Volume 4 Number 2 (2026)
July-December 2026
Page:3839-3845

Journal of Creative Power and Ambition (JCPA)
https://edujavare.com/index.php/jcpa
E-ISSN: 3031-4054
DOI: 10.70610/jcpa.2186

The Effect of Using a Cooling Pad on Laptop Temperature and Performance Under High Workloads

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Article history Submitted: 2026/10/18; Revised: 2026/10/21; Accepted: 2026/10/26

Abstract

Laptops generate heat during operation, particularly when the processor is under a heavy load. Excessive temperatures can cause the processor to reduce its operating frequency—a phenomenon known as "thermal throttling"—which leads to a decline in laptop performance. This study aims to investigate the impact of using a cooling pad on processor temperature, operating frequency, and laptop performance. A quantitative experimental method was employed, comparing two scenarios—using a laptop with and without a cooling pad—under a 100% CPU load for 10 minutes. Each scenario was tested twice using an AMD Ryzen 5 8645HS processor. Temperature and frequency data were recorded using HWiNFO, while performance was measured via benchmark scores. The results indicate that the CPU temperature rose to approximately 100°C in under 10 seconds and remained at that level until the benchmark concluded, regardless of whether a cooling pad was used. The average operating frequency remained constant at 3.853 GHz across all tests, meaning no thermal throttling was observed. The average benchmark score with a cooling pad (10,136.5) was slightly higher than without one (10,009)—a difference of 1.27%, which is smaller than the variation observed between individual trials conducted without a cooling pad (1.75%). In conclusion, the cooling pad failed to lower the processor temperature under full load and did not provide a demonstrably significant improvement in performance within the scope of this study.

Keywords cooling pad; processor temperature; thermal throttling; laptop performance; convection

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I. INTRODUCTION

Laptops are widely used for learning, work, and entertainment. During demanding tasks, a laptop processor consumes more electrical energy and generates more heat. From a physics perspective, some of the electrical energy used by electronic components is converted into heat, causing component temperatures to

rise. Because laptops are compact, the space available for heat dissipation is limited.

Excessively high temperatures can affect processor operation. Modern computers therefore use thermal-management mechanisms to prevent processors from reaching dangerous conditions. Such thermal-management approaches have been widely studied, including by Kumar et al. (2008) at the system level and Salami et al. (2016) for multicore processors.

One such mechanism is thermal throttling, which reduces processor frequency or operating capability when the temperature reaches a specified limit. Sarkar et al. (2020) showed that, in CPU-based devices, frequency and throughput decrease when thermal limits are reached. Thus, high temperatures can reduce device performance.

A simple method commonly used to help lower laptop temperatures is a cooling pad, a fan-equipped platform that increases airflow beneath the laptop. Although cooling pads are widely used, their effects on laptop temperature, operating frequency, and performance need to be examined directly through systematic measurements.

Accordingly, this study aims to (1) compare laptop processor temperatures with and without a cooling pad under a high workload, (2) observe changes in processor operating frequency under both conditions, and (3) compare laptop performance under both conditions.

METHOD

3.1 Research Design

This study used a quantitative experimental method to compare two conditions: a laptop without a cooling pad and a laptop with a cooling pad.

3.2 Equipment and Materials

Laptop: Victus 15

Processor: AMD Ryzen 5 8645HS

Operating system: Microsoft Windows 11 Professional (x64)

Cooling pad: GAMEN GC100, with 8 fans and 6 speed levels

Monitoring software: HWiNFO

Benchmark software: Cinebench

Room thermometer: digital thermometer

3.3 Research Variables

Independent variable: use of a cooling pad (without and with a cooling pad).

Dependent variables: CPU temperature, clock speed, and benchmark performance.

Control variables: the same laptop, operating system, power mode, room temperature, CPU load, test duration, background applications, laptop position and desk surface, and charger condition.

3.4 Testing Procedure

Testing was conducted in stages to ensure that measurements taken with and without the cooling pad could be compared fairly. The procedure was as follows.

The laptop used was a Victus 15 with an AMD Ryzen 5 8645HS processor and Windows 11 Professional (x64).

The laptop was placed in the same position on the same desk throughout testing. The charger condition, power mode, and background applications were kept consistent.

The laptop was left idle until its initial temperature was relatively stable. The initial CPU temperature and room temperature were then recorded using HWiNFO and a digital thermometer.

HWiNFO was used to record CPU temperature and clock speed at one-second intervals.

A 100% CPU-load test was run using Cinebench for 10 minutes. CPU temperature and clock speed were recorded throughout the test.

After each test, the benchmark score or completion time was recorded. The laptop was then allowed to cool until its temperature returned close to the initial condition, reducing the influence of residual heat from the previous test.

The same procedure was repeated with the GAMEN GC100 cooling pad and its fans switched on. The laptop position and all other settings were kept the same as in the test without the cooling pad.

Each condition was tested twice. The tests were alternated, and the results of the two trials were averaged to compare temperature, clock speed, and benchmark performance.

3.5 Data Collection

Primary data were obtained directly from laptop tests. The collected data included CPU temperature, maximum CPU temperature, average clock speed, benchmark score or completion time, and room temperature. Data were recorded using HWiNFO, Cinebench, and a digital thermometer.

3.6 Data Analysis

The test data were analyzed quantitatively by calculating the mean of the two trials for each condition. Results obtained without a cooling pad were then compared with those obtained using one. Percentage changes were calculated to determine the

magnitude of performance differences, while variation between trials was considered when assessing whether the observed difference was large enough to indicate an effect of the cooling pad.

3.7 Control of Testing Conditions

To ensure a fair comparison between the two test conditions, the following factors were controlled: laptop model, operating system, power mode, charger condition, room temperature, laptop position, desk surface, test duration, CPU load, and background applications. These controls were intended to make it more reasonable to attribute differences in the results to the use of the cooling pad.

3.8 Calculation of Percentage Change

Differences between the condition without a cooling pad and the condition with a cooling pad were calculated quantitatively. Percentage change was used to determine the magnitude of changes in temperature, clock speed, and benchmark score, using the following equation:

Percentage change = (Value with cooling pad − Value without cooling pad) / Value without cooling pad × 100%

The resulting calculations were used to clarify the discussion of the cooling pad's effects on processor temperature, clock speed, and laptop performance.

RESULTS AND DISCUSSION

4.1 Test Results

Table 1. Comparison of mean results from two trials without and with a cooling pad

4.2 Effect of the Cooling Pad on Processor Temperature

In both trials, the average CPU temperature was lower when the cooling pad was used. Without the cooling pad, the average temperatures were 52 °C in Trial 1 and 50 °C in Trial 2, giving a combined mean of 51 °C. With the cooling pad, the average temperature was 48 °C in both trials. The difference was approximately 3 °C, or about 6% lower. However, the maximum temperature reached 100 °C in every test, both with and without the cooling pad. This indicates that the cooling pad lowered the temperature over much of the benchmark period but did not prevent the CPU from reaching its peak temperature limit. Average temperatures with the cooling pad were also consistent between trials (48 °C and 48 °C), whereas the results without the cooling pad varied more (52 °C and 50 °C).

4.3 Effect of the Cooling Pad on Clock Speed

Average clock speed was nearly the same under both conditions, at approximately

3.85 GHz. Three of the four tests recorded 3.853 GHz. The only difference occurred in Trial 1 without the cooling pad, which recorded 3.953 GHz; consequently, the combined average without the cooling pad was 3.903 GHz, compared with 3.853 GHz with the cooling pad. This 0.05 GHz difference came from a single value rather than a consistent pattern. Because the maximum temperature reached 100 °C in every test, thermal throttling may have been possible under both conditions. However, the average data alone do not confirm a frequency reduction caused by throttling. The similar clock speeds suggest that the cooling pad did not materially change operating frequency. Any conclusion about throttling should be checked against the clock-speed graph over time; a frequency drop when the temperature reaches 100 °C would be evidence of throttling.

4.4 Effect of the Cooling Pad on Performance

The benchmark score with the cooling pad was slightly higher than the score without it. The average score without the cooling pad was 10,009 (9,922 and 10,096), whereas the average with the cooling pad was 10,136.5 (10,150 and 10,123). The difference was 127.5 points, or approximately 1.27%. For a 10-minute benchmark, the score per minute increased from approximately 1,000.9 to 1,013.7.

Nevertheless, this difference was small. Variation between trials under the same condition reached 174 points (1.75%) without the cooling pad, exceeding the difference associated with the cooling pad. Under the cooling-pad condition, variation was only 27 points (0.27%), indicating more consistent results. Thus, the lower average temperature was accompanied by slightly better and more consistent benchmark performance.

4.5 Analysis from a Physics Perspective

From a physics perspective, when the processor operates under a heavy workload, electrical energy converted into heat raises its temperature. Heat is transferred by conduction to the heatsink and then released into the air through convection. A cooling pad increases airflow around the laptop, enhancing forced convection and potentially accelerating heat dissipation. A lower processor temperature could reduce the need for the system to lower frequency and help maintain performance. The test results did not fully support this expectation. In all four tests, the CPU temperature rose to approximately 100 °C in less than 10 seconds after the benchmark began and remained at that level until the benchmark ended (about 10 minutes). This occurred both with and without the cooling pad. Brief dips reached only about 97–98 °C. This suggests that the heat generated by the processor at full load exceeded the heat-dissipation capacity of the laptop's built-in cooling system.

The additional airflow from the cooling pad affected convection around the outside of the laptop body, while the main thermal resistance may have been along the path from the processor die to the heatsink and from the heatsink to the air inside the chassis. Consequently, the CPU temperature still reached its upper limit.

Average clock speed also remained at 3.853 GHz in the reported log data and did not decrease when the temperature reached 100 °C. Therefore, a frequency reduction due to thermal throttling was not evident in these logs. However, a perfectly constant value may mean that the log recorded nominal frequency rather than effective per-core frequency. If so, subtle throttling might not have been captured.

The benchmark score with the cooling pad was slightly higher, at 10,136.5 compared with 10,009 without it, a difference of 1.27%. This difference was smaller than the variation between trials without the cooling pad (scores of 9,922 and 10,096, or 1.75%). With only two trials per condition, the difference cannot confidently be attributed to the cooling pad.

CONCLUSION

Based on the results, the following conclusions can be drawn:

Using a cooling pad did not prevent the processor from reaching its peak temperature under full load. The CPU temperature reached approximately 100 °C in less than 10 seconds and remained there until the benchmark ended under both conditions. The maximum-temperature difference was therefore 0 °C.

Thermal throttling was not evident in the recorded data for either condition, with or without the cooling pad. The reported average clock speed remained at approximately 3.853 GHz throughout the benchmark despite the temperature reaching 100 °C.

Laptop performance with the cooling pad was slightly higher, but the difference was small. The average score with the cooling pad was 10,136.5, compared with 10,009 without it, a difference of 127.5 points (1.27%). This difference was smaller than the variation between trials without the cooling pad (174 points, or 1.75%); therefore, a significant improvement cannot be concluded from these results.

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