1.4 System Software: 30-minute Pack

OCR J277 · Calculators not allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Complete the table below by naming the type of utility software described in each row.

Description	Type of utility software
1) Reorganises files stored on a hard disk drive so that fragmented parts of a file are stored closer together, reducing the time taken to access them.	?
2) Scrambles data using an algorithm and a key so that it cannot be understood if it is intercepted.	?
3) Reduces the size of a file so that it takes up less storage space or can be transferred more quickly.	?

(Total for Question 1 is 3 marks)

2 A student connects a new 3D printer to their laptop for the first time. Describe how a device driver allows the operating system to communicate with the new printer.

(Total for Question 2 is 3 marks)

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3 Describe, using an example, how memory management by the operating system allows a laptop to run more than one application at the same time.

(Total for Question 3 is 4 marks)

4 Explain the difference between lossy and lossless compression, using an example of when each would be an appropriate choice.

(Total for Question 4 is 4 marks)

5 A computer receives four interrupt signals at almost the same moment: a mouse click, a keyboard key press, a critical low battery warning, and a request from the printer to say it has run out of paper. State the order, from highest priority to lowest, in which the operating system should service these four interrupts, and justify your ordering.

(Total for Question 5 is 3 marks)

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6 Modern operating systems use virtual memory to manage RAM.

(a) State what is meant by the term 'virtual memory'. **(2)**

(b) A student notices their laptop has become extremely slow after opening many large applications at once. Explain, in terms of virtual memory, why this has happened. **(3)**

(Total for Question 6 is 5 marks)

7 A simple black and white image is stored as a single row of 12 pixels, shown below, where W = white and B = black:

WWWWWBBBWWWW



(a) Use run-length encoding (RLE) to encode this row of pixels. Show your encoding as pairs of (colour, run length). **(2)**

(b) Each (colour, run length) pair is stored using 2 bytes: 1 byte for the colour and 1 byte for the run length. Calculate the compression ratio achieved, given that storing the original row (uncompressed, 1 byte per pixel) uses 12 bytes. Give your answer in the form x:1. **(2)**

(c) Explain why run-length encoding is an effective compression technique for this image but would be far less effective for a photograph of a busy street. **(2)**

(Total for Question 7 is 6 marks)

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Mark scheme · 1.4 System Software: 30-minute Pack

Question 1

Row 1: Defragmentation software cao	**B1**
Row 2: Encryption software cao	**B1**
Row 3: Compression software cao	**B1**

Answer: 1) Defragmentation software 2) Encryption software 3) Compression software

Question 2

a device driver is translation software written specifically for that peripheral device oe	**B1**
it converts general commands/data from the operating system into the specific signals the printer's hardware understands (and vice versa) oe	**B1**
without the correct driver installed the operating system cannot send/receive data correctly to/from the printer oe	**B1**

Answer: The driver acts as translation software written for that specific printer; it converts the general commands sent by the operating system into the specific signals the printer's hardware understands, and translates any data returned by the printer back for the operating system, allowing the OS to control the printer correctly without needing to know its internal workings.

Question 3

the operating system allocates a separate area of RAM to each open application/process oe	**B1**
it keeps track of which areas of memory are free or in use, preventing one application from overwriting another's data oe	**B1**
if RAM becomes full, the OS can move data between RAM and virtual memory on secondary storage, allowing more applications to appear to run at once oe	**B1**
a relevant example is given, e.g. a student streaming music while writing a document, each given its own memory space so both continue running without crashing or corrupting each other oe	**B1**

Answer: The operating system allocates a separate, protected area of RAM to each application that is opened, for example a music streaming app and a word processor. It keeps track of which parts of memory are free or in use so that one application's data cannot overwrite another's. If RAM becomes full, the OS can move less-used data out to virtual memory on the hard disk/SSD, freeing RAM so more applications can keep running, appearing to run simultaneously.

Question 4

lossy compression permanently removes some data/detail from the file to reduce its size, so the file cannot be restored to its exact original oe	**B1**
example use of lossy compression, e.g. streaming music/video over the internet, where a small loss in quality is acceptable in exchange for a much smaller file oe	**B1**
lossless compression reduces file size without removing any data, so the file can be restored exactly to its original oe	**B1**
example use of lossless compression, e.g. compressing a text document or a database backup, where every bit of data must be recovered exactly oe	**B1**

Answer: Lossy compression permanently discards some of the original data to achieve a much smaller file size, so the file cannot be restored exactly, for example streaming music or video, where a slight reduction in quality is an acceptable trade-off for faster streaming. Lossless compression reduces file size without discarding any data, so the original file can be perfectly restored, for example compressing a text document or database backup, where every byte must be recoverable exactly.

Question 5

critical low battery warning placed first (highest priority) cao	**B1**
printer out of paper placed last (lowest priority), keyboard and mouse in between (either order accepted) cao	**B1**
valid justification linking urgency to consequence of delay, e.g. the battery warning risks losing power and unsaved data if not dealt with immediately, whereas nothing is lost by delaying the printer message, and user input delays are noticeable but far less critical than losing power oe	**B1**

Answer: 1) critical low battery warning, 2) keyboard key press / mouse click (either order), 3) printer out of paper. The battery warning is serviced first because the computer risks losing power and unsaved data if it is not dealt with immediately. The printer's out-of-paper message is serviced last because no data is lost or work interrupted while it waits; keyboard and mouse input are given quicker attention than the printer notice because delays to user input are noticeable, but they are far less urgent than the risk of total power loss.

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Question 6

(a) an area of secondary storage (e.g. the hard disk/SSD) that is used as if it were extra RAM oe **B1**

(a) used by the operating system when RAM becomes full, to hold data/pages temporarily oe **B1**

(a) Answer: Virtual memory is a portion of secondary storage, such as the hard disk or SSD, that the operating system uses as if it were extra RAM, temporarily holding data when RAM is full.

(b) RAM has become full, so the OS is repeatedly swapping (paging) data between RAM and virtual memory on the hard disk/SSD oe **B1**

(b) this constant swapping is known as thrashing oe **B1**

(b) because secondary storage is much slower to access than RAM, the constant swapping significantly increases the time taken to process tasks, slowing the whole system down oe **B1**

(b) Answer: RAM has filled up, so the operating system is constantly swapping (paging) data back and forth between RAM and virtual memory on the hard disk/SSD, a state known as thrashing. Because secondary storage is much slower to read from and write to than RAM, this constant swapping greatly increases access times and makes the whole system appear to slow down.

Question 7

(a) correct identification of the three runs (5W, 3B, 4W) **M1**

(a) correctly written as (W,5)(B,3)(W,4), or equivalent notation such as W5B3W4, cao **A1**

(a) Answer: (W,5)(B,3)(W,4) i.e. W5 B3 W4

(b) compressed size = 3 pairs x 2 bytes = 6 bytes **M1**

(b) ratio = 12:6 = 2:1 cao **A1**

(b) Answer: 2:1

(c) RLE works well here because the image has long runs of the same repeated colour/value next to each other oe **B1**

(c) a busy street photo has colours changing frequently between neighbouring pixels, so there are few or no long runs, meaning RLE would give little or no reduction in size (and may even increase it) oe **B1**

(c) Answer: RLE is effective here because the row contains long runs of identical pixel values next to each other. A photograph of a busy street has pixel colours that change frequently between neighbouring pixels, with few long runs of the same colour, so RLE would find very few repeated runs to compress, giving little or no reduction in file size.

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