COMP 102 · FORMAN CHRISTIAN UNIVERSITY

Midterm Exam

Programming Fundamentals **ANSWER KEY**

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Tue 20 Oct 2026
1 h 45 min
100 marks
13 pages

YOU

Name

Roll number

Section ◯ A ◯ B

I pledge that the work in this booklet is my own, done without help from anyone or anything the rules do not allow.

Signature

FOR THE EXAMINER

Ch.	Out of	Score
1	20	
2	20	
3	15	
4	10	
5	15	
6	20	
Total	**100**	
Bonus	10	

THE RULES

Closed Do not open this booklet until you are told to.

Phones Phones and smart watches switched off and in your bag. No books, notes or calculators.

Pages Check that you have all 13 pages. The last two pages are for rough work.

Python All code is Python 3 as Thonny runs it. Where a line stops with an error, write `Error`.

Time Each chapter shows its marks and about how many minutes it needs. Stuck? Move on.

Your code Indentation counts. Use only what the lectures so far have taught.

Doubts If a question seems wrong, write what you assumed and carry on. Invigilators cannot explain the content.

Answers Write each answer on its rule or in its box. Work elsewhere is not marked unless you point to it.

Pen Answers in pen; pencil only for rough work.

Roll no Put your roll number at the top of every page.

1 Inside the Shell

20 marks · about 18 min

For every line, write exactly what Python shows. If a line stops with an error, write the word `Error`*.*

(a) **[8 marks] A Shell session.** On each blank, write what the Shell shows after that line is entered. A line that only stores a value shows nothing, so it has no blank.

```
>>> runs = 112
>>> runs // 10          11
>>> runs % 10           2
>>> runs / 2            56.0
>>> flight = "PK-3417"
>>> len(flight)         7
>>> flight[1] + flight[3]   'K3'
>>> flight[3:5]         '34'
>>> int(flight[3:7]) + 1    3418
>>> flight[0] == "P" and runs > 112   False
```

Key. One mark a rule. The quotes round a string are not needed. `56` for `56.0` is wrong.

(b) **[4 marks] One program, four runs.** The program reads a distance in km and prints how to travel. The user runs the program **four separate times**, and each time types a different number: one row of the table for each run. Write what the program prints each time.

```
km = int(input())
if km < 5:
    print("walk")
elif km <= 20:
    print("cycle")
else:
    print("drive")
```

The user types	The program prints
4	`walk`
5	`cycle`
20	`cycle`
21	`drive`

Key. One mark a row: `walk`, `cycle`, `cycle`, `drive`. 5 is not below 5, and 20 is not above 20. The quotes round a word are not needed.

(c) **[8 marks] A second Shell session.** The file in the small box has just been run with F5, so the Shell knows `share`. Further down, `goals` holds the goals scored in four matches.

```
def share(sweets, kids=2):
    return sweets // kids
```

```
>>> share(90)                                  45
>>> share(90, 20)                              4
>>> twice = lambda n: n * 2
>>> twice(share(10)) + 1                       11
>>> goals = [3, 0, 5, 2]
>>> goals[1] + goals[-1]                       2
>>> goals[1:3]                                 [0, 5]
>>> sum(goals) / len(goals)                    2.5
>>> low, high = min(goals), max(goals)
>>> high - low                                 5
>>> goals[4]                                   Error
```

Key. One mark a rule. For `goals[4]`, `IndexError` also earns the mark.

---

2 Follow the Tracks

20 marks · about 20 min

Go through each program one step at a time and write down what is in memory.

(a) **[8 marks] A trace table.** To *trace* a program, follow it one line at a time and keep track of its variables. One run of the loop body (lines 4 to 6) is one **round**, and each row of the table is one round.

```
1 money = 90
2 week = 0
3 while money > 15:
4     spent = money // 3
5     money = money - spent
6     week = week + 1
7 print(week, money)
```

Round	spent	money	week
1	30	60	1
2	20	40	2
3	13	27	3
4	9	18	4
5	6	12	5

i. **[5 marks]** For each round, write the values of `spent`, `money` and `week` at the **end** of that round.

ii. **[1 mark]** The program prints: `5 12`

iii. **[2 marks]** Line 3 is changed to `while money >= 12:` and the program is run again. Now it prints: `6 8`

Key. (i) One mark for each of rounds 1 to 5. A row counts if all three values follow correctly from the row above, so one slip costs one mark. (iii) `12 >= 12` is `True`, so one more round runs.

(b) **[7 marks] Frames.** Fill in the frames the way the lectures draw them: one `name : value` row for each name, and for a name that holds a function write `func` as its value. Leave spare rows empty. If a frame no longer exists at that moment, cross out its whole box. Memory is drawn at **two moments** of the run. Each dashed box is one moment, a snapshot: both frames inside it belong to that moment.

```
1 rate = 80
2 def discount(price, rate):
3     off = price * rate // 100
4     # * pause here
5     return off
6 price = 120
7 n = discount(price - 20, 75)
```

i. **[5 marks] Snapshot 1:** the program has stopped at the line marked `*`, inside the call, just before line 5 runs. Fill in its two frames.

ii. **[2 marks] Snapshot 2:** line 7 has finished. Fill in its two frames.

Snapshot 1
stopped at *, just before line 5 runs

Global frame

rate	80
discount	func
price	120

discount frame

price	100
rate	75
off	75

Snapshot 2
after line 7 has finished

Global frame

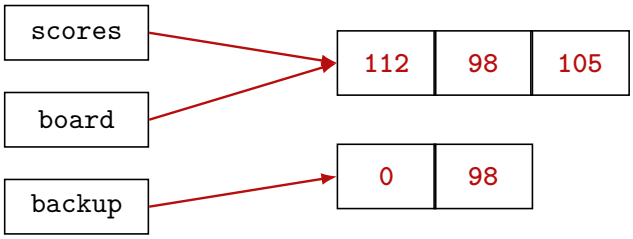
rate	80
discount	func
price	120
n	75

discount frame

Key. (i) Global frame 2 marks: the three rows, and no `n` yet (one slip, 1 mark). `discount` frame 3 marks, one a row: the frame has its own `price` and `rate`, and the caller's 120 and 80 are untouched. (ii) `n : 75` 1 mark; the `discount` frame crossed out 1 mark. The order of the rows does not matter.

(c) **[5 marks] Arrows.** Read the program on the left.

```
1 scores = [112, 98]
2 board = scores
3 backup = scores[:]
4 board.append(105)
5 backup[0] = 0
```



i. **[2 marks]** The picture shows memory after line 5: three names and two list objects. Draw an arrow from each name to the list it points at.

ii. **[2 marks]** Write the value held in each of the five cells.

iii. **[1 mark]** Write `True` or `False` on each rule.

`scores is board` **True** `scores == backup` **False**

Key. (i) All three arrows 2 marks, two of them 1 mark. `board` is a second name for the same list; `[:]` made a new one. (ii) One mark a list. (iii) Both needed for the mark.

3 The Case of the Wrong Count

15 marks · about 16 min

One program gives the wrong answer. For another, work out what the user typed from what it printed.

(a) **[8 marks] Two bugs.** `count_top(total, got)` gets two lists of the same length: `total[i]` is the total marks of test `i`, and `got[i]` is the student's mark in it. A test is a *top* test if the student got 80% marks or more. Line 9 should print `2`: the student got 80% in the first test (top), 50% in the second and 90% in the third (top). It does not. The program has exactly **two** bugs. No line is missing and no line is extra.

```
1 def count_top(total, got):
2     """How many tests are top tests."""
3     top = 0
4     for i in range(len(total)):
5         rate = got[i] * 100 // total[i]
6         if rate > 80:
7             top = top + 1
8         return top
9 print(count_top([100, 120, 50], [80, 60, 45]))
```

What a **correct** `count_top` returns for two other calls:

```
>>> count_top([50], [20])
0
>>> count_top([10, 5], [9, 5])
2
```

i. **[2 marks]** As it stands, line 9 prints `0` and line 5 runs `1` time(s).

ii. **[6 marks]** Give the number of each line that has a bug, and write the line as it should be. If only the indentation of a line is wrong, say which line it should line up with.

Line	The line as it should be
6	`if rate >= 80:`
8	`return top` moved left, to line up with `for` on line 4

Key. (i) One mark each: the `return` is inside the loop, so the function leaves in round 1, where `80 > 80` is `False`. (ii) For each bug: line number 1 mark, repair 2 marks. `rate > 79` is also right, and so is any other repair that keeps the rule and makes line 9 print 2.

(b) **[7 marks] Work backwards.** This program has **no bugs**. The user types the number of days, then the minutes of exercise for each day, one per line. No number is negative.

```
1 days = int(input())
2 total = 0
3 best = 0
4 for i in range(days):
5     minutes = int(input())
6     total = total + minutes
7     if minutes > best:
8         best = minutes
9 print(total, best)
```

i. **[2 marks]** The user types the four lines in the box, exactly as shown.

```
3
90
120
90
```

The program prints: `300 120`

ii. **[2 marks]** In another run the program printed `250 100`. The user typed `3` first, and two of the days had 100 and 60 minutes. How many minutes did the third day have? `90`

iii. **[1 mark]** The shortest input that makes the program print `0 0` is: `0`

iv. **[2 marks]** Someone says that a run printed `100 120`. In one sentence, explain why this program can never print that.

Key. (iv) `best` is one of the numbers added into `total` and none is negative, so `total` is never below `best`. Both halves 2 marks; "the total is at least the biggest" with no reason 1 mark. (iii) The loop never runs. `1` then `0` prints the same but is longer: no mark.

4 Three Answers, One Job

10 marks · about 12 min

Three students wrote the same function. Only one of them is right. Run each one in your head and find it.

What was asked for. The function `clean(counts)` is given a list of numbers. It **returns a new list** that holds only the numbers that are not `0`, in the same order. **The list it was given must not change.**

The test. The test is the code in the box on the **right**. Each answer below is run with it. With a correct `clean`, the test prints `[98]` and then `[0, 0, 98, 0]`.

The test

```
votes = [0, 0, 98, 0]
r = clean(votes)
print(r)
print(votes)
```

(a) **[5 marks]** Beside each answer, write **everything** the test prints when it is run with that answer, one line of output on each rule. Leave spare rules empty. (Answer A: 2 marks, B: 1 mark, C: 2 marks.)

Answer A

```
def clean(counts):
    kept = []
    for c in counts:
        if c != 0:
            kept.append(c)
    print(kept)
```

The test prints:

`[98]`

`None`

`[0, 0, 98, 0]`

Answer B

```
def clean(counts):
    kept = []
    i = 0
    while i < len(counts):
        if counts[i] > 0:
            kept = kept + [counts[i]]
        i = i + 1
    return kept
```

The test prints:

`[98]`

`[0, 0, 98, 0]`

Answer C

```
def clean(counts):
    for c in counts:
        if c == 0:
            counts.remove(c)
    return counts
```

The test prints:

`[98, 0]`

`[98, 0]`

Key. A: `[98]` and the unchanged list 1 mark, `None` between them 1 mark. B: both lines 1 mark. C: 1 mark a line. The loop skips the item after each one it removes, so the last `0` stays, and `r` and `votes` are one list.

(b) **[1 mark]** Which answer does what was asked for? Answer B

Key. B, 1 mark. Two letters, or none, earn nothing.

(c) **[2 marks]** For each of the other two answers, say in one sentence what is wrong with it.

Key. A: it prints the new list but does not return it, so the caller gets `None` (1 mark). C: it removes items from the very list it is looping over, so it skips an item; *or* it changes the caller's list and hands the same list back (1 mark for either).

(d) **[1 mark]** Answer A can be made correct by changing one line. Write the new line.

`return kept`

Key. `return kept`, in place of `print(kept)`: 1 mark. A return of a copy of `kept` earns it too. A line that still prints, or returns `counts`, earns nothing.

(e) **[1 mark]** After the test with Answer C, is `r is votes` `True` or `False`? True

Key. `True`, 1 mark: Answer C hands back the very list it was given, so `r` and `votes` are one list. No reason is asked for.

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5 Lost Lines

15 marks · about 15 min

One program has its lines mixed up. Another program has gaps. Put them back together.

(a) **[7 marks] Shuffled lines.** The days of a year are numbered 1 to 365. `due_day(start, wait)` returns the day that comes `wait` days after day `start`. If the caller does not give `wait`, it is 60. After day 365 the count starts again from 1.

The eight lines in the box are that program with its lines shuffled. Each line is shown with its correct indentation. **One line does not belong to the program.**

```
A       return day
B   for start in [10, 320]:
C           day = day - 365
D   def due_day(start, wait=60):
E       print(start, "->", due_day(start))
F       day = start + wait
G           day = 365 - day
H       if day > 365:
```

When the seven lines are in the right order and the program is run, it prints **exactly this**:

```
10 -> 70
320 -> 15
```

Each line shows a start day, then the day 60 days after it.

i. **[6 marks]** Write the letters of the seven lines of the program in the order they must be typed, the first line in the first box.

first	D	F	H	C	A	B	E	last

ii. **[1 mark]** The letter of the line that does not belong: G

Key. (i) One mark for each box, after the first, that holds the line which comes directly after the line in the box before it: F after D, H after F, C after H, A after C, B after A, E after B. (ii) With G in place of C the second line printed would be `320 -> -15`.

(b) **[8 marks] Fill the gaps.** The program reads the runs of some cricket players. The first line of the input is the number of players. Then comes one line for each player: a name, a space, and the runs. For a player with runs, the program prints the name and one star for every 20 runs (only full 20s count). A player with 0 runs goes into the list `zeros`. At the end the program prints the total runs and that list.

The user types

```
3
Ali 104
Sara 0
Omar 65
```

The program prints

```
Ali *****
Omar ***
Total: 169
Zeros: ['Sara']
```

Write the missing code for each blank on the rule below with the same letter. One mark a blank.

```
n = __ⓐ__
total = 0
zeros = __ⓑ__
for i in __ⓒ__ :
    parts = input().__ⓓ__
    runs = __ⓔ__
    total = total + runs
    if __ⓕ__ :
        zeros.__ⓖ__
    else:
        print(parts[0], __ⓗ__)
print("Total:", total)
print("Zeros:", zeros)
```

ⓐ `int(input())` ⓑ `[]` ⓒ `range(n)`

ⓓ `split()` ⓔ `int(parts[1])`

ⓕ `runs == 0` ⓖ `append(parts[0])`

ⓗ `"*" * (runs // 20)`

Key. Anything that runs and gives the same output earns the mark, for example `h`: `(runs // 20) * "*"`, and `f`: `runs < 1` or `parts[1] == "0"`. In `e` the `int` is needed: `parts[1]` alone is a string, and line 7 would stop with an error.

6 Write It Yourself

20 marks · about 22 min

Each part tells you what a function must do and gives you an empty box. Write the code yourself.

Major marks are for the logic. Indentation is part of the logic, so make it clear which lines are inside which. Each function must **return** its answer, not print it.

(a) **[8 marks] The average.**

Write the function `how_hot(temps)`. `temps` is a list of one or more temperatures. Find their **average**. If it is below 28, return `'cool'`. If it is 31 or more, return `'hot'`. Anything in between returns `'warm'`.

```
>>> how_hot([27, 28, 26])
'cool'
>>> how_hot([30, 32, 31])
'hot'
>>> how_hot([28, 28])
'warm'
```

Key.

```
def how_hot(temps):
    total = 0
    for t in temps:
        total = total + t
    average = total / len(temps)
    if average < 28:
        return "cool"
    elif average >= 31:
        return "hot"
    else:
        return "warm"
```

Header with one parameter 1. All the temperatures added up, by a loop or by `sum(temps)` 1. Divided by `len(temps)` 1. Returns a string, does not print 1. (These four are the Core marks.) `< 28` gives cool 1. `>= 31` gives hot 1. Everything else gives warm, with no temperature falling in two cases or in none 1. The three cases are tested on the average, not on single temperatures 1.

(b) **[3 marks] A change of rule.** Change your `how_hot` from part (a): before the average is found, the **hottest** and the **coolest** temperature are left out. (`temps` now always has three or more temperatures.) For example, with `[27, 28, 35, 26]` the 35 and the 26 are left out, so the average is of 27 and 28, which is 27.5, and the answer is `'cool'`.

In the box, write **only the lines that change**, as they should be now. Do not copy the whole function again.

Key.

```
    total = sum(temps) - max(temps) - min(temps)
    average = total / (len(temps) - 2)
```

These two lines take the place of lines 2 to 5 of the function in (a). The hottest taken out of the total 1, the coolest taken out 1, divided by the number of temperatures less two 1. A student who keeps the loop and takes the two away after it earns full marks; so does one who sorts the list and adds up all but its first and last.

(c) **[5 marks] The first hot day.** Write the function `first_hot(temps, limit)`. `temps` has one temperature for each day: `temps[0]` is day 1, `temps[1]` is day 2, and so on. A day is **hot** if its temperature is `limit` or more. Return the **day number** of the first hot day. If no day is hot, return `0`.

```
>>> first_hot([27, 29, 31, 30, 32], 31)
3
>>> first_hot([33, 20], 31)
1
>>> first_hot([27, 29], 31)
0
```

First call: days 1 and 2 are not hot; day 3 (31) is the first hot day.

Second call: day 1 (33) is already hot.

Third call: no day is hot.

Key.

```
def first_hot(temps, limit):
    for i in range(len(temps)):
        if temps[i] >= limit:
            return i + 1
    return 0
```

Header with two parameters, and a loop over the list 1. The test `>= limit` 1. Leaves at the **first** such day, by `return` or `break` 1. The day number is the position plus one 1. `0` returned after the loop, not inside it 1.

(d) **[4 marks] The longest hot spell.** Write the function `hot_spell(temps, limit)`. A day is **hot** if its temperature is `limit` or more. A **hot spell** is a group of hot days that come one straight after another. Return the number of days in the **longest** hot spell. If no day is hot, return `0`.

```
>>> hot_spell([31, 32, 29, 31, 33, 34, 30], 31)
3
>>> hot_spell([31, 20, 31], 31)
1
>>> hot_spell([27, 29], 31)
0
```

First call: 31, 32 is a spell of 2 days; 29 is not hot; then 31, 33, 34 is a spell of 3 days. The longest is 3.

Second call: two spells of 1 day each.

Third call: no day is hot.

Key.

```
def hot_spell(temps, limit):
    longest = 0
    run = 0
    for t in temps:
        if t >= limit:
            run = run + 1
            if run > longest:
                longest = run
        else:
            run = 0
    return longest
```

A count of the present run that grows on a hot day 1. The count goes back to 0 on a day that is not hot 1. The longest run so far is kept and replaced when the present run passes it 1. That value is returned, and a run that ends at the last day is not lost 1.

7 Bonus: Look Closer

10 bonus marks · about 10 min

(a) **[5 bonus marks] The mystery list.**

```
1  def mystery(rows):
2      first = rows[0]
3      rows = rows[:]
4      rows.append(first)
5      first.append(len(rows))
6      return rows
7
8  a = [[1], [2]]
9  b = mystery(a)
10 b[0].append(0)
11 print(a)
12 print(b)
```

i. **[2 bonus marks]** Line 11 prints:

`[[1, 3, 0], [2]]`

ii. **[2 bonus marks]** Line 12 prints:

`[[1, 3, 0], [2], [1, 3, 0]]`

iii. **[1 bonus mark]** After line 12, how many **different** list objects are there in memory? Count every list, inside and outside. `4`

Key. `first` is a second name for the inner list `[1]`. `rows[:]` copies only the outer list, so the inner lists are shared. After line 4 `rows` has 3 items, so line 5 puts 3 into the shared inner list, and line 10 puts 0 into it too, through `b[0]`. `b` holds that one inner list twice. The four lists: `a`, `b`, the inner `[1, 3, 0]` and the inner `[2]`. (i) and (ii): the inner list right 1 mark, the rest right 1 mark.

(b) **[5 bonus marks] The secret function.**

```
1  def secret(n):
2      result = 0
3      while n > 0:
4          result = result * 10 + n % 10
5          n = n // 10
6      return result
```

i. **[1 bonus mark]** `secret(1205)` returns:

`5021`

ii. **[1 bonus mark]** A number `n` with **three** digits for which `secret(n) == n` is:

`121`

iii. **[1 bonus mark]** In one sentence, what does `secret` do to a number greater than 0?
Key. It returns the number with its digits in reverse order (1 mark).

iv. **[2 bonus marks]** `secret(secret(120))` returns `12`, not 120. In one sentence, explain why.
Key. `secret(120)` is 21: the 0 at the end of 120 would come first, and a number cannot start with a 0, so it is lost. The value 1 mark, the reason 1 mark.

End of the paper. Check that your roll number is on every page.

Rough work

Nothing on this page is marked.

Rough work

Nothing on this page is marked.