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Practice: Spring 2023 Midterm Exam

⚠ This is a preview of the draft version of the quiz

Instructions

- This exam is an individual effort.
- You are not permitted to help others, in any way, with this exam.
- You are not permitted to release or to discuss this exam with anyone, except the course staff, until given permission to do so by the instructors (which will not occur until all students have completed the exam. There may be exceptional cases that take it late).
- You are permitted to use only the official course textbook, the official course slides, and your own personal notes.
- A simple calculator is permitted, but won't prove to be helpful (we don't think).
- You have 90 minutes, from first exposure through submission to take this exam. Do not attempt to "peek", "check", or "test" the exam. This will start your clock.
- We only expect the exam to take 70-90 minutes.
- The exam counts for the 25% "exam portion" of the midterm grade, but is reduced to counting as a "double homework" for the final grade.
- In order to make the exam an "invested but low stakes" experience, half of this exam's weight toward the final grade may be dropped as one of the two "homework drops", but the full weight can't be dropped.

Question	Topic	Points
1	Integers	10
2	Floats	15
3	Array Sizes	5
4	Array Arithmetic	5

5	Structs and Alignment	12
6	Assembly: Basic	8
7	Assembly: Switch	15
8	Assembly: Loops and Conditionals	12
9	Memory Hierarchy	5
10	Locality	3
11	Caching	10
Total:		100

Quiz Type Graded Quiz

Points 100

Assignment Group Midterm Exam (Homeworks #6 and #7)

Shuffle Answers No

Time Limit 90 Minutes

Multiple Attempts Yes

Score to Keep Highest

Attempts Unlimited

View Responses Always

Show Correct Answers After Aug 28, 2023 at 12:01am

One Question at a Time No

Require Respondus LockDown Browser No

Required to View Quiz Results No

Webcam Required No

Due	For	Available from	Until
May 3	Everyone	Jan 16 at 10pm	May 3 at 11:59pm

Preview

Score for this attempt: 0 out of 100

Submitted Aug 24 at 9:12am

This attempt took less than 1 minute.



Unanswered Question 1

0 / 10 pts

1. Integers (10 points, 2 points per blank)

This question is based upon the following declaration on a **machine using 8-bit two's complement arithmetic for signed integers**.

Fill in the empty boxes in the table below.

- **Show all digits for the "Binary" column, including any leading 0s. Do not add spaces, letters, annotations, groupings, units, etc.**
- You need not fill in entries marked with "--".
- TMax denotes the largest positive two's complement number
- TMin denotes the most negative two's complement number.

Expression	Decimal Representation	Binary Representation
0xFF	<input type="text"/>	-
0x80	<input type="text"/>	-
-28 - 5	<input type="text"/>	-
--	<input type="text"/>	10000001
100 + 70	<input type="text"/>	--

Answer 1:

You Answered (You left this blank)

Correct Answer

-1

Correct Answer

- 1

Answer 2:

You Answered (You left this blank)

Correct Answer

-128

Correct Answer

- 128

Answer 3:

You Answered (You left this blank)

Correct Answer

-33

Correct Answer

- 33

Answer 4:

You Answered (You left this blank)

Correct Answer

-127

Correct Answer

- 127

Answer 5:

You Answered (You left this blank)

Correct Answer

-86

Correct Answer

- 86



2. Floats (15 points)

The floating point questions below are based upon an IEEE-like floating point format with the following specification:

- 8-bit width
- There is $s = 1$ sign bit
- There are $k = 3$ fraction bits
- Wherever rounding is necessary, round-to-even should be used. In addition, you should give the rounded value of the encoded floating point number.
- This question asks about the undecoded bits within the IEEE-like representation, answer in binary without spaces, groupings, annotations, letters, units, etc.



Unanswered Question 2

0 / 1 pts

Question 2: Floats (15 points, 1 point for this part)

2(A) (1 points) What is the bias? (Answer in decimal)

You Answered

3 (with margin: 0)



Unanswered Question 3

0 / 1 pts

Question 2: Floats (15 points, 1 point for this part)

2(B) (1 points) What is the exponent for denormalized numbers? (Answer in decimal)

Hint: This question asks about the actual, decoded exponent, not the bit pattern or value of the bit pattern in isolation.

You Answered

-2 (with margin: 0)



UnansweredQuestion 4

0 / 1 pts

Question 2: Floats (15 points, 1 point for this part)

2(C) (1 points) What is the maximum exponent for normalized numbers? (Answer in decimal)

Hint: This question asks about the actual, decoded exponent, not the bit pattern or value of the bit pattern in isolation.

You Answered

3 (with margin: 0)



UnansweredQuestion 5

0 / 1 pts

Question 2: Floats (15 points, 1 point for this part)

2(D) (1 points) What exponent bit pattern is used for special values (infinity, NaN, etc)?

Hint: This question asks about the undecoded bits within the IEEE-like representation, answer in binary without spaces, groupings, annotations, letters, units, etc.

You Answered

111 (with margin: 0)



Unanswered Question 6

0 / 11 pts

Question 2: Floats (11 points, 1 point for each blank in this part)

This question is based upon an IEEE-like floating point format with the following specification:

- 8-bit width
- There is $s = 1$ sign bit
- There are $k = 4$ fraction bits
- **Wherever rounding is necessary, round-to-even** should be used. In addition, you should give the rounded value of the encoded floating point number.
- If the question asks about the undecoded bits within the IEEE-like representation, answer in binary without spaces, groupings, annotations, letters, units, etc.
- **For the 3rd column: Answer as a fully reduced decimal fraction**, i.e. use the smallest denominator possible without a fractional numerator. The fraction need not be proper: In other words, **the numerator can be larger than the denominator.**

2(E-I) (1 point per blank) Fill in the following:

Value	Binary Representation	Rounded Value as a reduced decimal fraction	Rounding <i>ERROR</i> as a reduced decimal fraction
-13	<input type="text"/>	--	--
13/16	<input type="text"/>	--	--
- Infinity -Inf	<input type="text"/>	--	--

3-3/8	<input type="text"/>	<p>Fully reduced:</p> <input type="text"/> / <input type="text"/>	<p>Fully reduced: (neglect sign)</p> <input type="text"/> / <input type="text"/>
-5/32	<input type="text"/>	<p>Fully reduced:</p> <p>-</p> <input type="text"/> / <input type="text"/>	<p>--</p>

Answer 1:

You Answered (You left this blank)

Correct Answer

1 110 1010

Correct Answer

11101010

Correct Answer

11101010b

Correct Answer

11101010 b

Correct Answer

1110 1010

Correct Answer

1110 1010 b

Correct Answer

1110 1010b

Answer 2:

You Answered (You left this blank)

Correct Answer

0 010 1010

Correct Answer

00101010

Correct Answer

00101010b

Correct Answer

00101010 b

Correct Answer

0010 1010

Correct Answer

0010 1010 b

Correct Answer

0010 1010b

Correct Answer

0 010 1010b

Answer 3:

You Answered (You left this blank)

Correct Answer

11110000

Correct Answer

11110000b

Correct Answer

11110000 b

Correct Answer

1 111 0000

Correct Answer

1 111 0000 b

Correct Answer

1 111 0000b

Answer 4:

You Answered (You left this blank)

Correct Answer

0 100 1011

Correct Answer

01001011

Correct Answer

01001011b

Correct Answer

01001011 b

Correct Answer

0100 1011

Answer 5:

You Answered (You left this blank)

Correct Answer

27

Answer 6:

You Answered (You left this blank)

Correct Answer

8

Answer 7:

You Answered (You left this blank)

Correct Answer

0

Answer 8:

You Answered (You left this blank)

Correct Answer

1

Answer 9:

You Answered (You left this blank)

Correct Answer

1 000 1010

Correct Answer

10001010

Correct Answer

10001010b

Correct Answer

10001010 b

Correct Answer

1000 1010

Correct Answer

1000 1010b

Correct Answer

1000 1010 b

Answer 10:

You Answered (You left this blank)

Correct Answer

5

Answer 11:

You Answered (You left this blank)

Correct Answer

32



Unanswered Question 7

0 / 5 pts

3. Arrays Sizes (5 points, 2.5pts per part)

Consider the following definitions in an x86-64 system with 8-byte pointers and 2-byte shorts, 4-byte ints, and 8-byte longs. Answer with only a decimal number

Definition A	Definition B
<code>int numbersA[5][3][2];</code>	<code>char *numbersB = numbersA;</code>

3(A) (2.5 points): If the address of numbersB is 10000, what is the address of numbersA[3][2][1]?

Hint: Answer with only a whole decimal number. Not prefix, no suffix, no units, etc. Just a number

The address of numbersA[3][2][1] is

Hint: Answer with only a whole decimal number. No units. no fractions. No weirdness.

3(B) (2.5 points): What would be returned by sizeof(numbersB) after the assignment is completed?

Hint: Answer with only a whole decimal number. No units. no fractions. No weirdness.

Answer 1:

You Answered (You left this blank)

Correct Answer

10092

Correct Answer

0x276C

Correct Answer

276C

Answer 2:

You Answered (You left this blank)

Correct Answer

8



5. Structs and Alignment (12 points, 2 points per part)

The struct questions below are based upon the following definition as implemented on a shark machine, i.e. x86-64 with 1-byte chars, 2-byte shorts, 4-byte ints, 8-byte longs, and 8-byte pointers.

```
struct {
    char c1;
    short s;
    long l;
    int i;
} exam;
```

Assume a system which requires “natural alignment” (the alignment presented in lectures), i.e. each type needs to be aligned to a multiple of its data type size.



Unanswered Question 8

0 / 2 pts

5. Structs and Alignment (12 points, 2 points per part)

5(A) (2 points) What is the value of `sizeof(struct exam)`?

You Answered

24 (with margin: 0)



Unanswered Question 9

0 / 2 pts

5. Structs and Alignment (12 points, 2 points per part)

5(B) (2 points) How many bytes of padding does the compiler introduce after `s`?

You Answered

4 (with margin: 0)



UnansweredQuestion 10

0 / 2 pts

5. Structs and Alignment (12 points, 2 points per part)

5(C) (2 points) How many bytes of padding does the compiler introduce after l?

You Answered

0 (with margin: 0)



UnansweredQuestion 11

0 / 2 pts

5. Structs and Alignment (12 points, 2 points per part)

5(D) (2 points) How many bytes of padding does the compiler introduce after i?

You Answered

4 (with margin: 0)



UnansweredQuestion 12

0 / 2 pts

5. Structs and Alignment (10 points, 2 points per part)

5(E) (2 points) Which of the following field orderings minimize the amount of padding introduced by the compiler?

c1, s, l, i

c1, l, s, i

Correct Answer

l, i, s, c1

l, s, i, c1

All of the above

None of the above



Unanswered Question 13

0 / 2 pts

5. Structs and Alignment (12 points, 2 points per part)

5(F) (2 points) Assuming the fields of the struct were organized optimally by the programmer, what would be the value of `sizeof (struct exam)`?

You Answered

16 (with margin: 0)



Unanswered Question 14

0 / 10 pts

6. Assembly-Basic (8 points, 2 points per part)

Please consider the following assembly:

fun:

```

movslq %edx, %rdx
movslq %edi, %rdi
movzwl (%rsi,%rdx,2), %eax
movw %ax, (%rsi,%rdi,2)
movzwl 4(%rsi,%rdx,2), %eax
sall $4, %eax
movw %ax, 4(%rsi,%rdi,2)
movzwl 6(%rsi), %eax

```

ret

6(A) (2 points) What type are the elements of the array? [Select]

6(B) (2 points) Which of the following arguments to the function contains the base of an array? Answer 0, 1, 2, 3, 4, 5, or 6 [Select]

6(C) (2 points) Which of the following arguments to the function contains an index to the array? Answer 0, 1, 3, 4, or 5 [Select]

6(D) (2 points) This code performs a mathematical operation, which one is performed? [Select]

6(E) (2 points) Which of the following is one of the operands for the operation above? [Select]

Answer 1:

You Answered (You left this blank)

char

Correct Answer

short

int

long

Answer 2:

You Answered (You left this blank)

0

Correct Answer

2

4

6

Answer 3:

You Answered (You left this blank)

Correct Answer

0

1

3

4

5

Answer 4:

You Answered (You left this blank)

Multiply by 2

Multiply by 4

Multiply by 5

Multiply by 8

Multiply by 10

Correct Answer

Multiply by 16

Multiply by 20

addition

subtraction

multiplication

division

Answer 5:

You Answered (You left this blank)

16

Correct Answer

4

1/4

-16

-4

-1/4



7. Assembly-Switch (18 points)

Consider the following code, which was compiled from C Programming Language source code containing one switch statement and no (zero) if statements:

```
(gdb) disassemble foo
Dump of assembler code for function foo:
   0x000000000040052d <+0>:   push   %rbp
   0x000000000040052e <+1>:   mov    %rsp,%rbp
   0x0000000000400531 <+4>:   mov    %edi,-0x4(%rbp)
   0x0000000000400534 <+7>:   mov    %esi,-0x8(%rbp)
   0x0000000000400537 <+10>:  cml    $0x5,-0x8(%rbp)
   0x000000000040053b <+14>:  ja     0x40055d <foo+48>
   0x000000000040053d <+16>:  mov    -0x8(%rbp),%eax
   0x0000000000400540 <+19>:  mov    0x400640(,%rax,8),%rax
   0x0000000000400548 <+27>:  jmpq   *%rax
   0x000000000040054a <+29>:  addl   $0x1,-0x4(%rbp)
   0x000000000040054e <+33>:  addl   $0x4,-0x4(%rbp)
   0x0000000000400552 <+37>:  shll   -0x4(%rbp)
   0x0000000000400555 <+40>:  jmp    0x400560 <foo+51>
   0x0000000000400557 <+42>:  subl   $0x2,-0x4(%rbp)
   0x000000000040055b <+46>:  jmp    0x400560 <foo+51>
   0x000000000040055d <+48>:  shll   -0x4(%rbp)
   0x0000000000400560 <+51>:  mov    -0x4(%rbp),%eax
   0x0000000000400563 <+54>:  pop    %rbp
   0x0000000000400564 <+55>:  retq
End of assembler dump.
```


Consider also the following dump:

```

0x400630:      0x0000000000020001      0x0000000000000000
0x400640:      0x0000000000040054a    0x0000000000040054e
0x400650:      0x0000000000040054e    0x00000000000400552
0x400660:      0x0000000000040055d    0x00000000000400557
0x400670:      0x0000003c3b031b01     0xfffffd9000000006
0x400680:      0xfffffdd000000088     0xfffffebd00000058
0x400690:      0xfffffef5000000b0     0xfffff4000000d0
0x4006a0:      0xffffffb0000000f0     Cannot access memory at address 0x4006a8

```



UnansweredQuestion 15

0 / 3 pts

7(A)(3 points) What is the address of case=3's entry in the switch table (not what the switch table points to)? Please do **not** include the leading 0s or a leading 0x

You Answered

Correct Answers

400658

0x400658

0x00000000000400658

0000000000400658



UnansweredQuestion 16

0 / 3 pts

7. Assembly-Switch (18 points)

7(B) (3 points) Which of the following executes for case 3?

- addl \$0x1,-0x4(%rbp)
- addl \$0x4,-0x4(%rbp)
- subl \$0x2,-0x4(%rbp)

Correct Answer

- shll -0x4(%rbp)
- mov -0x8(%rbp),%eax
- None of the above



UnansweredQuestion 17

0 / 3 pts

7. Assembly-Switch (18 points)

7(C) (3 points) Which integer input values are managed by non-default cases of the switch statement?
Check all that apply.

Correct Answer

 0

Correct Answer

 1

Correct Answer

 2

Correct Answer

 3 4

Correct Answer

 5 Other value(s) in addition to those above None of the above

UnansweredQuestion 18

0 / 3 pts

7. Assembly-Switch (18 points)

7(D) (3 points) If there is a default case, at what address, in hex, does the begin?

- If there isn't a default case, write NONE.
- When writing an address, please do not include any leading 0s, prefixes or suffixes, or any spaces, and please write any letters in either all upper or all lower case, not mixed case. Please do not include the 0x prefix.

Your answer: [blank]

You Answered

Correct Answers

0x000000000040055d

0x000000000040055D

000000000040055d

000000000040055D

40055d

40055D



UnansweredQuestion 19

0 / 3 pts

7. Assembly-Switch (18 points)

7(E) (3 points) Which of the following case(s), if any, consist of exactly the same code as least one other, **but not default**, case (no extra code, no code missing)? Check all that apply. [exact_same]

0

Correct Answer

1

Correct Answer

2

3

4

5

None of the above



UnansweredQuestion 20

0 / 3 pts

7. Assembly-Switch (18 points)

7(F) (3 points) Which case(s), if any, fall through to the next case *after executing some of their own code*?

Correct Answer

0

1

2

3

- 4
- 5
- None of the above



8. Loops and Conditionals (12 points)

Consider the following code, under the assumption that it was compiled in the same environment using the same "shark machine" toolset you've used all semester:

```
(gdb) disassemble loop
Dump of assembler code for function loop:
0x00000000040059d <+0>:    push   %rbp
0x00000000040059e <+1>:    mov    %rsp,%rbp
0x0000000004005a1 <+4>:    push   %rbx
0x0000000004005a2 <+5>:    mov    %edi,-0x1c(%rbp)
0x0000000004005a5 <+8>:    mov    %esi,-0x20(%rbp)
0x0000000004005a8 <+11>:   mov    %edx,-0x24(%rbp)
0x0000000004005ab <+14>:   mov    %rcx,-0x30(%rbp)
0x0000000004005af <+18>:   mov    $0x0,%ebx
0x0000000004005b4 <+23>:   mov    -0x1c(%rbp),%eax
0x0000000004005b7 <+26>:   mov    %eax,-0xc(%rbp)
0x0000000004005ba <+29>:   jmp   0x4005d8 <loop+59>
0x0000000004005bc <+31>:   mov    -0xc(%rbp),%eax
0x0000000004005bf <+34>:   cltq
0x0000000004005c1 <+36>:   lea   0x0(,%rax,4),%rdx
0x0000000004005c9 <+44>:   mov    -0x30(%rbp),%rax
0x0000000004005cd <+48>:   add   %rdx,%rax
0x0000000004005d0 <+51>:   mov    (%rax),%eax
0x0000000004005d2 <+53>:   add   %eax,%ebx
0x0000000004005d4 <+55>:   addl  $0x2,-0xc(%rbp)
0x0000000004005d8 <+59>:   mov    -0xc(%rbp),%eax
0x0000000004005db <+62>:   cmp   -0x24(%rbp),%eax
0x0000000004005de <+65>:   jl    0x4005bc <loop+31>
0x0000000004005e0 <+67>:   mov    -0x1c(%rbp),%eax
0x0000000004005e3 <+70>:   add   $0x1,%eax
0x0000000004005e6 <+73>:   mov    %eax,-0x10(%rbp)
0x0000000004005e9 <+76>:   jmp   0x400607 <loop+106>
0x0000000004005eb <+78>:   mov    -0x10(%rbp),%eax
0x0000000004005ee <+81>:   cltq
0x0000000004005f0 <+83>:   lea   0x0(,%rax,4),%rdx
0x0000000004005f8 <+91>:   mov    -0x30(%rbp),%rax
0x0000000004005fc <+95>:   add   %rdx,%rax
0x0000000004005ff <+98>:   mov    (%rax),%eax
0x000000000400601 <+100>:  add   %eax,%ebx
0x000000000400603 <+102>:  addl  $0x2,-0x10(%rbp)
0x000000000400607 <+106>:  mov    -0x10(%rbp),%eax
0x00000000040060a <+109>:  cmp   -0x24(%rbp),%eax
0x00000000040060d <+112>:  jl    0x4005eb <loop+78>
0x00000000040060f <+114>:  mov    %ebx,%eax
0x000000000400611 <+116>:  pop   %rbx
0x000000000400612 <+117>:  pop   %rbp
0x000000000400613 <+118>:  retq
End of assembler dump.
```



UnansweredQuestion 21

0 / 3 pts

8. Loops and Conditionals (12 points)**8(A) (3 points)** How many loops are in the code? 0 1

Correct Answer

 2 3 4 or more

UnansweredQuestion 22

0 / 3 pts

8. Loops and Conditionals (12 points)**8(B) (3 points)** What is the relationship between/among the loop(s)? There is only one loop, so there is no relationship between or among loops They are all nested

Correct Answer

 One after another Nested and one after another

UnansweredQuestion 23

0 / 3 pts

8. Loops and Conditionals (12 points)**8(C) (3 points)** Which of the following are true? Check all that apply. Two or more loops have a starting value in common, e.g. progress with the same number.

Correct Answer

 Two or more loops have a stopping value in common, e.g. progress up to or down to the same number. The loops have body code in common

UnansweredQuestion 24

0 / 3 pts

8. Loops and Conditionals (12 points)

8(D) (3 points) How many times is the ?-operator likely used in the source C Language code?

Correct Answer

- 0
- 1
- 2
- 3
- 4 or more



UnansweredQuestion 25

0 / 5 pts

9. Memory Hierarchy (5 points)

You are given the following:

- L1 cache with an access time of 2ns and a miss rate of 1%
- L2 cache with an access time of 10ns and a miss rate of 10%
- Main memory with an access time of 100ns

Access to a level of the memory hierarchy is preceded by access to the layers above it. The times given do **not** include this prior time.

What is the effective (average) memory access time for this system in nS? Please include only the number, not the units. Please answer in decimal notation (not fractional notation)

You Answered

2.2 (with margin: 0)



UnansweredQuestion 26

0 / 3 pts

10. Locality (3 points)

Consider a cache with 4 sets, 2 lines/set, and a block size of 16 bytes on a system with 2-byte shorts.

What is the maximum stride (index step) size while sequentially accessing a 1D short array to maintain a cache miss rate of no more than 28%?

You Answered

2 (with margin: 0)



11. Caching (10 points)

Given a model described as follows:

- 8-bit addresses
- 2-way set associative
- 4 sets
- Total size: 64 bytes (not counting meta data)
- Replacement policy: Set-wise LRU



UnansweredQuestion 27

0 / 1 pts

11. Caching (10 points)

11(A) (1 point) How many lines per set?

You Answered

2 (with margin: 0)



UnansweredQuestion 28

0 / 1 pts

11. Caching (10 points)

11(B) (1 point) How many bytes per block?

You Answered

8 (with margin: 0)



UnansweredQuestion 29

0 / 8 pts

11. Caching (10 points)

11(C) (8 points, 0.5 points each blank): Consider the following memory access trace, which is in order and begins at the beginning of time. For each of the following memory accesses, please indicate if it hits or misses, and if it misses, if it suffers from a capacity miss, a conflict miss, or a cold miss:

Question Number	Address	Hit or Miss? Circle one (per row):	Miss Type? Circle one (per row)
11(C)(1)	0x20	[Select]	[Select]
11(C)(2)	0x40	[Select]	[Select]
11(C)(3)	0X42	[Select]	[Select]
11(C)(4)	0X22	[Select]	[Select]
11(C)(5)	0X66	[Select]	[Select]
11(C)(6)	0X80	[Select]	[Select]
11(C)(7)	0XA0	[Select]	[Select]
11(C)(8)	0X42	[Select]	[Select]

Answer 1:

You Answered (You left this blank)

Hit

Correct Answer

Miss

Answer 2:

You Answered (You left this blank)

N/A

Capacity

Correct Answer

Cold/Compulsory

Conflict

Answer 3:

You Answered (You left this blank)

Hit

Correct Answer

Miss

Answer 4:

You Answered (You left this blank)

N/A

Capacity

Correct Answer

Cold/Compulsory

Conflict

Answer 5:

You Answered (You left this blank)

Correct Answer

Hit

Miss

Answer 6:

You Answered (You left this blank)

Correct Answer

N/A

Capacity

Cold/Compulsory

Conflict

Answer 7:

You Answered (You left this blank)

Correct Answer

Hit

Miss

Answer 8:

You Answered (You left this blank)

Correct Answer

N/A

Capacity

Cold/Compulsory

Conflict

Answer 9:

You Answered (You left this blank)

Hit

Correct Answer

Miss

Answer 10:

You Answered (You left this blank)

N/A

Capacity

Correct Answer

Cold/Compulsory

Conflict

Answer 11:

You Answered (You left this blank)

Hit

Correct Answer

Miss

Answer 12:

You Answered (You left this blank)

N/A

Capacity

Correct Answer

Cold/Compulsory

Conflict

Answer 13:

You Answered (You left this blank)

Hit

Correct Answer

Miss

Answer 14:

You Answered (You left this blank)

N/A

Capacity

Correct Answer

Cold/Compulsory

Conflict

Answer 15:

You Answered (You left this blank)

Hit

Correct Answer

Miss

Answer 16:

You Answered (You left this blank)

N/A

Capacity

Cold/Compulsory

Correct Answer

Conflict

Quiz Score: 0 out of 100