

Content Advisory: Contains **very** dusty components

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Unit 25, Assignment 2

Maintaining Computer Systems

Task One, Part One & Two P4, D1

Routine Maintenance & Evaluation

Cleaning & Dusting the System

A clean, dust-free system allows for better airflow through the case, ensuring sufficient airflow through it. This means that air-cooled components are able to be sufficiently cooled. Components such as the CPU and GPU operate optimally when running at cooler temperatures. Overheating components leads to a shorter lifespan and incurs throttling, hindering performance.

To clean the internal components, I first made sure that the computer was turned off and unplugged to prevent damage to both me and the delicate componentry.

I focused my attention on the exceptionally dusty CPU heatsink and fan. To clean this, I made use of a small paintbrush. Outside—so as not to get dust everywhere—I gently brushed the large clumps of dust out of the heatsink and off the blades of the fan. I neglected to take any 'after' photos, however the cosmetic improvement was substantial.



Alongside the CPU heatsink and fan, I also cleaned other components in the system. The removable intake dust covers on the case were also dusty. These were removed from the case and then cleaned using a vacuum and the same paintbrush.



Clean Peripherals

The keyboard and mouse of the system were surprisingly clean in nature. Had these needed cleaning, I would have cleaned the surfaces of the mouse with a damp microfibre cloth. The keyboard would have been fully disassembled to remove dirt well within the casing. Each individual keycap would have been submerged in a bath before being wiped down.

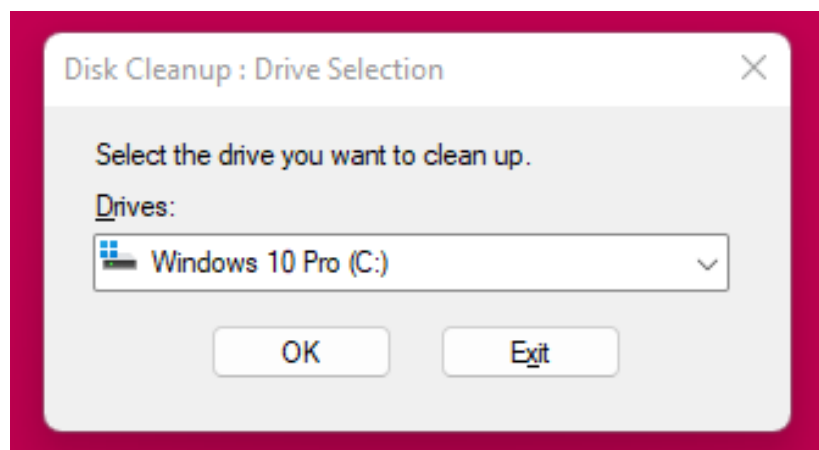
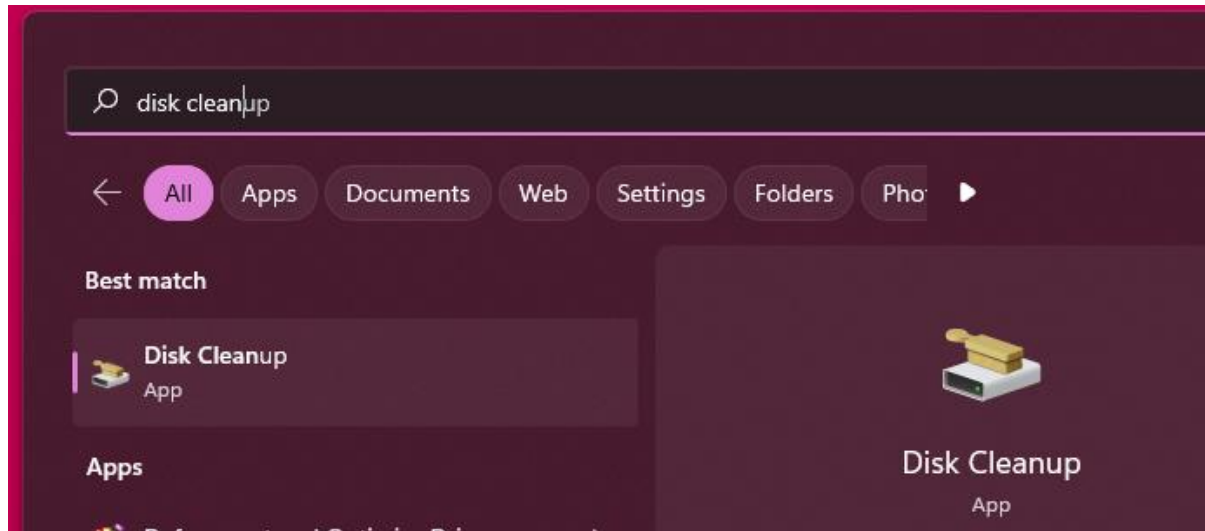


The dirtiest part of the external peripherals of this system was the monitors. To clean these, I used a microfibre cloth and a lens cleaner spray.

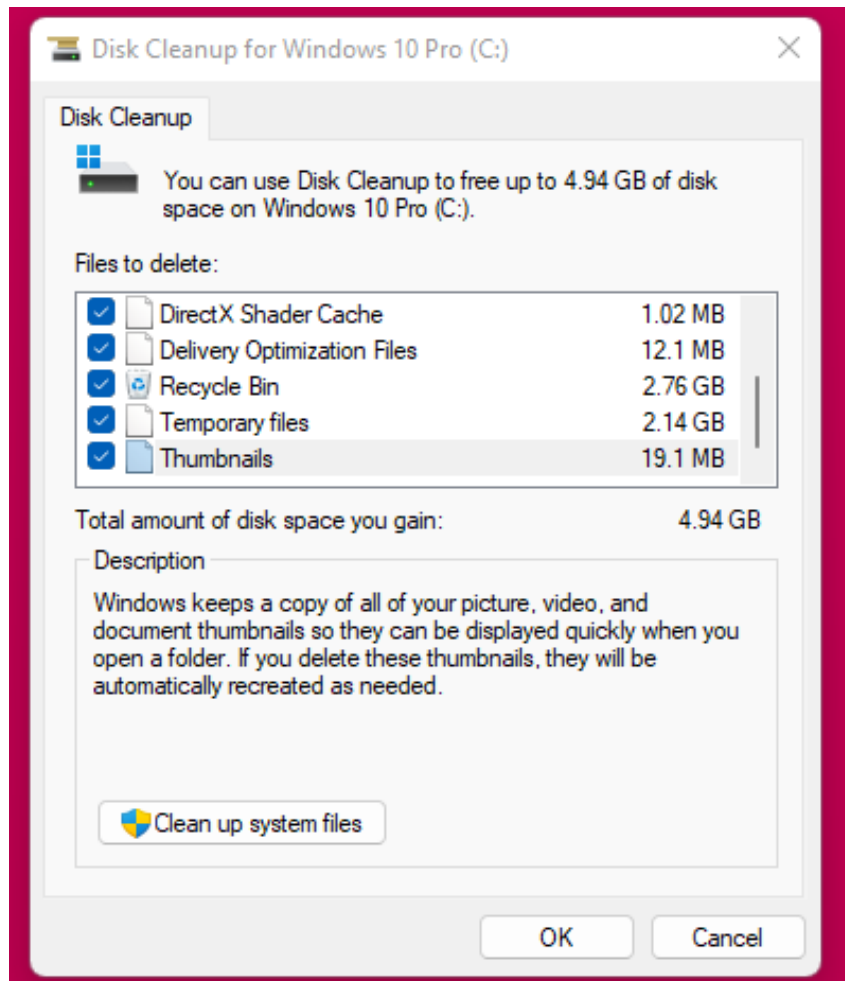
Input devices connected to a system also should be clean. A dirty keyboard with intermittent functionality can significantly hamper productivity. Likewise, a desk with a non-smooth surface will make a mouse's tracking poor.

File Cleanup

To run a file cleanup, I used Windows Search to open the built-in Disk Cleanup tool.



Here, I am selecting the drive to be analysed. In this case, I choose the drive the operating system is installed on.



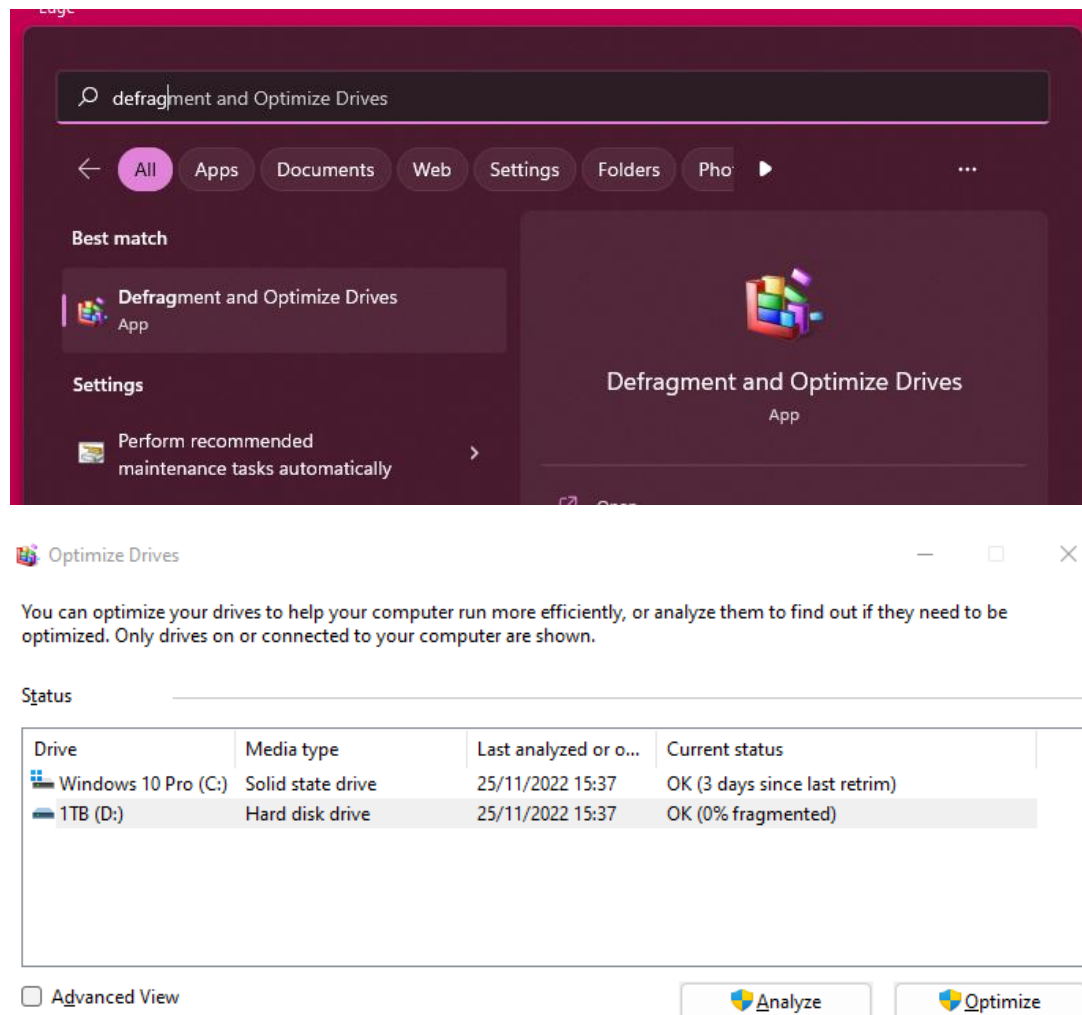
This screenshot shows the results of the analysis. 4.94GB of data can be removed, with the majority coming from the recycle bin and temporary files.

To start the clean-up, I pressed the OK button,

The purpose of a clean-up utility is to remove any unneeded temporary files left behind by programs or the operating system during normal use, such as web-browser caches, debug logs and recycled files. Their main purpose is to free up storage space if a user is running out of space on a drive. Solid State Drives in particular can perform sub optimally when they are nearing full capacity.

Defragmentation

To defragment a drive, Windows includes a built-in utility. To open it, I used the Windows Search feature.



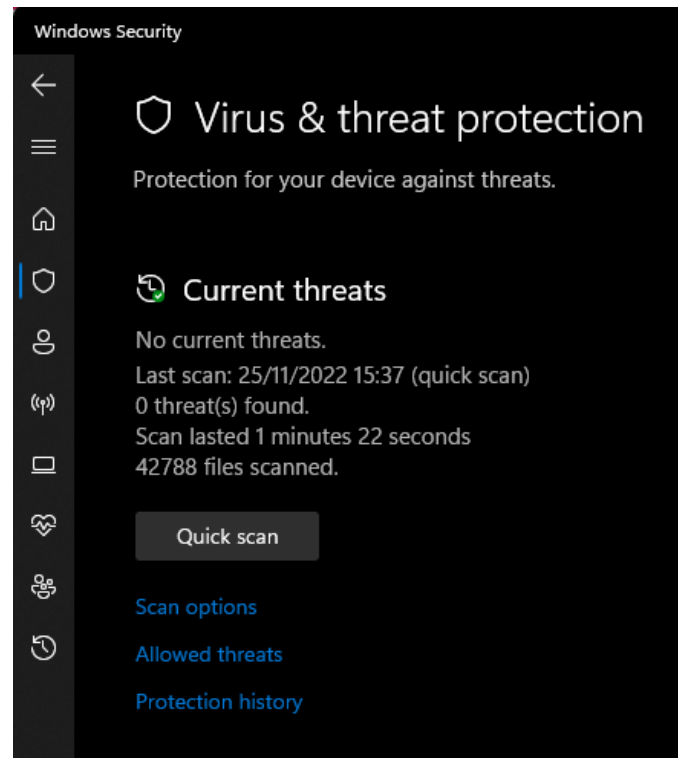
Within the application, to defragment a drive, I pressed the “Optimize” option.

Solid State Drives undergo a similar—though not the same—process called retrimming. TRIM also improves the performance of the drive, however it does so by reducing the number erase operations performed on the internal flash, increasing drive longevity and performance.

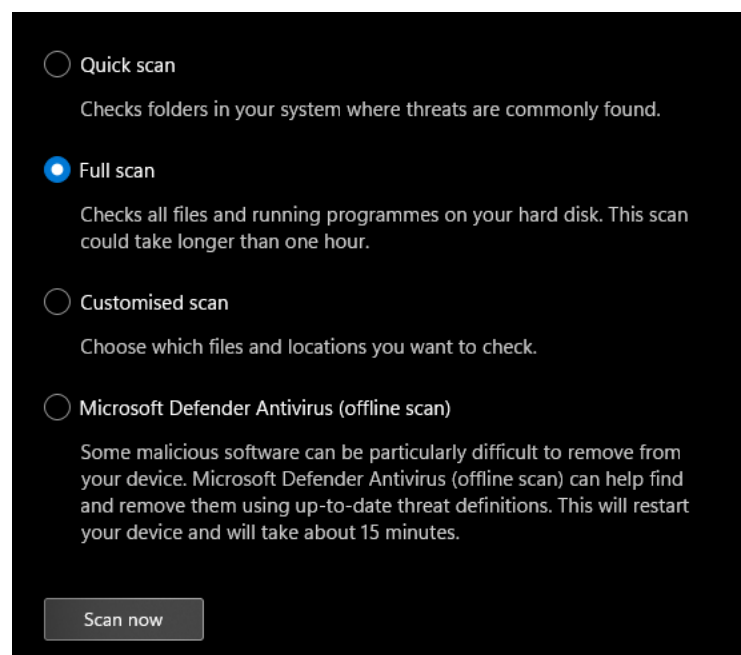
Over the course of regular use, the location of parts of files across a hard disk drive’s physical surface become errant and non-continuous. A file being spread across different areas of the disk rather than being in one continuous place makes it slower to access and read. Defragmenting is the process of optimising the location of files on a drive so they can be read continuously.

Anti-Malware

To run an anti-malware scan, I used the built-in Windows Security Virus & Threat Protection scanner.

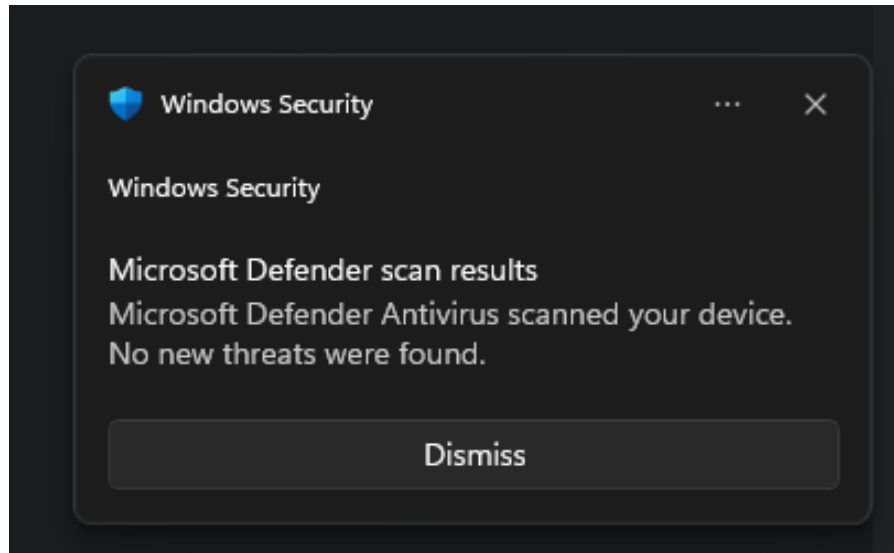


In order to run a full scan, I selected 'Scan options.'



To begin the scan, I selected 'Scan now.'

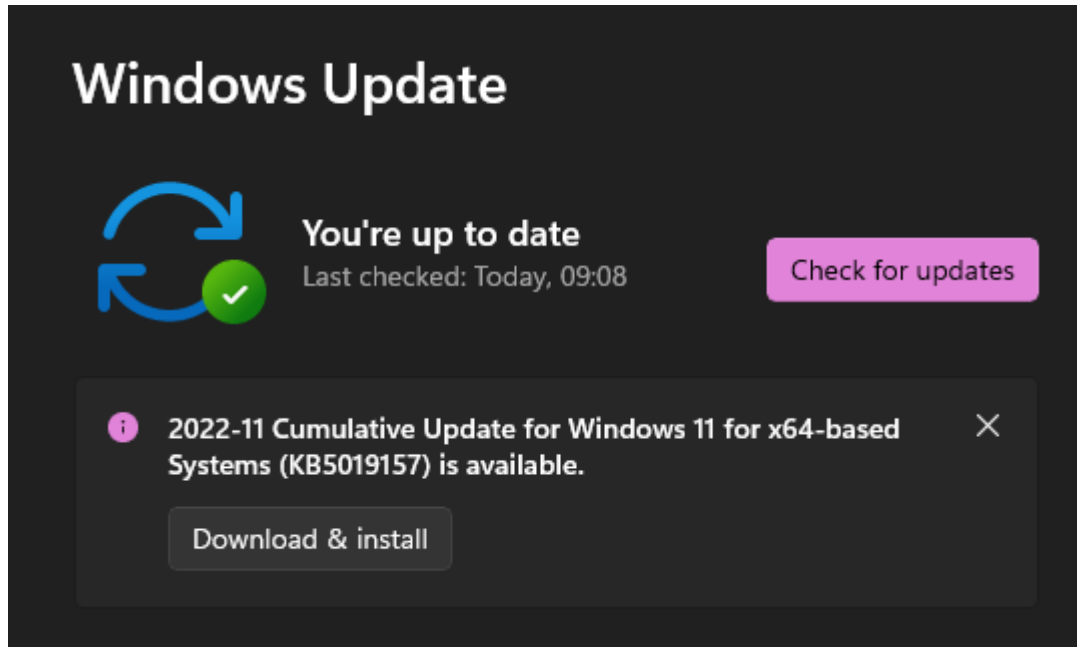
Viruses, malware and bloatware can contribute to a poorly performing PC. Running in the background, they take up system resources that could be used for user applications. Anti-malware tools are used to scan for and remove potentially unwanted programs, including viruses.



Upon the completion of the scan, this notification informed me that my system found no threats.

Updates

The Windows Settings application houses Windows Update. From here, I was able to install the latest Feature Update by selecting 'Download & install.'



Updates to software, including the operating system, can provide performance enhancements, security fixes and general improvements.

These changes can improve the performance and the reliability of a system.

Task Two, Part One P5

System Performance

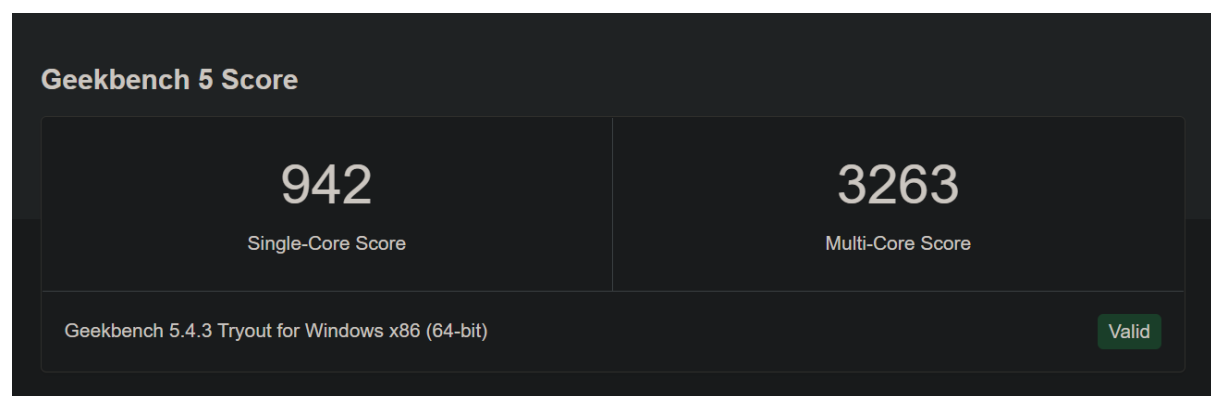
To test the system, I used a variety of benchmarking software to test different aspects. I ran each benchmark thrice, back-to-back and will be using an average of the results for comparisons.

The principal specifications of the system are as follows:

- Intel Core i7 4790K CPU (at stock 4GHz)
- Integrated Intel HD 6000 Graphics
- 8GB Kingston HyperX RAM

Geekbench CPU

Geekbench is used to test the single-core and multi-core performance of a CPU. The scores given are based on a baseline result of 1000 from a specified CPU. Double the score indicates double the performance. Geekbench version 5 uses an i3-8100 for this baseline.

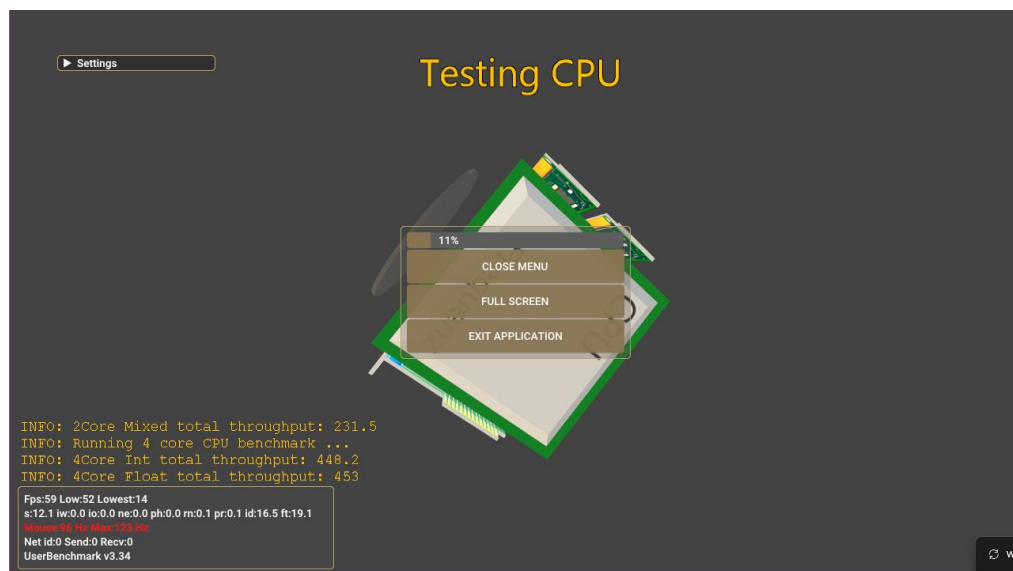


After running the 64-bit CPU test, the result is uploaded to the Geekbench Browser website. Above is the score given by the first run of the test.

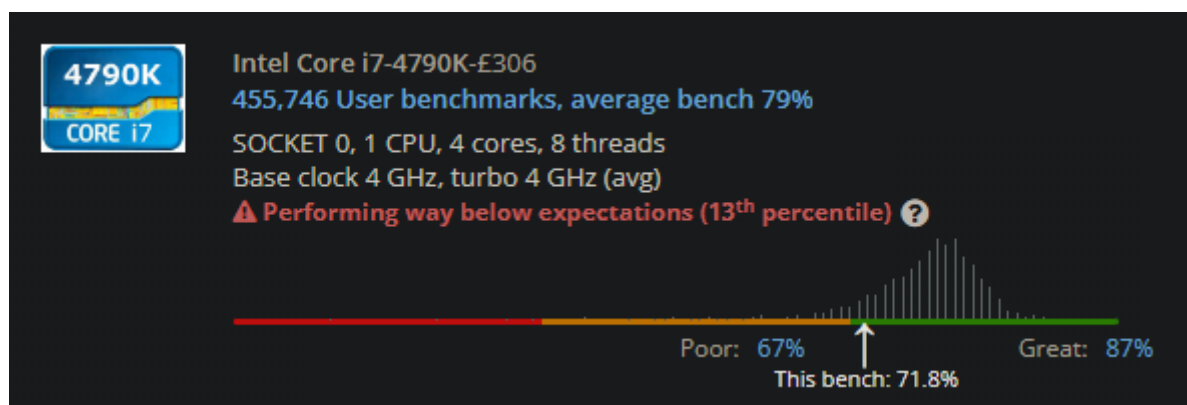
The average of all three runs resulted in a Single-Core Score of **967** and a Multi-Core Score of **3281**.

Userbenchmark

While I disagree with the reviews provided by the website, the Userbenchmark tool provides a useful way of measuring the high-level performance of a system against other components.



As a score, I used the percentage given for “Desktop” suitability. The average of three runs was **68%**. This desktop performance metric uses data from the CPU benchmark, the disk benchmark and the RAM benchmark. It is weighted to the CPU performance; however, it is unclear what this percentage relates to or how exactly it is calculated.



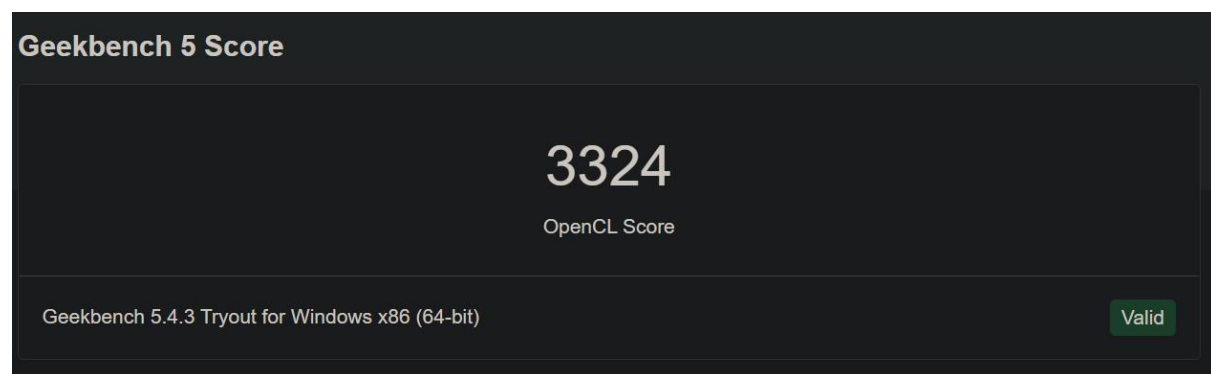
On the results page, the results from this system are compared to other systems featuring the same or similar components. As an example, the Intel i7 4790K CPU's result was in the 13th percentile of all results, implying it is performing 'below expectations.'

Cinebench R23

Cinebench is a tool used to test the rendering performance of a CPU. It is a real-world workload using the Cinema 4D engine. Three tests resulted in an average point score of **4665**.

Geekbench Compute

The Geekbench Compute test measures the OpenCL performance of a GPU by running tests relating to image manipulation and physics simulation.



Like the CPU tests, results are uploaded to the Geekbench Browser. The average result of three runs was a score of **3331**.

GTA V Benchmark

To test the gaming performance of the system, I used the Benchmark option built into Grand Theft Auto V. This tests all aspects of the system, including CPU, GPU and RAM. The average result of three runs was **11 frames per second**.

Unigine Heaven

Heaven is a graphics benchmark that tests the GPU performance of a system. **3.8 frames per second** was the average of three tests.

General Performance

When using the system, general performance was more than adequate. The primary limiting factor was the number of applications and browser tabs that could be opened, as well as the performance during even simple games.

Task Two, Part Two M2

Recommended Upgrades

Based on the results in the previous section, I would recommend the following upgrades be made to the system to improve performance.

Dedicated GPU

One of the primary shortcomings of the system was its lack of dedicated GPU. This is evidenced in the low Geekbench Compute scores and poor FPS averages during the GTA V and Heaven benchmarks.

Based on the era of the 4th Generation Core CPU, I would recommend a GPU from around this time period so as not to be too great of a bottleneck. This should significantly improve the performance of graphics-heavy applications.

More RAM

Doubling the RAM from a single 8GB stick to 16GB will enable a greater number of applications to be run at once. Having two sticks of RAM also enables the use of dual channel, increasing data transfer speed to memory. Additionally, we can enable XMP (eXtreme Memory Profiles) to increase the speed of the RAM, again increasing its performance.

Overclocking

Despite its age, the 4790K CPU is still very performant and up to the job of most modern tasks. To increase its working lifespan, we can apply a overclock – increasing the frequency of the chip allowing it to run more operations per second.

Operating System & Programs

The computer is currently running Windows 10. Upgrading to the latest version—Windows 11—could potentially improve the performance of the system. Newer software versions often contain performance enhancements and generally perform more efficiently.

There is a plethora of software installed on the system. While not all of it is configured to start at boot, a large amount is. Background processes that are not useful simply serve to take resources away from more important tasks. Culling the list of installed programs, in particular those

that make use of background services, may also yield a performance increase.

Task Three, Part One P6

Applying the Upgrades

Hardware

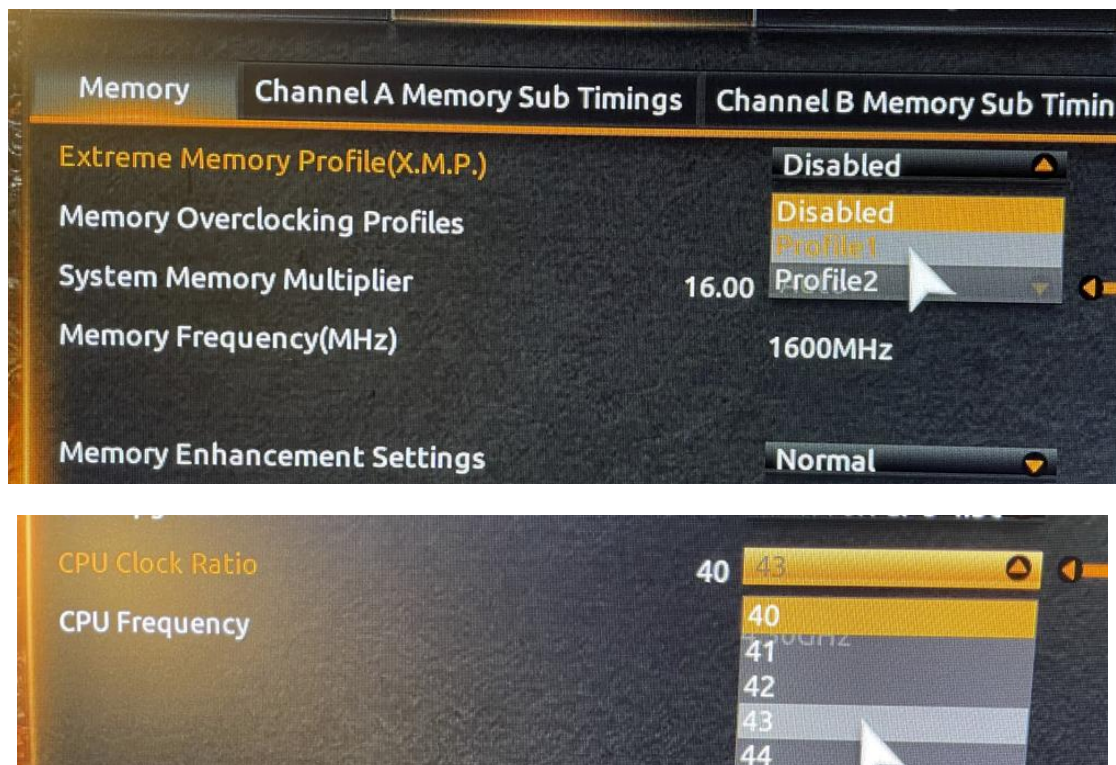


The above picture shows the hardware components that will be installed. In the foreground is the GPU, behind it a stick of RAM.



To install the GPU, I inserted it into the topmost PCIe slot on my motherboard. After inserting it in the slot and ensuring the retaining clip had closed, I screwed in the card to the case at the rear. When the GPU was secured in its slot, I then connected the two power connectors.

To upgrade the memory, I performed a similar process. I made sure to insert the DIMM in the appropriate slot for dual-channel support.



Performing the overclock and applying an XMP profile to the RAM was performed in the BIOS setup of the motherboard. Applying XMP "Profile1" increased the speed of the memory from 1600MHz to 2133MHz. The overclock was achieved by increasing the clock multiplier of the CPU from 40 to 43. Additionally, I increased the CPU voltage by a small amount to perform the higher power consumption of a faster chip.

Software

Unfortunately, it is not possible to upgrade this system to Windows 11 as recommended. This is primarily due to its lack of support for the Trusted Platform Module. It is possible to purchase a TPM add-on board for this motherboard, however purchasing this component was beyond the scope of the assignment. It is also possible to force an upgrade and bypass the minimum requirements, however I decided against this, since this may eventually lead to system instability.

Assuming the PC met the requirements, to reinstall a new operating system, I would have burned an ISO disc image of the new OS to a flash drive and selected it as a boot option. From then, it would have been possible to run through the installer process. To upgrade in-place without reinstalling, one can do this from the Windows Update page in the Settings application.

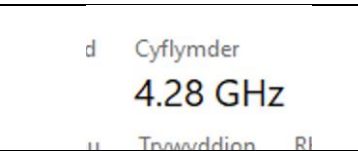
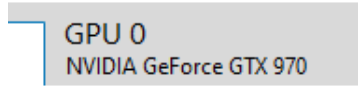
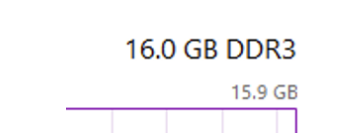
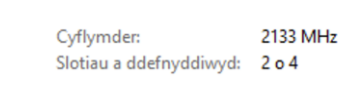
Task Three, Part Two M3

Testing the Upgrades

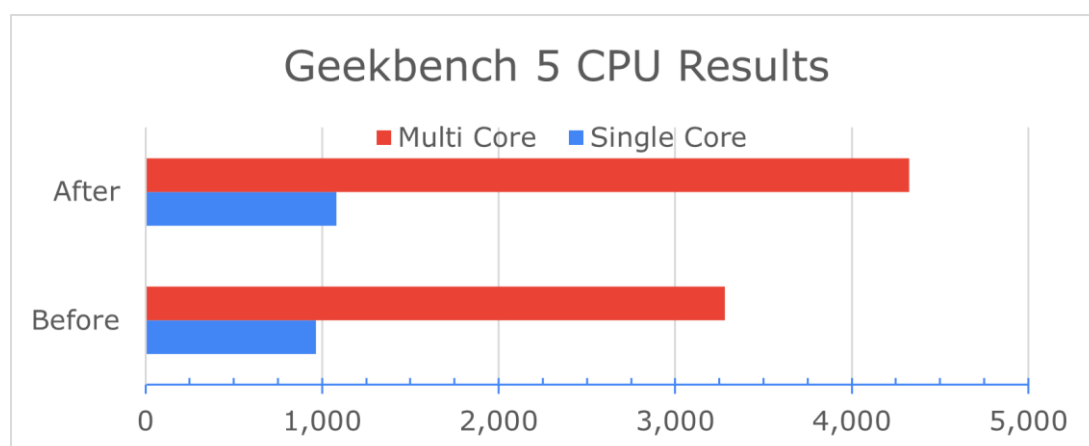
To test the upgrades and their performance improvements, I ran the same benchmarks as before the changes. A full comparison table is available alongside this assignment or at the end of this document.

Checking the Upgrades

To check the installation of the upgrades, I used Windows Task Manager.

Testing the:	Expected Result	Result
Application of the Overclock	CPU shows as running at ~4.3GHz in Task Manager	
GPU installation	The GPU appears in Task Manager	
Amount of RAM	16GB of RAM shows as available in Task Manager	
Speed of RAM	RAM shows as running at XMP profile speed (2133MHz)	

Geekbench CPU

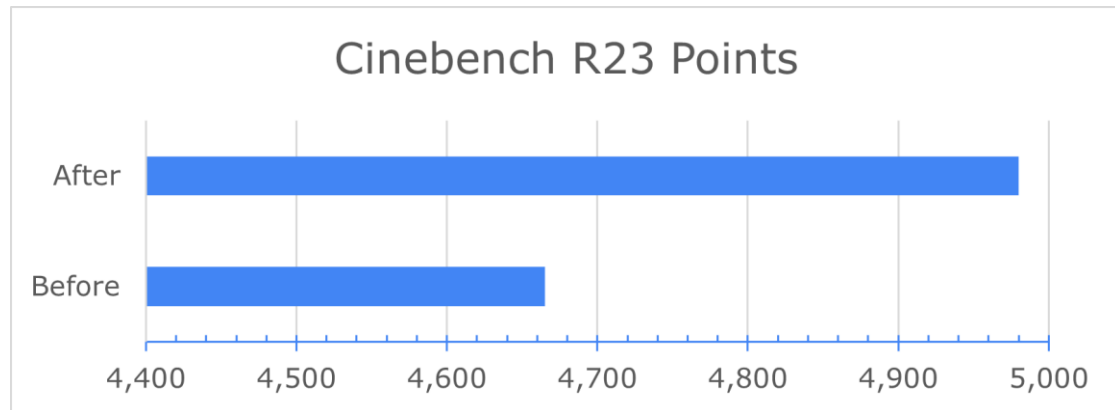


Geekbench results increased by **12%** in the single core score and **32%** in the multi-core score. This result is due to the overclock performed on the CPU.

Userbenchmark

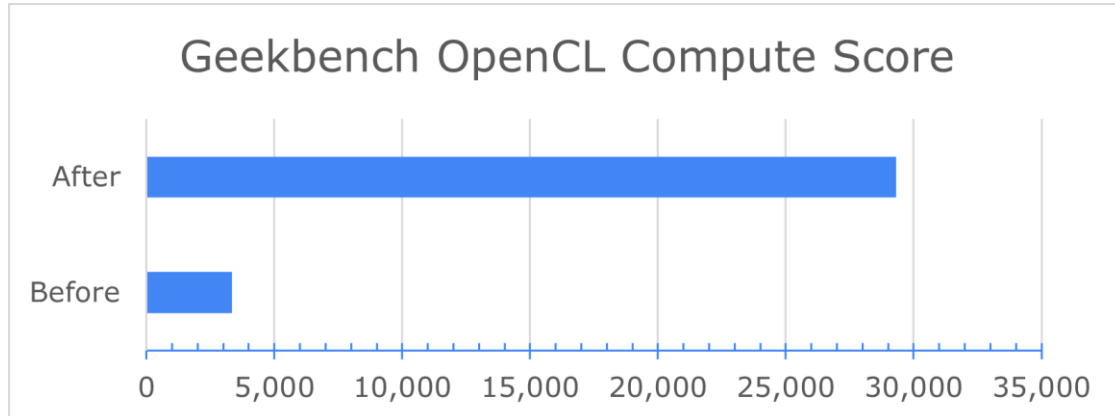
The combination of improvements increased the Userbenchmark 'Desktop' percentage by **33%**: from 68% to 90%.

Cinebench R23



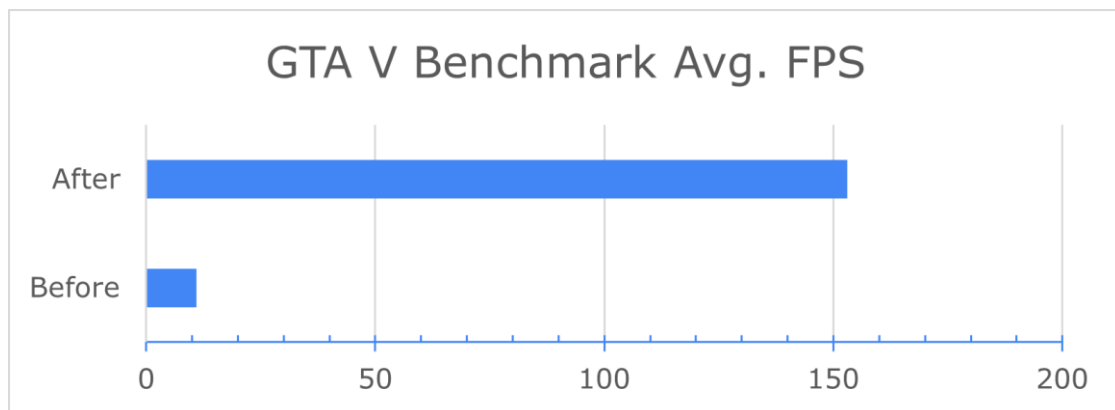
The Cinebench score increased by **7%**, again due to the overclock on the CPU.

Geekbench Compute



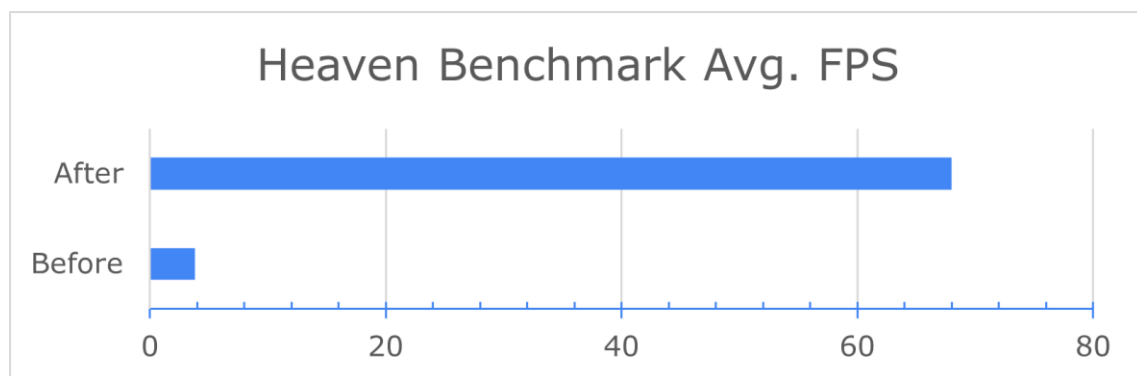
The introduction of a dedicated GPU increased the Geekbench Compute score by **780%**.

GTA V Benchmark



As with the Geekbench Compute results, the GTA V benchmark fared much better with the addition of a dedicated GPU. The average frame rate increased by **1334%**.

Unigine Heaven



The average framerate in Heaven improved by **1712%**, the biggest single improvement of all the benchmarks ran.

General Usage

Since the upgrades, the general usability of the system is greatly improved. Thanks to the RAM upgrade, more applications are able to be open at a given time. This also facilitates the running of a higher quantity of concurrent virtual machines and other tasks that require significant memory usage.

Task Four D2

Evaluating the Upgrades

Overclocking the CPU is a relatively simple process that only has to be performed once. Making the CPU to run faster does bring performance improvements for no extra monetary cost.

If done incorrectly, there is a significant risk of damaging the CPU. There is also the potential for system instability if too aggressive of an overclock is attempted. The performance improvement visible from this overclock could be considered negligible; CPU-oriented benchmark results improving by less than 10%.

The memory upgrade was also an easy task. Assuming there are free RAM sticks, a RAM upgrade can be performed whenever the need arises for a larger amount of multitasking. No benchmark specifically focused on testing memory performance, however the increased capacity brought noticeable improvements to the general user experience when using the system, especially when it came to multitasking with several applications and browser tabs open at once. The price of memory, especially for a system of this vintage, is not huge, therefore a memory upgrade is an easy decision if greater multitasking is desired.

The addition of a dedicated GPU to the system made the most significant difference. Graphically inclined benchmarks performed at least 750% faster when compared to using the integrated graphics. A significant improvement worth mentioning was to the framerate when running the GTA V benchmark. The 1334% increase in FPS demonstrates the importance of a performant graphics card for gaming. The purchase of a modern GPU will set one back many hundreds of pounds, however an older, less performant, and less efficient card will not cost as much. The example in this upgrade was a GTX 970, currently selling for around £80 on the used market. If graphical performance for games, 3D modelling and rendering is a priority, a GPU upgrade is definitely worth looking into, particularly if you are using integrated graphics built into the CPU.

Many of the software maintenance tasks are trivial to run, and many are run automatically by the operating system. Antivirus scans, SSD TRIM and HDD defragmenting are all run regularly automatically by default in the latest version of Windows. File cleanup is an example of a task that is not performed automatically, and while it may yield a small performance improvement, its primary purpose is to free up storage space on a drive.

A file cleanup should be run whenever a drive is running out of usable capacity.

Operating System upgrades are another example of a task typically performed automatically. If not installed automatically, users should regularly check for important security updates and have them installed at the earliest convenience. Larger feature updates are often not installed automatically and installation of these are typically at the users' discretion. These may bring desirable fixes and improvements to system, however, could take a significant amount of time to download and install.

Figures

Unfortunately, due to Word limitations, it is not practical to embed the entire Excel Workbook used to record benchmark results. For this reason, it is attached below as an embedded file.



U25A2
Benchmarking.xlsx

Benchmark	Units	Before Changes				After Changes				Δ
		Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average	
Geekbench 5 CPU Single Core	Score	942	980	980	967	1,072	1,104	1,071	1,082	12%
Geekbench 5 CPU Multi Core	Score	3,263	3,291	3,288	3,281	4,323	4,327	4,322	4,324	32%
Geekbench 5 Compute OpenCL	Score	3,324	3,332	3,337	3,331	29,425	29,069	29,412	29,302	780%
Cinebench R23 Multi Core, No Min Time	Points	4,670	4,658	4,667	4,665	5,012	4,952	4,976	4,980	7%
GTA V Benchmark Mixed Settings, 1080p	Avg FPS	11	10	11	11	153	152	154	153	1334%
Unigine Heaven Extreme Preset	Avg FPS	3.7	3.8	3.8	3.8	68.6	68.1	68	68	1712%
Userbenchmark "Desktop" Rating	Pct	67	68	68	68	91	90	90	90	33%

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Unit 25, Assignment 2
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