workload as possible. Running processes P and Q on one processor will take a total of 40 seconds. Running processes R and S on the other processor will take a total of 35 seconds. As the processors run in parallel, all four operations are completed in 40 seconds.	
(B)	Incorrect. Running processes P and R on one processor will take a total of 50 seconds. Running processes Q and S on the other processor will take a total of 25 seconds. With the processors running in parallel, this solution will take 50 seconds; the optimal solution takes only 40 seconds.	
(C)	Incorrect. Running processes P and S on one processor will take a total of 45 seconds. Running processes Q and R on the other processor will take a total of 30 seconds. With the processors running in parallel, this solution will take 45 seconds; the optimal solution takes only 40 seconds.	
(D)	Incorrect. Running process P on one processor will take a total of 30 seconds. Running processes Q, R, and S on the other processor will take a total of 45 seconds. With the processors running in parallel, this solution will take 45 seconds; the optimal solution takes only 40 seconds.	

Question 58

Skill	Learning Objective	Topic
3.A: Generalize data sources through variables.	CRD-2.C: Identify input(s) to a program.	1.2: Program Function and Purpose
(A)	Incorrect. Information about available running routes would not need to be collected from the user's device. In addition, the user may not be currently located near the user's home.	
(B)	Incorrect. The application does not necessarily need to know the current time in order to recommend a running route.	
(C)	Incorrect. The application does not need to know the starting location of the user's previous run in order to recommend a running route.	
(D)	<b>Correct.</b> In order to suggest a running route, the application needs to know the current location of the user. This information is collected from the user's device.	

Question 59

Skill	Learning Objective	Topic
3.A: Generalize data sources through variables.	CRD-2.C: Identify input(s) to a program.	1.2: Program Function and Purpose
(A)	Incorrect. While Adrianna's average running speed is useful in determining whether other users are considered compatible with Adrianna, this information is determined using data collected from Adrianna's device.	
(B)	Incorrect. While Adrianna's preferred running distance is needed to recommend a running route, this information is provided directly by Adrianna.	
(C)	<b>Correct.</b> In order to share Adrianna's running route with nearby users, the application needs to know the current locations of users other than Adrianna. This information is collected from other user's devices, not Adrianna's device.	
(D)	Incorrect. While the usernames on Adrianna's contact list is useful in determining whether other users are considered compatible with Adrianna, this information is determined using data provided directly by Adrianna when she creates her contact list.	

Question 60

Skill	Learning Objective	Topic
5.C: Describe the impact of a computing innovation.	IOC-1.A: Explain how an effect of a computing innovation can be both beneficial and harmful.	5.1: Beneficial and Harmful Effects
(A)	Incorrect. Using a mobile application outside of a user's home is likely to increase, not decrease, the user's mobile data usage.	
(B)	Incorrect. The application only sends notifications to compatible users who are nearby. Since not all people will be considered compatible, users are unlikely to be able to identify all other users in the area.	
(C)	<b>Correct.</b> The application can be used to connect users with other nearby users, which may encourage users to exercise together. This may have the effect of improving user health.	
(D)	Incorrect. The application relies on geolocation information in order to suggest a running route. In addition, the application requires network connectivity in order to send and receive data.	

Question 61

Skill	Learning Objective	Topic
5.D: Describe the impact of gathering data.	IOC-2.A: Describe the risks to privacy from collecting and storing personal data on a computer system.	5.6: Safe Computing
(A)	Incorrect. While some users may find it undesirable to carry their smartphones while running, this is not considered a privacy concern.	
(B)	<b>Correct.</b> The application will inform a user whenever a nearby compatible user starts a run. This could allow users to determine the location of a stranger, which is considered a privacy concern.	
(C)	Incorrect. While running data captured by the application may be inaccurate if two users are using the same account, this is not considered a privacy concern.	
(D)	Incorrect. While a user may not be able to make full use of the application's features if there are no compatible users nearby, this is not considered a privacy concern.	



Question 62

Skill	Learning Objective	Topic
5.C: Describe the impact of a computing innovation.	IOC-1.B: Explain how a computing innovation can have an impact beyond its intended purpose.	5.1: Beneficial and Harmful Effects
(A)	Incorrect. Any two users with a basic account can receive targeted advertisements, even if they appear on each other's contact lists.	
(B)	Incorrect. Any user with a basic account can receive targeted advertisements, regardless of whether they are interested in health and fitness.	
(C)	<b>Correct.</b> Users with a premium account do not receive advertisements.	
(D)	Incorrect. Any user with a basic account can receive targeted advertisements. If a user's running route is located near a particular business, that information can be used to target an advertisement to the user.	

Question 131

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	AAP-2.F.a: For relationships between Boolean values, write expressions using logical operators.	3.5: Boolean Expressions
(A)	<b>Correct.</b> When <code>input1</code> and <code>input2</code> are both true, the expressions <code>(NOT input1)</code> and <code>(NOT input2)</code> are both false, so <code>(NOT input1) OR (NOT input2)</code> will evaluate to false. In all other cases, either <code>(NOT input1)</code> or <code>(NOT input2)</code> (or both) will evaluate to true, so <code>(NOT input1) OR (NOT input2)</code> will evaluate to true.	
(B)	Incorrect. For example, when <code>input1</code> is true and <code>input2</code> is false, then <code>(NOT input1)</code> will be false and <code>(NOT input2)</code> will be true. Therefore, <code>(NOT input1) AND (NOT input2)</code> will be false instead of the intended value true.	
(C)	Incorrect. For example, when <code>input1</code> is true and <code>input2</code> is false, then <code>(input1 OR input2)</code> will be true. Therefore, <code>NOT (input1 OR input2)</code> will be false instead of the intended value true.	
(D)	Correct. When <code>input1</code> and <code>input2</code> are both true, the expression <code>(input1 AND input2)</code> is true, so <code>NOT (input1 AND input2)</code> will evaluate to false. In all other cases, <code>(input1 AND input2)</code> will evaluate to false, so <code>NOT (input1 AND input2)</code> will evaluate to true.	

Question 132

Skill	Learning Objective	Topic
4.C: Identify and correct errors in algorithms and programs, including error discovery through testing.	CRD-2.I.b: For errors in an algorithm or program, correct the error.	1.4: Identifying and Correcting Errors
(A)	Incorrect. This line should not be removed. The variable <code>result</code> is assigned the value <code>"adult"</code> by default and then assigned the value <code>"senior citizen"</code> or <code>"minor"</code> only when appropriate.	
(B)	<b>Correct.</b> This line should be removed. This return statement causes execution of the procedure to end early. As a result, if <code>age</code> is less than 18, <code>result</code> will never be assigned the value <code>"minor"</code> .	
(C)	<b>Correct.</b> This line should be removed. This statement causes <code>result</code> to be assigned the value <code>"adult"</code> , even if it should have been assigned the value <code>"senior citizen"</code> .	
(D)	Incorrect. This line should not be removed. The value of <code>result</code> should be returned at the end of the procedure, after <code>age</code> is compared to both 65 and 18.	

Question 133

Skill	Learning Objective	Topic
4.B: Determine the result of code segments.	AAP-2.H.b: For selection, determine the result of conditional statements.	3.6: Conditionals
(A)	Incorrect. Since <code>hot</code> is <code>true</code> , the body of the <code>IF</code> statement is executed. Since <code>hot AND humid</code> evaluates to <code>false</code> , <code>false</code> is displayed.	
(B)	<b>Correct.</b> Since <code>NOT humid</code> evaluates to <code>true</code> , the body of the <code>IF</code> statement is executed. Since <code>hot OR humid</code> evaluates to <code>true</code> , <code>true</code> is displayed.	
(C)	<b>Correct.</b> Since <code>hot OR humid</code> evaluates to <code>true</code> , the body of the <code>IF</code> statement is executed. Since <code>hot</code> is <code>true</code> , <code>true</code> is displayed.	
(D)	Incorrect. Since <code>hot AND humid</code> evaluates to <code>false</code> , the body of the <code>IF</code> statement is not executed, and nothing is displayed.	

## Question 134

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	AAP-2.H.a: For selection, write conditional statements.	3.6: Conditionals
(A)	<b>Correct.</b> This code segment assigns 500 bonus points by default. If <code>timer</code> is less than 30, no additional bonus points are added. If <code>timer</code> is between 30 and 60 inclusive, <code>bonus</code> is incremented by 500 in the first IF block. If <code>timer</code> is greater than 60, <code>bonus</code> is incremented by 500 twice (once in each IF block). The correct number of bonus points is assigned to <code>bonus</code> for all possible values of <code>timer</code> .	
(B)	Incorrect. This code segment does not work as intended. For example, if <code>timer</code> is greater than 60, <code>bonus</code> will be initially assigned 1500, then decreased to 1000 in the first IF block. As a result, <code>bonus</code> will be assigned 1000 instead of the intended 1500.	
(C)	Incorrect. This code segment does not work as intended. For example, if <code>timer</code> is greater than 60, <code>bonus</code> is assigned 1500 in the first IF block. Then <code>bonus</code> is assigned 1000 in the second IF block. As a result, <code>bonus</code> will be assigned 1000 instead of the intended 1500.	
(D)	<b>Correct.</b> In this code segment, if <code>timer</code> is greater than 60, <code>bonus</code> is assigned 1500 in the first IF block. If <code>timer</code> is between 30 and 60, inclusive, <code>bonus</code> is assigned 1000 in the second IF block. If <code>timer</code> is less than 30, <code>bonus</code> is assigned 500 in the third IF block. The correct number of bonus points is assigned to <code>bonus</code> for all possible values of <code>timer</code> .	

Question 135

Skill	Learning Objective	Topic
2.B: Implement and apply an algorithm.	AAP-3.E.a: For generating random values, write expressions to generate possible values.	3.15: Random Values
(A)	<p><b>Correct.</b> For this spinner, there is a <math>\frac{1}{4}</math> chance of "blue". The remaining <math>\frac{3}{4}</math> of the time, "orange" and "purple" are equally likely. If the first call to <code>RANDOM</code> returns 1 (which occurs <math>\frac{1}{4}</math> of the time), the code segment prints "blue". Otherwise, if the second call to <code>random</code> returns 1 (which occurs <math>\frac{1}{2}</math> of the time that "blue" does not occur), the code segment prints "orange". The other <math>\frac{1}{2}</math> of the time that "blue" does not occur, the code segment prints "purple".</p>	
(B)	<p><b>Incorrect.</b> This code segment simulates a spinner in which there is a <math>\frac{3}{4}</math> chance of "blue", a <math>\frac{1}{8}</math> chance of "orange", and a <math>\frac{1}{8}</math> chance of "purple". However, the given spinner has a <math>\frac{1}{4}</math> chance of "blue", a <math>\frac{3}{8}</math> chance of "orange", and a <math>\frac{3}{8}</math> chance of "purple".</p>	
(C)	<p><b>Incorrect.</b> This code segment simulates a spinner in which there is a <math>\frac{1}{4}</math> chance of "blue", a <math>\frac{1}{4}</math> chance of "orange", and a <math>\frac{1}{2}</math> chance of "purple". However, the given spinner has a <math>\frac{1}{4}</math> chance of "blue", a <math>\frac{3}{8}</math> chance of "orange", and a <math>\frac{3}{8}</math> chance of "purple".</p>	
(D)	<p><b>Correct.</b> For this spinner, there is a <math>\frac{1}{4}</math> chance of "blue". The remaining <math>\frac{3}{4}</math> of the time, "orange" and "purple" are equally likely. The variable <code>spin</code> is set to a random value between 1 and 4, inclusive. If <code>spin</code> is 1 (which occurs <math>\frac{1}{4}</math> of the time), the code segment prints "blue". Otherwise, <code>spin</code> is set to a random value between 1 and 2, inclusive. If <code>spin</code> is 2 (which occurs <math>\frac{1}{2}</math> of the time that "blue" does not occur), the code segment prints "orange". The other <math>\frac{1}{2}</math> of the time that "blue" does not occur, the code segment prints "purple".</p>	

Question 136

Skill	Learning Objective	Topic
1.B: Determine and design an appropriate method or approach to achieve the purpose.	CRD-2.J: Identify inputs and corresponding expected outputs or behaviors that can be used to check the correctness of an algorithm or program.	1.4: Identifying and Correcting Errors
(A)	<b>Correct.</b> The code segment will iterate over <code>myList</code> from right to left, removing each element that is equal in value to the element immediately preceding it. For this list, the code segment will remove the sixth element (10), the fourth element (20), and the second element (10). This results in the list <code>[10, 20, 10]</code> , which still contains duplicates.	
(B)	Incorrect. The code segment will iterate over <code>myList</code> from right to left, removing the sixth element (20), the third element (30), and the second element (30). This results in the list <code>[30, 10, 20]</code> , which contains no duplicates, as intended.	
(C)	<b>Correct.</b> The code segment will iterate over <code>myList</code> from right to left, removing each element that is equal in value to the element immediately preceding it. This list does not contain any pairs of adjacent elements that are equal in value, so no elements will be removed even though the value <code>40</code> appears twice in the list.	
(D)	Incorrect. The code segment will iterate over <code>myList</code> from right to left, removing the all elements but the first. This results in the list <code>[50]</code> , which contains no duplicates, as intended.	

Question 137

Skill	Learning Objective	Topic
5.B: Explain how knowledge can be generated from data.	DAT-2.B: Describe what information can be extracted from metadata.	2.3: Extracting Information from Data
(A)	<b>Correct.</b> The time and date that a photo is taken is considered metadata about the image. This information can be used to determine the chronological order of the images.	
(B)	Incorrect. The number of clouds in a particular picture cannot be determined from the date, time, and location metadata. To determine this information, the content of the picture itself must be analyzed.	
(C)	Incorrect. The suitability of a picture for printing in black-and-white cannot be determined from the date, time, and location metadata. To determine this information, the colors of the pixels in the photo must be analyzed.	
(D)	<b>Correct.</b> The location and date that a photo is taken is considered metadata about the image. This information can be used to determine whether two pictures were taken at the same location on different dates.	

Question 138

Skill	Learning Objective	Topic
3.B: Use abstraction to manage complexity in a program.	AAP-3.A.a: For procedure calls, write statements to call procedures.	3.12: Calling Procedures
(A)	<p><b>Correct.</b> This code segment assigns the characters to the left of position <code>n</code> to the variable <code>left</code> and the characters to the right of position <code>n</code> to the variable <code>right</code>. It then concatenates <code>left</code> and <code>right</code> and assigns the result to <code>newStr</code>. For example, if <code>oldStr</code> is "best" and <code>n</code> is 3, the code segment assigns "be" to <code>left</code>, "t" to <code>right</code>, and "bet" to <code>newStr</code>.</p>	
(B)	<p><b>Incorrect.</b> This code segment assigns the characters from the start of the string to one past position <code>n</code> to the variable <code>left</code>. The code segment then assigns the characters from one before position <code>n</code> to the end of the string to the variable <code>right</code>. It then concatenates <code>left</code> and <code>right</code> and assigns the result to <code>newStr</code>. For example, if <code>oldStr</code> is "best" and <code>n</code> is 3, the code segment assigns "best" to <code>left</code>, "est" to <code>right</code>, and "bestest" to <code>newStr</code>.</p>	
(C)	<p><b>Correct.</b> This code segment assigns the characters to the left of position <code>n</code> to <code>newStr</code>. The code segment then concatenates <code>newStr</code> with the substring consisting of the characters to the right of position <code>n</code>. For example, if <code>oldStr</code> is "best" and <code>n</code> is 3, the code segment assigns "be" to <code>newStr</code>, then concatenates "be" and the substring "t" and assigns the result "bet" to <code>newStr</code>.</p>	
(D)	<p><b>Incorrect.</b> This code segment assigns the characters to the right of position <code>n</code> to <code>newStr</code>. The code segment then concatenates <code>newStr</code> with the substring consisting of the characters to the left of position <code>n</code>. For example, if <code>oldStr</code> is "best" and <code>n</code> is 3, the code segment assigns "t" to <code>newStr</code>, then concatenates "t" and the substring "be" and assigns the result "tbe" to <code>newStr</code>.</p>	

## Answer Key and Question Alignment to Course Framework

Multiple-Choice Question	Answer	Skill	Learning Objective	Topic
1	D	5.E	IOC-2.C	5.6: Safe Computing
2	A	2.B	AAP-2.Fa	3.5: Boolean Expressions
3	A	4.B	AAP-1.B	3.1: Variables and Assignments
4	D	5.A	CSN-1.D	4.1: The Internet
5	A	2.B	AAP-2.K.a	3.8: Iteration
6	C	5.E	IOC-2.B	5.6: Safe Computing
7	C	2.A	AAP-2.J	3.8: Iteration
8	C	1.D	CSN-1.E.a	4.2: Fault Tolerance
9	B	3.C	DAT-1.A	2.1: Binary Numbers
10	C	2.B	DAT-1.C.a	2.1: Binary Numbers
11	D	2.B	DAT-1.C.a	2.1: Binary Numbers
12	C	2.B	AAP-2.H.a	3.6: Conditionals
13	C	1.C	CRD-1.A	1.1: Collaboration
14	C	4.C	CRD-2.I.b	1.4: Identifying and Correcting Errors
15	A	3.B	AAP-3.A.a	3.12: Calling Procedures
16	B	5.E	IOC-1.F	5.5: Legal and Ethical Concerns
17	B	1.D	CSN-1.E.c	4.2: Fault Tolerance
18	C	1.D	CSN-1.E.c	4.2: Fault Tolerance
19	D	5.E	IOC-2.B	5.6: Safe Computing
20	D	5.A	CSN-1.A	4.1: The Internet
21	A	1.D	DAT-1.B	2.1: Binary Numbers
22	A	1.D	AAP-2.L	3.9: Developing Algorithms
23	B	5.A	CSN-1.B	4.1: The Internet
24	C	1.D	DAT-1.D	2.2: Data Compression
25	D	4.B	AAP-2.K.b	3.8: Iteration
26	A	1.D	CSN-2.B	4.3: Parallel and Distributed Computing
27	B	5.E	IOC-1.D	5.3: Computing Bias
28	D	2.A	AAP-2.J	3.8: Iteration
29	D	2.A	AAP-2.J	3.8: Iteration
30	B	5.A	CSN-1.C	4.1: The Internet
31	C	2.B	DAT-1.C.b	2.1: Binary Numbers
32	A	5.E	IOC-2.B	5.6: Safe Computing

Multiple-Choice Question	Answer	Skill	Learning Objective	Topic
33	B	1.D	AAP-4.A.b	3.17: Algorithmic Efficiency
34	B	4.C	CRD-2.I.b	1.4: Identifying and Correcting Errors
35	B	5.B	DAT-2.A	2.3: Extracting Information from Data
36	D	5.D	IOC-2.A	5.6: Safe Computing
37	C	4.B	AAP-2.I.b	3.7: Nested Conditionals
38	D	1.D	AAP-3.F.b	3.16: Simulations
39	C	2.B	DAT-1.C.a	2.1: Binary Numbers
40	B	5.C	IOC-1.C	5.2: Digital Divide
41	A	1.C	IOC-1.E	5.4: Crowdsourcing
42	A	4.B	AAP-2.O.b	3.10: Lists
43	A	5.E	IOC-2.C	5.6: Safe Computing
44	B	1.D	DAT-1.B	2.1: Binary Numbers
45	C	3.B	AAP-3.A.a	3.12: Calling Procedures
46	D	2.B	DAT-2.D	2.4: Using Programs with Data
47	B	2.B	DAT-2.D	2.4: Using Programs with Data
48	A	5.E	IOC-2.C	5.6: Safe Computing
49	D	1.A	AAP-4.B	3.18: Undecidable Problems
50	A	5.E	IOC-2.B	5.6: Safe Computing
51	A	1.C	IOC-1.E	5.4: Crowdsourcing
52	B	1.D	AAP-2.P	3.11: Binary Search
53	A	2.A	AAP-2.J	3.8: Iteration
54	B	5.B	DAT-2.A	2.3: Extracting Information from Data
55	C	2.B	AAP-2.N.a	3.10: Lists
56	A	5.B	DAT-2.A	2.3: Extracting Information from Data (2.3)
57	A	1.D	CSN-2.A.b	4.3: Parallel and Distributed Computing
58	D	3.A	CRD-2.C	1.2: Program Function and Purpose
59	C	3.A	CRD-2.C	1.2: Program Function and Purpose
60	D	5.C	IOC-1.A	5.1: Beneficial and Harmful Effects
61	B	5.D	IOC-2.A	5.6: Safe Computing
62	C	5.C	IOC-1.B	5.1: Beneficial and Harmful Effects



Multiple-Choice Question	Answer	Skill	Learning Objective	Topic
131	A,D	2.B	AAP-2.Fa	3.5: Boolean Expressions
132	B,C	4.C	CRD-2.I.b	1.4: Identifying and Correcting Errors
133	B,C	4.B	AAP-2.H.b	3.6: Conditionals
134	A,D	2.B	AAP-2.H.a	3.6: Conditionals
135	A,D	2.B	AAP-3.E.a	3.15: Random Values
136	A,C	1.B	CRD-2.J	1.4: Identifying and Correcting Errors
137	A,D	5.B	DAT-2.B	2.3: Extracting Information from Data
138	A,C	3.B	AAP-3.A.a	3.12: Calling Procedures