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# Kinematic Changes during a Marathon for Fast and Slow Runners

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A thesis submitted to the faculty of
Brigham Young University
In partial fulfillment of the requirements for the degree of
Master of Science

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# ABSTRACT

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The purpose of this study was to describe kinematic changes that occur during an actual marathon. We hypothesized that (1) certain running kinematic measures would change between miles 5 and 25 of a marathon and (2) fast runners would demonstrate smaller changes than slow runners. Subjects ($n = 179$) were selected according to finish time (Range = 2:20:47 to 5:30:10). Two high-speed cameras were used to measure sagittal-plane kinematics at miles 5 and 25 of the marathon. The dependent variables were stride length, ground time, peak knee flexion during support and swing, and peak hip flexion and extension during swing. Two-tailed paired t-tests were used to compare dependent variables between miles 5 and 25 for all subjects, and regression analyses were used to determine whether faster runners exhibited smaller changes (between miles 5 and 25) than slower runners. For all runners, every dependent variable changed significantly between miles 5 and 25 ($p < 0.001$). Stride length increased 1.3%, ground time increased 13.1%, peak knee flexion during support decreased 3.2%, and peak hip extension, knee flexion, and hip flexion during swing decreased 27.9%, increased 4.3%, and increased 7.4%, respectively ($p<0.001$). Among these significant changes, all runners generally changed the same from miles 5 to 25 except that fast runners decreased peak knee flexion during support less than the slow runners ($p < 0.002$). We believe these kinematic changes were an attempt by all runners (fast and slow) to decrease energy expenditure and enhance performance at the late stage of the race. The fact that fast runners maintained knee flexion during support more consistently might be due to their condition on the race day. Strengthening of knee extensor muscles may facilitate increased knee flexion during support throughout a marathon.

Keywords: fatigue, endurance, run, biomechanics, race

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# Kinematic Changes during a Marathon for Fast and Slow Runners

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## ABSTRACT

The purpose of this study was to describe kinematic changes that occur during an actual marathon. We hypothesized that (1) certain running kinematic measures would change between miles 5 and 25 of a marathon and (2) fast runners would demonstrate smaller changes than slow runners. Subjects (n = 179) were selected according to finish time (Range = 2:20:47 to 5:30:10). Two high-speed cameras were used to measure sagittal-plane kinematics at miles 5 and 25 of the marathon. The dependent variables were stride length, ground time, peak knee flexion during support and swing, and peak hip flexion and extension during swing. Two-tailed paired t-tests were used to compare dependent variables between miles 5 and 25 for all subjects, and regression analyses were used to determine whether faster runners exhibited smaller changes (between miles 5 and 25) than slower runners. For all runners, every dependent variable changed significantly between miles 5 and 25 ($p < 0.001$). Stride length increased 1.3%, ground time increased 13.1%, peak knee flexion during support decreased 3.2%, and peak hip extension, knee flexion, and hip flexion during swing decreased 27.9%, increased 4.3%, and increased 7.4%, respectively ($p<0.001$). Among these significant changes, all runners generally changed the same from miles 5 to 25 except that fast runners decreased peak knee flexion during support less than the slow runners ($p < 0.002$). We believe these kinematic changes were an attempt by all runners (fast and slow) to decrease energy expenditure and enhance performance at the late stage of the race. The fact that fast runners maintained knee flexion during support more consistently might be due to their condition on the race day. Strengthening of knee extensor muscles may facilitate increased knee flexion during support throughout a marathon.

## INTRODUCTION

Marathon running is becoming an increasingly popular sport. In 2001, the five most well-known marathons in the world—Boston, Chicago, Berlin, London and New York City—had a total of 121,291 finishers. In 2010, the total finishers of these marathons increased by over 43% to 173,958. Marathon running involves a challenging distance (26.2 miles) and produces physiological changes that may alter running biomechanics during the race (Hausswirth and Lehénaff, 2001).

Kinematics and economy of prolonged running have been extensively studied. Most runners choose their stride length (SL) to optimize their running economy throughout a race when running non-fatigued (Cavanagh and Williams, 1982). When running fatigued, however, neither decreased SL (Kyröläinen et al., 2000; Elliot and Roberts, 1980) nor increased SL (Hunter and Smith, 2007) affect running economy. Ground time (GT) increases slightly as fatigue occurs (Elliot and Roberts, 1980), due to increased peak knee flexion during support (KFSu) (Nicol et al., 1991; (Derrick et al. 2002)(Derrick et al. 2002)(Derrick et al. 2002)(Derrick et al. 2002)Derrick et al., 2002; Kellis and Liassou, 2009). Peak knee flexion during swing (KFSw) also increases during fatigue (Hausswirth et al., 1997). Although peak hip flexion during swing (HFSw) does not change, peak hip extension during swing (HESw) decreases during prolonged running (Elliot and Roberts, 1980). However, kinematic alterations when running under fatigued conditions vary among individuals (Nicol et al., 1991; Siler and Martin, 1991) and between study designs (Williams, 2007).

Although the kinematics of prolonged running has been previously studied, little is known regarding how kinematics may change during an actual marathon. To our knowledge, no one has evaluated kinematic changes between the early and late stage of an over-ground marathon.  Additionally, only one group of researchers has compared kinematic changes between fast and slow runners during a prolonged run: Siler and Martin (1991) reported that kinematics for fast and slow runners change similarly during a fatiguing 10-km treadmill run.  However, treadmill running in a laboratory setting likely results in kinematics that differs from over-ground racing (McKenna and Riches, 2007; Riley et al., 2008; Nigg et al., 1995; Morin et al., 2009).

The purpose of this study was to evaluate certain running kinematics during early and late stages of an actual marathon, for fast and slow runners.  We asked two research questions: (1) Do certain running kinematics change over an actual marathon?, and (2) Do potential kinematic changes differ between  fast and slow runners?  We hypothesized that certain running kinematics change from the early to late stage of an actual marathon, and that observed kinematic changes would be smaller for fast runners than slow runners.

## METHODS

### Subjects

Subjects (n=179) were all participants in the 2010 Salt Lake City Deseret News Marathon.  Subject selection was based primarily on finish time.  Subject finish times ranged from 2:20:47 to 5:30:10.  We attempted to select approximately one subject per half minute (finish time).  Subjects were excluded if they walked, carried a water bottle or cup, wore a backpack, or exhibited obvious limping, tripping, or falling when passing our cameras' fields of view.  Selected subjects were matched using their race bib number and/or clothing between miles 5 (station 1) and 25 (station 2).  Approval for this study was obtained from the race executive board and appropriate human subject institution review board prior to data collection.

## Data Collection

Three cameras were set up at miles 5 and 25 (Figure 1). Two high-speed digital cameras (Cameras 1 and 2; shutter speed = 1/250 s, frame rate = 120 Hz) were set on tripods side by side, 10 m away from the right side of the race course, at a height of 1 meter. Only one of these cameras recorded at a time. Digital storage space limited each camera to 11.5 minutes of recording at a time. After every 11.5 minute recording, 5minutes were needed to process and download the recorded video to a computer. The second high-speed camera recorded during this 5-minute duration. Five meters of level course were measured and marked with white chalk lines (Figure 1). We ensured that these 5 meters were level using survey equipment. Fields of view for Cameras 1 and 2 were both set to video across the entirety of this 5-m length. A third camera (Camera 3; shutter speed = 1/250 s, frame rate = 60 Hz) was set on a tripod at a height of 1 meter, with a frontal view of the runners. This camera was used to identify and match the runners between miles 5 and 25. A digital clock was placed directly across from Cameras 1 and 2 to show the marathon time and assist with subject selection

## Data Analysis

The following kinematic variables were derived from the collected video at miles 5 and 25 using Dartfish 5.5 software (Dartfish, Fribourg, Switzerland): (1) Station speed (SS; average forward velocity through the aforementioned 5-meter length), (2) SL, (3) GT, (4) sagittal-plane knee angle throughout one gait cycle, and (5) sagittal-plane hip angle throughout one gait cycle. For the joint angles, zero degrees represented anatomical position. Hip flexion, hip extension (beyond anatomical position), and knee flexion were indicated by angles that were greater than zero (as these motions increased, the magnitude of angle also increased). The following six dependent variables were examined at miles 5 and 25 for all subjects: (1) SL, (2) GT, (3) KFSu, (4) HFSw, (5) KFSw and (6) HESw.

### Statistical Analyses

Related to the first research question, the influence of running from mile 5 to 25 on the six dependent variables was evaluated using two-tailed paired t-tests. The dependent variables were normalized to station speed (SS) and calculated as a ratio of miles 25 to 5. These ratios were then compared to the value of 1 using the aforementioned t-tests. A ratio that was significantly less than 1 indicated that the dependent variable decreased between miles 5 and 25, while a ratio that was greater than 1 indicated that the dependent variable increased between miles 5 and 25.

Related to the second research question, we used a mixed models regression analysis blocking on subjects, with SS as a covariate, to examine a potential interaction between average running speed (across the entire marathon) and between-station (mile 5 to 25) changes for the six kinematic dependent variables in a non-normalized form. This procedure allowed us to determine whether fast runners altered their running kinematics differently than slow runners. Significance levels for all statistical analyses were set to 0.01, due to multiple variables and tests. Because SS had direct correlation with all the dependent variables except KFSu, SS was not used as a covariate for KFSu.

## RESULTS

SS decreased from 3.2 ± 0.4 m/s at mile 5 to 2.9 ± 0.5 m/s at mile 25. The non-normalized sample means and standard deviations for each dependent variable are presented in Table 1. Related to the first research question, all dependent variables changed significantly from mile 5 to 25 (Table 2). SL, GT, KFSw, and HFSw increased between miles 5 and 25, while

KFSu and HESw decreased. Related to the second research question, the only kinematic variable that exhibited a significant interaction between miles 5 and 25 was KFSu ($t = 3.19$, $p < 0.002$), which indicated that the fast runners decreased KFSu less than the slow runners at mile 25 when compared to mile 5 (Figure 2). Additionally, the regression analyses related to KFSu were statistically significant at miles 5 ($t = -6.90$, $p < 0.001$) and 25 ($t = -3.88$, $p < 0.001$); although this finding does not directly relate to our research questions, it indicates that fast runners exhibited more KFSu than the slow runners throughout the race (Figure 2 and Table 3).

In summary, the runners demonstrated significant kinematic changes between miles 5 and 25 for all of the observed kinematic variables. The fast runners decreased their KFSu significantly less than the slow runners between miles 5 and 25.

## DISCUSSION

The purposes of this study were to (1) evaluate potential changes in running kinematics during an actual marathon and (2) compare these potential changes between fast and slow runners. Although running kinematics has been studied extensively, this was the first observation of running kinematics during early and late stages of an actual marathon. Related to the first research question, all of the observed running kinematics changed significantly between miles 5 and 25 of a marathon, even after adjusting for the speed differences between the early and late stages of the race. Related to the second research question, fast runners exhibited smaller decreases in KFSu than slow runners, between miles 5 and 25 (i.e., the fast runners more consistently maintained KFSu throughout the race, relative to the slow runner); otherwise, the fast runners changed their running kinematics in a way that was similar to the slow runners.

For all runners, SL increased significantly between miles 5 and 25 (Table 2). This finding agrees with the findings of Hunter and Smith (2007), but contradicts the results of

Kyröläinen et al. (2000) and Elliot and Roberts (1980). Based on these previous findings, neither increased nor decreased SL, alone, is likely to alter running economy. In combination with other kinematic changes, discussed in the following paragraphs, increased SL may facilitate optimization of running economy at the late stage of a marathon (Cavanagh and Williams, 1982).

The present results regarding GT concur with previously reported results (Nicol et al., 1991; Derrick et al., 2002; Kellis and Liassou, 2009). In the presence of fatigue, GT increases (Table 2) because of the attenuation of ground reaction forces that are applied to the lower extremities (Mercer et al., 2002). The present kinematic data support the idea that fatigued runners fail to fully utilize the stretch-shortening mechanism (Derrick et al., 2002), especially about the hip and knee joints. This may be related to the fact that the biceps femoris and rectus femoris are the first to fatigue during long-distance running (Hanon and Thépaut-Mathieu, 2005). Muscle fatigue can result in the attenuation of ground reaction forces and increased GT.

Related to the increased GT, decreased KFSu (Figure 2 and Table 2) could be explained by the inverse relationship between leg stiffness and energy cost of running (Dalleau at al., 1998) and/or the change of impulse during support. Because decreased KFSu implies an increase in leg stiffness (McMahon and Cheng, 1990), the energy cost of running therefore decreases (Dalleau at al., 1998). The equation of impulse, $F \times \Delta t = m \times \Delta v$, explains the interaction of an increased GT and a decreased KFSu we observed, where F is the force transferred to the lower extremities during the support phase, $\Delta t$ is the GT, m is the mass of the runner and $\Delta v$ is the change of vertical velocity at the center of mass. The measurement of ground reaction forces during an actual marathon, although logistically difficulty, could elucidate the aforementioned speculation.

Data relating to the increased KFSw (Table 2) at the late stage of the race when compared to the early stage of the race in this study may be best explained by the principle of angular inertia ($H = I\omega$, where $H$ is angular momentum, $I$ is the inertia and $\omega$ is the angular velocity). Increased KFSw decreases the inertia of the lower extremities about the hip joint and increases angular velocity (Shim et al., 2003). This increased KFSw supports the ease of swing phase and appears to be a more economical running attribute (Hausswirth et al., 1997).

Data in this study showed a 27.9% decrease in HESw and a 7.4% increase in HFSw (Table 2). These changes in hip kinematics could have been caused by increased trunk flexion that has been previously documented during fatigued running (Elliott and Roberts, 1980 and Hausswirth et al., 1997). Because the hip joint angles were measured in reference to the trunk position, increased trunk flexion shifted the hip measurements forward (i.e., more hip flexion and less hip extension during swing) with an overall decrease range of motion about the hip joint. Increased trunk flexion, however, provides better dynamic stability even though it may increase abnormal stress on the lower-extremity joints (Farrokhi et al., 2008) and further fatigue the lower-extremity muscles and increase the risk of injury (Hart et al., 2009).

Kinematic changes we observed between miles 5 and 25 may also be the result of other factors, in addition to the failure of force production among lower-extremity muscles due to fatigue (Hanon and Thépaut-Mathieu, 2005). Decreased neuromuscular activation (Nicol et al., 1991), altered energy substrate utilization, increased demands for body temperature regulation, muscle damage (Kyröläinen et al., 2000), and/or musculotendon structural changes (Tardioli, 2011) could all potentially influence kinematics during a long run. Although these issues are outside the scope of this study, they might be clarified with future research.

Related to our second research question, the present data fit with the findings of Siler and Martin (1991). All runners change their running kinematics similarly, except that the fast runners in this study decreased their KFSu less than the slow runners between miles 5 and 25 (Table 3).

Fast runners also exhibited significantly more KFSu than slow runners throughout the race. We believe this KFSu difference is best explained by the different conditions of the runners on the race day: through genetic differences or differences in training. Fast runners are likely more capable to effectively produce muscular force over a more extended period of time, relative to the slow runners. Additionally, the slow runners in our study ran for a longer period of time: the fastest and slowest subjects finished the marathon at 2:20:47 and 5:30:10, respectively. In speculation, if the fast runners would have been forced to run for another 3 hours, the results from the comparisons between fast and slow runners may have been different.

The present findings imply that runners need not be overly concerned about any kinematics in order to run faster. While KFSu was the only kinematic variable separated the fast runners from the slow runners, focusing on resistance training that would increases in both muscular strength and endurance of the knee extensors may increase KFSu and maintain a more KFSu throughout a marathon.

There were some limitations related to this study. First, some direct lines of sight were blocked by other runners when some of the runners passed by the cameras' fields of view, especially at mile 5. Consequently, we were unable to collect some data that would have otherwise been collected, particularly for some of the fast runners. Second, using the present methods, any change of running kinematics that may have been related to an existing injury or injury acquired during the race could not be evaluated. Third, subjects might run asymmetrically between left and right lower extremities, however, only the right leg was analyzed. For future reference, setting cameras on both sides of the race course could minimize some of these limitations and increase validity.

In conclusion, we observed that, between miles 5 and 25, runners generally demonstrate increased SL, GT, HFSw, and KFSw, and decreased KFSu and HESu.  We believe that these changes reflect an attempt from the runners to minimize energy cost and enhance performance generally.  In contradiction to our second hypothesis, the observed kinematics generally changed the same (between miles 5 and 25) for the fast and slow runners; however, the fast runners did exhibit a more consistent KFSu throughout the race, relative to the slow runners.  This may have been related more to the runners' condition on race day.  Runners should focus on resistance training which would be directed toward increases in both muscular strength and endurance of knee extensors.  By so doing, KFSu should be increased and be able to be maintained longer throughout the marathon.

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Table 1. The non-normalized means and standard deviations for each kinematic variables at miles 5 and 25. SL = stride length; GT = ground time; HESw = peak hip extension angle during swing; KFSw = peak knee flexion angle during swing; and HFSw = peak hip flexion angle during swing.

| **Kinematic variables** | **Mile 5** | **Mile 25** |
|---|---|---|
| SL (m) | 2.26 ± 0.30 | 2.04 ± 0.33 |
| GT (s) | 0.29 ± 0.04 | 0.31 ± 0.04 |
| KFSu (degree) | 42.7 ± 4.4 | 41.2 ± 4.8 |
| HESw (degree) | 16.4 ± 6.7 | 13.4 ± 7.7 |
| KFSw (degree) | 94.1 ± 12.1 | 87.0 ± 11.6 |
| HFSw (degree) | 42.0 ± 5.9 | 39.7 ± 6.6 |

Table 2. Average ratios of mile 25 to mile 5 for each kinematic variable, normalized to corresponding station speed. The asterisks indicate that the ratio was significantly different from the value 1 (a value greater than 1 represents an increase in that variable after accounting for the station speed). SL = stride length; GT = ground time; HESw = peak hip extension angle during swing; KFSw = peak knee flexion angle during swing; and HFSw = peak hip flexion angle during swing.

| **Kinematic variables** | **Ratio of Mile 25:5 ± SD** | **t** | **p** |
|---|---|---|---|
| SL | *1.013 ± 0.003 | 4.56 | <0.001 |
| GT | *1.131 ± 0.010 | 13.42 | <0.001 |
| KFSu | *0.968 ± 0.007 | -4.52 | <0.001 |
| HESw | *0.721 ± 0.211 | -1.32 | <0.001 |
| KFSw | *1.043 ± 0.008 | 5.74 | <0.001 |
| HFSw | *1.074 ± 0.014 | 5.43 | <0.001 |

Table 3. Regression slopes (kinematic variable × average running speed) and corresponding p values for the dependent variables at miles 5 and 25, and the p-value related to the comparison between the two slopes. The asterisks indicate that the fast runners had greater peak knee flexion at support (KFSu) than the slow runners. The cross indicates that the fast runners decreased their KFSu less than the slow runners between miles 5 and 25. SL = stride length; GT = ground time; HESw = peak hip extension angle during swing; KFSw = peak knee flexion angle during swing; and HFSw = peak hip flexion angle during swing.

| | **Slope** | | | | |
|---|---|---|---|---|---|
| **Kinematic variables** | **Mile 5** | **p value** | **Mile 25** | **p value** | **Slope difference (p value)** |
| **SL** | 0.013 | 0.528 | 0.020 | 0.340 | 0.521 |
| **GT** | -0.005 | 0.208 | -0.007 | 0.113 | 0.461 |
| **KFSu** | 2.299 | *<0.001 | 4.085 | *<0.001 | †<0.002 |
| **HESw** | 0.905 | 0.480 | 1.024 | 0.448 | 0.887 |
| **KFSw** | 2.853 | 0.063 | 1.529 | 0.341 | 0.175 |
| **HFSw** | 0.891 | 0.449 | 2.228 | 0.072 | 0.063 |

Figure 1. A schematic depicting the arrangement of the three cameras that were set up at miles 5 and 25 in order to evaluate sagittal-plane running kinematics during an actual marathon.

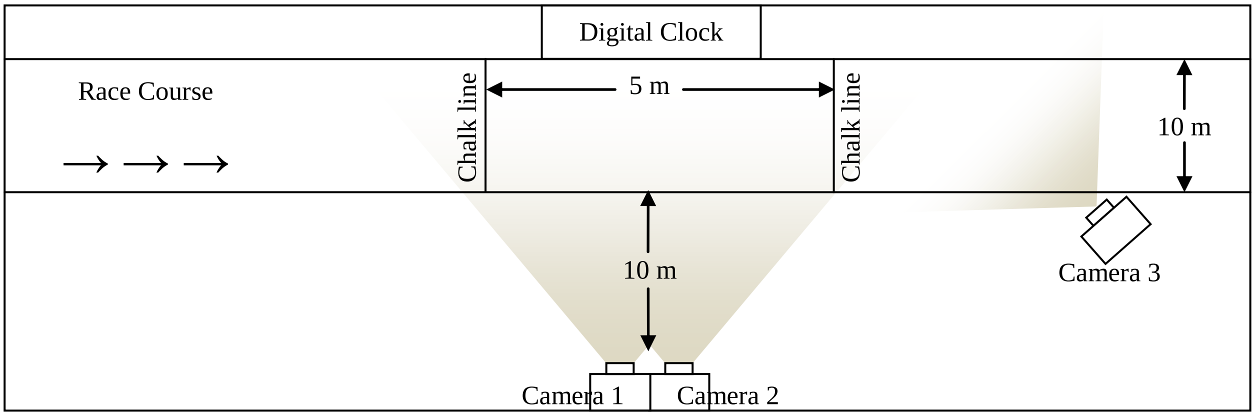
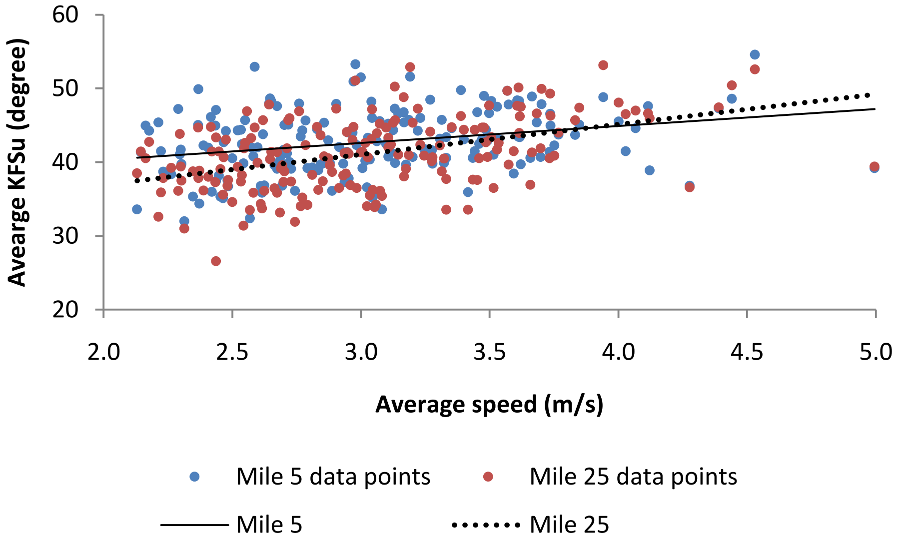


Figure 2. Peak knee flexion during support (KFSu) plotted against average speed (throughout the entire marathon). The fast runners demonstrated significantly greater KFSu than the slow runners at miles 5 ($p<0.001$) and 25 ($p<0.001$). The regression slopes were different between miles 5 and 25, indicating that the fast runners decreased their KFSu less than the slow runners ($p<0.002$) between miles 5 and 25.



# Appendix A: Prospectus

# CHAPTER ONE: INTRODUCTION

Marathon running is a growing sport. In 2009, the five most well-known marathons in the world—Boston, Chicago, Berlin, London and New York City—had a total of 170,360 finishers. In the USA alone, 397 marathons were recorded in 2009 with nearly 468,000 runners finished. Marathon running involves a challenging distance (26.2 miles) that produces physiological changes; which may lead to alterations in the runners' biomechanics during the race.

The biomechanics of long-distance running have been previously studied. Hunter et al. (2007) reported that runners change their stride length (SL) and stride frequency (SF) throughout a long distance race in order to optimize metabolic cost of running. Kyrolaninen et al. (2000) also studied SL and SF during long distance running, and found that SL decreases while SF increases in order to maintain the pre-set speed on a treadmill. Valiant et al. (1990) found that each five-degree increase of knee flexion during the support phase causes a 25% increase in the metabolic cost of running. Also, Hasegawa et al. (2007) showed that faster marathoners exhibit less ground time than slower marathoners. Gazeau et al. (1997) observed that a more stable running pattern (i.e., less medial-lateral movement of the center of mass) enhances running efficiency, allowing runners to run longer.

Other biomechanical variables change across the duration of a race, depending upon the distance and speed of the runners. Ground time increases slightly over a 3000 m trial run (Elliot et al., 1980). Peak knee flexion during the support phase increases when fatigue onsets (Kellis et al., 2009) because quadriceps muscles are highly activated in a running cycle (Adelaar et al., 1986). Knee flexion during the swing phase decreases (Hausswirth et al., 1997) as hamstring muscles fatigue (Adelaar et al., 1986). Figure 1 illustrates these kinematic descriptions in a running cycle.

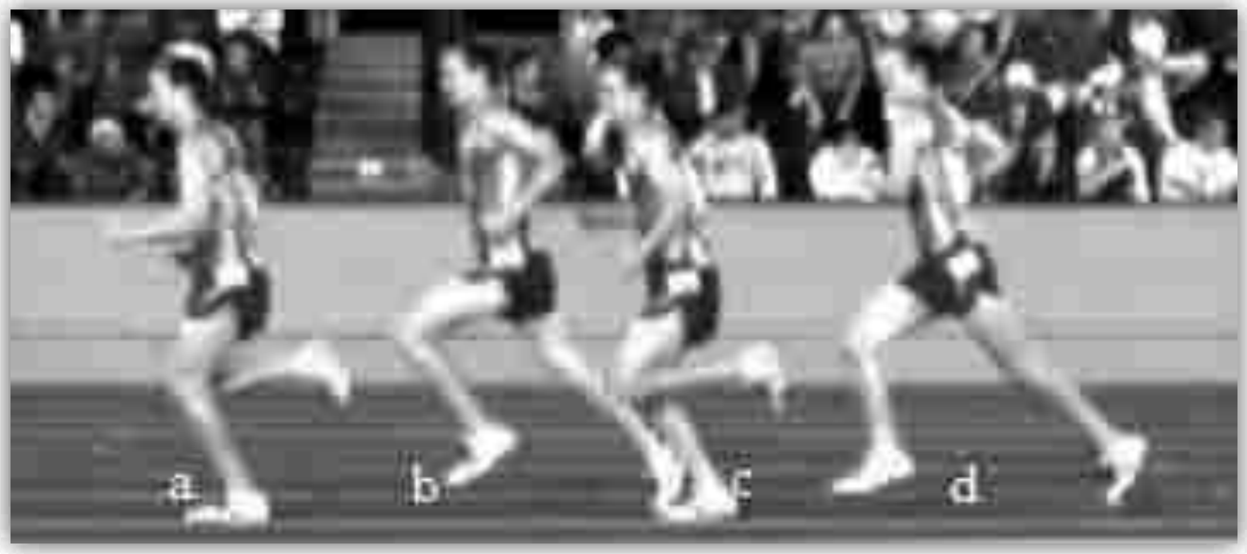


**Figure 1.** A Running cycle with one full stride. (a) Peak knee flexion during the support phase. (b) Peak hip flexion during the swing phase. (c) Peak knee flexion during the swing phase. (d) Peak hip extension during the early-swing phase.

Although a comprehensive knowledge of the mechanics exhibited by successful marathoners may increase marathon performance, we know little about the biomechanics of fast and slow marathoners during a marathon. Siler et al. (1991) reported that relatively slow runners demonstrate similar kinematic changes, relative to fast runners, during fatigue in a 10-km run. These results may not apply to an actual marathon; particularly since these data were collected on a treadmill in a laboratory setting. Treadmill running may result in kinematics that differ from overground running (e.g., more plantarflexion at impact; Riley et al., 2008; and less push-off; Nigg et al., 1995). As treadmill speed is usually held constant, subjects may adjust their kinematics in order to maintain the speed that is required to stay on the treadmill belt. In reality, runners likely adjust running speed and mechanics when fatigued in an actual race. Therefore, a study investigating kinematic changes during an actual marathon should be conducted.

The purpose of this study is to compare running kinematics between the beginning and end of an actual marathon in fast and slow marathoners.  We ask the following research questions: (1) How do leg kinematics change over an actual marathon?, and (2) How do these potential changes differ between the top 10% and bottom 10% marathon finishers?

## Hypothesis

We first hypothesize that the leg kinematics are expected to change between the beginning and end of a marathon as described in Table 1.

| Kinematic Variables | Direction of change |
|---|---|
| Stride length | Increase |
| Stride frequency | Decrease |
| Ground time | Increase |
| Peak knee flexion during the support phase | Increase |
| Peak hip extension during the early swing phase | Increase |
| Peak knee flexion during the swing phase | Decrease |
| Peak hip flexion during the swing phase | Decrease |

**Table 1**. Direction of kinematic changes between the beginning and end of a marathon.

We also hypothesis that the fast runners (fastest 10%) will exhibit smaller kinematic changes than the slow runners (slowest 10%) during a marathon.

## Null Hypothesis

Leg kinematics changes are insignificant between the beginning and end of a marathon. And, there is no difference in the leg kinematic changes between the top and bottom 10% of marathon finishers over the course of a marathon.

## Operational Definition

<u>Speed:</u>  a 5-m mark traveled by the runners divided by the time of travel when passing by the cameras’ fields of view

Stride length:  displacement between two consecutive heel strikes of the same foot

Stride frequency:  number of strides per second

Ground time:  time between the initial foot contact and toe-off

Knee joint angle:  the knee joint center of the vertex, hip joint center and ankle joint center as end points, calculated at peak knee flexion during the support phase (Figure 2) and peak knee flexion during the swing phase (Figure 3) with the anatomical knee joint position at 180 degrees—any knee flexion results in less than 180 degrees.

Hip joint angle:  the hip joint center of the vertex, knee joint center and base of neck as end points, calculated at peak hip flexion during the swing phase (Figure 4) and peak hip extension during the early swing phase (Figure 5) with the anatomical hip joint position at 180 degrees—any hip flexion results in less than 180 degrees and any hip extension results in greater than 180 degrees.

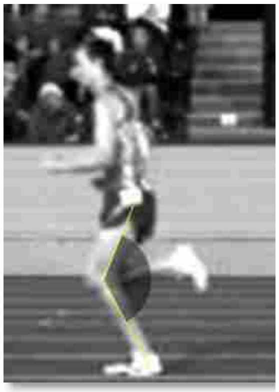


**Figure 2**.  Knee joint angle at peak knee flexion during support phase.

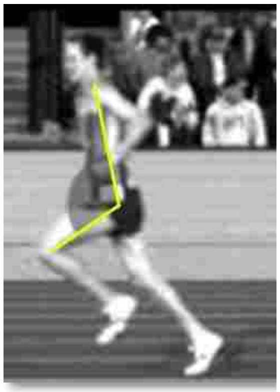


**Figure 3**.  Hip joint angle at peak hip flexion during swing phase.

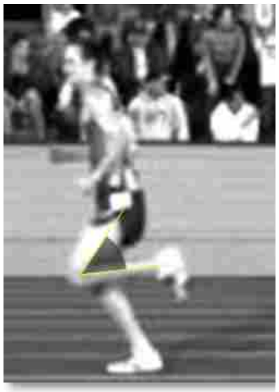


**Figure 4.** Knee joint angle at peak knee flexion during support phase.

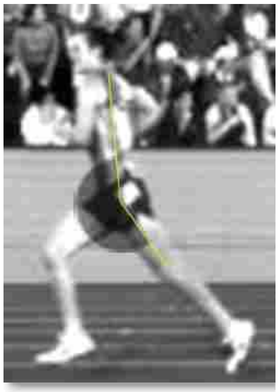


**Figure 5**.  Knee joint angle at peak hip extension during early swing phase.

## Delimitations

Subjects are participants in the 2010 Deseret News Marathon, located in Salt Lake City, Salt Lake County, Utah on July 24th in 2010.

Walkers are excluded (i.e., no non-support phase) due to the differences in kinematics between walking and running.

Runners, who carry water bottles or cups on their hands, or camelback on their backs, are also excluded.

Runners with obvious limping, tripping, or falling when passing by the cameras' fields of view are also excluded.

## Limitations

Direct line of sight may be blocked by other runners or spectators when runners passing by the cameras' fields of view. Some potential significant data cannot be collected.

## Assumptions

We assume that the change of leg kinematics is not compensatory to any existing injury or injury acquired during the race.

We further assume that any change of leg kinematics by the runners is not due to injury.

We also assume that subjects run relatively symmetrical between left and right sides. Cameras are set only on the right side of the course.

In addition, we assume that subjects exhibit their normal form and level of effort for the given phases of the race when passing by the cameras' fields of view.

## Significance

Because marathon running is a popular sport, and most marathoners want to know how to improve performance, understanding the kinematic changes during a marathon race will potentially help runners better prepare for the race physiologically and mentally.  Coaches and runners may adjust their training programs accordingly to improve certain muscle groups' strength and endurance in order to minimize the kinematic changes and maintain the optimal running pattern throughout the race.  Further research will be needed to evaluate the influence of various strength and conditioning interventions on kinematic changes during a marathon.

# CHAPTER TWO: REVIEW OF LITERATURE

## Introduction

Running is popular because it is simple and inexpensive. In 2009, the five most well-known marathons in the world—Boston, Chicago, Berlin, London and New York City—had a total of 170,360 finishers (Verndale 2009, active.com 2009, running 2009, Marathon 2009, RUNNERS 2009). Marathon running involves a challenging distance in which many physiological changes link to biomechanical alterations. The purpose of this literature review is to explore studies that have shown how biomechanics change during long-distance running and discuss limitations related to the studies. This literature review will first briefly discuss some physiological issues that are involved in a marathon. Physiology is discussed first because it potentially causes the biomechanical changes that will be measured in the current study. Secondly, the relationship between fatigue, running mechanics, and running economy will follow. Thirdly, studies relating strictly to kinematic changes during fatigued running will be reviewed. An especially relevant study, Siler et al. (1991), will be highlighted during this section; these researchers compared fast and slow distance runners during fatigued running. Finally, this review will cover some validity issues that may occur in the past literature.

## Physiology

During a 26.2-mile marathon race, many physiological changes occur. Oxygen consumption, energy expenditure, ventilation, and heart rate increase. Conversely, respiratory exchange ratio and true oxygen percent usage decrease; these changes indicate increased utilization of fat as energy substrates. Serum creatine kinase and skeletal troponin I increase, indicating increased muscle damage, and decreased muscular force production and reaction time. Catecholamine levels increase, also indicating a shift of energy utilization from glycogen to fat and increased demand of body thermal regulation (Kyrolaninen et al., 2000). All of the aforementioned physiological changes indicate fatigue. Fatigue likely leads to alteration of biomechanics during long distance running.

## Fatigue, Running Mechanics, and Running Economy

Fatigue is an acute motor impairment (Enoka et al., 1992) that is influenced by central and peripheral factors (Meeusen et al., 2006). It has been shown that altering SL, SF, ground time, and foot contact placement while running long distances affect running economy, and thus performance. Hunter et al. (2007) conducted a study on a treadmill with piezoelectric force transducers on 16 subjects, and oxygen uptake was measured. Subjects changed their SL and SF throughout a long distance race in order to optimize their metabolic cost of running while fatigued. Kong et al. (2008) observed six elite Kenyan runners using the Vicon motion analysis system and found that their shorter ground time may improve running economy. During ground time, a braking force is exerted until the center of mass passes over the foot’s point of impact. Shorter ground time results in less total braking force. Hasegawa et al. (2007) observed that the majority of marathoners are rear-foot strikers, but more mid-foot strikers are among the fast marathoners than the slow marathoners. They also stated that shorter ground time is related to good running economy. Inversion during foot impact correlates to shorter ground time, and mid-foot strikers are more likely to exhibit inversion during foot impact compared to that among rear-foot strikers. Consequently, they concluded that mid-foot strikers that exhibit increased inversion may have improved running economy. On the contrary, Williams et al. (1987) showed that rear foot strikers with longer ground time, smaller vertical oscillation and more knee extension at foot impact have better running economy when compared to the mid-foot and forefoot strikers.  The relationship between running economy and foot inversion may be dependent upon other more significant variables.

Subjects' fatigue tolerance may affect running mechanics, running economy and performance.  Siler et al. (1991) observed that some runners are more sensitive to fatigue than others; i.e., some runners performed more poorly than others at the same fatigue level in their study.  Kyrolainen et al, (2000) explained that increased muscle damage while running fatigued may reduce running economy due to increased oxygen uptake.  The amount of impact of fatigue on both running mechanics and economy has yet to be investigated.

## Kinematic Changes During Fatigued Running

Previous researchers have shown that fatigue during a long-distance run alters running mechanics.  Derrick et al. (2002) showed that runners increase peak knee flexion and rearfoot inversion during the support phase. Gerlach et al. (2005) demonstrated that the peak impact force magnitude and associated loading rate decrease significantly when running fatigued.  On the other hand, the other peak magnitudes were unchanged when SF decreases, and SL increases together with knee flexion during the support phase and ankle dorsiflexion at impact. Hausswirth et al. (1997), however, claimed that SL decreases significantly with increasing knee extension at foot impact and decreasing knee flexion during the swing phase when running at 75% of their maximal aerobic speed (MAS).  Kellis et al. (2009) demonstrated that center of pressure location moves posteriorly, knee flexion at toe-off and at foot impact increases, and hip flexion at toe-off increases during fatigued running.  Le Bris et al. (2006) showed that runners' kinematics is inconsistent when fatigued; i.e., lack of similarity of crania-caudal movements from one stride to another.  Elliot et al. (1980) recorded that runners decrease SL and air time, while increasing SF and ground time; the lower legs become more angled at foot impact, the thighs become less extended prior to toe-off, and the trunk leans more forward. Adelaa et al. (1986) comprehensive analysis of long distance running mechanics explains some reasons why runners change their mechanics when fatigued.

Derrick et al. (2002) conducted a laboratory treadmill experiment on 10 recreational runners, who ran at their 3200-m race pace (3.40 m/s ± 0.38 m/s) to volitional exhaustion. Data were collected at the beginning, middle and end of the run. Accelerometers were attached to the head and legs to measure shock and shock attenuation. Electrogoniometers were attached to the knee and rear-foot to measure joint angles. At foot impact, the knee was flexed 4.4 degrees more, and maximum rear-foot angle was inverted 1.4 degrees more at the end. Such changes lowered the effective mass, which was defined as the portion of the mass accelerated. Runners accelerated faster, and the shock attenuation was higher at the end. These authors suggested that these biomechanical changes when running fatigued could be the bodies' natural instinct to prevent joint injury, or the bodies just could not further maintain the optimal performance. Therefore, they suggested future research to focus on the cause of these kinematic changes.

Gerlach et al. (2005) collected ground reaction force data from 90 female runners on a force-measuring treadmill before and after a modified discontinuous VO2max treadmill protocol. The peak force magnitude and peak loading rate at impact significantly decreased with fatigue, but the peak force at toe-off did not change. These could be explained by the significant decreased SF accompanied by the increased SL. They explained that runners adopt a different running style when fatigued—increase in knee flexion and/or ankle dorsiflexion at foot impact. These changes decrease the effective mass, which was defined by Derrick et al. (2002) to allow faster acceleration and higher shock attenuation. They asked the same questions as Derrick et al.

(2002) did: Do biomechanical changes represent a strategy to prevent injury when running fatigued, or do runners just lose their optimal performance capabilities?

Hausswirth et al. (1997) measured VO2, minute ventilation, heart rate and respiratory exchange ratio data to represent the energy cost of running and used motion analysis for the kinematic changes. Seven male triathletes participated in this treadmill study. Each subject finished three running conditions (1) a 45-minute isolated run at 75% of their MAS—representing their non-fatigued state of running, (2) a 2-hour-15-minute triathlon with a 30-minute swim, a 60-minute bike and a 45-minute run at 75% of their MAS—representing one of the two fatiguing protocols, and (3) a 2-hour-15-minute marathon with a 1-hour-30-minute track run mostly at 80-85% of their maximum heart rate and a 45-minute run on a treadmill at 75% of their MAS—representing the second fatiguing protocol. Only the results that are relevant to our study are summarized here. The marathon run condition resulted in a higher energy cost of running, shorter SL, increased knee extension at foot impact and knee flexion during the swing phase; when compared with the triathlon run. They concluded that these results implied muscle activation changes. The relationship between running economy and biomechanics was complicated. Not one single kinematic variable could explain the decrease in running economy when running fatigued.

Kellis et al. (2009) measured kinematic data and elecromyographic signals of the vastus medialis, gastrocnemius, and biceps femoris muscles of 15 females, running at 3.61 m/s on a treadmill. Measurements were recorded before and after two isolated-muscle fatiguing protocols—knee flexor/extensor and ankle dorsiflexor/plantarflexors—on two separate days. After the ankle-fatigue protocol, decreased dorsiflexion caused foot landing location to be more toward the heel, which lead to greater shock attenuation at impact. Increased knee flexion at toe-off may not have any significance, but subjects had to alter their kinematics to compensate for the ankle fatigue. After the knee-fatigue protocol, the shock attenuation decreased because of an increase in knee flexion at foot impact. Therefore the joints act as a spring to minimize the internal shock to prevent injury. On the other hand, both vastus medialis and gastronemius activities increased after either protocol, which indicated the increase of muscle sensitivity for alpha-gamma coactivation and enhanced stretch reflexes. Such decline in muscle force production might; however, increase the risk of musculoskeletal injury and a decline in performance.

Le Bris et al. (2006) used accelerometers to record certain joint angles on six male sub-elite middle-distance runners on a flat track at their MAS to volitional exhaustion. Stride regularity decreases significantly (i.e., medio-lateral movement increases) by the end of the run. The energy needed to move forward transferred to the stride irregularity. As a result, performance declined when running fatigued. A stable running style without excessive medio-lateral movement throughout the entire race is important.

Elliot et al. (1980) recorded eight runners in a 3000-m time trial on a flat track. They analyzed kinematic changes at the 500-m, 900-m, 1300-m, 2100-m and 2900-m marks. The subjects' goal was to maintain a constant speed throughout the entire run. Decreased SL, accompanied by increased SF, was observed. Also, ground time increased while air-time decreased slightly. The lower leg became more angled at foot impact, which produced a greater deceleration before the center of mass passing the longitudinal axis of the body. The thigh was less extended prior to toe-off and the trunk leaned forward. They recommended coaches to implement specific training to minimize the kinematic changes induced by fatigue.

Adelaa et al. (1986) reviewed different literature about running cycle. At foot impact, the center of mass is decelerated by the gluteus maximus and hamstring musculature while the hip adductors help stabilize the support leg. The quadriceps is the most activated muscles in each running cycle, therefore strength and fatigue tolerance are important for long distance runners. The plantar flexors and peroneals stabilized the plantar surface and hindfoot during the mid-support phase at the highest loading rate. These same foot and ankle muscles also assisted plantar flexion at foot impact and resisted the dorsiflexors at toe-off. These muscles also coordinated the rear-foot inversion and supination of the forefoot with the support of the ligaments, which maintained the integrity of the arch. The plantar flexors were especially important for acceleration. When the gastrosoleus does not function properly; it changes how the center of gravity moves forward during the support phase, dorsi-flexion decreases after foot clearance at toe-off, and thus the activity of the knee flexors increase. The peroneals stabilize ankle during the support phase. They explained how some muscle groups fatigue earlier in a race than others, which caused muscle imbalance and kinematic changes.

In summary, certain mechanical variables are affected by fatigue and change across the duration of a long-distance race. SL decreases, with increased SF, in order to maintain optimal speed (Kyrolaninen et al, 2000). Peak hip flexion during the swing phase (see figure 1) decreases while peak hip extension during the early swing (see figure 2) increases. This is likely due to fatigued hip flexors which fail to produce optimal forces (Siler et al, 1991). Maximum knee flexion during the support phase (see figure 3) increases (Kellis et al, 2009) due to quadricep muscles fatigue; these muscles are activate most in a running cycle (Adelaar et al, 1986). Knee flexion during the swing phase (see figure 4) decreases due to hamstring muscle fatigue; the hamstrings decelerate the forward motion at each foot strike before the center of mass passes the longitudinal axis of the body (Adelaar et al, 1986). Ground time increases (Elliot et al, 1980), probably due to a combination of all of the aforementioned kinematic changes.

## Fast versus Slow Runners

Although a comprehensive knowledge of the mechanics exhibited by successful marathoners may increase marathon performance, we know little about the biomechanics of fast marathoners, compared to slow marathoners. Siler et al. (1991) conducted the only study that reported kinematic differences between slow and fast runners. They observed nine fast and 10 slow males running on a treadmill at a pace closest to their most recent 10-km race; the subjects ran to volitional exhaustion. Statistically significant, but small, changes differed between the fast and slow runners for average SL, range of motion at the thigh, maximum thigh flexion, maximum knee extension, maximum knee flexion, and head-neck-trunk segment angle at maximum thigh extension. However, these changes were found to be insignificant when these variables were compared at the same percentage of the total run time (when the subjects reached volitional exhaustion). They concluded that slow runners demonstrated similar kinematic changes relative to fast runners under fatigued conditions.

We found Siler et al. (1991) measurements were inconsistent. As mentioned in the study, small changes in running pattern might be caused by conscious modifications during fatigued running. Almost all of their measurements had extreme contradictory changes. For example, the SL ranged from a 9.0 cm decrease to more than a 34.0 cm increase between the beginning and end of the run. For some subjects, parameters measured at the end were almost the same as at the beginning. Subjects might have consciously tried to maintain their perceived optimal running mechanics because they knew they were being recorded. This highlights one disadvantage of conducting studies in a laboratory setting. Additionally, by including too many dependent variables, the statistics may have been significantly weakened. For example, the observed maximum knee flexion and extension angles were measured but not compared to a fixed plane over the course of the run. The resulting measured range of motion appeared to remain constant and actual changes in flexion and extension were therefore ignored.

## Validity of the Past Literature

In addition to subject variability and statistical issues related to the Siler et al. (1991) study, treadmill running likely results in other differences, when compared to overground running. First, treadmill running requires familiarization (Jaskolske et al., 1996). Most subjects may not have the experience of running on a treadmill prior to data collection. Also, treadmill running involves decreased push-off requirements (Riley et al., 2008) and increased plantar flexion at impact (Nigg et al., 1995). Also, importantly, treadmill running involves a constant, predetermined speed regardless of the subjects' condition. Running on a treadmill requires subjects to change their biomechanics to keep pace with the constant moving belt, even when fatigued. In reality, however, when runners fatigue, they likely slow down as well as potentially alter their running mechanics. As mechanical changes are small, these differences between treadmill and overground running are important to consider.

Mechanical changes are dependent upon the running speed. Normalization or statistical adjustment should be employed to eliminate this confounding factor. Siler et al. (1991) did consider the running speed of the subjects and found the significant kinematic differences between fast and slow runners became insignificant. Other studies were conducted on a treadmill; a predetermined constant speed provided an advantage on this issue.

Standardized running shoes could cause unrepresentative mechanics in Derrick et al. (2002) and Kellis et al (2009) studies, compared to the use of shoes subjects normally used. If a subject is not accustomed to the shoes used during the testing protocol, unrepresentative performance may result. For example, among other potential alterations, certain muscles may suffer premature fatigue (Cheung, 2010), and kinematic changes may be altered by the choice to use standardized running shoes. Using different kinds of shoes might increase the variability within a study in Gerlarch et al. (2005), but results may be more applicable to a real race.

Weather conditions also likely affect race performance. Marathon season is normally cooler because hot and humid conditions raise potential risks of dehydration and hyperthermia. Ely et al. (2008) studied performances between slower runners and faster runners in warm weather—slower runners demonstrated a slower overall pace rather than a reduction of speed, exhibited by faster runners. A laboratory normally keeps at a constant temperature and humidity to eliminate these conditions and strengthen the internal validity. However, no official race had ever been done on a treadmill in a laboratory setting (especially a marathon distance).

Because marathon running is a popular sport, and most marathoners want to know how to improve performance. Understanding how kinematic changes differ between fast and slow marathoners during a race will potentially help runners better prepare for the race physiologically and mentally. With the information in this review, we know the direction of certain kinematics change during a marathon. In the current study, we will determine how large the selected kinematic changes are, and how the fast marathoners change their kinematics, relative to the slow marathoners.

# CHAPTER THREE: METHODS

## Subjects

Two hundred male runners will be selected in the 2010 Deseret News Marathon on July 24, 2010 in Salt Lake City, Utah. Subject selection will be based on the time that each subject passes the 25-mile mark. Beginning with the first subject to pass the 25-mile mark, we will attempt to observe one subject per minute for the next 200 minutes. The selected subjects will then be matched according to subjects' race bib numbers and/or clothing from the 4-mile-mark recording to compare the leg kinematic changes between the beginning and end of the marathon. Approval will be obtained from the race executive board and the appropriate human subject protection committee prior to data collection. Informed consent will not be required as no contact will be made with the subjects.

## Data Collection

At mile markers 4 and 25, two high-speed digital cameras (Cameras 1 and 2) will be set on tripods (shutter speed = 1/250 s, frame rate = 120 Hz) side by side, 10 m away from the right side of course, at a height that is perpendicular to the runners' legs (Figure 6). Only one of these high-speed cameras will be running at any given time. Factors related to digital storage space limit each camera to 11.5 minutes of recording at a time. A 15-second break is then needed to process the recording, and a 5-minute break is needed to download the recordings to a computer. The second high-speed camera will record during the aforementioned 15 seconds and 5 minutes.

Five meters of level course will be measured by survey equipment and marked with white chalk lines that will be placed across the entire width of 10-meter-wide course for Dartfish 5.5 (Atlanta, GA, USA) analysis (Figure 6). The two aforementioned cameras' fields of view will be set to video across this 5-m length. A third camera (Camera 3) will be set on a tripod (shutter speed = 1/250 s, frame rate = 60 Hz), at a height of 1 m, with a frontal view of the runners for identification purposes.  A digital clock will be placed directly across from Cameras 1 and 2 to show the marathon time; this will facilitate subject selection at each minute of the race.

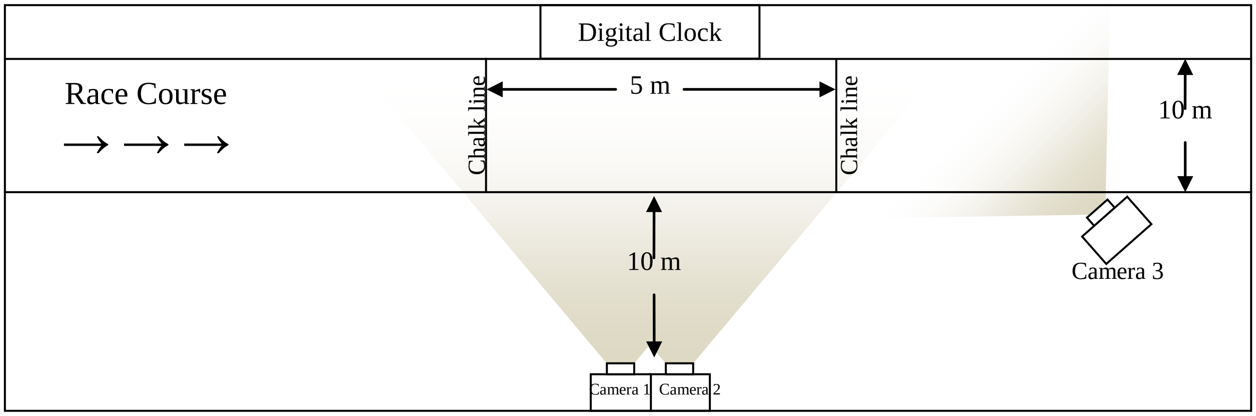


**Figure 6.** A schematic depicting the camera set up at mile markers 4 and 25.

**The independent variable will be the** time at which each runner passes the 25-mile mark. The dependent variables for this study will be the difference (between the 4- and 25-mile markers) for the following variables: (1) SL, (2) SF, (3) ground time, (4) peak knee joint flexion angle during the support phase (Figure 2), (5) peak knee joint flexion angle during the swing phase (Figure 3), (6) peak hip joint flexion angle during the swing phase (Figure 4), and (7) peak hip joint extension angle during the early swing phase (Figure 5).  These variables will be measured using Dartfish 5.5 (Atlanta, GA).  SL (meters per stride) will be calculated as the displacement between two consecutive heel strikes of the same foot.  SF (stride per second) will be calculated as 1/(stride time).  Ground time will be calculated as the time (s) between the initial foot contact and toe-off.  Knee joint angle will be calculated as the orientation between two lines: (1) knee joint center to hip joint center and (2) knee joint center to ankle joint center (the anatomical knee joint angle will equal 180 degrees, and any knee flexion will result in a knee angle that is less than 180 degrees).  Hip joint angle will be calculated as the orientation between two lines: (1) knee joint center to hip joint center and (2) hip joint center to the posterior side of the base of the neck. The anatomical hip joint angle will equal 180 degrees, and any hip flexion will result in a hip joint angle that is less than 180 degrees. Hip extension will produce a hip joint angle that is greater than 180 degrees. Each dependent variable, except peak knee flexion during the support phase, will be normalized to the running speed of subject at the time they passed the cameras' fields of view.

**Data Analysis**

Paired *t* test will be used to compare the change in each dependent variable between the beginning and end of the marathon per individual. Since the seven dependent variable measures per individual are expected to be correlated, a multivariate regression model (                    ) will be fit to account for and quantify this correlation in the response structure. The model, which will be fit using SAS, relates    , the changes in each individual's seven dependent variables, to    , the time taken to reach the 25-mile marker. The     vector of coefficients will be analyzed, using Hotelling's      distribution, to determine the nature and strength of the relationship between      and    , providing insight into significant relationships between time to run a marathon and the dependent variables.

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# Appendix B: Raw Data

| sub | place | Time | ave_sp | Sp1 | Sp2 | SL1 | SL2 | NSL1 | NSL2 | NSLR | GT1 | GT2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 8447 | 4.995 | 4.463 | 4.621 | 3.130 | 2.970 | 0.701 | 0.643 | 0.917 | 0.183 | 0.208 |
| 2 | 4 | 9315 | 4.530 | 4.666 | 4.321 | 2.820 | 3.140 | 0.604 | 0.727 | 1.202 | 0.250 | 0.270 |
| 3 | 5 | 9503 | 4.440 | 4.156 | 4.142 | 3.060 | 2.870 | 0.736 | 0.693 | 0.941 | 0.250 | 0.244 |
| 4 | 6 | 9613 | 4.389 | 4.288 | 3.754 | 2.970 | 2.725 | 0.693 | 0.726 | 1.048 | 0.275 | 0.313 |
| 5 | 7 | 9867 | 4.276 | 4.417 | 4.058 | 3.010 | 2.760 | 0.681 | 0.680 | 0.998 | 0.216 | 0.233 |
| 6 | 8 | 10238 | 4.121 | 3.834 | 4.142 | 2.430 | 2.705 | 0.634 | 0.653 | 1.030 | 0.220 | 0.211 |
| 7 | 9 | 10253 | 4.115 | 4.200 | 3.826 | 2.850 | 2.577 | 0.679 | 0.673 | 0.993 | 0.241 | 0.255 |
| 8 | 11 | 10376 | 4.067 | 3.991 | 3.926 | 2.640 | 2.543 | 0.661 | 0.648 | 0.980 | 0.241 | 0.252 |
| 9 | 13 | 10475 | 4.028 | 4.107 | 3.575 | 2.700 | 2.387 | 0.657 | 0.668 | 1.015 | 0.212 | 0.222 |
| 10 | 14 | 10545 | 4.001 | 4.050 | 3.575 | 2.620 | 2.395 | 0.647 | 0.670 | 1.036 | 0.225 | 0.258 |
| 11 | 16 | 10706 | 3.941 | 3.733 | 3.708 | 2.860 | 2.780 | 0.766 | 0.750 | 0.979 | 0.241 | 0.261 |
| 12 | 17 | 10965 | 3.848 | 3.554 | 3.802 | 2.455 | 2.590 | 0.691 | 0.681 | 0.986 | 0.277 | 0.275 |
| 13 | 18 | 11013 | 3.831 | 3.740 | 3.826 | 2.480 | 2.595 | 0.663 | 0.678 | 1.023 | 0.246 | 0.250 |
| 14 | 21 | 11199 | 3.768 | 3.778 | 3.413 | 2.560 | 2.395 | 0.678 | 0.702 | 1.036 | 0.258 | 0.288 |
| 15 | 22 | 11247 | 3.752 | 3.432 | 3.413 | 2.410 | 2.335 | 0.702 | 0.684 | 0.974 | 0.241 | 0.258 |
| 16 | 23 | 11295 | 3.736 | 3.904 | 2.743 | 2.720 | 2.007 | 0.697 | 0.732 | 1.050 | 0.237 | 0.302 |
| 17 | 24 | 11299 | 3.734 | 3.652 | 3.472 | 2.590 | 2.375 | 0.709 | 0.684 | 0.964 | 0.241 | 0.247 |
| 18 | 25 | 11305 | 3.732 | 3.666 | 3.575 | 2.790 | 2.570 | 0.761 | 0.719 | 0.945 | 0.216 | 0.241 |
| 19 | 26 | 11400 | 3.701 | 3.678 | 3.926 | 2.770 | 2.955 | 0.753 | 0.753 | 1.000 | 0.312 | 0.283 |
| 20 | 27 | 11410 | 3.698 | 3.723 | 3.452 | 2.450 | 2.275 | 0.658 | 0.659 | 1.001 | 0.258 | 0.255 |
| 21 | 28 | 11457 | 3.683 | 3.662 | 3.619 | 2.520 | 2.485 | 0.688 | 0.687 | 0.998 | 0.246 | 0.262 |
| 22 | 29 | 11514 | 3.665 | 3.648 | 3.264 | 2.640 | 2.290 | 0.724 | 0.702 | 0.969 | 0.258 | 0.277 |
| 23 | 30 | 11536 | 3.658 | 3.687 | 3.513 | 2.637 | 2.550 | 0.715 | 0.726 | 1.015 | 0.266 | 0.287 |
| 24 | 32 | 11654 | 3.621 | 3.822 | 3.065 | 2.900 | 2.230 | 0.759 | 0.728 | 0.959 | 0.250 | 0.311 |
| 25 | 33 | 11667 | 3.617 | 3.762 | 3.395 | 3.060 | 2.530 | 0.813 | 0.745 | 0.916 | 0.250 | 0.294 |
| 26 | 34 | 11676 | 3.614 | 3.728 | 3.432 | 2.580 | 2.495 | 0.692 | 0.727 | 1.051 | 0.250 | 0.269 |
| 27 | 35 | 11684 | 3.611 | 3.685 | 3.575 | 2.520 | 2.435 | 0.684 | 0.681 | 0.996 | 0.283 | 0.289 |
| 28 | 36 | 11700 | 3.606 | 3.819 | 3.247 | 2.420 | 2.100 | 0.634 | 0.647 | 1.021 | 0.229 | 0.262 |
| 29 | 37 | 11743 | 3.593 | 3.513 | 3.575 | 2.330 | 2.435 | 0.663 | 0.681 | 1.027 | 0.275 | 0.266 |
| 30 | 39 | 11806 | 3.574 | 3.292 | 3.575 | 2.150 | 2.300 | 0.653 | 0.643 | 0.985 | 0.262 | 0.255 |
| 31 | 40 | 11823 | 3.569 | 3.695 | 3.096 | 2.500 | 2.165 | 0.677 | 0.699 | 1.034 | 0.254 | 0.283 |
| 32 | 44 | 11938 | 3.535 | 3.585 | 3.394 | 2.420 | 2.370 | 0.675 | 0.698 | 1.035 | 0.266 | 0.283 |
| 33 | 45 | 11957 | 3.529 | 3.824 | 3.128 | 2.800 | 2.280 | 0.732 | 0.729 | 0.995 | 0.250 | 0.313 |
| 34 | 47 | 12005 | 3.515 | 3.777 | 3.318 | 2.460 | 2.185 | 0.651 | 0.658 | 1.011 | 0.258 | 0.283 |
| 35 | 48 | 12032 | 3.507 | 3.510 | 3.112 | 2.640 | 2.420 | 0.752 | 0.778 | 1.034 | 0.275 | 0.316 |
| 36 | 49 | 12063 | 3.498 | 3.658 | 3.685 | 2.370 | 2.390 | 0.648 | 0.649 | 1.001 | 0.266 | 0.283 |
| 37 | 51 | 12084 | 3.492 | 3.332 | 3.597 | 2.300 | 2.425 | 0.690 | 0.674 | 0.977 | 0.258 | 0.250 |
| 38 | 52 | 12109 | 3.485 | 3.684 | 3.112 | 2.690 | 2.310 | 0.730 | 0.742 | 1.016 | 0.250 | 0.283 |
| 39 | 53 | 12131 | 3.478 | 3.468 | 3.034 | 2.420 | 2.180 | 0.698 | 0.719 | 1.030 | 0.283 | 0.289 |
| 40 | 54 | 12158 | 3.471 | 3.640 | 3.413 | 2.750 | 2.530 | 0.755 | 0.741 | 0.981 | 0.250 | 0.275 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | 56 | 12197 | 3.459 | 3.493 | 2.794 | 2.280 | 1.840 | 0.653 | 0.659 | 1.009 | 0.254 | 0.310 |
| 42 | 57 | 12225 | 3.452 | 3.314 | 3.356 | 2.240 | 2.210 | 0.676 | 0.659 | 0.974 | 0.275 | 0.266 |
| 43 | 59 | 12261 | 3.441 | 3.544 | 3.034 | 2.440 | 2.230 | 0.689 | 0.735 | 1.068 | 0.295 | 0.338 |
| 44 | 60 | 12288 | 3.434 | 3.554 | 2.755 | 2.560 | 2.120 | 0.720 | 0.770 | 1.068 | 0.266 | 0.322 |
| 45 | 64 | 12352 | 3.416 | 3.619 | 2.944 | 2.360 | 1.950 | 0.652 | 0.662 | 1.015 | 0.248 | 0.300 |
| 46 | 66 | 12413 | 3.399 | 3.513 | 2.916 | 2.375 | 2.027 | 0.676 | 0.695 | 1.028 | 0.255 | 0.291 |
| 47 | 69 | 12455 | 3.388 | 3.412 | 3.318 | 2.520 | 2.440 | 0.739 | 0.735 | 0.996 | 0.304 | 0.308 |
| 48 | 76 | 12587 | 3.352 | 3.348 | 2.988 | 2.140 | 2.050 | 0.639 | 0.686 | 1.073 | 0.275 | 0.302 |
| 49 | 78 | 12669 | 3.331 | 3.417 | 3.003 | 2.520 | 2.270 | 0.737 | 0.756 | 1.025 | 0.283 | 0.322 |
| 50 | 79 | 12669 | 3.331 | 3.773 | 2.578 | 2.610 | 1.900 | 0.692 | 0.737 | 1.065 | 0.250 | 0.302 |
| 51 | 82 | 12699 | 3.323 | 3.373 | 3.145 | 2.280 | 2.155 | 0.676 | 0.685 | 1.014 | 0.283 | 0.297 |
| 52 | 88 | 12731 | 3.314 | 3.492 | 2.944 | 2.555 | 2.175 | 0.732 | 0.739 | 1.010 | 0.277 | 0.291 |
| 53 | 90 | 12762 | 3.306 | 3.290 | 3.049 | 2.160 | 2.045 | 0.657 | 0.671 | 1.022 | 0.279 | 0.266 |
| 54 | 95 | 12871 | 3.278 | 3.665 | 3.128 | 2.680 | 2.200 | 0.731 | 0.703 | 0.962 | 0.246 | 0.287 |
| 55 | 96 | 12883 | 3.275 | 3.463 | 3.080 | 2.410 | 2.185 | 0.696 | 0.709 | 1.019 | 0.308 | 0.316 |
| 56 | 97 | 12907 | 3.269 | 3.582 | 2.462 | 2.430 | 1.795 | 0.678 | 0.729 | 1.075 | 0.308 | 0.391 |
| 57 | 106 | 13002 | 3.245 | 3.302 | 3.034 | 2.240 | 2.165 | 0.678 | 0.714 | 1.052 | 0.287 | 0.300 |
| 58 | 112 | 13061 | 3.231 | 3.109 | 2.743 | 2.120 | 1.853 | 0.682 | 0.676 | 0.991 | 0.295 | 0.347 |
| 59 | 114 | 13104 | 3.220 | 3.282 | 2.833 | 2.230 | 2.065 | 0.680 | 0.729 | 1.073 | 0.283 | 0.295 |
| 60 | 119 | 13183 | 3.201 | 3.499 | 2.755 | 2.180 | 1.855 | 0.623 | 0.673 | 1.081 | 0.283 | 0.333 |
| 61 | 123 | 13224 | 3.191 | 3.393 | 3.034 | 2.260 | 2.067 | 0.666 | 0.681 | 1.023 | 0.283 | 0.316 |
| 62 | 124 | 13247 | 3.185 | 3.385 | 2.681 | 2.480 | 1.987 | 0.733 | 0.741 | 1.011 | 0.291 | 0.316 |
| 63 | 126 | 13294 | 3.174 | 3.164 | 3.432 | 2.160 | 2.327 | 0.683 | 0.678 | 0.993 | 0.283 | 0.258 |
| 64 | 127 | 13321 | 3.168 | 3.328 | 2.944 | 2.300 | 2.040 | 0.691 | 0.693 | 1.002 | 0.287 | 0.294 |
| 65 | 129 | 13328 | 3.166 | 3.283 | 3.978 | 2.490 | 2.900 | 0.759 | 0.729 | 0.961 | 0.291 | 0.250 |
| 66 | 136 | 13420 | 3.144 | 3.095 | 3.640 | 2.210 | 2.560 | 0.714 | 0.703 | 0.985 | 0.291 | 0.233 |
| 67 | 140 | 13469 | 3.133 | 2.962 | 3.212 | 2.120 | 2.315 | 0.716 | 0.721 | 1.007 | 0.291 | 0.266 |
| 68 | 142 | 13478 | 3.131 | 3.452 | 3.229 | 2.290 | 2.165 | 0.663 | 0.670 | 1.011 | 0.293 | 0.288 |
| 69 | 145 | 13501 | 3.125 | 3.363 | 2.694 | 2.380 | 1.950 | 0.708 | 0.724 | 1.023 | 0.287 | 0.333 |
| 70 | 148 | 13538 | 3.117 | 3.170 | 2.743 | 2.290 | 2.003 | 0.722 | 0.730 | 1.011 | 0.312 | 0.327 |
| 71 | 152 | 13583 | 3.106 | 3.212 | 2.578 | 2.370 | 1.970 | 0.738 | 0.764 | 1.036 | 0.320 | 0.344 |
| 72 | 155 | 13586 | 3.106 | 3.137 | 3.264 | 2.320 | 2.430 | 0.740 | 0.744 | 1.006 | 0.327 | 0.305 |
| 73 | 160 | 13624 | 3.097 | 3.195 | 2.959 | 2.400 | 2.295 | 0.751 | 0.776 | 1.033 | 0.275 | 0.261 |
| 74 | 163 | 13694 | 3.081 | 2.959 | 2.502 | 2.055 | 1.833 | 0.695 | 0.733 | 1.055 | 0.316 | 0.338 |
| 75 | 164 | 13728 | 3.074 | 3.011 | 2.743 | 2.070 | 1.945 | 0.688 | 0.709 | 1.032 | 0.324 | 0.319 |
| 76 | 165 | 13733 | 3.073 | 3.246 | 2.902 | 2.010 | 1.790 | 0.619 | 0.617 | 0.996 | 0.250 | 0.277 |
| 77 | 167 | 13781 | 3.062 | 3.318 | 2.902 | 2.290 | 2.095 | 0.690 | 0.722 | 1.046 | 0.313 | 0.313 |
| 78 | 170 | 13802 | 3.057 | 3.337 | 2.930 | 2.373 | 2.047 | 0.711 | 0.699 | 0.982 | 0.277 | 0.297 |
| 79 | 172 | 13824 | 3.052 | 3.037 | 3.247 | 2.115 | 2.270 | 0.696 | 0.699 | 1.004 | 0.312 | 0.305 |
| 80 | 176 | 13856 | 3.045 | 3.325 | 2.847 | 2.150 | 1.873 | 0.647 | 0.658 | 1.018 | 0.258 | 0.280 |
| 81 | 178 | 13869 | 3.042 | 3.162 | 3.264 | 2.480 | 2.480 | 0.784 | 0.760 | 0.969 | 0.325 | 0.312 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 82 | 179 | 13877 | 3.041 | 2.966 | 2.888 | 2.130 | 1.997 | 0.718 | 0.691 | 0.963 | 0.283 | 0.280 |
| 83 | 182 | 13907 | 3.034 | 3.575 | 2.422 | 2.375 | 1.700 | 0.664 | 0.702 | 1.057 | 0.261 | 0.330 |
| 84 | 184 | 13941 | 3.027 | 3.375 | 2.647 | 2.350 | 1.990 | 0.696 | 0.752 | 1.080 | 0.295 | 0.347 |
| 85 | 186 | 13957 | 3.023 | 3.148 | 2.524 | 2.220 | 1.875 | 0.705 | 0.743 | 1.053 | 0.283 | 0.311 |
| 86 | 187 | 13986 | 3.017 | 3.108 | 2.930 | 2.100 | 1.930 | 0.676 | 0.659 | 0.975 | 0.279 | 0.266 |
| 87 | 190 | 14041 | 3.005 | 3.061 | 2.795 | 2.280 | 2.005 | 0.745 | 0.717 | 0.963 | 0.329 | 0.319 |
| 88 | 193 | 14069 | 2.999 | 3.264 | 3.112 | 2.575 | 2.325 | 0.789 | 0.747 | 0.947 | 0.313 | 0.336 |
| 89 | 197 | 14143 | 2.983 | 3.413 | 2.820 | 2.440 | 2.040 | 0.715 | 0.723 | 1.012 | 0.308 | 0.311 |
| 90 | 201 | 14169 | 2.978 | 3.255 | 2.730 | 2.390 | 2.067 | 0.734 | 0.757 | 1.031 | 0.262 | 0.291 |
| 91 | 203 | 14203 | 2.971 | 3.235 | 2.888 | 2.460 | 2.120 | 0.761 | 0.734 | 0.965 | 0.291 | 0.308 |
| 92 | 206 | 14222 | 2.967 | 2.874 | 2.611 | 1.990 | 2.120 | 0.692 | 0.812 | 1.172 | 0.322 | 0.330 |
| 93 | 210 | 14264 | 2.958 | 3.065 | 2.681 | 2.310 | 1.970 | 0.754 | 0.735 | 0.975 | 0.287 | 0.327 |
| 94 | 215 | 14290 | 2.953 | 3.018 | 2.833 | 2.010 | 2.000 | 0.666 | 0.706 | 1.060 | 0.308 | 0.305 |
| 95 | 216 | 14317 | 2.947 | 3.501 | 2.860 | 2.610 | 2.165 | 0.745 | 0.757 | 1.016 | 0.270 | 0.308 |
| 96 | 217 | 14330 | 2.945 | 3.037 | 2.730 | 2.085 | 1.887 | 0.686 | 0.691 | 1.007 | 0.304 | 0.336 |
| 97 | 218 | 14345 | 2.941 | 3.104 | 2.781 | 1.960 | 1.763 | 0.631 | 0.634 | 1.004 | 0.268 | 0.289 |
| 98 | 224 | 14373 | 2.936 | 3.374 | 2.567 | 2.400 | 1.810 | 0.711 | 0.705 | 0.991 | 0.275 | 0.316 |
| 99 | 226 | 14397 | 2.931 | 2.973 | 3.018 | 1.915 | 1.990 | 0.644 | 0.659 | 1.024 | 0.304 | 0.283 |
| 100 | 229 | 14476 | 2.915 | 3.153 | 2.403 | 2.270 | 1.800 | 0.720 | 0.749 | 1.041 | 0.324 | 0.380 |
| 101 | 234 | 14532 | 2.904 | 3.072 | 3.034 | 2.100 | 2.030 | 0.684 | 0.669 | 0.979 | 0.298 | 0.291 |
| 102 | 241 | 14611 | 2.888 | 3.003 | 2.422 | 2.135 | 1.723 | 0.711 | 0.712 | 1.001 | 0.311 | 0.355 |
| 103 | 244 | 14658 | 2.879 | 2.874 | 2.860 | 2.010 | 1.980 | 0.699 | 0.692 | 0.990 | 0.295 | 0.297 |
| 104 | 246 | 14688 | 2.873 | 3.195 | 2.706 | 2.220 | 1.900 | 0.695 | 0.702 | 1.011 | 0.312 | 0.322 |
| 105 | 248 | 14769 | 2.857 | 3.141 | 2.916 | 2.300 | 2.165 | 0.732 | 0.743 | 1.014 | 0.312 | 0.327 |
| 106 | 250 | 14800 | 2.851 | 2.923 | 2.755 | 1.870 | 1.850 | 0.640 | 0.672 | 1.050 | 0.322 | 0.322 |
| 107 | 252 | 14844 | 2.843 | 3.065 | 2.794 | 2.170 | 2.045 | 0.708 | 0.732 | 1.034 | 0.327 | 0.324 |
| 108 | 254 | 14887 | 2.834 | 3.312 | 2.794 | 2.230 | 1.917 | 0.673 | 0.686 | 1.019 | 0.283 | 0.316 |
| 109 | 256 | 14913 | 2.829 | 3.309 | 2.874 | 2.285 | 2.025 | 0.691 | 0.705 | 1.020 | 0.286 | 0.280 |
| 110 | 261 | 15014 | 2.810 | 2.944 | 2.743 | 1.935 | 1.787 | 0.657 | 0.651 | 0.991 | 0.308 | 0.311 |
| 111 | 272 | 15115 | 2.792 | 3.161 | 2.567 | 2.075 | 1.757 | 0.656 | 0.684 | 1.043 | 0.295 | 0.325 |
| 112 | 278 | 15156 | 2.784 | 2.973 | 2.545 | 2.230 | 1.970 | 0.750 | 0.774 | 1.032 | 0.345 | 0.341 |
| 113 | 279 | 15223 | 2.772 | 3.206 | 2.534 | 2.430 | 1.953 | 0.758 | 0.771 | 1.017 | 0.300 | 0.330 |
| 114 | 282 | 15258 | 2.765 | 3.161 | 2.365 | 2.240 | 1.763 | 0.709 | 0.746 | 1.052 | 0.345 | 0.399 |
| 115 | 287 | 15288 | 2.760 | 3.206 | 2.578 | 2.220 | 1.853 | 0.692 | 0.719 | 1.038 | 0.316 | 0.347 |
| 116 | 294 | 15381 | 2.743 | 3.161 | 2.337 | 2.320 | 1.773 | 0.734 | 0.759 | 1.034 | 0.302 | 0.330 |
| 117 | 297 | 15466 | 2.728 | 2.820 | 2.781 | 1.850 | 1.833 | 0.656 | 0.659 | 1.005 | 0.313 | 0.327 |
| 118 | 301 | 15498 | 2.723 | 2.895 | 2.706 | 2.080 | 2.030 | 0.719 | 0.750 | 1.044 | 0.316 | 0.319 |
| 119 | 303 | 15526 | 2.718 | 3.180 | 2.634 | 2.220 | 1.793 | 0.698 | 0.681 | 0.975 | 0.258 | 0.297 |
| 120 | 307 | 15553 | 2.713 | 3.080 | 2.346 | 2.200 | 1.725 | 0.714 | 0.735 | 1.029 | 0.283 | 0.355 |
| 121 | 313 | 15613 | 2.703 | 2.847 | 2.781 | 2.010 | 2.000 | 0.706 | 0.719 | 1.019 | 0.325 | 0.330 |
| 122 | 315 | 15636 | 2.699 | 3.049 | 2.319 | 2.130 | 1.650 | 0.699 | 0.712 | 1.018 | 0.291 | 0.341 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 123 | 316 | 15662 | 2.694 | 2.981 | 2.681 | 1.950 | 1.780 | 0.654 | 0.664 | 1.015 | 0.287 | 0.308 |
| 124 | 318 | 15690 | 2.689 | 2.678 | 2.781 | 1.890 | 1.920 | 0.706 | 0.690 | 0.978 | 0.302 | 0.313 |
| 125 | 322 | 15713 | 2.685 | 3.365 | 2.623 | 2.410 | 1.880 | 0.716 | 0.717 | 1.001 | 0.262 | 0.316 |
| 126 | 324 | 15781 | 2.674 | 2.847 | 2.545 | 1.995 | 1.843 | 0.701 | 0.724 | 1.033 | 0.283 | 0.322 |
| 127 | 326 | 15784 | 2.673 | 2.988 | 2.567 | 2.080 | 1.853 | 0.696 | 0.722 | 1.037 | 0.319 | 0.354 |
| 128 | 329 | 15843 | 2.663 | 2.934 | 2.781 | 1.990 | 1.877 | 0.678 | 0.675 | 0.995 | 0.283 | 0.308 |
| 129 | 335 | 15913 | 2.652 | 2.694 | 2.670 | 1.885 | 1.860 | 0.700 | 0.697 | 0.996 | 0.313 | 0.316 |
| 130 | 338 | 15947 | 2.646 | 2.897 | 2.355 | 1.950 | 1.613 | 0.673 | 0.685 | 1.017 | 0.304 | 0.347 |
| 131 | 342 | 15968 | 2.642 | 2.640 | 2.556 | 1.910 | 1.853 | 0.723 | 0.725 | 1.002 | 0.360 | 0.347 |
| 132 | 348 | 16083 | 2.624 | 2.681 | 2.768 | 1.845 | 1.900 | 0.688 | 0.686 | 0.998 | 0.345 | 0.333 |
| 133 | 353 | 16108 | 2.620 | 3.003 | 2.916 | 2.140 | 2.080 | 0.713 | 0.713 | 1.001 | 0.347 | 0.313 |
| 134 | 356 | 16133 | 2.615 | 2.667 | 2.472 | 2.010 | 1.793 | 0.754 | 0.726 | 0.963 | 0.312 | 0.347 |
| 135 | 358 | 16164 | 2.610 | 2.687 | 2.412 | 1.730 | 1.600 | 0.644 | 0.663 | 1.030 | 0.320 | 0.333 |
| 136 | 360 | 16240 | 2.598 | 3.034 | 2.224 | 2.290 | 1.607 | 0.755 | 0.722 | 0.957 | 0.291 | 0.352 |
| 137 | 366 | 16310 | 2.587 | 2.941 | 2.755 | 2.260 | 2.060 | 0.768 | 0.748 | 0.973 | 0.370 | 0.416 |
| 138 | 370 | 16345 | 2.582 | 2.820 | 2.482 | 1.960 | 1.750 | 0.695 | 0.705 | 1.014 | 0.316 | 0.352 |
| 139 | 373 | 16401 | 2.573 | 3.145 | 2.015 | 2.240 | 1.540 | 0.712 | 0.764 | 1.073 | 0.314 | 0.410 |
| 140 | 374 | 16433 | 2.568 | 3.247 | 2.100 | 2.310 | 1.590 | 0.711 | 0.757 | 1.064 | 0.300 | 0.380 |
| 141 | 376 | 16505 | 2.556 | 2.846 | 2.432 | 2.030 | 1.707 | 0.713 | 0.702 | 0.984 | 0.322 | 0.333 |
| 142 | 380 | 16551 | 2.549 | 3.218 | 2.706 | 2.290 | 2.055 | 0.712 | 0.760 | 1.067 | 0.291 | 0.322 |
| 143 | 381 | 16573 | 2.546 | 2.902 | 2.600 | 2.020 | 1.830 | 0.696 | 0.704 | 1.011 | 0.300 | 0.316 |
| 144 | 382 | 16592 | 2.543 | 2.905 | 2.502 | 1.950 | 1.743 | 0.671 | 0.697 | 1.038 | 0.312 | 0.355 |
| 145 | 385 | 16631 | 2.537 | 3.214 | 2.646 | 2.210 | 1.825 | 0.688 | 0.690 | 1.003 | 0.308 | 0.347 |
| 146 | 387 | 16654 | 2.534 | 3.019 | 2.043 | 2.060 | 1.497 | 0.682 | 0.733 | 1.073 | 0.300 | 0.383 |
| 147 | 393 | 16740 | 2.521 | 2.860 | 2.233 | 2.210 | 1.737 | 0.773 | 0.778 | 1.007 | 0.350 | 0.388 |
| 148 | 397 | 16875 | 2.500 | 2.808 | 2.412 | 2.190 | 1.935 | 0.780 | 0.802 | 1.029 | 0.404 | 0.444 |
| 149 | 403 | 16992 | 2.483 | 2.712 | 2.768 | 2.080 | 2.150 | 0.767 | 0.777 | 1.013 | 0.384 | 0.363 |
| 150 | 406 | 17008 | 2.481 | 2.988 | 2.545 | 2.040 | 1.713 | 0.683 | 0.673 | 0.986 | 0.325 | 0.333 |
| 151 | 407 | 17048 | 2.475 | 3.063 | 2.634 | 2.020 | 1.670 | 0.659 | 0.634 | 0.961 | 0.279 | 0.308 |
| 152 | 408 | 17105 | 2.467 | 2.533 | 2.513 | 1.805 | 1.750 | 0.712 | 0.696 | 0.977 | 0.330 | 0.354 |
| 153 | 409 | 17129 | 2.463 | 2.423 | 2.658 | 1.645 | 1.797 | 0.679 | 0.676 | 0.996 | 0.297 | 0.327 |
| 154 | 413 | 17192 | 2.454 | 2.694 | 2.847 | 1.885 | 1.943 | 0.700 | 0.683 | 0.976 | 0.297 | 0.299 |
| 155 | 415 | 17235 | 2.448 | 3.051 | 2.781 | 2.130 | 1.970 | 0.698 | 0.708 | 1.015 | 0.262 | 0.291 |
| 156 | 418 | 17314 | 2.437 | 2.977 | 2.442 | 2.140 | 1.770 | 0.719 | 0.725 | 1.009 | 0.316 | 0.380 |
| 157 | 419 | 17316 | 2.437 | 3.100 | 2.328 | 2.160 | 1.660 | 0.697 | 0.713 | 1.023 | 0.304 | 0.358 |
| 158 | 421 | 17337 | 2.434 | 3.096 | 2.988 | 2.270 | 2.060 | 0.733 | 0.689 | 0.940 | 0.287 | 0.291 |
| 159 | 425 | 17434 | 2.420 | 2.662 | 2.176 | 1.815 | 1.557 | 0.682 | 0.715 | 1.049 | 0.336 | 0.406 |
| 160 | 428 | 17459 | 2.417 | 3.018 | 1.989 | 2.120 | 1.453 | 0.702 | 0.731 | 1.040 | 0.312 | 0.402 |
| 161 | 430 | 17532 | 2.407 | 2.906 | 2.383 | 2.030 | 1.843 | 0.698 | 0.773 | 1.107 | 0.329 | 0.372 |
| 162 | 435 | 17671 | 2.388 | 3.102 | 2.768 | 2.280 | 1.970 | 0.735 | 0.712 | 0.968 | 0.320 | 0.341 |
| 163 | 442 | 17794 | 2.371 | 2.805 | 2.184 | 1.905 | 1.477 | 0.679 | 0.676 | 0.996 | 0.230 | 0.269 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 164 | 443 | 17822 | 2.368 | 2.865 | 2.374 | 1.990 | 1.583 | 0.695 | 0.667 | 0.960 | 0.279 | 0.313 |
| 165 | 445 | 17829 | 2.367 | 2.538 | 2.442 | 1.850 | 1.767 | 0.729 | 0.724 | 0.993 | 0.341 | 0.336 |
| 166 | 452 | 17980 | 2.347 | 2.567 | 2.250 | 1.955 | 1.747 | 0.762 | 0.776 | 1.019 | 0.333 | 0.352 |
| 167 | 457 | 18239 | 2.313 | 2.334 | 2.122 | 1.645 | 1.517 | 0.705 | 0.715 | 1.014 | 0.338 | 0.366 |
| 168 | 460 | 18327 | 2.302 | 2.650 | 2.422 | 1.950 | 1.757 | 0.736 | 0.725 | 0.986 | 0.375 | 0.386 |
| 169 | 461 | 18346 | 2.300 | 2.600 | 2.545 | 1.927 | 1.897 | 0.741 | 0.745 | 1.006 | 0.356 | 0.372 |
| 170 | 462 | 18377 | 2.296 | 2.658 | 2.168 | 1.930 | 1.647 | 0.726 | 0.759 | 1.046 | 0.312 | 0.377 |
| 171 | 464 | 18426 | 2.290 | 2.901 | 2.374 | 2.060 | 1.747 | 0.710 | 0.736 | 1.036 | 0.325 | 0.361 |
| 172 | 467 | 18648 | 2.263 | 2.224 | 2.009 | 1.610 | 1.457 | 0.724 | 0.725 | 1.002 | 0.377 | 0.383 |
| 173 | 477 | 18908 | 2.232 | 2.435 | 2.545 | 1.745 | 1.787 | 0.717 | 0.702 | 0.980 | 0.333 | 0.322 |
| 174 | 479 | 18978 | 2.223 | 2.650 | 2.422 | 1.890 | 1.755 | 0.713 | 0.725 | 1.016 | 0.329 | 0.354 |
| 175 | 486 | 19065 | 2.213 | 2.672 | 2.301 | 1.945 | 1.683 | 0.728 | 0.731 | 1.005 | 0.352 | 0.369 |
| 176 | 492 | 19383 | 2.177 | 2.473 | 2.355 | 1.750 | 1.647 | 0.708 | 0.699 | 0.988 | 0.341 | 0.358 |
| 177 | 495 | 19509 | 2.163 | 2.794 | 2.502 | 1.950 | 1.790 | 0.698 | 0.715 | 1.025 | 0.291 | 0.327 |
| 178 | 505 | 19673 | 2.145 | 2.403 | 2.192 | 1.780 | 1.675 | 0.741 | 0.764 | 1.031 | 0.383 | 0.422 |
| 179 | 509 | 19810 | 2.130 | 2.623 | 2.328 | 1.900 | 1.760 | 0.724 | 0.756 | 1.044 | 0.370 | 0.366 |

| NGT1 | NGT2 | NGTR | KFSu1 | KFSu2 | KFSuR | HESw1 | HESw2 | NHESw1 | NHESw2 | NHESwR |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.047 | 0.045 | 0.966 | 39.200 | 39.400 | 1.005 | 20.900 | 35.400 | 4.683 | 7.661 | 1.636 |
| 0.058 | 0.063 | 1.080 | 54.600 | 52.600 | 0.963 | 29.600 | 22.650 | 6.344 | 5.242 | 0.826 |
| 0.059 | 0.059 | 1.003 | 48.600 | 50.433 | 1.038 | 27.300 | 22.300 | 6.569 | 5.384 | 0.820 |
| 0.073 | 0.083 | 1.142 | 47.300 | 47.450 | 1.003 | 17.500 | 8.350 | 4.082 | 2.224 | 0.545 |
| 0.053 | 0.057 | 1.088 | 36.800 | 36.600 | 0.995 | 19.800 | 17.750 | 4.483 | 4.374 | 0.976 |
| 0.055 | 0.051 | 0.926 | 38.900 | 45.933 | 1.181 | 15.900 | 21.900 | 4.147 | 5.287 | 1.275 |
| 0.061 | 0.067 | 1.098 | 47.600 | 46.600 | 0.979 | 32.700 | 24.000 | 7.785 | 6.273 | 0.806 |
| 0.063 | 0.064 | 1.017 | 44.600 | 47.000 | 1.054 | 29.400 | 28.100 | 7.366 | 7.158 | 0.972 |
| 0.054 | 0.062 | 1.149 | 41.500 | 46.500 | 1.120 | 24.400 | 19.000 | 5.940 | 5.314 | 0.895 |
| 0.064 | 0.072 | 1.133 | 45.500 | 48.100 | 1.057 | 17.300 | 13.900 | 4.271 | 3.888 | 0.910 |
| 0.070 | 0.070 | 1.007 | 48.800 | 53.150 | 1.089 | 27.200 | 20.600 | 7.286 | 5.556 | 0.763 |
| 0.077 | 0.072 | 0.935 | 45.100 | 47.400 | 1.051 | 17.500 | 17.100 | 4.924 | 4.498 | 0.913 |
| 0.067 | 0.065 | 0.978 | 43.700 | 45.700 | 1.046 | 27.700 | 20.000 | 7.406 | 5.228 | 0.706 |
| 0.076 | 0.085 | 1.107 | 43.750 | 44.000 | 1.006 | 12.500 | 13.600 | 3.309 | 3.985 | 1.204 |
| 0.075 | 0.076 | 1.006 | 42.250 | 40.900 | 0.968 | 12.900 | 4.300 | 3.759 | 1.260 | 0.335 |
| 0.077 | 0.110 | 1.423 | 44.950 | 46.300 | 1.030 | 18.100 | 21.300 | 4.636 | 7.766 | 1.675 |
| 0.068 | 0.071 | 1.052 | 46.550 | 49.300 | 1.059 | 21.850 | 16.600 | 5.984 | 4.781 | 0.799 |
| 0.066 | 0.067 | 1.025 | 41.400 | 40.550 | 0.979 | 30.600 | 24.900 | 8.346 | 6.964 | 0.834 |
| 0.077 | 0.072 | 0.937 | 47.850 | 49.950 | 1.044 | -5.100 | -1.400 | -1.387 | -0.357 | 0.257 |
| 0.069 | 0.074 | 1.078 | 40.700 | 41.900 | 1.029 | 24.600 | 22.700 | 6.608 | 6.576 | 0.995 |
| 0.072 | 0.072 | 1.012 | 45.400 | 46.600 | 1.026 | 20.350 | 19.550 | 5.557 | 5.403 | 0.972 |
| 0.076 | 0.085 | 1.118 | 48.900 | 41.300 | 0.845 | 28.100 | 23.000 | 7.702 | 7.046 | 0.915 |
| 0.078 | 0.082 | 1.049 | 40.600 | 36.950 | 0.910 | 23.750 | 21.600 | 6.442 | 6.149 | 0.954 |
| 0.081 | 0.101 | 1.247 | 39.700 | 47.500 | 1.196 | 32.000 | 14.500 | 8.374 | 4.731 | 0.565 |
| 0.078 | 0.087 | 1.108 | 43.400 | 46.200 | 1.065 | 25.700 | 17.100 | 6.832 | 5.037 | 0.737 |
| 0.072 | 0.078 | 1.086 | 48.300 | 43.950 | 0.910 | 22.100 | 24.750 | 5.928 | 7.211 | 1.217 |
| 0.078 | 0.081 | 1.031 | 43.450 | 50.100 | 1.153 | 20.150 | 20.100 | 5.468 | 5.622 | 1.028 |
| 0.069 | 0.081 | 1.176 | 48.400 | 47.650 | 0.985 | 20.300 | 28.400 | 5.316 | 8.747 | 1.645 |
| 0.076 | 0.074 | 0.982 | 38.450 | 41.500 | 1.079 | 24.100 | 22.850 | 6.861 | 6.391 | 0.932 |
| 0.078 | 0.071 | 0.921 | 47.800 | 39.650 | 0.829 | 7.400 | 10.300 | 2.248 | 2.881 | 1.282 |
| 0.077 | 0.091 | 1.194 | 49.700 | 49.700 | 1.000 | 21.400 | 18.600 | 5.791 | 6.008 | 1.037 |
| 0.079 | 0.083 | 1.056 | 43.100 | 42.600 | 0.988 | 26.900 | 15.650 | 7.504 | 4.611 | 0.615 |
| 0.082 | 0.100 | 1.222 | 47.500 | 41.700 | 0.878 | 22.800 | 18.500 | 5.963 | 5.914 | 0.992 |
| 0.075 | 0.085 | 1.138 | 41.000 | 36.500 | 0.890 | 15.500 | 13.600 | 4.104 | 4.098 | 0.999 |
| 0.090 | 0.102 | 1.128 | 48.300 | 43.400 | 0.899 | 25.700 | 27.900 | 7.323 | 8.964 | 1.224 |
| 0.077 | 0.077 | 0.993 | 46.650 | 47.700 | 1.023 | 18.100 | 20.700 | 4.948 | 5.617 | 1.135 |
| 0.075 | 0.069 | 0.927 | 42.900 | 40.700 | 0.949 | 24.800 | 25.000 | 7.442 | 6.951 | 0.934 |
| 0.077 | 0.091 | 1.184 | 44.400 | 42.700 | 0.962 | 11.200 | 13.400 | 3.040 | 4.306 | 1.416 |
| 0.083 | 0.095 | 1.143 | 49.000 | 44.700 | 0.912 | 17.300 | 12.300 | 4.988 | 4.055 | 0.813 |
| 0.075 | 0.080 | 1.067 | 43.100 | 44.700 | 1.037 | 19.100 | 7.600 | 5.247 | 2.227 | 0.424 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 0.089 | 0.111 | 1.250 | 42.500 | 40.550 | 0.954 | 18.900 | 13.900 | 5.411 | 4.975 | 0.920 |
| 0.080 | 0.079 | 0.988 | 46.800 | 37.600 | 0.803 | 13.050 | 16.500 | 3.938 | 4.917 | 1.249 |
| 0.096 | 0.112 | 1.168 | 41.500 | 44.400 | 1.070 | 12.700 | 12.750 | 3.584 | 4.203 | 1.173 |
| 0.091 | 0.117 | 1.290 | 40.600 | 37.650 | 0.927 | 22.700 | 13.800 | 6.387 | 5.009 | 0.784 |
| 0.083 | 0.102 | 1.229 | 35.950 | 33.550 | 0.933 | 17.500 | 18.300 | 4.836 | 6.215 | 1.285 |
| 0.083 | 0.100 | 1.205 | 43.100 | 44.400 | 1.030 | 30.000 | 24.500 | 8.540 | 8.403 | 0.984 |
| 0.090 | 0.093 | 1.028 | 49.750 | 46.250 | 0.930 | 15.050 | 9.350 | 4.411 | 2.818 | 0.639 |
| 0.090 | 0.101 | 1.120 | 44.600 | 44.750 | 1.003 | 19.800 | 25.350 | 5.914 | 8.483 | 1.434 |
| 0.094 | 0.107 | 1.138 | 43.400 | 37.700 | 0.869 | 20.300 | 11.700 | 5.941 | 3.896 | 0.656 |
| 0.080 | 0.117 | 1.464 | 40.600 | 33.550 | 0.826 | 19.400 | 7.500 | 5.142 | 2.909 | 0.566 |
| 0.088 | 0.094 | 1.073 | 39.900 | 40.500 | 1.015 | 12.400 | 5.000 | 3.676 | 1.590 | 0.433 |
| 0.083 | 0.099 | 1.186 | 45.750 | 38.750 | 0.847 | 20.550 | 18.800 | 5.885 | 6.385 | 1.085 |
| 0.081 | 0.087 | 1.079 | 43.200 | 42.250 | 0.978 | 14.600 | 22.450 | 4.438 | 7.363 | 1.659 |
| 0.078 | 0.092 | 1.172 | 39.800 | 40.650 | 1.021 | 35.800 | 18.950 | 9.768 | 6.058 | 0.620 |
| 0.091 | 0.103 | 1.124 | 41.600 | 40.150 | 0.965 | 7.300 | 6.350 | 2.108 | 2.062 | 0.978 |
| 0.109 | 0.159 | 1.455 | 48.450 | 44.150 | 0.911 | 14.000 | 2.450 | 3.908 | 0.995 | 0.255 |
| 0.091 | 0.099 | 1.088 | 41.800 | 40.900 | 0.978 | 16.200 | 19.100 | 4.906 | 6.296 | 1.283 |
| 0.112 | 0.126 | 1.134 | 46.000 | 42.350 | 0.921 | 13.400 | 5.900 | 4.310 | 2.151 | 0.499 |
| 0.090 | 0.104 | 1.158 | 44.250 | 47.250 | 1.068 | 12.500 | 11.100 | 3.809 | 3.918 | 1.029 |
| 0.095 | 0.121 | 1.270 | 40.700 | 45.350 | 1.114 | 11.200 | 10.900 | 3.201 | 3.956 | 1.236 |
| 0.093 | 0.104 | 1.118 | 51.600 | 52.900 | 1.025 | 5.950 | 2.750 | 1.754 | 0.907 | 0.517 |
| 0.093 | 0.118 | 1.262 | 45.750 | 40.950 | 0.895 | 16.000 | 23.050 | 4.727 | 8.597 | 1.818 |
| 0.082 | 0.075 | 0.922 | 39.650 | 39.100 | 0.986 | 8.800 | 14.450 | 2.781 | 4.210 | 1.514 |
| 0.088 | 0.100 | 1.130 | 45.400 | 38.050 | 0.838 | 28.800 | 26.600 | 8.654 | 9.034 | 1.044 |
| 0.076 | 0.063 | 0.825 | 46.800 | 48.800 | 1.043 | 13.800 | 22.600 | 4.204 | 5.682 | 1.351 |
| 0.075 | 0.064 | 0.850 | 46.600 | 41.000 | 0.880 | 15.000 | 24.000 | 4.847 | 6.593 | 1.360 |
| 0.090 | 0.083 | 0.922 | 39.900 | 45.700 | 1.145 | 18.700 | 18.850 | 6.313 | 5.869 | 0.930 |
| 0.084 | 0.089 | 1.069 | 47.250 | 50.250 | 1.063 | 12.650 | 8.800 | 3.664 | 2.725 | 0.744 |
| 0.099 | 0.124 | 1.249 | 44.350 | 45.350 | 1.023 | 26.600 | 16.333 | 7.909 | 6.064 | 0.767 |
| 0.103 | 0.119 | 1.156 | 41.300 | 42.400 | 1.027 | 12.000 | 23.250 | 3.786 | 8.477 | 2.239 |
| 0.107 | 0.133 | 1.246 | 45.200 | 43.300 | 0.958 | 15.900 | 5.600 | 4.950 | 2.172 | 0.439 |
| 0.097 | 0.093 | 0.961 | 40.750 | 42.000 | 1.031 | 15.450 | 14.750 | 4.926 | 4.518 | 0.917 |
| 0.082 | 0.088 | 1.080 | 42.500 | 44.700 | 1.052 | 16.300 | 19.000 | 5.101 | 6.422 | 1.259 |
| 0.114 | 0.135 | 1.182 | 33.600 | 35.400 | 1.054 | 25.100 | 13.700 | 8.483 | 5.475 | 0.645 |
| 0.106 | 0.116 | 1.098 | 45.300 | 36.100 | 0.797 | 27.100 | 16.800 | 9.001 | 6.126 | 0.681 |
| 0.085 | 0.096 | 1.119 | 45.550 | 45.200 | 0.992 | 11.750 | 11.050 | 3.620 | 3.808 | 1.052 |
| 0.094 | 0.108 | 1.144 | 42.850 | 43.900 | 1.025 | 20.300 | 15.050 | 6.117 | 5.186 | 0.848 |
| 0.089 | 0.101 | 1.139 | 35.933 | 34.250 | 0.953 | 21.450 | 12.100 | 6.429 | 4.130 | 0.642 |
| 0.100 | 0.094 | 0.935 | 35.650 | 33.900 | 0.951 | 12.400 | 9.300 | 4.082 | 2.864 | 0.702 |
| 0.084 | 0.098 | 1.168 | 35.150 | 36.250 | 1.031 | 9.000 | 10.633 | 2.706 | 3.735 | 1.380 |
| 0.099 | 0.096 | 0.969 | 46.000 | 47.150 | 1.025 | 18.000 | 18.600 | 5.692 | 5.698 | 1.001 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 0.094 | 0.097 | 1.027 | 48.200 | 43.150 | 0.895 | 23.000 | 18.300 | 7.754 | 6.337 | 0.817 |
| 0.092 | 0.136 | 1.476 | 40.350 | 35.500 | 0.880 | 26.050 | 17.550 | 7.286 | 7.247 | 0.995 |
| 0.103 | 0.131 | 1.275 | 43.300 | 40.650 | 0.939 | 14.000 | 3.400 | 4.148 | 1.284 | 0.310 |
| 0.099 | 0.123 | 1.247 | 36.600 | 34.050 | 0.930 | 12.200 | 1.700 | 3.876 | 0.674 | 0.174 |
| 0.086 | 0.091 | 1.061 | 40.200 | 42.600 | 1.060 | 8.850 | 15.000 | 2.847 | 5.120 | 1.798 |
| 0.104 | 0.114 | 1.095 | 39.200 | 41.400 | 1.056 | 18.400 | 18.800 | 6.011 | 6.726 | 1.119 |
| 0.103 | 0.108 | 1.049 | 51.500 | 41.300 | 0.802 | 11.700 | 7.900 | 3.584 | 2.539 | 0.708 |
| 0.091 | 0.110 | 1.210 | 42.300 | 36.500 | 0.863 | 23.550 | 16.200 | 6.900 | 5.745 | 0.833 |
| 0.089 | 0.107 | 1.192 | 53.300 | 51.050 | 0.958 | 14.900 | 14.200 | 4.577 | 5.201 | 1.136 |
| 0.095 | 0.107 | 1.120 | 50.950 | 44.800 | 0.879 | 21.300 | 16.000 | 6.585 | 5.541 | 0.841 |
| 0.115 | 0.126 | 1.101 | 44.000 | 43.000 | 0.977 | 13.350 | 7.000 | 4.645 | 2.681 | 0.577 |
| 0.107 | 0.122 | 1.143 | 44.200 | 36.900 | 0.835 | 16.400 | 9.550 | 5.351 | 3.562 | 0.666 |
| 0.101 | 0.108 | 1.065 | 37.800 | 41.150 | 1.089 | 15.450 | 12.350 | 5.119 | 4.359 | 0.851 |
| 0.088 | 0.108 | 1.224 | 44.050 | 41.300 | 0.938 | 10.500 | 4.200 | 2.999 | 1.469 | 0.490 |
| 0.111 | 0.123 | 1.112 | 41.400 | 44.100 | 1.065 | 11.150 | 16.300 | 3.671 | 5.970 | 1.626 |
| 0.093 | 0.104 | 1.116 | 38.200 | 38.450 | 1.007 | 18.150 | 12.750 | 5.847 | 4.585 | 0.784 |
| 0.094 | 0.123 | 1.315 | 37.300 | 41.250 | 1.106 | 19.800 | 11.900 | 5.868 | 4.636 | 0.790 |
| 0.095 | 0.094 | 0.985 | 39.800 | 38.200 | 0.960 | 9.700 | 4.900 | 3.262 | 1.624 | 0.498 |
| 0.121 | 0.158 | 1.312 | 42.050 | 36.500 | 0.868 | 13.400 | 4.000 | 4.250 | 1.665 | 0.392 |
| 0.095 | 0.096 | 1.013 | 47.900 | 47.250 | 0.986 | 16.000 | 23.800 | 5.208 | 7.845 | 1.506 |
| 0.118 | 0.147 | 1.240 | 36.100 | 38.667 | 1.071 | 14.950 | 7.300 | 4.978 | 3.014 | 0.606 |
| 0.103 | 0.104 | 1.005 | 39.950 | 39.600 | 0.991 | 10.050 | 0.350 | 3.497 | 0.122 | 0.035 |
| 0.101 | 0.119 | 1.181 | 42.950 | 40.550 | 0.944 | 9.050 | 8.100 | 2.832 | 2.994 | 1.057 |
| 0.104 | 0.112 | 1.077 | 45.350 | 40.800 | 0.900 | 9.300 | 13.200 | 2.961 | 4.527 | 1.529 |
| 0.110 | 0.117 | 1.061 | 39.850 | 37.400 | 0.939 | 15.900 | 10.900 | 5.440 | 3.956 | 0.727 |
| 0.106 | 0.116 | 1.097 | 39.650 | 43.650 | 1.101 | 8.500 | 8.000 | 2.774 | 2.863 | 1.032 |
| 0.095 | 0.113 | 1.186 | 38.950 | 36.250 | 0.931 | 9.200 | 2.150 | 2.778 | 0.770 | 0.277 |
| 0.085 | 0.097 | 1.151 | 44.500 | 44.800 | 1.007 | 20.200 | 24.300 | 6.104 | 8.455 | 1.385 |
| 0.105 | 0.113 | 1.074 | 39.300 | 38.300 | 0.975 | 13.650 | 15.700 | 4.636 | 5.725 | 1.235 |
| 0.103 | 0.126 | 1.232 | 39.200 | 34.200 | 0.872 | 9.500 | 3.050 | 3.005 | 1.188 | 0.395 |
| 0.115 | 0.134 | 1.168 | 45.650 | 42.300 | 0.927 | 13.200 | 13.200 | 4.440 | 5.186 | 1.168 |
| 0.103 | 0.130 | 1.265 | 44.300 | 35.200 | 0.795 | 16.000 | 14.750 | 4.991 | 5.820 | 1.166 |
| 0.126 | 0.169 | 1.337 | 43.500 | 34.050 | 0.783 | 20.300 | 10.350 | 6.421 | 4.377 | 0.682 |
| 0.108 | 0.135 | 1.244 | 47.950 | 46.900 | 0.978 | 19.550 | 14.500 | 6.098 | 5.625 | 0.922 |
| 0.104 | 0.141 | 1.353 | 36.100 | 31.900 | 0.884 | 22.900 | 9.600 | 7.244 | 4.108 | 0.567 |
| 0.116 | 0.117 | 1.014 | 39.100 | 37.350 | 0.955 | 5.550 | 8.050 | 1.968 | 2.895 | 1.471 |
| 0.110 | 0.118 | 1.070 | 40.000 | 45.950 | 1.149 | 11.333 | 7.200 | 3.915 | 2.661 | 0.680 |
| 0.093 | 0.113 | 1.207 | 45.100 | 45.700 | 1.013 | 13.000 | 11.000 | 4.088 | 4.175 | 1.021 |
| 0.115 | 0.151 | 1.313 | 41.200 | 41.900 | 1.017 | 15.900 | 14.000 | 5.162 | 5.967 | 1.156 |
| 0.116 | 0.119 | 1.024 | 45.033 | 38.750 | 0.860 | 11.950 | 13.150 | 4.198 | 4.729 | 1.127 |
| 0.112 | 0.147 | 1.315 | 41.650 | 37.333 | 0.896 | 21.600 | 8.750 | 7.085 | 3.773 | 0.533 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 0.103 | 0.115 | 1.112 | 36.800 | 39.600 | 1.076 | 5.833 | -0.450 | 1.957 | -0.168 | -0.086 |
| 0.117 | 0.113 | 0.963 | 40.867 | 39.200 | 0.959 | 8.450 | 5.500 | 3.155 | 1.978 | 0.627 |
| 0.094 | 0.121 | 1.283 | 40.200 | 33.150 | 0.825 | 21.000 | 14.400 | 6.240 | 5.491 | 0.880 |
| 0.113 | 0.126 | 1.118 | 39.100 | 41.350 | 1.058 | 24.000 | 26.150 | 8.431 | 10.275 | 1.219 |
| 0.118 | 0.138 | 1.164 | 47.600 | 35.850 | 0.753 | 9.900 | -0.300 | 3.313 | -0.117 | -0.035 |
| 0.105 | 0.111 | 1.055 | 39.600 | 36.467 | 0.921 | 19.000 | 12.033 | 6.476 | 4.328 | 0.668 |
| 0.117 | 0.118 | 1.009 | 48.267 | 41.400 | 0.858 | 13.600 | 23.100 | 5.049 | 8.653 | 1.714 |
| 0.120 | 0.147 | 1.230 | 48.650 | 40.400 | 0.830 | 20.150 | 4.750 | 6.957 | 2.017 | 0.290 |
| 0.131 | 0.136 | 1.033 | 47.933 | 47.800 | 0.997 | 8.950 | 4.450 | 3.390 | 1.741 | 0.514 |
| 0.124 | 0.120 | 0.969 | 36.833 | 36.100 | 0.980 | 13.500 | 10.050 | 5.035 | 3.631 | 0.721 |
| 0.104 | 0.107 | 1.030 | 43.800 | 45.700 | 1.043 | 15.350 | 14.850 | 5.111 | 5.093 | 0.996 |
| 0.130 | 0.140 | 1.079 | 35.850 | 33.750 | 0.941 | 14.700 | 42.250 | 5.512 | 17.094 | 3.101 |
| 0.124 | 0.138 | 1.114 | 36.750 | 34.350 | 0.935 | 12.500 | 6.750 | 4.651 | 2.798 | 0.602 |
| 0.116 | 0.158 | 1.364 | 42.000 | 39.950 | 0.951 | 14.300 | 8.667 | 4.714 | 3.896 | 0.827 |
| 0.142 | 0.151 | 1.067 | 52.950 | 44.700 | 0.844 | 3.000 | 2.400 | 1.020 | 0.871 | 0.854 |
| 0.125 | 0.142 | 1.136 | 40.800 | 35.850 | 0.879 | 20.300 | 17.000 | 7.199 | 6.849 | 0.951 |
| 0.130 | 0.203 | 1.560 | 42.000 | 43.250 | 1.030 | 11.700 | 4.400 | 3.721 | 2.183 | 0.587 |
| 0.117 | 0.181 | 1.546 | 32.400 | 33.500 | 1.034 | 9.500 | 4.900 | 2.926 | 2.333 | 0.797 |
| 0.117 | 0.137 | 1.170 | 42.250 | 46.900 | 1.110 | 12.950 | 12.700 | 4.551 | 5.223 | 1.148 |
| 0.100 | 0.119 | 1.189 | 45.700 | 42.600 | 0.932 | 17.800 | 19.100 | 5.532 | 7.060 | 1.276 |
| 0.109 | 0.122 | 1.116 | 41.950 | 41.900 | 0.999 | 2.933 | 5.500 | 1.011 | 2.115 | 2.092 |
| 0.122 | 0.142 | 1.161 | 39.850 | 31.400 | 0.788 | 10.600 | 10.500 | 3.649 | 4.196 | 1.150 |
| 0.108 | 0.131 | 1.215 | 42.450 | 38.250 | 0.901 | 16.000 | 1.800 | 4.978 | 0.680 | 0.137 |
| 0.127 | 0.187 | 1.477 | 44.400 | 37.367 | 0.842 | 23.800 | 15.733 | 7.885 | 7.701 | 0.977 |
| 0.136 | 0.174 | 1.281 | 44.300 | 39.350 | 0.888 | 21.200 | 6.750 | 7.413 | 3.023 | 0.408 |
| 0.158 | 0.184 | 1.164 | 40.550 | 34.600 | 0.853 | 13.100 | 8.050 | 4.665 | 3.337 | 0.715 |
| 0.134 | 0.131 | 0.980 | 36.700 | 37.600 | 1.025 | 10.800 | 9.100 | 3.983 | 3.288 | 0.825 |
| 0.111 | 0.131 | 1.174 | 37.550 | 36.800 | 0.980 | 7.500 | 6.550 | 2.510 | 2.574 | 1.025 |
| 0.101 | 0.117 | 1.163 | 44.200 | 43.033 | 0.974 | 13.050 | 7.500 | 4.261 | 2.847 | 0.668 |
| 0.140 | 0.141 | 1.008 | 42.700 | 40.667 | 0.952 | 14.750 | 9.567 | 5.822 | 3.807 | 0.654 |
| 0.135 | 0.123 | 0.912 | 35.100 | 35.575 | 1.014 | 11.200 | 4.200 | 4.622 | 1.580 | 0.342 |
| 0.111 | 0.105 | 0.946 | 35.350 | 39.050 | 1.105 | 15.650 | 12.000 | 5.810 | 4.216 | 0.726 |
| 0.095 | 0.105 | 1.097 | 38.200 | 41.450 | 1.085 | 16.150 | 11.400 | 5.293 | 4.100 | 0.775 |
| 0.128 | 0.156 | 1.219 | 47.100 | 43.333 | 0.920 | 16.900 | 7.850 | 5.676 | 3.215 | 0.566 |
| 0.115 | 0.154 | 1.332 | 37.400 | 26.567 | 0.710 | 22.350 | 19.300 | 7.209 | 8.290 | 1.150 |
| 0.094 | 0.097 | 1.036 | 44.950 | 37.300 | 0.830 | 19.100 | 12.450 | 6.169 | 4.166 | 0.675 |
| 0.152 | 0.186 | 1.223 | 36.000 | 41.433 | 1.151 | 9.200 | 22.300 | 3.456 | 10.248 | 2.965 |
| 0.133 | 0.202 | 1.517 | 46.150 | 44.800 | 0.971 | 12.500 | 6.000 | 4.142 | 3.017 | 0.728 |
| 0.128 | 0.156 | 1.219 | 41.950 | 38.000 | 0.906 | 10.700 | 2.700 | 3.681 | 1.133 | 0.308 |
| 0.110 | 0.123 | 1.121 | 42.250 | 36.150 | 0.856 | 8.750 | 6.800 | 2.820 | 2.457 | 0.871 |
| 0.096 | 0.123 | 1.284 | 34.400 | 38.850 | 1.129 | 18.900 | 14.967 | 6.737 | 6.852 | 1.017 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.109 | 0.132 | 1.207 | 49.900 | 37.833 | 0.758 | 10.400 | 5.750 | 3.630 | 2.422 | 0.667 |
| 0.132 | 0.138 | 1.040 | 45.050 | 44.700 | 0.992 | 12.850 | 9.360 | 5.063 | 3.834 | 0.757 |
| 0.137 | 0.157 | 1.141 | 35.350 | 38.767 | 1.097 | 19.550 | 11.967 | 7.616 | 5.319 | 0.698 |
| 0.157 | 0.173 | 1.100 | 32.000 | 31.000 | 0.969 | 4.250 | 0.367 | 1.821 | 0.173 | 0.095 |
| 0.146 | 0.159 | 1.094 | 39.750 | 37.500 | 0.943 | 5.850 | 2.750 | 2.207 | 1.136 | 0.514 |
| 0.143 | 0.146 | 1.022 | 41.700 | 39.400 | 0.945 | 12.000 | 11.000 | 4.615 | 4.322 | 0.937 |
| 0.142 | 0.174 | 1.226 | 41.050 | 43.850 | 1.068 | 18.250 | 22.350 | 6.867 | 10.307 | 1.501 |
| 0.124 | 0.152 | 1.222 | 47.200 | 36.100 | 0.765 | 17.800 | 9.850 | 6.135 | 4.149 | 0.676 |
| 0.172 | 0.191 | 1.107 | 38.350 | 39.250 | 1.023 | 9.100 | 8.050 | 4.091 | 4.007 | 0.980 |
| 0.132 | 0.126 | 0.957 | 38.700 | 37.850 | 0.978 | 14.800 | 17.950 | 6.078 | 7.053 | 1.160 |
| 0.134 | 0.146 | 1.094 | 41.500 | 35.900 | 0.865 | 12.350 | 12.500 | 4.660 | 5.162 | 1.108 |
| 0.138 | 0.160 | 1.161 | 45.400 | 32.600 | 0.718 | 8.100 | 8.950 | 3.032 | 3.889 | 1.283 |
| 0.145 | 0.152 | 1.050 | 44.250 | 42.750 | 0.966 | 0.300 | -10.350 | 0.121 | -4.394 | -36.221 |
| 0.117 | 0.131 | 1.116 | 44.950 | 40.550 | 0.902 | 30.650 | 15.550 | 10.971 | 6.214 | 0.566 |
| 0.176 | 0.192 | 1.096 | 41.350 | 41.450 | 1.002 | 10.850 | 28.050 | 4.516 | 12.796 | 2.833 |
| 0.140 | 0.157 | 1.127 | 33.600 | 38.500 | 1.146 | 10.900 | 8.100 | 4.156 | 3.479 | 0.837 |

| KFSw1 | KFSw2 | NKFSw1 | NKFSw2 | NKFSwR | HFSw1 | HFSw2 | NHFSw1 | NHFSw2 | NHFSwR |
|---|---|---|---|---|---|---|---|---|---|
| 129.600 | 121.750 | 29.037 | 26.349 | 0.907 | 46.000 | 40.000 | 10.306 | 8.657 | 0.840 |
| 116.400 | 113.850 | 24.947 | 26.349 | 1.056 | 42.800 | 43.050 | 9.173 | 9.963 | 1.086 |
| 112.700 | 109.000 | 27.118 | 26.314 | 0.970 | 51.300 | 41.350 | 12.344 | 9.983 | 0.809 |
| 92.900 | 91.650 | 21.667 | 24.413 | 1.127 | 51.200 | 44.433 | 11.942 | 11.836 | 0.991 |
| 107.500 | 95.700 | 24.338 | 23.581 | 0.969 | 41.500 | 37.100 | 9.395 | 9.142 | 0.973 |
| 113.300 | 117.200 | 29.550 | 28.294 | 0.957 | 44.300 | 46.267 | 11.554 | 11.170 | 0.967 |
| 109.700 | 104.800 | 26.117 | 27.392 | 1.049 | 42.000 | 32.900 | 9.999 | 8.599 | 0.860 |
| 105.900 | 89.500 | 26.533 | 22.799 | 0.859 | 38.400 | 37.500 | 9.621 | 9.553 | 0.993 |
| 119.500 | 109.700 | 29.094 | 30.682 | 1.055 | 35.400 | 34.800 | 8.619 | 9.733 | 1.129 |
| 111.450 | 101.800 | 27.518 | 28.473 | 1.035 | 44.000 | 42.800 | 10.864 | 11.971 | 1.102 |
| 122.500 | 119.600 | 32.813 | 32.257 | 0.983 | 44.200 | 48.100 | 11.840 | 12.973 | 1.096 |
| 104.350 | 108.900 | 29.363 | 28.643 | 0.975 | 49.450 | 49.100 | 13.915 | 12.914 | 0.928 |
| 112.000 | 114.700 | 29.945 | 29.980 | 1.001 | 42.500 | 44.200 | 11.363 | 11.553 | 1.017 |
| 112.400 | 99.100 | 29.755 | 29.038 | 0.976 | 53.400 | 46.900 | 14.136 | 13.742 | 0.972 |
| 90.800 | 102.000 | 26.456 | 29.887 | 1.130 | 43.150 | 42.100 | 12.572 | 12.336 | 0.981 |
| 112.200 | 89.200 | 28.741 | 32.524 | 1.132 | 42.000 | 32.500 | 10.758 | 11.850 | 1.101 |
| 101.100 | 94.600 | 27.686 | 27.247 | 0.984 | 34.800 | 34.900 | 9.530 | 10.052 | 1.055 |
| 110.000 | 102.200 | 30.003 | 28.584 | 0.953 | 36.400 | 36.900 | 9.928 | 10.321 | 1.040 |
| 90.800 | 115.200 | 24.685 | 29.346 | 1.189 | 52.300 | 54.300 | 14.219 | 13.832 | 0.973 |
| 97.550 | 100.700 | 26.204 | 29.170 | 1.113 | 38.400 | 28.600 | 10.315 | 8.285 | 0.803 |
| 106.100 | 113.250 | 28.971 | 31.296 | 1.080 | 38.350 | 28.400 | 10.472 | 7.848 | 0.749 |
| 98.600 | 92.900 | 27.026 | 28.459 | 1.053 | 38.200 | 38.250 | 10.471 | 11.717 | 1.119 |
| 104.300 | 96.000 | 28.292 | 27.329 | 0.966 | 41.500 | 45.950 | 11.257 | 13.081 | 1.162 |
| 115.650 | 87.800 | 30.263 | 28.649 | 0.947 | 41.600 | 34.300 | 10.886 | 11.192 | 1.028 |
| 117.950 | 92.550 | 31.353 | 27.262 | 0.869 | 51.000 | 42.750 | 13.557 | 12.592 | 0.929 |
| 120.000 | 112.800 | 32.186 | 32.866 | 1.021 | 48.300 | 47.250 | 12.955 | 13.767 | 1.063 |
| 96.700 | 88.350 | 26.240 | 24.711 | 0.942 | 42.150 | 38.300 | 11.438 | 10.712 | 0.937 |
| 114.550 | 93.100 | 29.998 | 28.673 | 0.956 | 46.300 | 41.300 | 12.125 | 12.720 | 1.049 |
| 84.500 | 81.900 | 24.056 | 22.907 | 0.952 | 33.550 | 32.800 | 9.551 | 9.174 | 0.961 |
| 99.900 | 97.850 | 30.342 | 27.368 | 0.902 | 44.200 | 31.600 | 13.425 | 8.838 | 0.658 |
| 119.000 | 98.300 | 32.202 | 31.751 | 0.986 | 37.000 | 32.450 | 10.012 | 10.481 | 1.047 |
| 90.200 | 85.200 | 25.161 | 25.105 | 0.998 | 45.650 | 39.750 | 12.734 | 11.713 | 0.920 |
| 104.300 | 97.400 | 27.277 | 31.135 | 1.141 | 37.500 | 33.200 | 9.807 | 10.613 | 1.082 |
| 90.200 | 83.700 | 23.882 | 25.223 | 1.056 | 44.200 | 42.050 | 11.703 | 12.672 | 1.083 |
| 122.050 | 107.200 | 34.776 | 34.444 | 0.990 | 45.900 | 46.150 | 13.078 | 14.828 | 1.134 |
| 91.500 | 92.600 | 25.012 | 25.128 | 1.005 | 43.100 | 37.750 | 11.782 | 10.244 | 0.869 |
| 99.000 | 97.750 | 29.710 | 27.179 | 0.915 | 33.700 | 34.100 | 10.113 | 9.481 | 0.938 |
| 99.800 | 89.200 | 27.091 | 28.661 | 1.058 | 47.000 | 42.000 | 12.758 | 13.495 | 1.058 |
| 100.450 | 91.550 | 28.962 | 30.179 | 1.042 | 46.400 | 46.700 | 13.378 | 15.394 | 1.151 |
| 113.900 | 96.050 | 31.288 | 28.144 | 0.900 | 39.800 | 37.050 | 10.933 | 10.856 | 0.993 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 102.800 | 85.400 | 29.429 | 30.568 | 1.039 | 45.900 | 33.500 | 13.140 | 11.991 | 0.913 |
| 99.000 | 95.000 | 29.875 | 28.310 | 0.948 | 44.300 | 39.550 | 13.368 | 11.786 | 0.882 |
| 96.000 | 89.450 | 27.092 | 29.486 | 1.088 | 49.000 | 50.200 | 13.828 | 16.548 | 1.197 |
| 112.600 | 92.250 | 31.684 | 33.484 | 1.057 | 37.150 | 30.500 | 10.454 | 11.071 | 1.059 |
| 85.800 | 75.150 | 23.711 | 25.523 | 1.076 | 45.100 | 38.250 | 12.463 | 12.990 | 1.042 |
| 95.500 | 84.350 | 27.187 | 28.929 | 1.064 | 38.200 | 24.500 | 10.875 | 8.403 | 0.773 |
| 98.900 | 96.400 | 28.984 | 29.050 | 1.002 | 38.200 | 36.750 | 11.195 | 11.075 | 0.989 |
| 92.600 | 87.000 | 27.657 | 29.113 | 1.053 | 41.800 | 32.750 | 12.484 | 10.959 | 0.878 |
| 107.750 | 92.700 | 31.532 | 30.868 | 0.979 | 52.400 | 48.800 | 15.335 | 16.250 | 1.060 |
| 110.200 | 87.433 | 29.210 | 33.918 | 1.161 | 39.900 | 33.050 | 10.576 | 12.821 | 1.212 |
| 93.100 | 85.100 | 27.600 | 27.063 | 0.981 | 44.950 | 41.950 | 13.326 | 13.341 | 1.001 |
| 105.000 | 94.600 | 30.070 | 32.128 | 1.068 | 52.750 | 41.800 | 15.106 | 14.196 | 0.940 |
| 94.300 | 89.200 | 28.666 | 29.257 | 1.021 | 36.350 | 42.250 | 11.050 | 13.858 | 1.254 |
| 120.000 | 77.700 | 32.743 | 24.838 | 0.759 | 37.800 | 30.050 | 10.314 | 9.606 | 0.931 |
| 95.400 | 86.050 | 27.550 | 27.936 | 1.014 | 45.250 | 39.200 | 13.067 | 12.726 | 0.974 |
| 85.000 | 77.900 | 23.727 | 31.646 | 1.334 | 46.000 | 38.450 | 12.841 | 15.620 | 1.216 |
| 89.850 | 84.850 | 27.211 | 27.970 | 1.028 | 35.800 | 33.750 | 10.842 | 11.125 | 1.026 |
| 86.150 | 78.850 | 27.706 | 28.750 | 1.038 | 48.550 | 47.650 | 15.614 | 17.374 | 1.113 |
| 100.500 | 97.000 | 30.624 | 34.236 | 1.118 | 40.900 | 38.100 | 12.463 | 13.447 | 1.079 |
| 88.950 | 75.100 | 25.425 | 27.259 | 1.072 | 38.650 | 41.750 | 11.047 | 15.154 | 1.372 |
| 87.200 | 78.550 | 25.702 | 25.893 | 1.007 | 41.900 | 47.000 | 12.350 | 15.493 | 1.255 |
| 110.500 | 96.400 | 32.648 | 35.953 | 1.101 | 39.500 | 32.050 | 11.671 | 11.953 | 1.024 |
| 82.650 | 89.300 | 26.122 | 26.019 | 0.996 | 41.850 | 34.900 | 13.227 | 10.169 | 0.769 |
| 94.700 | 85.500 | 28.457 | 29.038 | 1.020 | 27.600 | 23.400 | 8.294 | 7.947 | 0.958 |
| 95.500 | 106.550 | 29.093 | 26.786 | 0.921 | 41.500 | 41.700 | 12.642 | 10.483 | 0.829 |
| 93.800 | 109.500 | 30.308 | 30.080 | 0.992 | 44.450 | 42.850 | 14.362 | 11.771 | 0.820 |
| 95.700 | 108.300 | 32.306 | 33.717 | 1.044 | 47.850 | 51.200 | 16.153 | 15.940 | 0.987 |
| 89.650 | 94.800 | 25.969 | 29.358 | 1.130 | 46.850 | 48.300 | 13.571 | 14.958 | 1.102 |
| 93.050 | 81.750 | 27.666 | 30.350 | 1.097 | 31.700 | 33.300 | 9.425 | 12.363 | 1.312 |
| 85.500 | 74.700 | 26.975 | 27.237 | 1.010 | 42.800 | 36.050 | 13.503 | 13.145 | 0.973 |
| 102.800 | 88.750 | 32.004 | 34.428 | 1.076 | 40.200 | 45.300 | 12.515 | 17.573 | 1.404 |
| 94.950 | 101.500 | 30.271 | 31.093 | 1.027 | 46.450 | 44.500 | 14.809 | 13.632 | 0.921 |
| 117.200 | 108.850 | 36.681 | 36.788 | 1.003 | 37.400 | 37.000 | 11.705 | 12.505 | 1.068 |
| 82.067 | 78.000 | 27.736 | 31.169 | 1.124 | 26.000 | 31.700 | 8.787 | 12.667 | 1.442 |
| 99.067 | 87.400 | 32.904 | 31.868 | 0.969 | 41.900 | 44.700 | 13.916 | 16.299 | 1.171 |
| 86.400 | 79.350 | 26.617 | 27.345 | 1.027 | 32.800 | 27.200 | 10.105 | 9.373 | 0.928 |
| 96.000 | 94.000 | 28.929 | 32.393 | 1.120 | 41.600 | 41.300 | 12.536 | 14.232 | 1.135 |
| 99.100 | 82.600 | 29.700 | 28.193 | 0.949 | 36.500 | 37.550 | 10.939 | 12.816 | 1.172 |
| 84.600 | 85.850 | 27.853 | 26.440 | 0.949 | 41.250 | 39.250 | 13.581 | 12.088 | 0.890 |
| 97.400 | 87.400 | 29.290 | 30.703 | 1.048 | 38.850 | 38.450 | 11.683 | 13.507 | 1.156 |
| 96.800 | 103.500 | 30.611 | 31.706 | 1.036 | 53.100 | 48.400 | 16.792 | 14.827 | 0.883 |

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|---|---|---|---|---|---|---|---|---|---|
| 96.500 | 96.200 | 32.533 | 33.315 | 1.024 | 43.300 | 41.400 | 14.598 | 14.337 | 0.982 |
| 90.900 | 74.300 | 25.424 | 30.680 | 1.207 | 29.500 | 31.950 | 8.251 | 13.193 | 1.599 |
| 98.050 | 85.800 | 29.050 | 32.410 | 1.116 | 45.050 | 43.350 | 13.347 | 16.375 | 1.227 |
| 96.400 | 80.550 | 30.627 | 31.919 | 1.042 | 40.600 | 34.300 | 12.899 | 13.592 | 1.054 |
| 91.400 | 89.000 | 29.407 | 30.377 | 1.033 | 42.200 | 47.400 | 13.577 | 16.178 | 1.192 |
| 90.200 | 87.200 | 29.468 | 31.199 | 1.059 | 40.350 | 34.050 | 13.182 | 12.183 | 0.924 |
| 109.300 | 93.200 | 33.483 | 29.950 | 0.895 | 44.500 | 48.600 | 13.632 | 15.618 | 1.146 |
| 110.150 | 92.250 | 32.275 | 32.716 | 1.014 | 47.600 | 39.650 | 13.947 | 14.062 | 1.008 |
| 106.300 | 91.050 | 32.654 | 33.349 | 1.021 | 44.800 | 43.850 | 13.762 | 16.061 | 1.167 |
| 97.050 | 89.400 | 30.003 | 30.960 | 1.032 | 35.900 | 36.100 | 11.099 | 12.502 | 1.126 |
| 102.300 | 88.900 | 35.596 | 34.043 | 0.956 | 38.500 | 46.150 | 13.396 | 17.672 | 1.319 |
| 96.500 | 84.100 | 31.488 | 31.365 | 0.996 | 43.000 | 32.550 | 14.031 | 12.140 | 0.865 |
| 79.700 | 74.500 | 26.408 | 26.294 | 0.996 | 49.900 | 48.350 | 16.534 | 17.065 | 1.032 |
| 99.800 | 84.000 | 28.503 | 29.371 | 1.030 | 43.800 | 38.500 | 12.509 | 13.462 | 1.076 |
| 89.100 | 81.900 | 29.337 | 29.997 | 1.023 | 42.000 | 41.150 | 13.829 | 15.072 | 1.090 |
| 88.100 | 76.100 | 28.382 | 27.368 | 0.964 | 32.200 | 43.450 | 10.373 | 15.626 | 1.506 |
| 90.500 | 76.150 | 26.820 | 29.666 | 1.106 | 43.800 | 43.200 | 12.980 | 16.829 | 1.297 |
| 78.850 | 84.500 | 26.519 | 27.998 | 1.056 | 42.550 | 46.800 | 14.311 | 15.507 | 1.084 |
| 91.700 | 78.500 | 29.084 | 32.673 | 1.123 | 40.700 | 39.900 | 12.909 | 16.607 | 1.287 |
| 92.100 | 91.400 | 29.978 | 30.129 | 1.005 | 41.100 | 38.500 | 13.378 | 12.691 | 0.949 |
| 85.950 | 73.650 | 28.620 | 30.412 | 1.063 | 39.550 | 34.000 | 13.170 | 14.039 | 1.066 |
| 86.300 | 83.700 | 30.028 | 29.266 | 0.975 | 45.250 | 49.300 | 15.745 | 17.238 | 1.095 |
| 81.800 | 75.200 | 25.601 | 27.795 | 1.086 | 45.650 | 44.900 | 14.287 | 16.596 | 1.162 |
| 90.000 | 84.800 | 28.658 | 29.083 | 1.015 | 38.900 | 38.000 | 12.387 | 13.033 | 1.052 |
| 83.800 | 81.950 | 28.669 | 29.746 | 1.038 | 47.200 | 44.700 | 16.148 | 16.225 | 1.005 |
| 88.600 | 83.400 | 28.910 | 29.852 | 1.033 | 47.700 | 46.600 | 15.564 | 16.680 | 1.072 |
| 95.150 | 84.100 | 28.727 | 30.102 | 1.048 | 48.600 | 50.100 | 14.673 | 17.933 | 1.222 |
| 106.600 | 104.150 | 32.214 | 36.239 | 1.125 | 43.000 | 37.300 | 12.994 | 12.979 | 0.999 |
| 83.250 | 83.850 | 28.273 | 30.573 | 1.081 | 36.900 | 38.500 | 12.532 | 14.038 | 1.120 |
| 95.950 | 89.300 | 30.351 | 34.789 | 1.146 | 50.250 | 48.250 | 15.895 | 18.797 | 1.183 |
| 73.250 | 90.333 | 24.636 | 35.493 | 1.441 | 44.900 | 44.550 | 15.101 | 17.504 | 1.159 |
| 93.500 | 83.200 | 29.164 | 32.827 | 1.126 | 40.300 | 38.500 | 12.570 | 15.191 | 1.208 |
| 92.950 | 79.750 | 29.402 | 33.727 | 1.147 | 53.300 | 49.200 | 16.860 | 20.807 | 1.234 |
| 81.950 | 83.800 | 25.561 | 32.508 | 1.272 | 42.550 | 43.100 | 13.272 | 16.720 | 1.260 |
| 83.300 | 71.750 | 26.349 | 30.701 | 1.165 | 20.000 | 28.100 | 6.326 | 12.024 | 1.901 |
| 90.800 | 87.100 | 32.201 | 31.324 | 0.973 | 45.100 | 47.867 | 15.994 | 17.214 | 1.076 |
| 94.300 | 102.100 | 32.577 | 37.737 | 1.158 | 46.733 | 39.950 | 16.144 | 14.766 | 0.915 |
| 101.400 | 74.700 | 31.890 | 28.355 | 0.889 | 50.200 | 37.100 | 15.788 | 14.083 | 0.892 |
| 92.150 | 73.950 | 29.919 | 31.517 | 1.053 | 39.800 | 43.550 | 12.922 | 18.561 | 1.436 |
| 81.050 | 79.900 | 28.473 | 28.734 | 1.009 | 41.333 | 44.900 | 14.520 | 16.147 | 1.112 |
| 113.650 | 92.250 | 37.277 | 39.782 | 1.067 | 45.900 | 44.100 | 15.055 | 19.018 | 1.263 |

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|---|---|---|---|---|---|---|---|---|---|
| 75.350 | 73.250 | 25.278 | 27.319 | 1.081 | 43.150 | 39.700 | 14.476 | 14.806 | 1.023 |
| 78.600 | 84.450 | 29.347 | 30.371 | 1.035 | 41.400 | 39.500 | 15.458 | 14.205 | 0.919 |
| 101.300 | 79.700 | 30.102 | 30.389 | 1.010 | 33.800 | 35.100 | 10.044 | 13.383 | 1.332 |
| 82.350 | 80.650 | 28.929 | 31.689 | 1.095 | 39.400 | 42.100 | 13.841 | 16.542 | 1.195 |
| 88.950 | 83.800 | 29.765 | 32.646 | 1.097 | 50.950 | 48.700 | 17.049 | 18.972 | 1.113 |
| 86.500 | 81.650 | 29.484 | 29.364 | 0.996 | 30.950 | 36.400 | 10.549 | 13.091 | 1.241 |
| 82.500 | 82.850 | 30.629 | 31.036 | 1.013 | 42.100 | 45.200 | 15.630 | 16.932 | 1.083 |
| 94.250 | 79.950 | 32.539 | 33.943 | 1.043 | 52.550 | 47.800 | 18.142 | 20.294 | 1.119 |
| 82.950 | 78.950 | 31.417 | 30.891 | 0.983 | 51.033 | 51.450 | 19.328 | 20.131 | 1.042 |
| 75.000 | 73.450 | 27.972 | 26.536 | 0.949 | 48.433 | 48.550 | 18.063 | 17.540 | 0.971 |
| 91.900 | 93.200 | 30.601 | 31.964 | 1.045 | 47.500 | 43.250 | 15.817 | 14.833 | 0.938 |
| 82.700 | 55.200 | 31.012 | 22.333 | 0.720 | 31.300 | 47.700 | 11.737 | 19.299 | 1.644 |
| 77.000 | 70.200 | 28.652 | 29.103 | 1.016 | 38.050 | 40.300 | 14.159 | 16.707 | 1.180 |
| 108.650 | 88.167 | 35.815 | 39.635 | 1.107 | 38.333 | 32.800 | 12.636 | 14.745 | 1.167 |
| 90.800 | 80.900 | 30.875 | 29.365 | 0.951 | 48.700 | 47.350 | 16.560 | 17.187 | 1.038 |
| 76.200 | 72.800 | 27.022 | 29.331 | 1.085 | 43.250 | 40.450 | 15.337 | 16.297 | 1.063 |
| 89.000 | 72.000 | 28.303 | 35.723 | 1.262 | 46.800 | 39.600 | 14.883 | 19.648 | 1.320 |
| 76.900 | 74.100 | 23.684 | 35.283 | 1.490 | 39.400 | 32.267 | 12.135 | 15.364 | 1.266 |
| 89.250 | 84.100 | 31.362 | 34.584 | 1.103 | 37.750 | 35.200 | 13.265 | 14.475 | 1.091 |
| 76.400 | 74.700 | 23.743 | 27.610 | 1.163 | 43.100 | 36.950 | 13.395 | 13.657 | 1.020 |
| 87.250 | 87.200 | 30.067 | 33.535 | 1.115 | 51.150 | 59.500 | 17.627 | 22.883 | 1.298 |
| 74.000 | 73.500 | 25.473 | 29.371 | 1.153 | 40.500 | 26.900 | 13.942 | 10.749 | 0.771 |
| 92.250 | 79.000 | 28.701 | 29.858 | 1.040 | 49.850 | 49.200 | 15.509 | 18.595 | 1.199 |
| 90.350 | 77.500 | 29.932 | 37.934 | 1.267 | 39.300 | 41.600 | 13.020 | 20.362 | 1.564 |
| 83.100 | 75.100 | 29.056 | 33.634 | 1.158 | 42.150 | 39.400 | 14.738 | 17.645 | 1.197 |
| 81.300 | 78.300 | 28.949 | 32.461 | 1.121 | 48.000 | 45.250 | 17.092 | 18.759 | 1.098 |
| 81.600 | 85.050 | 30.091 | 30.727 | 1.021 | 41.400 | 37.400 | 15.267 | 13.512 | 0.885 |
| 88.500 | 79.050 | 29.615 | 31.060 | 1.049 | 45.650 | 45.750 | 15.276 | 17.976 | 1.177 |
| 98.750 | 85.367 | 32.240 | 32.404 | 1.005 | 48.750 | 31.800 | 15.916 | 12.071 | 0.758 |
| 80.850 | 74.367 | 31.914 | 29.591 | 0.927 | 43.450 | 41.567 | 17.151 | 16.540 | 0.964 |
| 78.100 | 82.200 | 32.231 | 30.928 | 0.960 | 31.350 | 40.467 | 12.938 | 15.225 | 1.177 |
| 88.967 | 81.600 | 33.030 | 28.666 | 0.868 | 30.333 | 12.200 | 11.261 | 4.286 | 0.381 |
| 92.350 | 72.067 | 30.268 | 25.917 | 0.856 | 40.050 | 37.900 | 13.127 | 13.630 | 1.038 |
| 96.500 | 84.500 | 32.412 | 34.610 | 1.068 | 42.700 | 41.633 | 14.342 | 17.052 | 1.189 |
| 89.450 | 70.033 | 28.852 | 30.082 | 1.043 | 40.700 | 31.900 | 13.128 | 13.702 | 1.044 |
| 103.150 | 92.200 | 33.318 | 30.853 | 0.926 | 44.500 | 35.167 | 14.374 | 11.768 | 0.819 |
| 74.800 | 71.500 | 28.097 | 32.856 | 1.169 | 38.350 | 33.533 | 14.405 | 15.410 | 1.070 |
| 82.367 | 75.133 | 27.291 | 37.777 | 1.384 | 48.850 | 41.133 | 16.186 | 20.682 | 1.278 |
| 78.500 | 79.700 | 27.009 | 33.439 | 1.238 | 47.150 | 39.600 | 16.223 | 16.615 | 1.024 |
| 91.800 | 84.900 | 29.590 | 30.672 | 1.037 | 45.150 | 38.800 | 14.553 | 14.018 | 0.963 |
| 99.050 | 78.900 | 35.308 | 36.123 | 1.023 | 32.400 | 25.850 | 11.549 | 11.835 | 1.025 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 80.600 | 75.950 | 28.129 | 31.991 | 1.137 | 42.550 | 29.400 | 14.850 | 12.384 | 0.834 |
| 88.550 | 83.400 | 34.890 | 34.159 | 0.979 | 42.850 | 39.133 | 16.884 | 16.028 | 0.949 |
| 79.300 | 77.350 | 30.893 | 34.383 | 1.113 | 31.300 | 32.800 | 12.194 | 14.580 | 1.196 |
| 77.950 | 71.900 | 33.395 | 33.876 | 1.014 | 39.200 | 33.700 | 16.794 | 15.878 | 0.945 |
| 84.850 | 74.450 | 32.018 | 30.742 | 0.960 | 42.850 | 42.100 | 16.169 | 17.384 | 1.075 |
| 88.500 | 83.550 | 34.035 | 32.828 | 0.965 | 27.300 | 29.700 | 10.499 | 11.670 | 1.111 |
| 86.600 | 78.900 | 32.583 | 36.387 | 1.117 | 31.100 | 35.667 | 11.701 | 16.449 | 1.406 |
| 91.600 | 77.850 | 31.571 | 32.791 | 1.039 | 39.500 | 39.350 | 13.614 | 16.575 | 1.217 |
| 74.000 | 73.500 | 33.267 | 36.589 | 1.100 | 37.800 | 42.400 | 16.993 | 21.107 | 1.242 |
| 75.650 | 75.250 | 31.068 | 29.567 | 0.952 | 37.867 | 39.950 | 15.551 | 15.697 | 1.009 |
| 76.100 | 73.800 | 28.716 | 30.474 | 1.061 | 33.450 | 35.200 | 12.622 | 14.535 | 1.152 |
| 82.850 | 73.900 | 31.011 | 32.112 | 1.036 | 43.900 | 35.300 | 16.432 | 15.339 | 0.933 |
| 75.700 | 72.200 | 30.611 | 30.653 | 1.001 | 46.367 | 46.250 | 18.750 | 19.635 | 1.047 |
| 87.100 | 81.250 | 31.176 | 32.468 | 1.041 | 34.150 | 35.050 | 12.223 | 14.006 | 1.146 |
| 79.150 | 85.000 | 32.945 | 38.776 | 1.177 | 37.250 | 42.600 | 15.505 | 19.434 | 1.253 |
| 84.500 | 78.700 | 32.219 | 33.805 | 1.049 | 42.100 | 35.500 | 16.052 | 15.249 | 0.950 |