Exam 1 – Operating Systems in Practice

Name: Ayush Manandhar

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| Duration:  1. Complete the info above: your name and ID  2. Phones off, please.  3. Leave your ID on the table.  4. Neither Internet nor VLE are not allowed.  5. Answers of the labsheets are not allowed.  6. You are more than welcome to use Linux man.  7. You can use your notes.  8. If you don’t know one item (question), go to the next item (question) solve and return to the ones you left later.  9. Mandatory:  a. Go to File > Info > Protect Document (Left) > Encrypt with Password.  b. Clear the password in the Password box, and then click OK.  10. Mandatory: do file, save as with your name. During the exam, keep saving it.  11. By the end, submit your exam file.  Wish you the best of luck! |

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| Instructions for transferring the files:  -Login on the bottom computer (Windows).  Download the following files:  Exam1.doc, question1.c, and question3.c.  Take notes of where you have saved these files (drive letter)  -Create three terminals in Windows:  type cmd.exe <enter> at the search bar 3 times  -In one of the terminals, change the drive to the drive letter you took notes of, for example, typing:  p: <enter>  Then do type:  cd Downloads <enter>  Then transfer the following files using scp:  scp question1.c [pi@192.168.0.227](mailto:pi@192.168.0.227): <enter>  -type the password “raspberry” <enter>  And same for question3.c:  scp question3.c [pi@192.168.0.227](mailto:pi@192.168.0.227): <enter>  -type the password “raspberry” <enter>  On each of the three terminals, do:  ssh [pi@192.168.0.227](mailto:pi@192.168.0.227) <enter> |

**Question 1 (50 marks)**

Open question1.c in any editor (pico/nano), and make sure you read and understand it. Note that this program has two infinite for loops. It is also relisted below to facilitate.

**//Operating Systems in Practice -**

**#include <sys/types.h>**

**#include <unistd.h>**

**#include <stdio.h>**

**#include <stdlib.h>**

**int main()**

**{**

**pid\_t r;**

**int i = 0;**

**/\* now create new process \*/**

**r = fork();**

**if (r > 0)**

**{**

**for (; ;)**

**{**

**i+=2;**

**}**

**}**

**else**

**{**

**if (r == 0)**

**{**

**for (; ;)**

**{**

**i+=2;**

**}**

**}**

**else**

**{**

**printf("error"); /\* display error message \*/**

**exit(0);**

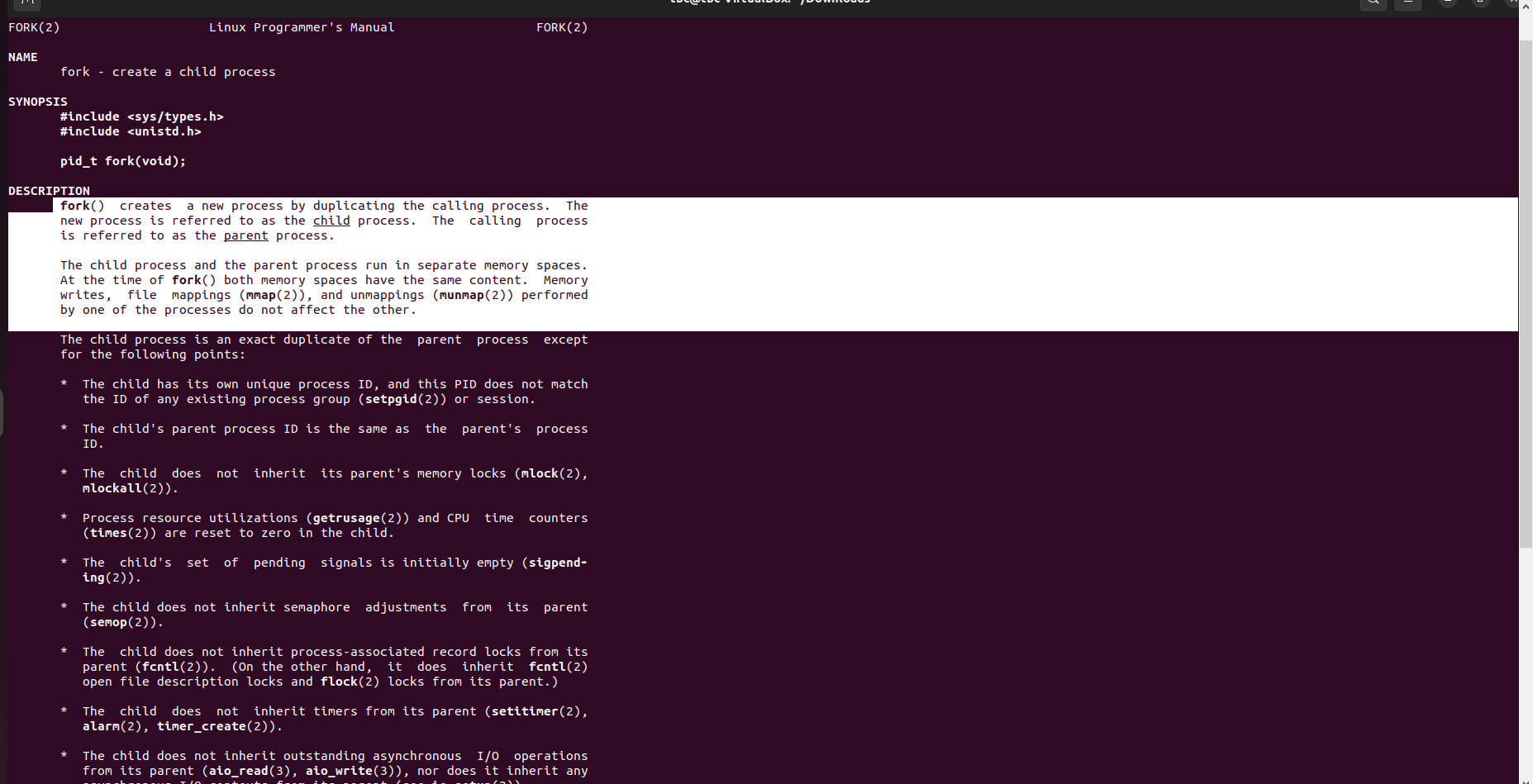
**}**

**}**

**}**

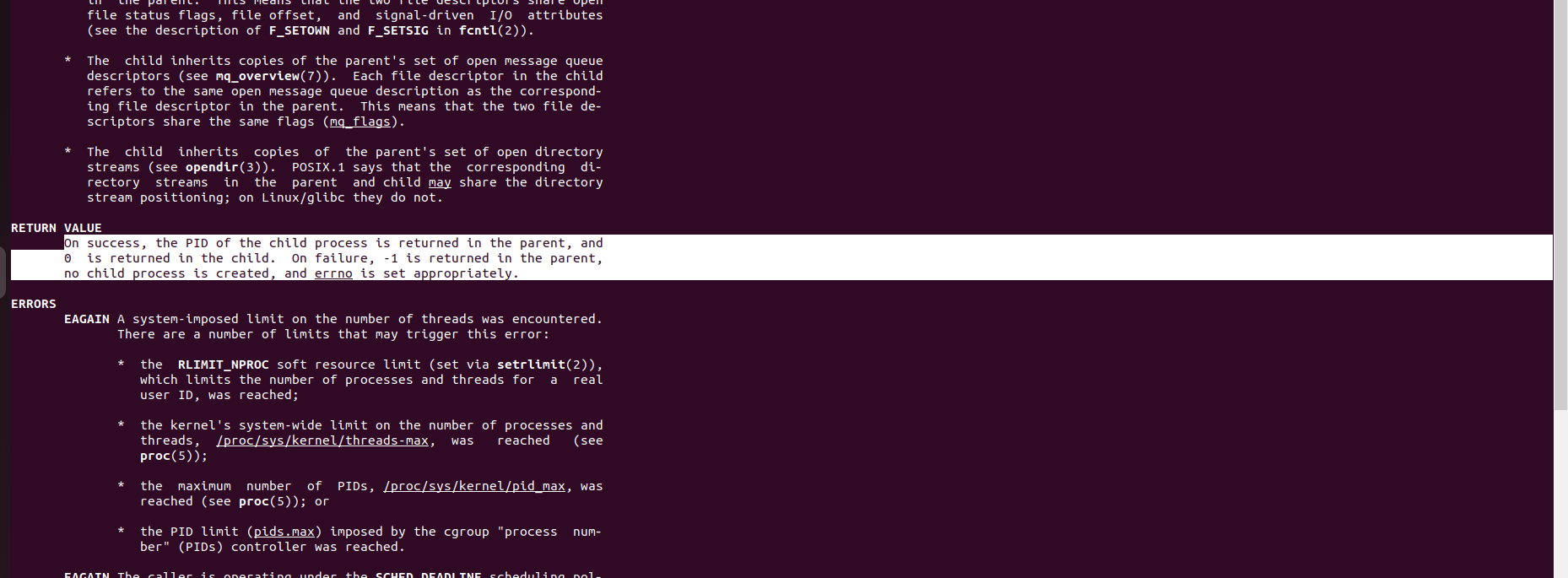
1a. You can see on the program above a C command named fork. Is fork a system call? Explain, and include a screenshot of fork manual to justify your statements. (5 marks)

Answers: Yes, Fork is a system call. It creates a new process by duplicating a process, duplicate process is child and original is the parent process.



1b. What does fork return? Explain it and use a screenshot of the fork manual to justify your statements. (5 marks)

Answers: Fork returns PID of child process in the parent is returned in the child on success. On failure -1 is returned on the parent and no child process is created.



1c. From the program above, extract the code executed by the parent, and list it below. Explain why the parent executes such code. (5 marks)

Answers: **r = fork();**

**if (r > 0)**

**{**

**for (; ;)**

**{**

**i+=2;**

**}**

**}**

This is the code executed by parent as the variable which has fork is greater than 1.

After successfully creating the child, PID of child is stored in the r and returns child PID. So we it is code executed by parent.

1d. From the program above, extract the code executed by the child and list it below. Explain why the child executes such code. (5 marks)

Answers: **if (r == 0)**

**{**

**for (; ;)**

**{**

**i+=2;**

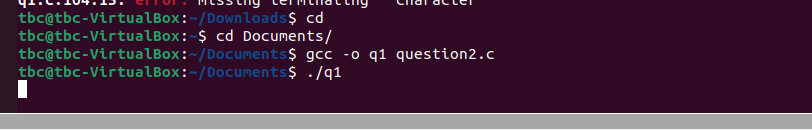
**}**

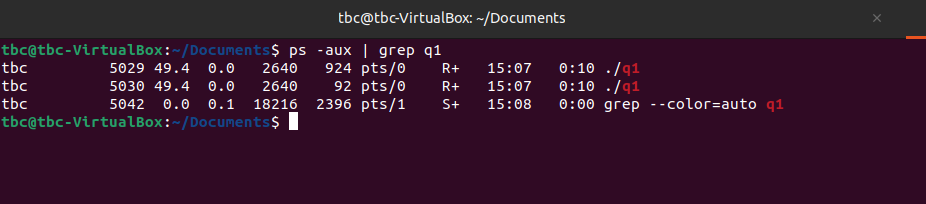
**}**

This is code executed by the child as the variable r is equal to 0.

Hence the fork returns 0 on the success of being child process created. It only runs certain code when r returns 0 so we can conclude it is code executed by the child.

1e. Get one (combined) or two-three screenshots of the following: compile question1.c and generate the binary (hint: use gcc to compile and generate the binary named question1). Then, run question1. Next, use ps to get the PID, CPU usage of question1 processes. (5 marks)

Answers: 



For parent

PID : 5029

%CPU : 49.4

For Child

PID : 5030

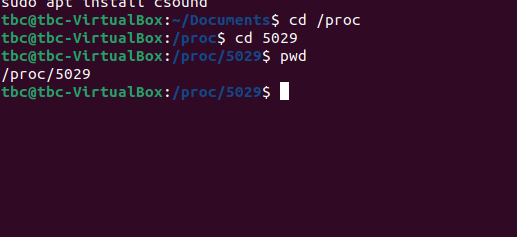
%CPU : 49.4

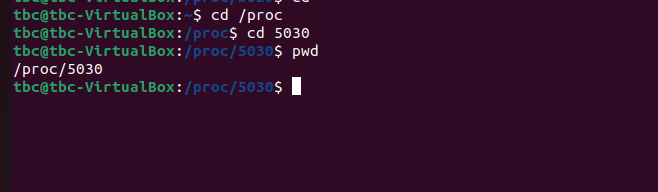
1f. Based on ps output of item 1e, explain which one is the parent process. Based on the source code (you have analysed in item 1c) and the output of item1e, explain the CPU usage of the parent. (5 marks)

Answers: Here the process with PID 5029 is the parent as PID of child is stored in the variable r and PID of child is greater by 1 than the parent. And the CPU usage of the parent is 49.4 as the process is still running.

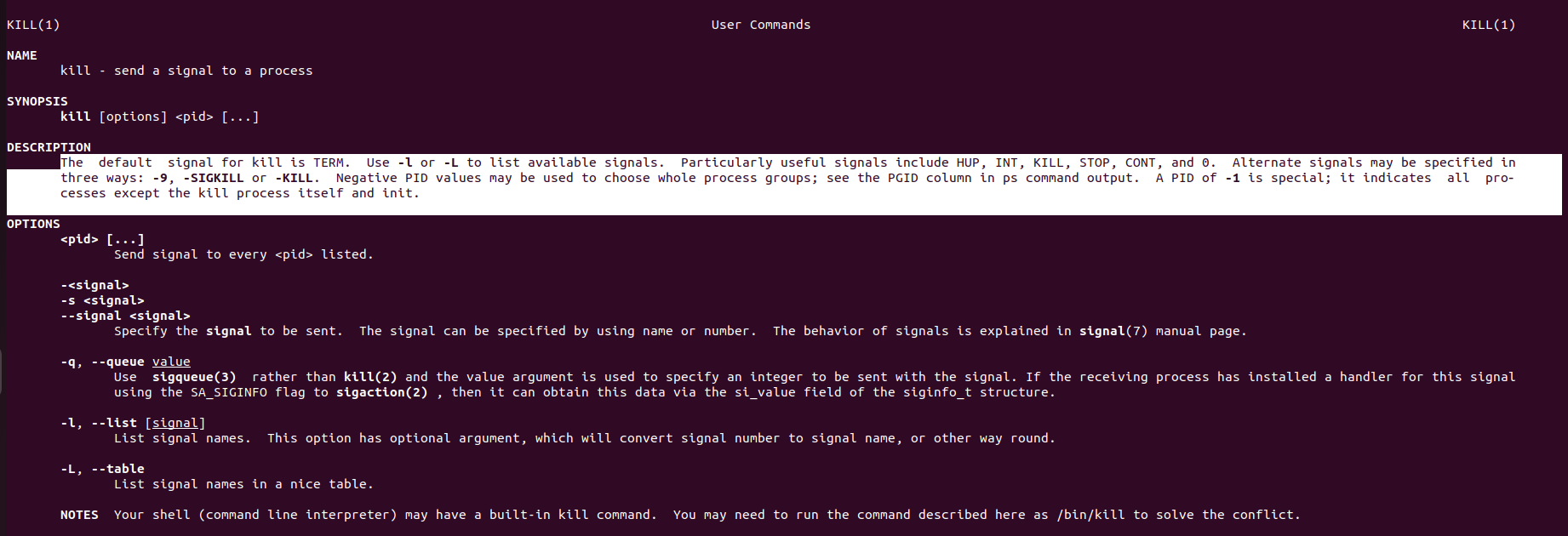
1g. Use the proc directory and the PID number obtained in item 1e to confirm the values of PID and state obtained in item 1e. Get a screenshot. (5 marks)

Answers:



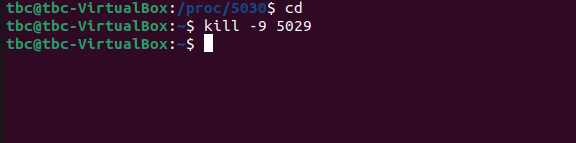
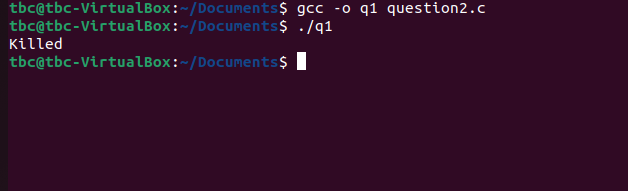
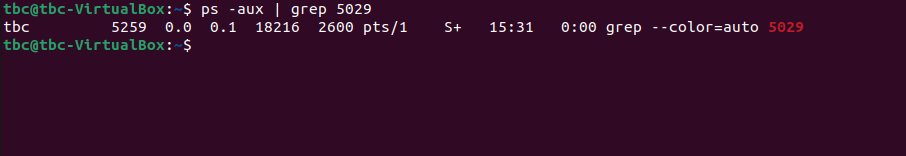


1h. We are about to use kill system call: to prove that kill is a system call, find it in syscalls manual (highlight it) and get a screenshot. (5 marks)

Answers: 

1i. Use kill to stop the parent. After the kill, similar to item 1e, get another ps screenshot of the parent. (total 5 marks).

Answers:

1j. In item 1e you have taken a screenshot before, and in item 1i another one, after the requested kill. Explain in detail the theory behind the differences observed between these two screenshots. (5 marks)

Answers: In 1e the program is in the running state and when the system provides unique PID to all process and they use some amount of CPU so it can execute properly.

In 1i we used kill command which terminates the process. Since the program has no longer in the running state it will not have any PID and %CPU will be 0

*Note: Before proceeding to question 2, at the terminal where you are running question1, make sure to type <CRTL+C> to stop it or use kill to stop all processes of question1.*

**Question 2 (30 marks)**

2a. Assuming you have only two processes running in a computer managed by an operating system (OS), and that these processes are CPU-bound (only use CPU). Explain in detail how the process control block (PCB) is used by the OS to manage the execution of these processes. Make sure to include the “time slice“ term in your explanation. (total 15 marks)

Answers: The process control block manages the execution of the processes by providing unique process number(PID) to each process so it can identify the process. After that it determines the process state of that process i.e. Running, Sleeping. It also checks the registers used by the each process, list of files. It checks I/O status information to get input or output. To manage the time of process it used time slice i.e. provides time to each process so it can run accordingly it is done based on priority.

2b. Briefly explain about the memory table used in the PCB (5 marks).

Answer: Memory table used in PCB contains the memory allocations of each process. It checks if OS has enough memory to run the process

2c. In terms of operating systems (OS), task\_struct variable represents the code of the PCB in Linux. A student has found task\_struct and extracted some of its source code as listed below:

**struct task\_struct {**

**volatile long state;**

**void \*stack;**

**unsigned int flags;**

**int prio, static\_prio;**

**struct list\_head tasks;**

**struct mm\_struct \*mm, \*active\_mm;**

**...**

**pid\_t pid;**

**pid\_t tgid;**

**struct task\_struct \*real\_parent;**

**char comm[TASK\_COMM\_LEN];**

**struct thread\_struct thread;**

**struct files\_struct \*files;**

**...**

**}**

In Linux, you have used top and/or ps to monitor the computer. Explain how ps or top obtain data that come from the Linux kernel. (5 marks) In your explanation, make sure to use two variables of the above code to exemplify the flow of the data transferred (5 marks). (total of 10 marks)

Answers:

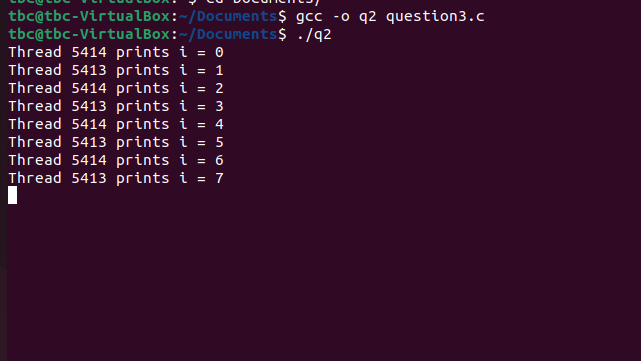
**Question 3 (20 marks)**

3a. Why are threads of lower overhead when compared to processes? (5 marks)

Answer: Thread occupy only one memory space where as process uses more memory so threads are of lower overhead compared to process

3b. Open question3.c in any editor (pico/nano) and make sure you read and understand it. Get a screenshot of the following: compile question3.c (hint: use gcc to obtain question3 binary, but note that this code has threads). Then, run it. (5 marks)

Answers:



3c. In the source code of question3.c you will notice that there is a variable that is shared by both threads: which variable is that? Explain briefly about the mechanism used to be able to share this variable. (5 marks)

Answers: Semaphore mechanism is used., sem\_wait, sem\_int

3d. Briefly explain how both threads are able to change the referred variable (shared) in item 3c (5 marks).

Answer: