Relative digestibility of Agropyron smithii and Bouteloua gracilis grown under six water regimes
by Jeffrey Martin Welker

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Range Science
Montana State University
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Abstract:
Rangeland production needs to be evaluated on a livestock digestibility basis as well as on gross dry-mater yield. The forage digestibility of two eastern Montana range sites were studied. The first site was dominanted by western wheatgrass, (Agropvron smithii Rybd) and the second site was dominanted primarily by blue grama, (Bouteloua gracilis (H.B.K.) Lag. ex Steud). At each site, plots were irrigated in the preceding fall(20cm), current spring (20cm), and summer (0, 6, 12, 25mm/week). Forage samples were collected in June, July, August and November in 1977 and June, July, August and October 1979. Digestibility was compared between water treatments by an in-vitro technique. Results suggest that while digestibility declines with season in all treatments, for both species, water availability has little effect on in-vitro digestibility.

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Date 18 June 1982

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# GROWN UNDER SIX WATER REGIMES

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JEFFREY MARTIN WELKER

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June, 1982

## ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to the following:

Dr. Tad Weaver for his professional guidance, inspiration, enthusiasm in plant ecology, friendship, and review of the thesis while serving as a co-chairman of my committee.

Dr. Clayton Marlow for his guidance, friendship, insight into range science and review of the thesis while serving as a co-chairman of my committee.

Dr. Kris Havstad for his patience, encouragement, scrupulous review of the thesis and unique insight into the field of range science.

The many professionals in the Animal and Range Science Department and the Biology Department, for without their support and encouragement, this research would have been extremely difficult.

The fellow graduate students with whom I have shared so much time enjoying and discussing the many aspects of range science.

I would also like to thank my parents, grandparents and other members of my family for their patience and quiet support during the many years of my formal education.

Finally, I would like to thank my wife Molly for her devoted patience, guidance and friendship during the duration of this research.

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## ABSTRACT

Rangeland production needs to be evaluated on a livestock digestibility basis as well as on gross dry-mater yield. The forage digestibility of two eastern Montana range sites were studied. The first site was dominanted by western wheatgrass, (Agropyron smithii Rybd) and the second site was dominanted primarily by blue grama, (Bouteloua gracilis (H.B.K.) Lag. ex Steud). At each site, plots were irrigated in the preceding fall(20cm), current spring (20cm), and summer (0, 6, 12, 25mm/week). Forage samples were collected in June, July, August and November in 1977 and June, July, August and October 1979. Digestibility was compared between water treatments by an in-vitro technique. Results suggest that while digestibility declines with season in all treatments, for both species, water availability has little effect on in-vitro digestibility.

# INTRODUCTION

Western rangelands are a major source of forage for livestock production. In order that the animals using the forage on these lands obtain profitable weight gains and maintain reproductive capabilities, the forage must provide essential nutrients in adequate amounts and the forage must be digestible by the rumen micro-flora. Therefore, any management practice which would improve nutrient content or increase forage digestibility would prove beneficial to the livestock producer.

Examples of management practices which may be incorporated to improve total nutrient content of rangeland's are: chisling, interseeding, reseeding, waterspreading, brush removal and fertilization (Vallentine 1980, Bokhari 1978). Yet a management tool which would increase forage digestibility has yet to be implemented.

Eck et al (1981) attempted to increase forage digestibility, with water supplementation. In the Southern Great Plains, tall fescue, (Festuca arundinacea Scherb.) and smooth bromegrass, (Bromus inermis Leyss.) were subjected to three water regimes. In two of the regimes water was applied over the entire growing season, while in the other regime supplemental water was applied only during the cool portion of the growing season. Only total period amounts of water were reported. This research showed that there was no significant differences in digestibility across water treatments. It therefore appears that climatic parameters, such as, photo-period, daily temperatures, relative humidity, rainfall pattern; or species chracteristics are limiting the ability of these species to respond with increased digestibility under supplemental water in the Southern Great Plains.

With the precipitation pattern, daily temperatures, relative humidity and wind patterns varying from the Southern Great Plains to the Northern Great Plains (Humprey, 1964). And with species to species variation in digestibility (Cogswell and Kamstra 1976 ), the possibility exist that different species, in other locations, might respond differently in terms of digestibility to supplemental water. With an irrigation project in eastern Montana directed at assessing the response of two grassland ecosystems to different water regimes, the opportunity to investigate the relationship between water regimes and digestibility presented itself. There were two objectives of this study.

1) Determine whether summer irrigation of 0, 6, 12, or 25mm/wk would significantly alter the forage digestibility of western wheatgrass, (*Agropyron smithii* Rybd) and blue grama,(*Bouteloua gracilis*(H.B.K.) Lag. ex Steud) and

2) Determine whether water applied at different seasons (Fall, Spring and Summer) would significantly alter forage digestibility of these two species.

# LITERATURE REVIEW

Agropyron smithii is an abundant native mid-grass found primarily in the mixed-grass and short-grass prairies of North America (Kuchler 1964). This species initiates growth in the cool part of the growing season, April and May, and achieves most of its production before the hot mid-summer months (Erickson, 1966). Plants of western wheatgrass reach maturity with the production of seed during the early to mid-summer months, depending upon environmental conditions.

Bouteloua gracilis is a warm season grass which usually begins growth in the warmer summer months of June and July, yet growth may begain as early as April in Montana. Maximum growth usually occurs in late July to late August, yet this period may vary from the southern ecotypes to the northern ecotypes (Launchbaugh and Hackerott, 1969; Pieper et al, 1971). Maturation occurs with the formation of seed, which usually occurs during the later part of the growing period. (Launchbaugh and Hackeroff, 1969).

Both Agropyron smithii and Bouteloua gracilis are known to be highly digestible early in their vegetative growth stage (Cogswell and Kamstra, 1976). Digestibility of both species decreases as the forage matures with the progression of the growing season. The factors which are most influential in dictating the seasonal changes in digestibility are leaf-stem ratio, phenological stage, species characteristics and concentration of metabolic compounds (Cook and Harris 1968, Kamstra et al 1968, Kamstra 1978, Erickerson et al 1978).

A primary result of water supplementation on native vegetation in the Northern Great Plains is to increase forage production ( Monson and Queensberry, 1958; Branson, 1956; 1965; Smika et al, 1965; Perry 1978). One wonders whether leaf-stem ratio important to digestibility may also be affected? Weaver and Welker (in prep.) have shown that application of large amounts of water increase leaf-stem ratios in Agropyron smithii communities and barely increase leaf-stem ratios in Bouteloua gracilis communities (Table 1). Yet the degree of response of the vegetation to water supplementation may be limited by other factors; nutrient supply, pattern of application and genetic limitations (Perry 1976).

Another correlate of digestibility, phenology, is not thought to be influenced by water supplementation. Dickinson and Dodd (1976), Wight and Black (1974), Weaver (1975) and Collins and Weaver (1978) have all demonstrated this relatioship. The phenological development (Fig. 1) of Agropyron smithii and Bouteloua gracilis at our sites in the Northern Great Plains, under a water gradient and seasonal water additions, were not significantly influenced by additions of water (Weaver and Welker in preperation).

Forage digestibility research has demonstrated that at a given period different species exhibit differences in digestibility (Cook

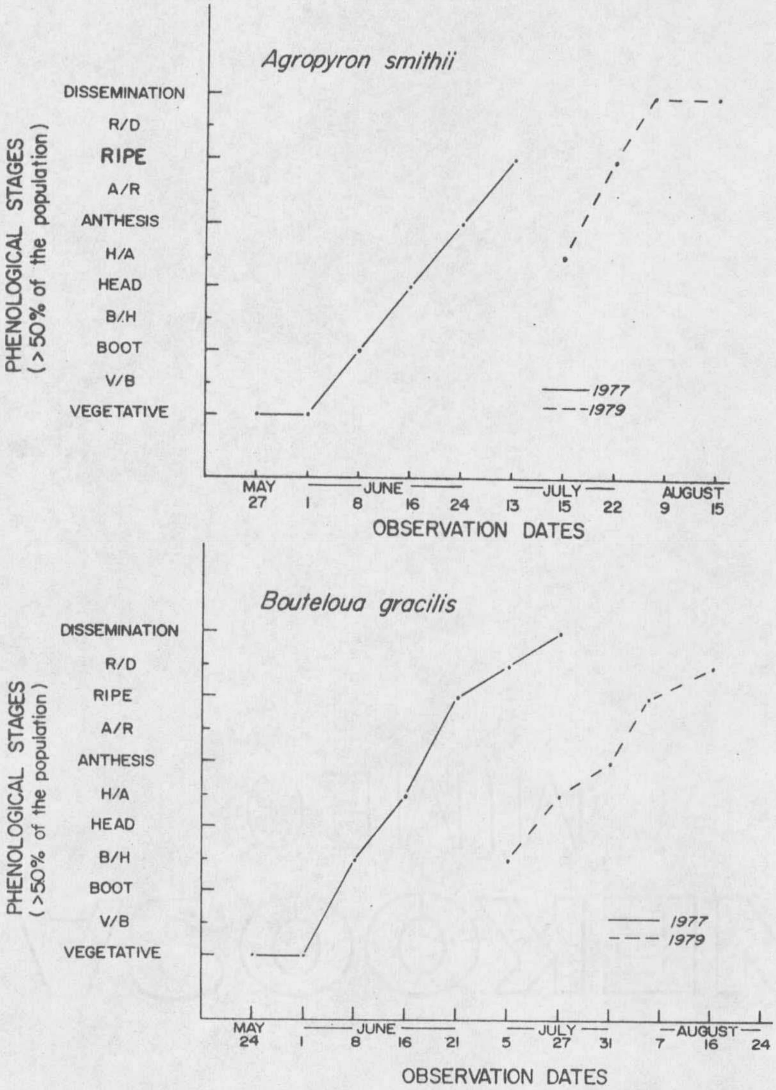
Table 1. Leaf-Stem Ratios of *Agropyron smithii* and *Bouteloua gracilis* under Six Water Regimes in 1980.

| Date | 25 June | 15 July | 18 August | 28 August |
|---|---|---|---|---|
| *Agropyron smithii* | | | | |
| Water Regime | | | | |
| Control[a] | 3 | * | 0.3 | 3 |
| 6mm/wk[a] | 1.0 | 3.0 | 0.16 | ** |
| 12mm/wk[a] | 2.5 | 0.4 | 1.9 | 3.6 |
| 25mm/wk[a] | 9.0 | 24.0 | 9.4 | 24.0 |
| Fall Wet[b] | 2.6 | 0.5 | 1.0 | 2.6 |
| Spring Wet[b] | 5.5 | 5.0 | 4.2 | 2.2 |
| *Bouteloua gracilis* | | | | |
| Control[a] | 2.0 | 2.0 | 1.8 | 5.5 |
| 6mm/wk[a] | 5.7 | 2.5 | 1.8 | 3.3 |
| 12mm/wk[a] | 4.2 | 1.6 | 2.3 | 3.8 |
| 25mm/wk[a] | 4.1 | 7.0 | 2.0 | 2.1 |
| Fall Wet[b] | 2.2 | 1.8 | 2.0 | 1.3 |
| Spring Wet[b] | 4.4 | 4.6 | 2.4 | 2.1 |

*= 4 leaf hits, 0 stem hits
**= 12 leaf hits, 0 stem hits

a) Minimum weekly water additions, natural + artificial. Control regime received no supplemental water.
b) Fall irrigation (Sept. 1 to Sept. 15) 20 cm of supplemental water or the amount of water required to saturate the soil to 75cm; Spring irrigation (May 15 to June 1) 20cm of supplemental water or the amount of water required to saturate the soil to 75cm. Fall or Spring were the only periods these plots received supplemental water.

Figure 1. Phenological Development of Agropyron smithii and Bouteloua gracilis.



and Harris 1968; Kamstra,1973; Cogswell and Kamstra,1976). The variations observed are generally attributed to the different phenological stages of each species during a given period in the growing season. Therefore species which complete their life cycle by mid-July should have a lower digestibility than species which are initiating vegetative growth at the same period (Kamstra, 1973).

Digestibility has been shown to be closley related to lignin content. Dehority et al (1963) examined the relationship between lignin concentration and forage digestibility, concluding that as the plant matures the concentration of undigestible lignin increases. He also showed that the lignin polymer acts as a coating agent along the plant cell wall, perhaps protecting the cellulose molecules and other compounds from ruminant micro-flora degradation. Increasing soil moisture may indeed increase growth (Perry, 1976), yet alteration of the genetic coding for specific metabolic reactions, such as those that might influence digestibility, is not feasible over a short period of water enrichment (Perry,1976).

Eck et al (1981) implemented a project incorporating two supplemental water regimes, 50 and 100cm of additional water applied over the growing season, on two introduced species of grasses in the Southern Great Plains. The results of this research suggest that supplemental water applied to these two species in the Southern Great Plains is not a effective management tool for increasing forage digestibility, or a tool for prolonging the period of maximum digestibility.

Another concern associated with irrigated forage and digestibility is the affect of season of water additions. The effect of timing of rainfall or irrigation has been neglected in range research (Perry, 1976). Although the timing factor has been noted as important in water use efficiency (Wight and Black,1974), nutritive levels of grass (Rogler and Haves, 1947) and community composition (Albertson and Tomaneck, 1965); only Eck et al (1981) tested the effect of additional spring moisture on forage digestibility. No effect was observed. The effect of supplemental soil moisture applied in the fall on native or introduced grass digestibility has not been assessed.

## Methods

### Site Description:

During the summer of 1977, an irrigation study was initiated by Dr. T. Weaver of the Biology Department at Montana State University. The purpose of this study was to examine the effects of additional moisture, which may occur due to weather modification, on the vegetation of the Northern Great Plains. The study sites were on the USDA Range and Livestock Experiment Station at Miles City, Montana. Two important grassland ecosystems within the Northern Great Plains were chosen for the project. One study site was dominanted by western wheatgrass, while the other study site was dominanted by blue grama. The sites were located on rarely flooded plains of the Yellowstone and Tongue Rivers. The western wheatgrass site received light cattle grazing for two years prior to the start of the study The blue grama study site has been used for the last 10 years as late summer and early fall grazing for cattle. The blue grama site received relatively heavy cattle use because a windmill and watering tank were nearby. Both the western wheatgrass and the blue grama sites were fenced at the start of the irrigation project to eliminate any domestic animal interference during the duration of the project. The blue grama site was approximately 150 meters by 50 meters while the western wheatgrass study site was approximately 150 meters by 300 meters. Soil orders for the western wheatgrass and blue grama sites are Borollic Camborthid and Ustic Torriorthent ,respectively . (Soil description are found in Appendix 1).

Water Treatments.

The experimental design was a completely randomized block. At each site, six water treatments were implemented, each treatment having two replications per site. Each treatment plot was 20 meters square, of which a centered, 14 meter square staked plot was delineated with nylon line attached to iron stakes. The water treatments implemented were applied at three seasons: 1)Summer water, consisting of four treatments,(a) a control plot which received no additional water, (b) a plot which was guaranteed 6 mm/week, (c) a plot which was guaranteed 12 mm/week and (d) a plot which received at least 25 mm/week or whatever amount was needed to keep the soil profile saturated to 75 cm, this plot will often be referred to as the "Wet" water treatment plot. 2) Fall water, this treatment involved saturating the soil profile to a depth of 75 cm in mid-September and thereafter received no additional supplemental water. 3) Spring water, in this treatment water was applied in 2-5cm intervals in May and early June, to wet the soil to 75cm and prevent dessication of the surface horizon (0-25cm) during this period.

The summer irrigation plots were guaranteed their respective amounts by recording naturally occurring rainfall on the sites, and then determining whether the natural rainfall met the specific water regimes required for the individual treatments. If the rainfall fell short of the water regime requirement, supplemental water was applied to meet the water regime requirements. If the natural rainfall exceeded the specified water regimes, this was recorded in the data log books, with each week a single unit, such that the previous week's precipitation had no bearing on the current weeks' water criteria.

Water applications were made in early moring windless conditions, using Rain Jet (Rain Jet, Burbank, Calif.) sprinklers (66u openings) on 50 cm risers. Four sprinklers were evenly placed in the plots to obtain even distribution throughout the 14 meter square treatment plots. Nine wedge gauges were placed regularly along the edges and within the treatment plots to record additions of supplemental water. A mean value of all nine wedge gauges were used to determine the amount of water applied to a specific treatment plot. The water supply for the western wheatgrass site was a irrigation canal filled with water from the Yellowstone River. The water supply for the blue grama site was from the nearby Tongue River.

Forage Sampling.

Forage samples were collected for all years (1977-1981) at approximately monthly intervals during June, July, August, October or November, from both sites and all treatments. The samples were used to determine above ground production of the primary species. The forage samples were taken using 10 randomly placed frames (25x50cm) per water regime. Live and dead material of each species was clipped to the ground with shears, separated as to grass or forbs, bagged as such and dried to constant weight at 35 degrees Centigrade. The samples were weighed for biomass determination and then ground through a 40 mesh screen using a Wiley Mill. The ground samples were then placed in plastic jars, sealed and stored in a dark, cool basement for further use.

For this digestibility study, forage samples from 1977 and 1979 were used. These years were choosen because they were similar in climatic conditions, primarily total precipitation on a water year basis (Table 2). This study used two subsamples from each replication of the six water regimes, 1a & 1b, 2a & 2b. Therefore, four samples from each water treatment were analyzed for each month, both species and for the two years. The actual collection dates are shown in Table 3.

Table 2. Precipitation (mm) and Average Temperature (Degrees Celsius) Miles City, Montana 1976-77 and 1978-79.

| Precipitation | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Normal | 18.0 | 13.0 | 12.1 | 12.4 | 12.9 | 8.1 | 31.2 | 52.3 | 84.3 | 39.4 | 30.4 | 30.2 | 344.3 |
| 1976-77 | 19.1 | 4.8 | 6.9 | 17.2 | 2.5 | 24.6 | 6.1 | 62.23 | 35.0 | 48.5 | 57.4 | 48.5 | 332.8 |
| 1978-79 | 6.9 | 55.1 | 16.0 | 8.4 | 28.9 | 6.6 | 19.3 | 34.5 | 19.5 | 70.8 | 17.0 | 0.8 | 283.8 |
| Temperature | | | | | | | | | | | | | |
| Normal | 9.3 | 0.2 | -5.5 | -9.3 | -5.7 | -1.0 | 7.4 | 13.5 | 18.2 | 23.5 | 22.5 | 15.5 | |
| 1976-77 | 6.7 | -1.4 | -3.6 | -13.5 | -0.16 | 2.3 | 10.6 | 16.3 | 21.7 | 23.5 | 18.7 | 15.1 | |
| 1978-79 | 9.2 | -5.1 | -10.6 | -17.6 | -13.3 | -1.2 | 5.2 | 12.0 | 19.6 | 23.6 | 22.2 | 18.7 | |

Table 3. Forage Sample Collection Dates for _Agropyron smithii_ and _Bouteloua gracilis_ in 1977 and 1979.

| | 1977 | | | | 1979 | | | |
|---|---|---|---|---|---|---|---|---|
| Species | June | July | Aug. | Nov. | June | July | Aug. | Oct. |
| _Agropyron smithii_ | 23 | 23 | 18 | 10 | 21 | 19 | 20 | 7 |
| _Bouteloua gracilis_ | 1 | 28 | 20 | 10 | 28 | 30 | 24 | 6 |

## _Digestibility Trial_.

The two stage in-vitro technique (Tilley and Terry, 1963) was used to determine the relative digestibility of western wheatgrass and blue grama at the four dates under the six water regimes for 1977 and 1979. Actual in vitro procedure was performed following Moore and Dunham (1978), with inclusion of phosphate buffer as recommended by Larry White (personal communication with K. Havstad, 1981).

A rumen fistulated black angus heifer was used as the inoculum source. The animal had been fed a grass hay diet for five days prior to the inoculum removal for the digestion trial.

Two digestion trials were run, one for each year. Due to lab limitations each trial was split in-half, such that half of the samples were cooled for 6 hours the other half cooled for 50 hours.

There was no significant difference ($P<.01$) between these half trials (Table 4). Dry matter of each sample was determined to incorporate into the digestibility calculation (Moore and Dunham, 1978).

## Statistical Analysis

Mean digestibility values were calculated and analyzed for significant differences at the 95% level using an Analysis of Variance Multi-factor. Years, species, months and treatments were tested for significant F values.

Table 4. In-Vitro Digestion Trial Results grouped by Laboratory Trials.

1977

| Laboratory Trial | $\bar{X}$ | SD | SE |
|---|---|---|---|
| 1a | $50.73_a$ | 8.17 | 0.83 |
| 1b | $51.38_a$ | 8.40 | 0.85 |
| 1979 | | | |
| 2a | $48.70_a$ | 7.04 | 0.71 |
| 2b | $50.00_a$ | 5.70 | 0.58 |

a, similar sub-script letters indicate no significant difference between mean values with in each year ($P<.01$) Student t-test.

## Results

### 1977 Observations. *Agropyron smithii*.

In 1977 the digestibility of *Agropyron smithii* forage under the control water regime was 57.4% in June. As the growing season progressed digestibility of this forage declined, with the digestibility being 51.0%, 47.3% and 43.0% during July, August and November, respectivly (Table 5, Fig. 2).

Water additions of 6, 12, or 25 mm/week during the summer months did not significantly alter the forage digestibility of *Agropyron smithii* (Table 5). Digestibility of the watered forage did follow the same seasonal trend as that of the control forage, with one exception, that being a slight but insignificant increase in digestibility of the 25 mm/week *Agropyron smithii* treatment between June and July (Table 5, Graph 2).

Seasonal water addition to *Agropyron smithii* forage was unique in 1977, such that no water was applied in the fall of 1976, yet water was applied in the spring of 1977. Therefore the fall water treatment plots were a duplicate of the control treated forage, until the fall of 1977 when the designated fall water plots of *Agropyron smithii* received approximately 10 cm of water, or enough to saturate the soil profile to the 75 cm level. The response of the *Agropyron smithii*

Table 5 Relative Digestibility (%) of _Agropyron_ _smithii_ and _Bouteloua_ _gracilis_ Under Six Water Regimes and Two Years (Mean and Standard Error).

Agropyron smithii

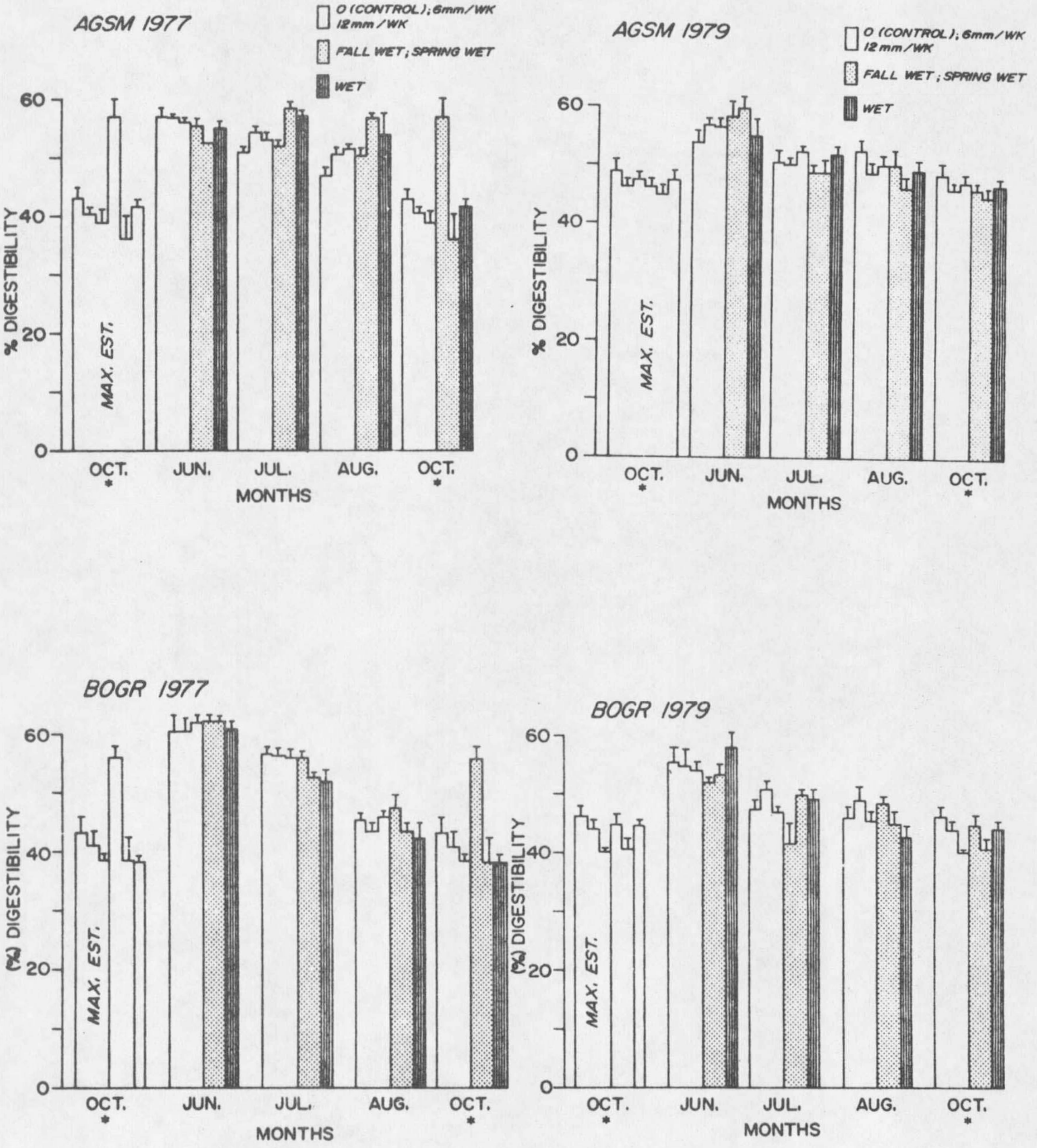
| Water Regime | 0 mm/week | | 6 mm/week | | 12 mm/week | | Fall Wet | | Spring Wet | | Wet | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Months | 1977 | 1979 | 1977 | 1979 | 1977 | 1979 | 1977 | 1979 | 1977 | 1979 | 1977 | 1979 |
| [1] June[a] | 57.3 | 54.0 | 57.0 | 57.0 | 56.0 | 58.3 | 55.8 | 58.3 | 52.5 | 59.8 | 55.5 | 55.8 |
| | 1.7 | 2.1 | 0.7 | 0.7 | 0.4 | 1.6 | 1.7 | 3.8 | 5.8 | 2.0 | 0.8 | 2.9 |
| July[b] | 51.0 | 50.8 | 54.3 | 50.0 | 53.0 | 52.8 | 52.0 | 49.3 | 58.3 | 49.5 | 57.3 | 52.3 |
| | 0.9 | 2.2 | 0.9 | 0.6 | 1.4 | 0.3 | 1.2 | 0.6 | 1.8 | 1.3 | 0.5 | 1.5 |
| August[b] | 47.3 | 53.3 | 50.8 | 49.0 | 51.8 | 50.3 | 50.3 | 50.3 | 56.8 | 46.8 | 53.3 | 49.8 |
| | 1.3 | 1.3 | 1.8 | 1.7 | 0.5 | 1.0 | 1.8 | 3.1 | 0.3 | 1.5 | 3.9 | 1.5 |
| Oct./Nov.[c] | 43.0 | 49.3 | 40.3 | 46.8 | 38.8 | 47.3 | 57.0 | 46.3 | 36.0 | 45.3 | 41.8 | 47.8 |
| | 2.2 | 2.0 | 1.3 | 1.2 | 2.2 | 1.7 | 3.8 | 1.3 | 4.3 | 1.7 | 1.3 | 1.4 |

Bouteloua gracilis

| Water Regime | 0 mm/week | | 6 mm/week | | 12 mm/week | | Fall Wet | | Spring Wet | | Wet | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Months | 1977 | 1979 | 1977 | 1979 | 1977 | 1979 | 1977 | 1979 | 1977 | 1979 | 1977 | 1979 |
| [1] June[a] | 60.5 | 55.5 | 60.5 | 55.5 | 62.3 | 54.0 | 62.5 | 52.0 | 62.3 | 53.0 | 61.0 | 58.0 |
| | 2.3 | 2.5 | 1.9 | 2.7 | 1.0 | 1.6 | 1.2 | 0.9 | 0.9 | 1.8 | 1.2 | 2.2 |
| July[b] | 56.8 | 47.5 | 56.5 | 51.0 | 56.1 | 47.0 | 56.0 | 41.8 | 52.8 | 50.0 | 52.0 | 49.3 |
| | 1.3 | 1.7 | 1.2 | 1.2 | 1.3 | 0.9 | 0.9 | 3.8 | 0.5 | 1.0 | 2.0 | 1.3 |
| August[b] | 45.8 | 46.0 | 43.8 | 49.3 | 46.0 | 45.8 | 46.8 | 48.5 | 43.8 | 45.3 | 42.5 | 42.8 |
| | 1.0 | 2.0 | 1.5 | 2.7 | 1.3 | 1.1 | 1.8 | 1.3 | 1.3 | 1.9 | 2.7 | 1.5 |
| Oct./Nov.[c] | 43.5 | 46.5 | 41.0 | 44.0 | 38.8 | 40.0 | 56.0 | 45.0 | 38.5 | 40.8 | 38.3 | 44.3 |
| | 3.1 | 1.5 | 2.6 | 1.7 | 1.1 | 0.4 | 2.2 | 1.7 | 4.2 | 1.8 | 1.1 | 1.0 |

[1] a,b,c superscripts indicate significant differences at the 99% level when years, species and treatments were pooled.

Figure 2. Relative Digestibility of Agropyron smithii (AGSM) and Bouteloua gracilis (BOGR) Under Six Water Regimes at Four Sample Periods.



forage to the first year of fall watering was an increase in relative digestibility of 7% over that of the previous sampling period. Spring watering of Agropyron smithii enhanced relative digestibility of the forage. In June the digestibility was 52.5%, with an insignificant increase in digestibility by July to 58.3%. The data for Spring Wet (Table 5) shows that in August of 1977 digestibility of the control forage was 9.4% less than the digestibility of spring watered Agropyron smithii. By November, the control forage digestibility was greater than the Spring Wet forage digestibility.

### 1977 Observations, Bouteloua gracilis.

Water additions applied to Bouteloua gracilis forage during the summer of 1977 (0, 6, 12, or 25 mm/week) did not significantly alter the forage digestibility. Regardless of summer water treatment, Bouteloua gracilis forage digestibility was high in June (60-62%), but declined there after by 0.1 - 0.2%/day regardless of water regime. Though digestibility was on a downward trend in late July, the digestibility of the Bouteloua gracilis forage was still above 50% (Table 5). By late August summer watered Bouteloua gracilis dropped below 50%, with values ranging between 42.5% to 46%. Relative digestibility continued to decline from late August to early November regardless of summer water regime.

Seasonal water irrigation applied to Bouteloua gracilis forage in the spring of 1977 did not alter the forage digestibility. Digestibility of the spring watered forage followed the digestibility trends of the control forage quite closely, falling slightly but insignificantly below the control forage digestibility in November (Table 5 and Fig. 2).

The fall watered Bouteloua gracilis forage was the same as the control treated forage until September of 1977, at which time water was applied to the designated treatment plots of Bouteloua gracilis. As noted at the Agropyron smithii site, relative digestibility of Bouteloua gracilis increased between August and October in the fall watered plots in 1977. This forage digestibility increase was probably associated with fall regrowth of both Bouteloua gracilis and Agropyron smithii after fall watering.

### 1979 Observations, Agropyron smithii.

In 1979 relative digestibility of Agropyron smithii was less than 60%, regardless of summer water regime in the month of June (Table 5). Values for the 0, 6, 12 and 25 mm/week water treatments were 54%, 57%, 56.8% and 55.8%, respectively. A general seasonal decline in forage digestibility for these treatments occurred from June through the early part of November (Table 5). By November the relative digestibility of Agropyron smithii, regardless of summer water regime, declined to between 45 and 50%.

Fall watering of Agropyron smithii produced a statistically insignificant increase in digestibility over that of the control forage in the month of June. Values for these treatments in June were 58.3%, and 54%, respectively. As the 1979 growing season progressed, the fall watered Agropyron smithii digestibility paralleled the control forage digestibility, through July, August and November (Table 5). The Fall Wet forage treatment plot received yearly watering in September of 1979, but the Agropyron smithii forage digestibility after this treatment did not increase between August and November as noted in 1977 (Table 5).

Spring watering of Agropyron smithii in 1979 increased forage digestibility over that of the control digestibility, 59.8% and 54% respectivley. After the month of June, the Spring Wet forage digestibility followed the digestibility trends of the control forage until the November sampling period. At this time the spring watered forage was insignificantly lower at the end of the season than the digestibility of the forage under the control water regime (Table 5).

### 1979 Observations, Bouteloua gracilis.

The digestibility of summer watered Bouteloua gracilis forage was similar in the month of June with one exception. For the Wet water regime, the relative digestibility was 58%, this was not a significant difference. Digestibility of all the summer watered treatments declined as the growing season progressed (Table 5). The largest decrease in digestibility on a monthly basis occurred between June and July regardless of summer water regime. By November the digestibility of summer watered Bouteloua gracilis forage decreased below 50% digestibility, with the 12 mm/week water regime having the lowest at 40% (Table 5).

Fall watered Bouteloua gracilis forage digestibility was very similar to the control forage digestibility in the month of June 1979. Between June and July the digestibility of the fall watered Bouteloua gracilis decreased dramatically from 52% to 41%. Between July and August, however, digestibilty of fall watered Bouteloua gracilis increased from 41% to 48.5%. From August to November the forage digestibility of the fall watered Bouteloua gracilis decreased to 45%. The yearly September watering of these treatment plots occurred in 1979, yet as noted with Agropyron smithii, forage digestibility of Bouteloua gracilis did not increase between August and November, as it did in 1977.

Spring watered Bouteloua gracilis forage digestibility was similar to the forage digestibility of the control treated forage in the month of June at 53% and 55.5%, respectively. As the growing season progressed relative digestibility of spring watered Bouteloua gracilis forage declined, such that the digestibility in July, August and November was 50%, 45.3% and 40.8%, respectivley. By November the digestibility of the spring watered Bouteloua gracilis forage was 6% less than the digestibility of Bouteloua gracilis forage under the control water regime, yet this difference was insignificant (Table 5).

The only significant interaction was that of monthly differences in digestibility, when years, species and treatments were pooled.

# DISCUSSION & CONCLUSION

The principle observations from this study were: 1) in all treatments relative digestibility of Agropyron smithii and Bouteloua gracilis declined from June through November, 2) relative digestibility of summer watered forage was not increased, 3) neither fall or spring water additions significantly altered forage digestibility, and 4) digestibility decline with season was not postponed with water supplementation.

Previous research has shown seasonal changes in forage digestibility (Cook and Harris, 1968; Kamstra, 1973; Cogswell and Kamstra, 1976). These seasonal flucuations in digestibility of native forage have been attributed to numerous factors: leaf-stem ratios, phenological stage and concentration of metabolic compounds (Cook, 1968; Dehority et al, 1963; Kamstra, 1973). A significant portion of these seasonal changes in digestibility have been ascribed to the lignification of the plant tissue as the maturation process occurs, with an inverse relationship developing between digestibility and the lignin content of the forage (Dehority et al, 1963). The existance of this inverse relationship may make alteration of digestibility difficult.

Control of forage digestibility must involve both genetic and environmental parameters. This study examined the environmental parameter of various water regimes and noted no significant effect on forage digestibility as well as no effect on seasonal decline in relative digestibility of *Agropyron smithii* and *Bouteloua gracilis*. These findings are supported by the work of Eck et al, (1981) who made similiar observations on smooth bromegrass and tall fescue in the Southern Great Plains. Increased water may not alter digestibility because of water's inability to significantly change the ratio of digestible compounds and lignin. That is, there may be more of each compound in a stand of watered forage, yet the ratio appears to be similar regardless of water regime. Phenology, a common correlate with digestibility, was also unaffected by increased avaiable water (Weaver and Welker in preperation), which suggest that some other seasonal indicator plays a major role in triggering changes in concentration of metabolic compounds. Photo-period, another environmental parameter which is closley associated with hormonal fluctuations within the plant, and is linked to temperature and enzymatic systems (Salisbury and Ross 1978) might be another parameter involved in triggering changes in concentration of metabolic compounds. Photo-periodic control of growth stages may be highly significant as a mechanism of altering digestibility. Investigating the digestibility of *Agropyron smithii* and *Bouteloua gracilis* in which vegetative growth was maintained without flora induction would be of interest. Also worthy of investigation would be the physiological triggering mechanism involved in the formation of cinnamic acid derivitives of which lignin is one (Bonner and Varner 1965).

Relative digestibility of both grasses increased after the fall watering in 1977. This increase suggested that after the watering, the forage was able to respond with vegetative regrowth, presumably lower in lignin concentration and therefore more digestible. However a similar increase was not detected in the fall of 1979. It is speculated that regrowth of _Agropyron smithii_ and _Bouteloua gracilis_ did indeed occur after the fall watering in 1979, yet due to the large amount of biomass produced in response to the water applied in the fall of 1978, abundant standing dead material may have masked the digestiblity of the regrowth. This masking effect did not occur in 1977 because no water was applied in the fall of 1976, therefore the large amount of mature lignified forage was not present.

The fact that digestibility continued to decline from October to November as contrasted across years for both western wheatgrass and blue grama is of interest. This decline late in the growing season may possibly be explained by several factors; a) continued lignification of the plant tissue, b) transport below ground of digestible compounds, and c) possible leaching of digestible compounds enhanced by fall precipitation.

The possible ecological implications of increased moisture are many (Perry, 1976). Responses of the native vegetation to additional water varies from site to site. At our sites digestibility of both species were not significantly altered by short periods of water supplementation. Yet inorder to alter digestibility in the long term sufficient exposure to the altered water conditions would have to occur to allow approprate mutations to occur (Perry 1976). As the period of continued water supplementation lengthened then the probability of natural selection for different enzmatic pathways, photo-periodic responses and alteration of the ratio of metabolites may increase. Any effect on forage digestibility of long term alteration of the local water regimes has yet to be reported.

I would hypothesis that long term alteration of the local water regime of any native rangeland plant community would give rise to genotypic changes with in the population, possibly leading to alteration of digestibility. One might also expect that with continued alteration of the local water regime a shift in the species occuping the site may occur. Therefore this shift may led to a change in the season of highly digestible forage. Also of interest is the effect of supplemental water on the percent of the plant which is greater than 40 to 50% digestible. If water supplementation increased the amount of the plant material which is greater than 50% digestible then more energy and protein would be avaiable for the herbivior.

# Summary

This research has documented that water applied to western wheatgrass or blue grama at different seasons or in varying amounts during the summer growing season was incapable of significantly altering the relative digestibility of these forages. These water treatments were also ineffective in prolonging the decline in forage digestibility which commonly occurs between the vegetative and the seed shattering period. Also noted was that season of water supplementation (Fall, Spring, or Summer) did not significantly alter the forage digestibility.

# APPENDICES

## Appendix 1. Soil Descriptions.

### Agropyron smithii Site

Well-drained, fine, montmorillonitic Borollic Camborthid, with plentiful free lime at 20cm and roots to 1.5m, Kobar sility clay loam which developed on alluvium lying in simple relief with a 2% north slope.

### Bouteloua gracilis Site

Well-drained, fine loamy, frigid calcareous Ustic Torriorhent with plentiful free lime at 75cm and roots to 105cm, Havre variant loam developed on a high alluvial terrace with simple relief and with 1% east slope.

Appendix 2. Computer Program to Calculate Digestibility and Data File.

```
      PROGRAM TO CALCULATE %DM,OM,ASH,IVOMD,IVDMD
      A=FRESH WT.,B=ORGINAL CRUC.WT.,C=CRU.+DRIEDSAMPLE
      D=CRU.+ASHED SAMPLE,E=ORG.DIG.SAMPLE,F=%DW,
      G=%ASH,H=ORG.GOOCH CRUC.WT.,I=DIGESTED SAMPLE
      +GOOCH CRUC.AFTER DRYING,J=DIGESTED SAMPLE +
      GOOCH CRUC.AFTER ASHING,K=BLANK CONSTANT,O=IVOMD
      M=IVDMD,N=%OM, L=CODE(YR,MONTH,SPECIES,TRT,REP)
      MONTH-JN=1,JL=2,AUG=3,OCT,NOV=4
      YEAR,9=1979,8=1978,7=1978; SPECIES,1=WWHEATGRASS,2=BGRAM
      TREAT, 1=CONTROL,2=6MM/WK,3=12MM/WK,4=FWET,5=SPWET,6=WET
      INTEGER G
      REAL H,I,J,K,L,M,N
              DO 15 II=1,416
      READ (50,10)A,B,C,D,E,F,G,H,I,J,K,L
 10    FORMAT (F5.3,X,3(F6.3,X),F6.5,X,I2,X,I2,X,
     *3(F8.5,X),F6.5,X,I5)
           F=((C-B)/A)*100
           G=((D-B)/A)*100
      N=(1-(G/100.0))
           O=((E*G/100.0)-(J-H-K))/(E*C/100.0)
           M=((E*F/100.0)-(I-H-K))/(E*F/100.0)
      WRITE(55,20) A,B,C,D,E,F,G,H,I,J,K,L,M,N,O
 20   FORMAT(F5.3,X,3(F6.3,X),F6.5,X,I2,X,I2,X,
     *3(F8.5,X),F6.5,X,I5,X,F6.2,X,F6.2,X,F6.2)
 15   CONTINUE
      END
```

Appendix 2. Continued.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.005 | 19.270 | 20.237 | 19.345 | .50008 | 96 | 7 | 35.97013 | 36.21882 | 35.98768 | .00562 | 91111 | .49 | .93 | .66 |
| 1.002 | 17.412 | 18.373 | 17.493 | .50000 | 95 | 8 | 34.68612 | 34.92374 | 34.70857 | .00562 | 91112 | .52 | .92 | .58 |
| 1.003 | 17.851 | 18.813 | 17.944 | .50000 | 95 | 9 | 34.67557 | 34.88535 | 34.69813 | .00562 | 91113 | .57 | .91 | .62 |
| 1.017 | 16.803 | 17.777 | 16.885 | .50000 | 95 | 8 | 35.98957 | 36.19686 | 36.00134 | .00562 | 91114 | .58 | .92 | .85 |
| 1.002 | 18.454 | 19.415 | 18.533 | .50000 | 95 | 7 | 36.17235 | 36.38245 | 36.18935 | .00562 | 91121 | .57 | .93 | .67 |
| 1.012 | 15.448 | 16.418 | 15.537 | .50000 | 95 | 8 | 37.41019 | 37.63023 | 37.42919 | .00562 | 91122 | .55 | .92 | .67 |
| 1.006 | 17.449 | 18.416 | 17.532 | .50009 | 96 | 8 | 36.90448 | 37.11283 | 36.91857 | .00562 | 91123 | .58 | .92 | .79 |
| 1.004 | 17.460 | 18.424 | 17.548 | .50000 | 96 | 8 | 34.75453 | 34.96374 | 34.77049 | .00562 | 91124 | .58 | .92 | .74 |
| 1.011 | 17.914 | 18.884 | 17.974 | .50002 | 95 | 5 | 34.76229 | 34.99850 | 34.77871 | .00562 | 91131 | .52 | .95 | .57 |
| 1.007 | 17.463 | 18.409 | 17.518 | .50000 | 93 | 5 | 37.25283 | 37.45800 | 37.26936 | .00562 | 91132 | .58 | .95 | .56 |
| 1.000 | 15.886 | 16.846 | 15.974 | .50008 | 96 | 8 | 36.97085 | 37.17440 | 36.98459 | .00562 | 91133 | .59 | .92 | .80 |
| 1.018 | 17.936 | 18.939 | 18.055 | .50000 | 98 | 11 | 34.89000 | 35.10371 | 34.90310 | .00562 | 91134 | .58 | .89 | .86 |
| 1.000 | 16.623 | 17.583 | 16.700 | .50000 | 96 | 7 | 35.63765 | 35.84840 | 35.64982 | .00562 | 91141 | .57 | .93 | .81 |
| 1.022 | 17.832 | 18.812 | 17.909 | .50008 | 95 | 7 | 37.07332 | 37.26683 | 37.08571 | .00562 | 91142 | .61 | .93 | .81 |
| 1.013 | 17.361 | 18.333 | 17.452 | .50000 | 95 | 8 | 36.55976 | 36.75323 | 36.56997 | .00562 | 91143 | .61 | .92 | .89 |
| 1.005 | 16.337 | 17.303 | 16.419 | .50000 | 96 | 8 | 34.79432 | 35.02123 | 34.81247 | .00562 | 91144 | .54 | .92 | .69 |
| 1.010 | 17.963 | 18.932 | 18.046 | .50000 | 95 | 8 | 36.06608 | 36.26492 | 36.08673 | .00562 | 91151 | .60 | .92 | .62 |
| 1.006 | 17.455 | 18.420 | 17.538 | .50000 | 95 | 8 | 36.72617 | 36.91549 | 36.74160 | .00562 | 91152 | .62 | .92 | .75 |
| 1.002 | 18.331 | 19.296 | 18.408 | .50000 | 96 | 7 | 34.10338 | 34.28490 | 34.11700 | .00562 | 91153 | .63 | .93 | .77 |
| 1.001 | 18.184 | 19.150 | 18.259 | .50000 | 96 | 7 | 36.83400 | 37.06229 | 36.85403 | .00562 | 91154 | .54 | .93 | .59 |
| 1.010 | 17.832 | 18.596 | 17.883 | .50000 | 75 | 5 | 35.99108 | 36.19009 | 36.00272 | .00562 | 91161 | .49 | .95 | .76 |
| 1.017 | 16.679 | 17.658 | 16.766 | .50000 | 96 | 8 | 34.49535 | 34.72750 | 34.51494 | .00562 | 91162 | .53 | .92 | .65 |
| 1.001 | 16.443 | 17.408 | 16.531 | .50000 | 96 | 8 | 37.93165 | 38.11837 | 37.94534 | .00562 | 91163 | .62 | .92 | .80 |
| 1.010 | 18.313 | 19.286 | 18.391 | .50000 | 96 | 7 | 35.37359 | 35.57879 | 35.38367 | .00562 | 91164 | .59 | .93 | .87 |
| 1.005 | 17.794 | 18.759 | 17.872 | .50000 | 96 | 7 | 36.28557 | 36.54607 | 36.31852 | .00562 | 92111 | .47 | .93 | .22 |
| 1.004 | 17.555 | 18.518 | 17.629 | .50000 | 95 | 7 | 34.58550 | 34.83800 | 34.60912 | .00562 | 92112 | .49 | .93 | .49 |
| 1.016 | 17.035 | 18.015 | 17.110 | .50000 | 96 | 7 | 35.46736 | 35.71272 | 35.48474 | .00562 | 92113 | .50 | .93 | .66 |
| 1.009 | 17.386 | 18.357 | 17.454 | .50002 | 96 | 6 | 34.62985 | 34.84410 | 34.64228 | .00562 | 92114 | .57 | .94 | .77 |
| 1.013 | 17.756 | 18.734 | 17.828 | .50002 | 96 | 7 | 34.92130 | 35.17435 | 34.94078 | .00562 | 92121 | .49 | .93 | .60 |
| 1.008 | 18.294 | 19.266 | 18.363 | .50002 | 96 | 6 | 34.10275 | 34.34270 | 34.12289 | .00562 | 92122 | .51 | .94 | .52 |
| 1.006 | 18.096 | 19.066 | 18.165 | .50000 | 96 | 6 | 36.28934 | 36.53714 | 36.30630 | .00562 | 92123 | .50 | .94 | .62 |
| 1.003 | 17.216 | 18.181 | 17.286 | .50002 | 96 | 6 | 34.98160 | 35.21918 | 34.99337 | .00562 | 92124 | .52 | .94 | .80 |
| 1.001 | 17.614 | 18.578 | 17.683 | .50000 | 96 | 6 | 35.59048 | 35.82278 | 35.60752 | .00562 | 92131 | .53 | .94 | .62 |
| 1.002 | 17.769 | 18.735 | 17.840 | .50000 | 96 | 7 | 35.81770 | 36.04875 | 35.83010 | .00562 | 92132 | .53 | .93 | .81 |
| 1.000 | 17.130 | 18.074 | 17.213 | .50000 | 96 | 8 | 36.83575 | 37.07262 | 36.85671 | .00562 | 92133 | .52 | .92 | .62 |
| 1.001 | 18.525 | 19.489 | 18.609 | .50000 | 96 | 8 | 35.95134 | 36.18178 | 35.97480 | .00562 | 92134 | .53 | .92 | .55 |
| 1.016 | 17.770 | 18.750 | 17.834 | .50002 | 96 | 6 | 35.45402 | 35.69766 | 35.46619 | .00562 | 92141 | .51 | .94 | .78 |
| 1.001 | 17.980 | 18.946 | 18.150 | .50000 | 96 | 16 | 36.17177 | 36.42583 | 36.18833 | .00562 | 92142 | .49 | .84 | .86 |
| 1.019 | 17.671 | 18.653 | 17.756 | .50000 | 96 | 8 | 35.37488 | 35.63228 | 35.39689 | .00562 | 92143 | .48 | .92 | .59 |
| 1.018 | 17.468 | 18.449 | 17.551 | .50000 | 96 | 8 | 36.06540 | 36.31499 | 36.08775 | .00562 | 92144 | .49 | .92 | .58 |
| 1.007 | 17.509 | 18.480 | 17.584 | .50005 | 96 | 7 | 37.25380 | 37.51085 | 37.27076 | .00562 | 92151 | .48 | .93 | .68 |
| 1.013 | 16.632 | 17.609 | 16.711 | .50003 | 96 | 7 | 37.55749 | 37.81964 | 37.58085 | .00562 | 92152 | .47 | .93 | .49 |
| 1.002 | 17.537 | 18.505 | 17.614 | .50000 | 96 | 7 | 36.07757 | 36.32300 | 36.10072 | .00562 | 92153 | .50 | .93 | .50 |
| 1.006 | 17.313 | 18.285 | 17.392 | .50000 | 96 | 7 | 36.84507 | 37.07648 | 36.86400 | .00562 | 92154 | .53 | .93 | .62 |
| 1.001 | 16.542 | 17.509 | 16.611 | .50000 | 96 | 6 | 35.81868 | 36.03657 | 35.83312 | .00562 | 92161 | .56 | .94 | .71 |
| 1.001 | 17.743 | 18.710 | 17.818 | .50000 | 96 | 7 | 36.65893 | 36.91077 | 36.67632 | .00562 | 92162 | .49 | .93 | .66 |
| 1.004 | 18.302 | 19.271 | 18.378 | .50000 | 96 | 7 | 34.89074 | 35.13475 | 34.90848 | .00562 | 92163 | .51 | .93 | .65 |
| 1.007 | 17.073 | 18.046 | 17.152 | .50000 | 96 | 7 | 35.10272 | 35.33445 | 35.12177 | .00562 | 92164 | .53 | .93 | .62 |
| 1.001 | 19.268 | 20.231 | 19.339 | .50000 | 96 | 7 | 36.12647 | 36.34365 | 36.14409 | .00562 | 93111 | .56 | .93 | .66 |
| 1.007 | 17.411 | 18.378 | 17.506 | .50000 | 96 | 9 | 36.81073 | 37.03264 | 36.83166 | .00562 | 93112 | .55 | .91 | .66 |
| 1.001 | 17.850 | 18.811 | 17.931 | .50000 | 96 | 8 | 38.14414 | 38.38262 | 38.16674 | .00562 | 93113 | .51 | .92 | .58 |
| 1.011 | 16.801 | 17.773 | 16.872 | .50003 | 96 | 7 | 36.13835 | 36.38134 | 36.15655 | .00562 | 93114 | .51 | .93 | .64 |
| 1.004 | 18.452 | 19.418 | 18.531 | .50000 | 96 | 7 | 34.63072 | 34.88719 | 34.65373 | .00562 | 93121 | .48 | .93 | .50 |
| 1.013 | 15.446 | 16.420 | 15.528 | .50000 | 96 | 8 | 36.96988 | 37.23152 | 36.99768 | .00562 | 93122 | .47 | .92 | .45 |
| 1.004 | 17.449 | 18.414 | 17.523 | .50004 | 96 | 7 | 34.75004 | 35.01071 | 34.77335 | .00562 | 93123 | .47 | .93 | .49 |
| 1.012 | 17.460 | 18.434 | 17.540 | .50000 | 96 | 7 | 35.52231 | 35.75134 | 35.54154 | .00562 | 93124 | .54 | .93 | .61 |
| 1.021 | 17.714 | 18.697 | 17.790 | .50006 | 96 | 7 | 36.21421 | 36.46187 | 36.23846 | .00562 | 93131 | .50 | .93 | .47 |
| 1.013 | 17.463 | 18.419 | 17.532 | .50000 | 94 | 6 | 36.28775 | 36.53363 | 36.31100 | .00562 | 93132 | .49 | .94 | .41 |
| 1.003 | 15.886 | 16.852 | 15.977 | .50000 | 96 | 9 | 34.49710 | 34.74935 | 34.52528 | .00562 | 93133 | .49 | .91 | .50 |
| 1.016 | 17.943 | 18.943 | 18.064 | .50000 | 98 | 11 | 38.15896 | 38.39633 | 38.18706 | .00562 | 93134 | .53 | .89 | .59 |

Appendix 2. Continued.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N̄ | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.011 | 16.623 | 17.597 | 16.693 | .50000 | 96 | 6 | 36.84669 | 37.09199 | 36.86371 | .00562 | 93141 | .50 | .94 | .62 |
| 1.015 | 17.832 | 18.812 | 17.903 | .50000 | 96 | 6 | 36.49762 | 36.73538 | 36.51317 | .00562 | 93142 | .52 | .94 | .67 |
| 1.015 | 17.333 | 18.337 | 17.440 | .50007 | 98 | 10 | 34.58733 | 34.87987 | 34.60911 | .00562 | 93143 | .42 | .90 | .68 |
| 1.019 | 16.337 | 17.321 | 16.415 | .50006 | 96 | 7 | 37.19122 | 37.40396 | 37.20542 | .00562 | 93144 | .57 | .93 | .75 |
| 1.016 | 17.963 | 18.945 | 18.041 | .50000 | 96 | 7 | 35.84707 | 36.12361 | 35.86982 | .00562 | 93151 | .44 | .93 | .51 |
| 1.011 | 17.455 | 18.432 | 17.526 | .50000 | 96 | 7 | 36.95980 | 37.21918 | 36.97741 | .00562 | 93152 | .47 | .93 | .66 |
| 1.001 | 18.290 | 19.284 | 18.394 | .50000 | 99 | 10 | 34.82988 | 35.10995 | 34.85174 | .00562 | 93153 | .45 | .90 | .68 |
| 1.005 | 18.184 | 19.156 | 18.264 | .50000 | 96 | 7 | 36.43543 | 36.67566 | 36.45453 | .00562 | 93154 | .51 | .93 | .56 |
| 1.002 | 17.623 | 18.592 | 17.700 | .50000 | 96 | 7 | 35.39762 | 35.65093 | 35.41747 | .00562 | 93161 | .49 | .93 | .59 |
| 1.048 | 16.679 | 17.692 | 16.765 | .50006 | 96 | 8 | 37.06919 | 37.31253 | 37.08789 | .00562 | 93162 | .51 | .92 | .67 |
| 1.054 | 16.443 | 17.462 | 16.530 | .50008 | 96 | 8 | 34.98212 | 35.24770 | 35.00348 | .00562 | 93163 | .46 | .92 | .61 |
| 1.012 | 18.313 | 19.291 | 18.391 | .50000 | 96 | 7 | 36.73463 | 36.96782 | 36.75194 | .00562 | 93164 | .53 | .93 | .67 |
| 1.010 | 17.794 | 18.772 | 17.860 | .50000 | 96 | 6 | 35.53546 | 35.79717 | 35.55572 | .00562 | 94111 | .47 | .94 | .51 |
| 1.007 | 17.555 | 18.527 | 17.624 | .50000 | 96 | 6 | 34.74920 | 35.01903 | 34.77115 | .00562 | 94112 | .45 | .94 | .46 |
| 1.035 | 17.035 | 18.036 | 17.090 | .50004 | 96 | 5 | 34.06800 | 34.30938 | 34.08278 | .00562 | 94113 | .51 | .95 | .63 |
| 1.019 | 17.386 | 18.371 | 17.442 | .50000 | 96 | 5 | 37.00890 | 37.23732 | 37.02633 | .00562 | 94114 | .54 | .95 | .53 |
| 1.013 | 17.756 | 18.737 | 17.831 | .50000 | 96 | 7 | 34.68738 | 34.93619 | 34.70924 | .00562 | 94121 | .50 | .93 | .54 |
| 1.005 | 18.294 | 19.268 | 18.358 | .50000 | 96 | 6 | 35.53616 | 35.80816 | 35.55500 | .00562 | 94122 | .45 | .94 | .56 |
| 1.065 | 18.096 | 19.130 | 18.158 | .50000 | 97 | 5 | 35.49445 | 35.75566 | 35.51125 | .00562 | 94123 | .47 | .95 | .55 |
| 1.009 | 17.216 | 18.195 | 17.285 | .50000 | 97 | 6 | 35.42249 | 35.69409 | 35.44190 | .00562 | 94124 | .45 | .94 | .54 |
| 1.068 | 17.614 | 18.651 | 17.704 | .50000 | 97 | 8 | 38.16013 | 38.40158 | 38.18320 | .00562 | 94131 | .51 | .92 | .56 |
| 1.062 | 17.769 | 18.801 | 17.849 | .50000 | 97 | 7 | 34.91915 | 35.19114 | 34.94435 | .00562 | 94132 | .45 | .93 | .44 |
| 1.020 | 17.130 | 18.123 | 17.221 | .50000 | 97 | 8 | 36.50031 | 36.75276 | 36.52534 | .00562 | 94133 | .49 | .92 | .51 |
| 1.061 | 18.525 | 19.558 | 18.611 | .50000 | 97 | 8 | 34.67522 | 34.95271 | 34.70729 | .00562 | 94134 | .44 | .92 | .34 |
| 1.031 | 17.770 | 18.770 | 17.837 | .50000 | 96 | 6 | 34.79787 | 35.06280 | 34.81494 | .00562 | 94141 | .47 | .94 | .62 |
| 1.084 | 17.980 | 19.032 | 18.041 | .50000 | 97 | 5 | 35.49381 | 35.74533 | 35.51370 | .00562 | 94142 | .49 | .95 | .43 |
| 1.055 | 17.671 | 18.695 | 17.742 | .50000 | 97 | 6 | 37.55962 | 37.82886 | 37.57707 | .00562 | 94143 | .46 | .94 | .61 |
| 1.005 | 17.468 | 18.442 | 17.530 | .50000 | 96 | 6 | 36.07840 | 36.36200 | 36.09840 | .00562 | 94144 | .43 | .94 | .52 |
| 1.036 | 17.509 | 18.513 | 17.571 | .50000 | 96 | 5 | 36.43557 | 36.70595 | 36.44889 | .00562 | 94151 | .45 | .95 | .69 |
| 1.003 | 16.632 | 17.605 | 16.698 | .50000 | 97 | 6 | 35.58733 | 35.83377 | 35.60770 | .00562 | 94152 | .50 | .94 | .51 |
| 1.045 | 17.537 | 18.553 | 17.606 | .50000 | 97 | 6 | 35.45237 | 35.73603 | 35.47014 | .00562 | 94153 | .43 | .94 | .59 |
| 1.049 | 17.313 | 18.333 | 17.375 | .50000 | 97 | 5 | 37.93048 | 38.21524 | 37.94615 | .00562 | 94154 | .43 | .95 | .60 |
| 1.037 | 16.542 | 17.541 | 16.631 | .50000 | 96 | 8 | 35.52350 | 35.76298 | 35.54591 | .00562 | 94161 | .51 | .92 | .58 |
| 1.073 | 17.743 | 18.784 | 17.830 | .50000 | 97 | 8 | 37.49851 | 37.75741 | 37.52143 | .00562 | 94162 | .48 | .92 | .57 |
| 1.021 | 18.302 | 19.274 | 18.380 | .50000 | 97 | 7 | 35.42376 | 35.70069 | 35.44347 | .00562 | 94163 | .44 | .93 | .60 |
| 1.031 | 17.073 | 18.077 | 17.165 | .50000 | 97 | 8 | 35.97009 | 36.22700 | 35.99427 | .00562 | 94164 | .48 | .92 | .54 |
| 1.020 | 19.268 | 20.257 | 19.332 | .50000 | 96 | 6 | 34.97397 | 35.22248 | 34.98878 | .00562 | 91211 | .50 | .94 | .69 |
| 1.019 | 17.411 | 18.399 | 17.474 | .50000 | 96 | 6 | 35.51911 | 35.71101 | 35.53408 | .00562 | 91212 | .62 | .94 | .69 |
| 1.405 | 17.858 | 19.260 | 17.943 | .50008 | 99 | 6 | 34.70135 | 34.93986 | 34.72513 | .00562 | 91213 | .54 | .94 | .39 |
| 1.035 | 16.801 | 17.800 | 16.889 | .50000 | 96 | 8 | 34.48825 | 34.70527 | 34.50842 | .00562 | 91214 | .56 | .92 | .64 |
| 1.040 | 18.452 | 19.457 | 18.527 | .50000 | 96 | 7 | 36.25182 | 36.50136 | 36.27207 | .00562 | 91221 | .50 | .93 | .58 |
| 1.014 | 15.446 | 16.427 | 15.526 | .50000 | 96 | 7 | 34.88586 | 35.08172 | 34.89850 | .00562 | 91222 | .61 | .93 | .80 |
| 1.060 | 17.449 | 18.473 | 17.540 | .50000 | 96 | 8 | 34.48542 | 34.71700 | 34.50722 | .00562 | 91223 | .53 | .92 | .60 |
| 1.064 | 17.460 | 18.490 | 17.554 | .50004 | 96 | 8 | 34.05908 | 34.27974 | 34.07946 | .00562 | 91224 | .56 | .92 | .63 |
| 1.012 | 17.714 | 18.695 | 17.781 | .50000 | 96 | 6 | 34.88187 | 35.10600 | 34.89848 | .00562 | 91231 | .55 | .94 | .63 |
| 1.016 | 17.463 | 18.428 | 17.527 | .50000 | 94 | 6 | 38.88165 | 39.11964 | 38.89399 | .00562 | 91232 | .51 | .94 | .78 |
| 1.048 | 15.886 | 16.901 | 15.990 | .50000 | 96 | 9 | 36.21264 | 36.45303 | 36.24164 | .00562 | 91233 | .52 | .91 | .48 |
| 1.033 | 17.943 | 18.963 | 18.078 | .50000 | 98 | 13 | 36.39281 | 36.60821 | 36.42427 | .00562 | 91234 | .58 | .87 | .60 |
| 1.025 | 16.623 | 17.614 | 16.703 | .50000 | 96 | 7 | 36.12509 | 36.36253 | 36.14104 | .00562 | 91241 | .52 | .93 | .70 |
| 1.028 | 17.832 | 18.828 | 17.904 | .50000 | 96 | 7 | 35.81248 | 36.03698 | 35.82814 | .00562 | 91242 | .55 | .93 | .71 |
| 1.016 | 17.333 | 18.344 | 17.443 | .50005 | 99 | 10 | 35.71100 | 35.97767 | 35.73470 | .00562 | 91243 | .48 | .90 | .64 |
| 1.074 | 16.337 | 17.378 | 16.423 | .50000 | 96 | 8 | 36.03866 | 36.27269 | 36.05709 | .00562 | 91244 | .53 | .92 | .68 |
| 1.081 | 17.963 | 19.011 | 18.072 | .50000 | 96 | 10 | 35.39673 | 35.63585 | 35.42352 | .00562 | 91251 | .52 | .90 | .58 |
| 1.011 | 17.455 | 18.435 | 17.567 | .50003 | 96 | 11 | 37.88488 | 38.10285 | 37.91243 | .00562 | 91252 | .56 | .89 | .60 |
| 1.044 | 18.290 | 19.327 | 18.413 | .50000 | 99 | 11 | 34.86310 | 35.12208 | 34.89023 | .00562 | 91253 | .49 | .89 | .61 |
| 1.077 | 18.184 | 19.227 | 18.297 | .50003 | 96 | 10 | 35.39819 | 35.61414 | 35.42901 | .00562 | 91254 | .57 | .90 | .50 |
| 1.042 | 17.632 | 18.630 | 17.732 | .50000 | 95 | 9 | 34.72523 | 34.95573 | 34.75600 | .00562 | 91261 | .53 | .91 | .44 |
| 1.008 | 16.679 | 17.654 | 16.778 | .50000 | 96 | 9 | 34.14019 | 34.35861 | 34.16486 | .00562 | 91262 | .56 | .91 | .58 |
| 1.067 | 16.443 | 17.477 | 16.559 | .50000 | 96 | 10 | 35.55088 | 35.74818 | 35.57925 | .00562 | 91263 | .60 | .90 | .55 |
| 1.054 | 18.313 | 19.333 | 18.413 | .50000 | 96 | 9 | 35.01670 | 35.20285 | 35.03922 | .00562 | 91264 | .63 | .91 | .62 |

Appendix 2. Continued.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.009 | 17.794 | 18.781 | 17.850 | .50000 | 97 | 5 | 35.87882 | 36.14478 | 35.89813 | .00562 | 92211 | .47 | .95 | .45 |
| 1.014 | 17.555 | 18.548 | 17.615 | .50000 | 97 | 5 | 34.70532 | 34.98656 | 34.72013 | .00562 | 92212 | .44 | .95 | .63 |
| 1.068 | 17.035 | 18.018 | 17.118 | .50000 | 92 | 7 | 35.14217 | 35.39400 | 35.16944 | .00562 | 92213 | .47 | .93 | .38 |
| 1.047 | 17.368 | 18.407 | 17.459 | .50000 | 99 | 8 | 35.33384 | 35.57549 | 35.35013 | .00562 | 92214 | .52 | .92 | .73 |
| 1.039 | 17.756 | 18.770 | 17.830 | .50000 | 97 | 7 | 35.49460 | 35.75345 | 35.52006 | .00562 | 92221 | .48 | .93 | .43 |
| 1.025 | 18.294 | 19.295 | 18.370 | .50000 | 97 | 7 | 34.72874 | 34.97566 | 34.74494 | .00562 | 92222 | .51 | .93 | .70 |
| 1.003 | 18.096 | 19.074 | 18.172 | .50008 | 97 | 7 | 36.15954 | 36.39058 | 36.18426 | .00562 | 92223 | .54 | .93 | .45 |
| 1.014 | 17.216 | 18.205 | 17.294 | .50000 | 97 | 7 | 35.40285 | 35.64692 | 35.42502 | .00562 | 92224 | .51 | .93 | .53 |
| 1.002 | 17.614 | 18.591 | 17.683 | .50000 | 97 | 6 | 36.23883 | 36.49519 | 36.25003 | .00562 | 92231 | .49 | .94 | .81 |
| 1.027 | 17.769 | 18.774 | 17.861 | .50000 | 97 | 8 | 37.66700 | 37.92789 | 37.69350 | .00562 | 92232 | .48 | .92 | .48 |
| 1.021 | 17.130 | 18.127 | 17.215 | .50000 | 97 | 8 | 36.52800 | 36.80280 | 36.55800 | .00562 | 92233 | .45 | .92 | .39 |
| 1.041 | 18.525 | 19.542 | 18.610 | .50008 | 97 | 8 | 35.55340 | 35.82242 | 35.58523 | .00562 | 92234 | .46 | .92 | .34 |
| 1.017 | 17.770 | 18.762 | 17.840 | .50000 | 97 | 6 | 37.13578 | 37.42123 | 37.15840 | .00562 | 92241 | .43 | .94 | .43 |
| 1.010 | 17.980 | 18.966 | 18.050 | .50000 | 97 | 6 | 34.92134 | 35.19967 | 34.93876 | .00562 | 92242 | .44 | .94 | .61 |
| 1.023 | 17.671 | 18.670 | 17.751 | .50002 | 97 | 7 | 39.41446 | 39.75508 | 39.44143 | .00562 | 92243 | .31 | .93 | .39 |
| 1.029 | 17.468 | 18.472 | 17.545 | .50000 | 97 | 7 | 36.38188 | 36.63845 | 36.40379 | .00562 | 92244 | .49 | .93 | .53 |
| 1.027 | 17.509 | 18.513 | 17.609 | .50000 | 97 | 9 | 35.39870 | 35.64840 | 35.43130 | .00562 | 92251 | .50 | .91 | .40 |
| 1.014 | 16.632 | 17.623 | 16.728 | .50000 | 97 | 9 | 36.25680 | 36.52133 | 36.27921 | .00562 | 92252 | .47 | .91 | .63 |
| 1.046 | 17.537 | 18.560 | 17.637 | .50000 | 97 | 9 | 36.39100 | 36.63011 | 36.42323 | .00562 | 92253 | .52 | .91 | .41 |
| 1.087 | 16.313 | 17.375 | 16.440 | .50005 | 97 | 11 | 36.03884 | 36.28627 | 36.07600 | .00562 | 92254 | .51 | .89 | .43 |
| 1.011 | 16.542 | 17.522 | 16.640 | .50000 | 96 | 9 | 35.63598 | 35.89218 | 35.66770 | .00562 | 92261 | .48 | .91 | .42 |
| 1.023 | 17.743 | 18.740 | 17.857 | .50000 | 97 | 11 | 36.23261 | 36.46835 | 36.26388 | .00562 | 92262 | .53 | .89 | .53 |
| 1.027 | 18.302 | 19.305 | 18.419 | .50000 | 97 | 11 | 35.49571 | 35.75646 | 35.53815 | .00562 | 92263 | .48 | .89 | .33 |
| 1.047 | 17.073 | 18.095 | 17.190 | .50000 | 97 | 11 | 37.50185 | 37.75951 | 37.53440 | .00562 | 92264 | .48 | .89 | .51 |
| 1.010 | 19.268 | 20.250 | 19.338 | .50000 | 97 | 6 | 36.37531 | 36.66558 | 36.39523 | .00562 | 93211 | .41 | .94 | .52 |
| 1.009 | 17.411 | 18.392 | 17.477 | .50000 | 97 | 6 | 34.91700 | 35.18283 | 34.93559 | .00562 | 93212 | .46 | .94 | .57 |
| 1.075 | 17.858 | 18.807 | 17.967 | .50000 | 88 | 10 | 35.01455 | 35.26053 | 35.04690 | .00562 | 93213 | .46 | .90 | .47 |
| 1.013 | 16.801 | 17.785 | 16.891 | .50000 | 97 | 8 | 35.95513 | 36.20106 | 35.98358 | .00562 | 93214 | .51 | .92 | .43 |
| 1.078 | 18.452 | 19.493 | 18.538 | .50000 | 97 | 7 | 35.51662 | 35.77815 | 35.54532 | .00562 | 93221 | .47 | .93 | .34 |
| 1.088 | 15.446 | 16.507 | 15.536 | .50000 | 97 | 8 | 35.57815 | 35.79363 | 35.60100 | .00562 | 93222 | .57 | .92 | .57 |
| 1.018 | 17.449 | 18.435 | 17.542 | .50000 | 96 | 9 | 35.39966 | 35.65273 | 35.42900 | .00562 | 93223 | .49 | .91 | .47 |
| 1.043 | 17.460 | 18.472 | 17.562 | .50000 | 97 | 9 | 35.50050 | 35.77959 | 35.53272 | .00562 | 93224 | .44 | .91 | .41 |
| 1.008 | 17.714 | 18.692 | 17.788 | .50000 | 97 | 7 | 37.88172 | 38.15358 | 37.90673 | .00562 | 93231 | .45 | .93 | .45 |
| 1.024 | 17.463 | 18.439 | 17.520 | .50000 | 95 | 5 | 35.71570 | 35.96655 | 35.73867 | .00562 | 93232 | .49 | .95 | .31 |
| 1.005 | 15.886 | 16.862 | 15.976 | .50008 | 97 | 10 | 34.05574 | 34.32659 | 34.09707 | .00562 | 93233 | .45 | .90 | .29 |
| 1.044 | 17.943 | 18.977 | 18.078 | .50006 | 99 | 12 | 35.59920 | 35.88235 | 35.63453 | .00562 | 93234 | .44 | .88 | .50 |
| 1.015 | 16.623 | 17.608 | 16.699 | .50000 | 97 | 7 | 38.87765 | 39.12708 | 38.90439 | .00562 | 93241 | .50 | .93 | .40 |
| 1.025 | 17.832 | 18.829 | 17.910 | .50000 | 97 | 7 | 35.51275 | 35.76950 | 35.53642 | .00562 | 93242 | .48 | .93 | .48 |
| 1.086 | 17.333 | 18.417 | 17.450 | .50000 | 99 | 10 | 36.55965 | 36.81175 | 36.58612 | .00562 | 93243 | .51 | .90 | .58 |
| 1.034 | 16.337 | 17.343 | 16.425 | .50000 | 97 | 8 | 35.10600 | 35.37723 | 35.13365 | .00562 | 93244 | .45 | .92 | .45 |
| 1.058 | 17.963 | 18.994 | 18.064 | .50000 | 97 | 9 | 35.46667 | 35.74737 | 35.49759 | .00562 | 93251 | .44 | .91 | .44 |
| 1.020 | 17.455 | 18.448 | 17.563 | .50000 | 97 | 10 | 36.30165 | 36.59039 | 36.33707 | .00562 | 93252 | .42 | .90 | .40 |
| 1.037 | 18.290 | 19.326 | 18.426 | .50000 | 99 | 13 | 37.06770 | 37.32000 | 37.10341 | .00562 | 93253 | .51 | .87 | .54 |
| 1.005 | 18.185 | 19.162 | 18.297 | .50000 | 97 | 11 | 35.88207 | 36.16206 | 35.92153 | .00562 | 93254 | .44 | .89 | .38 |
| 1.013 | 17.632 | 18.608 | 17.742 | .50000 | 96 | 10 | 34.91297 | 35.17575 | 34.95111 | .00562 | 93261 | .47 | .90 | .35 |
| 1.066 | 16.679 | 17.716 | 16.793 | .50000 | 97 | 10 | 36.16368 | 36.45836 | 36.19920 | .00562 | 93262 | .41 | .90 | .40 |
| 1.032 | 16.443 | 17.446 | 16.601 | .50002 | 97 | 15 | 35.32864 | 35.61237 | 35.39096 | .00562 | 93263 | .43 | .85 | .24 |
| 1.011 | 18.313 | 19.297 | 18.457 | .50000 | 97 | 14 | 35.40535 | 35.70483 | 35.45752 | .00562 | 93264 | .40 | .86 | .34 |
| 1.040 | 17.794 | 18.812 | 17.856 | .50000 | 97 | 5 | 34.91624 | 35.18408 | 34.93840 | .00562 | 94211 | .46 | .95 | .34 |
| 1.026 | 17.555 | 18.559 | 17.627 | .50000 | 97 | 7 | 34.97851 | 35.25705 | 34.99600 | .00562 | 94212 | .44 | .93 | .66 |
| 1.046 | 17.035 | 18.057 | 17.118 | .50008 | 97 | 7 | 35.50702 | 35.75170 | 35.53418 | .00562 | 94213 | .51 | .93 | .38 |
| 1.093 | 17.368 | 18.450 | 17.473 | .50000 | 98 | 9 | 36.53160 | 36.80814 | 36.55518 | .00562 | 94214 | .45 | .91 | .60 |
| 1.051 | 17.756 | 18.782 | 17.846 | .50000 | 97 | 8 | 36.29600 | 36.55290 | 36.33005 | .00562 | 94221 | .49 | .92 | .29 |
| 1.041 | 18.294 | 19.310 | 18.397 | .50000 | 97 | 9 | 39.41834 | 39.69828 | 39.44114 | .00562 | 94222 | .44 | .91 | .62 |
| 1.061 | 18.096 | 19.130 | 18.191 | .50000 | 97 | 8 | 35.80959 | 36.09584 | 35.84452 | .00562 | 94223 | .42 | .92 | .27 |
| 1.023 | 17.216 | 18.213 | 17.319 | .50000 | 97 | 10 | 34.86686 | 35.15853 | 34.89968 | .00562 | 94224 | .41 | .90 | .46 |
| 1.018 | 17.614 | 18.605 | 17.802 | .50000 | 97 | 18 | 36.03641 | 36.33897 | 36.10042 | .00562 | 94231 | .39 | .82 | .35 |
| 1.010 | 17.769 | 18.755 | 17.852 | .50000 | 97 | 8 | 37.01383 | 37.31437 | 37.03178 | .00562 | 94232 | .40 | .92 | .69 |
| 1.082 | 17.130 | 18.186 | 17.247 | .50000 | 97 | 10 | 36.90384 | 37.19558 | 36.94404 | .00562 | 94233 | .41 | .90 | .31 |
| 1.043 | 18.525 | 19.542 | 18.642 | .50000 | 97 | 11 | 35.14677 | 35.44280 | 35.18402 | .00562 | 94234 | .40 | .89 | .42 |

Appendix 2. Continued.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.067 | 17.770 | 18.811 | 17.878 | .50000 | 97 | 10 | 36.03386 | 36.29278 | 36.07115 | .00562 | 94241 | .48 | .90 | .37 |
| 1.020 | 17.980 | 18.976 | 18.109 | .50000 | 97 | 12 | 35.84527 | 36.13886 | 35.86488 | .00562 | 94242 | .41 | .88 | .77 |
| 1.008 | 17.671 | 18.653 | 17.775 | .50000 | 97 | 10 | 35.84527 | 36.13062 | 35.88100 | .00562 | 94243 | .43 | .90 | .40 |
| 1.020 | 17.468 | 18.463 | 17.579 | .50000 | 97 | 10 | 37.07859 | 37.33600 | 37.10986 | .00562 | 94244 | .48 | .90 | .49 |
| 1.089 | 17.509 | 18.574 | 17.620 | .50009 | 97 | 10 | 35.45180 | 35.75828 | 35.48600 | .00562 | 94251 | .38 | .90 | .43 |
| 1.043 | 16.632 | 17.651 | 16.718 | .50000 | 97 | 8 | 37.19390 | 37.46181 | 37.21846 | .00562 | 94252 | .46 | .92 | .53 |
| 1.032 | 17.537 | 18.544 | 17.659 | .50000 | 97 | 11 | 35.45263 | 35.75124 | 35.50152 | .00562 | 94253 | .40 | .89 | .21 |
| 1.013 | 17.313 | 18.303 | 17.426 | .50000 | 97 | 11 | 37.14177 | 37.44304 | 37.18030 | .00562 | 94254 | .39 | .89 | .40 |
| 1.030 | 16.542 | 17.541 | 16.660 | .50000 | 96 | 11 | 36.28449 | 36.57285 | 36.32807 | .00562 | 94261 | .42 | .89 | .31 |
| 1.021 | 17.743 | 18.740 | 17.876 | .50000 | 97 | 13 | 36.73821 | 37.00950 | 36.77492 | .00562 | 94262 | .46 | .87 | .52 |
| 1.055 | 18.302 | 19.332 | 18.455 | .50000 | 97 | 14 | 34.82805 | 35.09600 | 34.87945 | .00562 | 94263 | .46 | .86 | .35 |
| 1.068 | 17.073 | 18.116 | 17.247 | .50000 | 97 | 16 | 37.23783 | 37.52021 | 37.29389 | .00562 | 94264 | .43 | .84 | .37 |
| 1.071 | 19.268 | 20.308 | 19.337 | .50000 | 97 | 6 | 34.97563 | 35.20086 | 34.98825 | .00868 | 71111 | .55 | .94 | .87 |
| 1.010 | 17.411 | 18.392 | 17.475 | .50000 | 97 | 6 | 34.10391 | 34.31192 | 34.11686 | .00868 | 71112 | .59 | .94 | .86 |
| 1.026 | 17.850 | 18.850 | 17.917 | .50000 | 97 | 6 | 34.70237 | 34.93343 | 34.71585 | .00868 | 71113 | .54 | .94 | .84 |
| 1.033 | 16.801 | 17.806 | 16.868 | .50000 | 97 | 6 | 34.98219 | 35.18022 | 34.99462 | .00868 | 71114 | .61 | .94 | .87 |
| 1.021 | 18.452 | 19.443 | 18.519 | .50000 | 97 | 6 | 36.25300 | 36.47508 | 36.26637 | .00868 | 71121 | .56 | .94 | .84 |
| 1.079 | 15.446 | 16.493 | 15.524 | .50000 | 97 | 7 | 35.81883 | 36.02465 | 35.83232 | .00868 | 71122 | .59 | .93 | .86 |
| 1.011 | 17.449 | 18.433 | 17.517 | .50000 | 97 | 6 | 34.48651 | 34.71084 | 34.49914 | .00868 | 71123 | .56 | .94 | .87 |
| 1.020 | 17.460 | 18.451 | 17.521 | .50000 | 97 | 5 | 35.95203 | 36.16882 | 35.96439 | .00868 | 71124 | .57 | .95 | .85 |
| 1.026 | 17.714 | 18.706 | 17.783 | .50000 | 96 | 6 | 34.88360 | 35.10857 | 34.89719 | .00868 | 71131 | .55 | .94 | .84 |
| 1.004 | 17.463 | 18.417 | 17.504 | .50000 | 95 | 4 | 36.17392 | 36.39361 | 36.18466 | .00868 | 71132 | .56 | .96 | .90 |
| 1.037 | 15.886 | 16.898 | 15.955 | .50000 | 97 | 6 | 36.21374 | 36.43505 | 36.22615 | .00868 | 71133 | .56 | .94 | .88 |
| 1.012 | 17.943 | 18.949 | 18.031 | .50000 | 99 | 8 | 36.06648 | 36.29009 | 36.08077 | .00868 | 71134 | .57 | .92 | .86 |
| 1.016 | 16.623 | 17.608 | 16.691 | .50000 | 96 | 6 | 36.12558 | 36.36385 | 36.14112 | .00868 | 71141 | .53 | .94 | .77 |
| 1.005 | 17.832 | 18.807 | 17.902 | .50000 | 97 | 6 | 37.55933 | 37.76252 | 37.57363 | .00868 | 71142 | .60 | .94 | .81 |
| 1.018 | 17.361 | 18.353 | 17.433 | .50006 | 97 | 7 | 35.71188 | 35.94971 | 35.72843 | .00868 | 71143 | .53 | .93 | .78 |
| 1.057 | 16.337 | 17.367 | 16.411 | .50000 | 97 | 7 | 36.84692 | 37.06449 | 36.86333 | .00868 | 71144 | .57 | .93 | .78 |
| 1.008 | 17.963 | 18.942 | 18.056 | .50000 | 97 | 9 | 35.39855 | 35.62030 | 35.42392 | .00868 | 71151 | .56 | .91 | .63 |
| 1.014 | 17.455 | 18.439 | 17.553 | .50000 | 97 | 9 | 36.65990 | 36.86046 | 36.68500 | .00868 | 71152 | .60 | .91 | .64 |
| 1.019 | 18.290 | 19.250 | 18.412 | .50000 | 94 | 11 | 34.86429 | 35.18000 | 34.88953 | .00868 | 71153 | .35 | .89 | .70 |
| 1.052 | 18.184 | 19.209 | 18.283 | .50000 | 97 | 9 | 35.10429 | 35.31310 | 35.12890 | .00868 | 71154 | .59 | .91 | .65 |
| 1.008 | 17.623 | 18.600 | 17.720 | .50000 | 96 | 9 | 34.72736 | 34.94937 | 34.75248 | .00868 | 71161 | .56 | .91 | .63 |
| 1.044 | 16.679 | 17.692 | 16.776 | .50000 | 97 | 9 | 36.81316 | 37.02923 | 36.83849 | .00868 | 71162 | .57 | .91 | .63 |
| 1.046 | 16.443 | 17.461 | 16.545 | .50000 | 97 | 9 | 35.55216 | 35.78256 | 35.57832 | .00868 | 71163 | .54 | .91 | .61 |
| 1.015 | 18.313 | 19.301 | 18.411 | .50000 | 97 | 9 | 36.13971 | 36.37106 | 36.16391 | .00868 | 71164 | .54 | .91 | .66 |
| 1.014 | 17.794 | 18.781 | 17.862 | .50000 | 97 | 6 | 35.87912 | 36.13536 | 35.89408 | .00868 | 72111 | .49 | .94 | .79 |
| 1.058 | 17.555 | 18.585 | 17.625 | .50000 | 97 | 6 | 36.97236 | 37.20449 | 36.98682 | .00868 | 72112 | .54 | .94 | .81 |
| 1.077 | 17.035 | 18.083 | 17.105 | .50000 | 97 | 6 | 35.14352 | 35.40660 | 35.15932 | .00868 | 72113 | .48 | .94 | .76 |
| 1.021 | 17.368 | 18.382 | 17.449 | .50000 | 99 | 7 | 35.52337 | 35.76550 | 35.53761 | .00868 | 72114 | .53 | .93 | .84 |
| 1.040 | 17.756 | 18.768 | 17.830 | .50000 | 97 | 7 | 35.49570 | 35.73008 | 35.51310 | .00868 | 72121 | .54 | .93 | .75 |
| 1.062 | 18.294 | 19.326 | 18.367 | .50000 | 97 | 6 | 36.28926 | 36.50926 | 36.30562 | .00868 | 72122 | .57 | .94 | .74 |
| 1.018 | 18.096 | 19.089 | 18.165 | .50000 | 97 | 6 | 36.16122 | 36.39934 | 36.17933 | .00868 | 72123 | .53 | .94 | .69 |
| 1.043 | 17.216 | 18.232 | 17.283 | .50000 | 97 | 6 | 38.16102 | 38.40000 | 38.17774 | .00868 | 72124 | .53 | .94 | .73 |
| 1.044 | 17.614 | 18.625 | 17.674 | .50000 | 96 | 5 | 36.23010 | 36.46400 | 36.24503 | .00868 | 72131 | .53 | .95 | .75 |
| 1.013 | 17.769 | 18.755 | 17.833 | .50000 | 97 | 6 | 36.49707 | 36.74295 | 36.51531 | .00868 | 72132 | .51 | .94 | .68 |
| 1.047 | 17.130 | 18.151 | 17.198 | .50000 | 97 | 6 | 36.52936 | 36.77619 | 36.54489 | .00868 | 72133 | .51 | .94 | .77 |
| 1.050 | 18.525 | 19.549 | 18.596 | .50000 | 97 | 6 | 37.19212 | 37.41274 | 37.20694 | .00868 | 72134 | .57 | .94 | .80 |
| 1.031 | 17.770 | 18.771 | 17.835 | .50000 | 97 | 6 | 37.13722 | 37.38855 | 37.15449 | .00868 | 72141 | .50 | .94 | .71 |
| 1.029 | 17.980 | 18.983 | 18.042 | .50000 | 97 | 6 | 36.96200 | 37.19635 | 36.97393 | .00868 | 72142 | .54 | .94 | .89 |
| 1.058 | 17.671 | 18.702 | 17.731 | .50000 | 97 | 5 | 39.41548 | 39.66713 | 39.43385 | .00868 | 72143 | .50 | .95 | .61 |
| 1.018 | 17.468 | 18.460 | 17.535 | .50000 | 97 | 6 | 36.43618 | 36.67032 | 36.45083 | .00868 | 72144 | .54 | .94 | .80 |
| 1.007 | 17.509 | 18.487 | 17.620 | .50000 | 97 | 11 | 35.40108 | 35.60779 | 35.43220 | .00868 | 72151 | .59 | .89 | .59 |
| 1.043 | 16.632 | 17.650 | 16.741 | .50000 | 97 | 10 | 37.07200 | 37.26026 | 37.10263 | .00868 | 72152 | .63 | .90 | .56 |
| 1.012 | 17.537 | 18.521 | 17.636 | .50000 | 97 | 9 | 36.39149 | 36.62368 | 36.41752 | .00868 | 72153 | .54 | .91 | .61 |
| 1.028 | 17.313 | 18.313 | 17.410 | .50000 | 97 | 9 | 36.73619 | 36.95488 | 36.76112 | .00868 | 72154 | .57 | .91 | .64 |
| 1.060 | 16.542 | 17.560 | 16.653 | .50000 | 96 | 10 | 35.63761 | 35.85872 | 35.67239 | .00868 | 72161 | .56 | .90 | .48 |
| 1.084 | 17.743 | 18.796 | 17.856 | .50000 | 97 | 10 | 34.75211 | 34.96531 | 34.78373 | .00868 | 72162 | .58 | .90 | .54 |
| 1.040 | 18.302 | 19.314 | 18.412 | .50000 | 97 | 10 | 35.49723 | 35.71300 | 35.52608 | .00868 | 72163 | .57 | .90 | .60 |
| 1.052 | 17.073 | 18.097 | 17.188 | .50000 | 97 | 10 | 37.01010 | 37.22484 | 37.04060 | .00868 | 72164 | .58 | .90 | .56 |

Appendix 2. Continued.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.019 | 19.268 | 20.256 | 19.335 | .50000 | 96 | 6 | 36.37705 | 36.65000 | 36.39877 | .00868 | 73111 | .45 | .94 | .57 |
| 1.083 | 17.411 | 18.459 | 17.482 | .50000 | 96 | 6 | 35.53711 | 35.78645 | 35.55791 | .00868 | 73112 | .50 | .94 | .60 |
| 1.039 | 17.850 | 18.859 | 17.918 | .50000 | 97 | 6 | 35.01656 | 35.29275 | 35.03800 | .00868 | 73113 | .45 | .94 | .57 |
| 1.046 | 16.801 | 17.815 | 16.870 | .50000 | 96 | 6 | 35.42388 | 35.68087 | 35.44547 | .00868 | 73114 | .49 | .94 | .57 |
| 1.057 | 18.452 | 19.475 | 18.530 | .50000 | 96 | 7 | 35.51800 | 35.78208 | 35.54170 | .00868 | 73121 | .47 | .93 | .57 |
| 1.006 | 15.446 | 16.419 | 15.526 | .50000 | 96 | 7 | 34.92125 | 35.17788 | 34.95157 | .00868 | 73122 | .49 | .93 | .38 |
| 1.032 | 17.449 | 18.449 | 17.538 | .50000 | 96 | 8 | 35.40569 | 35.64904 | 35.43065 | .00868 | 73123 | .52 | .92 | .59 |
| 1.039 | 17.460 | 18.466 | 17.539 | .50000 | 96 | 7 | 34.67600 | 34.90178 | 34.70259 | .00868 | 73124 | .55 | .93 | .49 |
| 1.081 | 17.714 | 18.754 | 17.779 | .50000 | 96 | 6 | 37.88310 | 38.12692 | 37.90242 | .00868 | 73131 | .51 | .94 | .65 |
| 1.015 | 17.463 | 18.426 | 17.505 | .50000 | 94 | 4 | 35.49657 | 35.73291 | 35.51332 | .00868 | 73132 | .52 | .96 | .60 |
| 1.037 | 15.886 | 16.892 | 15.957 | .50000 | 97 | 6 | 34.05740 | 34.30504 | 34.07835 | .00868 | 73133 | .51 | .94 | .59 |
| 1.028 | 17.943 | 18.961 | 18.033 | .50000 | 99 | 8 | 36.07875 | 36.32058 | 36.09889 | .00868 | 73134 | .53 | .92 | .71 |
| 1.029 | 16.623 | 17.617 | 16.690 | .50000 | 96 | 6 | 38.87922 | 39.15144 | 38.90115 | .00868 | 73141 | .45 | .94 | .56 |
| 1.048 | 17.832 | 18.844 | 17.915 | .50000 | 96 | 7 | 35.58752 | 35.82867 | 35.61521 | .00868 | 73142 | .52 | .93 | .46 |
| 1.034 | 17.361 | 18.364 | 17.475 | .50000 | 97 | 11 | 36.56032 | 36.80796 | 36.60217 | .00868 | 73143 | .51 | .89 | .40 |
| 1.070 | 16.337 | 17.372 | 16.444 | .50000 | 96 | 10 | 37.93259 | 38.16970 | 37.96904 | .00868 | 73144 | .53 | .90 | .44 |
| 1.091 | 17.963 | 19.017 | 18.081 | .50000 | 96 | 10 | 35.46683 | 35.68205 | 35.49894 | .00868 | 73151 | .57 | .90 | .53 |
| 1.058 | 17.455 | 18.482 | 17.569 | .50000 | 97 | 10 | 37.49861 | 37.71469 | 37.53160 | .00868 | 73152 | .57 | .90 | .51 |
| 1.024 | 18.290 | 19.307 | 18.425 | .50000 | 99 | 13 | 37.06892 | 37.29240 | 37.10166 | .00868 | 73153 | .57 | .87 | .63 |
| 1.050 | 18.214 | 19.203 | 18.299 | .50000 | 94 | 8 | 35.97058 | 36.18547 | 36.00569 | .00868 | 73154 | .56 | .92 | .34 |
| 1.015 | 17.832 | 18.601 | 17.941 | .50000 | 75 | 10 | 34.91642 | 35.14190 | 34.95462 | .00868 | 73161 | .43 | .90 | .41 |
| 1.047 | 16.679 | 17.691 | 16.812 | .50000 | 96 | 12 | 37.66837 | 37.88516 | 37.71410 | .00868 | 73162 | .57 | .88 | .38 |
| 1.073 | 16.443 | 17.483 | 16.561 | .50000 | 96 | 10 | 35.33074 | 35.55156 | 35.36585 | .00868 | 73163 | .56 | .90 | .47 |
| 1.039 | 18.313 | 19.319 | 18.429 | .50000 | 96 | 11 | 38.14570 | 38.34546 | 38.18078 | .00868 | 73164 | .61 | .89 | .52 |
| 1.064 | 17.794 | 18.826 | 17.868 | .50000 | 96 | 6 | 34.91756 | 35.22325 | 34.94238 | .00868 | 74111 | .39 | .94 | .46 |
| 1.029 | 17.555 | 18.554 | 17.637 | .50000 | 97 | 7 | 34.07010 | 34.33317 | 34.10000 | .00868 | 74112 | .48 | .93 | .39 |
| 1.032 | 17.035 | 18.040 | 17.111 | .50000 | 97 | 7 | 35.51025 | 35.80969 | 35.53641 | .00868 | 74113 | .40 | .93 | .50 |
| 1.031 | 17.386 | 18.387 | 17.457 | .50000 | 97 | 6 | 35.57506 | 35.85300 | 35.60015 | .00868 | 74114 | .45 | .94 | .45 |
| 1.026 | 17.756 | 18.752 | 17.835 | .50000 | 97 | 7 | 36.29932 | 36.59971 | 36.32942 | .00868 | 74121 | .40 | .93 | .39 |
| 1.022 | 18.294 | 19.286 | 18.379 | .50000 | 97 | 8 | 36.89516 | 37.18911 | 36.92765 | .00868 | 74122 | .41 | .92 | .40 |
| 1.024 | 18.096 | 19.092 | 18.175 | .50000 | 97 | 7 | 35.81034 | 36.12300 | 35.84291 | .00868 | 74123 | .37 | .93 | .32 |
| 1.026 | 17.216 | 18.212 | 17.296 | .50000 | 97 | 7 | 36.84526 | 37.13254 | 36.87340 | .00868 | 74124 | .43 | .93 | .44 |
| 1.046 | 17.614 | 18.582 | 17.682 | .50000 | 92 | 6 | 36.03984 | 36.35582 | 36.06549 | .00868 | 74131 | .34 | .94 | .43 |
| 1.053 | 17.769 | 18.791 | 17.836 | .50000 | 97 | 6 | 36.92718 | 37.24630 | 36.94940 | .00868 | 74132 | .36 | .94 | .55 |
| 1.057 | 17.130 | 18.152 | 17.210 | .50000 | 96 | 7 | 36.90539 | 37.19838 | 36.93455 | .00868 | 74133 | .41 | .93 | .41 |
| 1.006 | 18.525 | 19.505 | 18.602 | .50000 | 97 | 7 | 37.38605 | 37.66703 | 37.41464 | .00868 | 74134 | .44 | .93 | .43 |
| 1.022 | 17.770 | 18.762 | 17.848 | .50000 | 97 | 7 | 36.03592 | 36.28775 | 36.06182 | .00868 | 74141 | .50 | .93 | .51 |
| 1.040 | 17.980 | 18.990 | 18.054 | .50000 | 97 | 7 | 37.10274 | 37.33141 | 37.12554 | .00868 | 74142 | .55 | .93 | .60 |
| 1.009 | 17.671 | 18.650 | 17.754 | .50000 | 97 | 8 | 35.84770 | 36.01400 | 35.87727 | .00868 | 74143 | .68 | .92 | .48 |
| 1.007 | 17.468 | 18.446 | 17.552 | .50000 | 97 | 8 | 37.09183 | 37.31917 | 37.12192 | .00868 | 74144 | .55 | .92 | .46 |
| 1.079 | 17.509 | 18.553 | 17.615 | .50000 | 96 | 9 | 35.45286 | 35.79528 | 35.49260 | .00868 | 74151 | .31 | .91 | .31 |
| 1.072 | 16.632 | 17.669 | 16.737 | .50000 | 96 | 9 | 37.12333 | 37.46049 | 37.16184 | .00868 | 74152 | .32 | .91 | .34 |
| 1.064 | 17.537 | 18.571 | 17.659 | .50000 | 97 | 11 | 35.45453 | 35.71037 | 35.50411 | .00868 | 74153 | .49 | .89 | .26 |
| 1.058 | 17.313 | 18.342 | 17.434 | .50000 | 97 | 11 | 36.90278 | 37.24023 | 36.95121 | .00868 | 74154 | .32 | .89 | .28 |
| 1.057 | 16.542 | 17.558 | 16.664 | .50000 | 96 | 11 | 36.28654 | 36.58170 | 36.33743 | .00868 | 74161 | .40 | .89 | .23 |
| 1.064 | 17.743 | 18.771 | 17.879 | .50000 | 96 | 12 | 36.89075 | 37.16494 | 36.94109 | .00868 | 74162 | .45 | .88 | .31 |
| 1.038 | 18.303 | 19.311 | 18.412 | .50000 | 97 | 10 | 34.83015 | 35.13359 | 34.86958 | .00868 | 74163 | .39 | .90 | .39 |
| 1.072 | 17.073 | 18.115 | 17.186 | .50000 | 97 | 10 | 36.48962 | 36.77509 | 36.52906 | .00868 | 74164 | .43 | .90 | .38 |
| 1.006 | 19.268 | 20.240 | 19.345 | .50000 | 96 | 7 | 34.97568 | 35.15526 | 34.99288 | .00860 | 71211 | .65 | .93 | .75 |
| 1.043 | 17.411 | 18.417 | 17.486 | .50000 | 96 | 7 | 36.72700 | 36.91034 | 36.74158 | .00860 | 71212 | .64 | .93 | .83 |
| 1.056 | 17.850 | 18.865 | 17.932 | .50000 | 96 | 7 | 34.70228 | 34.92420 | 34.72800 | .00860 | 71213 | .56 | .93 | .51 |
| 1.044 | 16.801 | 17.802 | 16.873 | .50000 | 95 | 6 | 36.83532 | 37.04917 | 36.85617 | .00860 | 71214 | .57 | .94 | .59 |
| 1.058 | 18.452 | 19.470 | 18.541 | .50000 | 96 | 8 | 36.25379 | 36.44368 | 36.27777 | .00860 | 71221 | .62 | .92 | .62 |
| 1.024 | 15.446 | 16.433 | 15.509 | .50000 | 96 | 6 | 34.49638 | 34.69481 | 34.51443 | .00860 | 71222 | .61 | .94 | .69 |
| 1.026 | 17.449 | 18.433 | 17.536 | .50000 | 95 | 8 | 34.48640 | 34.70974 | 34.51542 | .00860 | 71223 | .55 | .92 | .49 |
| 1.034 | 17.460 | 18.456 | 17.521 | .50000 | 96 | 5 | 35.37400 | 35.55388 | 35.38818 | .00860 | 71224 | .64 | .95 | .78 |
| 1.026 | 17.714 | 18.703 | 17.786 | .50000 | 96 | 7 | 34.88355 | 35.06719 | 34.90059 | .00860 | 71231 | .64 | .93 | .76 |
| 1.031 | 17.463 | 18.435 | 17.512 | .50000 | 94 | 4 | 34.58689 | 34.78544 | 34.60346 | .00860 | 71232 | .60 | .96 | .60 |
| 1.082 | 15.886 | 16.925 | 15.951 | .50000 | 96 | 6 | 36.21403 | 36.39594 | 36.23162 | .00860 | 71233 | .64 | .94 | .70 |
| 1.052 | 17.943 | 18.972 | 18.026 | .50000 | 97 | 7 | 34.63047 | 34.83083 | 34.65029 | .00860 | 71234 | .61 | .93 | .68 |

Appendix 2. Continued.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.010 | 16.623 | 17.599 | 16.689 | .50000 | 96 | 6 | 36.12678 | 36.30869 | 36.14126 | .00860 | 71241 | .64 | .94 | .80 |
| 1.042 | 17.832 | 18.835 | 17.904 | .50000 | 96 | 6 | 34.10340 | 34.30402 | 34.12365 | .00860 | 71242 | .60 | .94 | .61 |
| 1.036 | 17.361 | 18.356 | 17.437 | .50000 | 96 | 7 | 35.71279 | 35.90665 | 35.73522 | .00860 | 71243 | .61 | .93 | .60 |
| 1.023 | 16.337 | 17.324 | 16.410 | .50000 | 96 | 7 | 34.98106 | 35.15990 | 35.00023 | .00860 | 71244 | .65 | .93 | .70 |
| 1.013 | 17.963 | 18.938 | 18.040 | .50000 | 96 | 7 | 35.39745 | 35.59900 | 35.41982 | .00860 | 71251 | .60 | .93 | .61 |
| 1.050 | 17.455 | 18.470 | 17.527 | .50000 | 96 | 6 | 35.81891 | 36.00016 | 35.83700 | .00860 | 71252 | .64 | .94 | .68 |
| 1.094 | 18.290 | 19.369 | 18.449 | .50000 | 98 | 14 | 34.86462 | 35.05432 | 34.90552 | .00860 | 71253 | .63 | .86 | .56 |
| 1.050 | 18.214 | 19.194 | 18.256 | .50000 | 93 | 3 | 35.95134 | 36.13707 | 35.96600 | .00860 | 71254 | .62 | .97 | .60 |
| 1.095 | 17.632 | 18.678 | 17.767 | .50000 | 95 | 12 | 34.72740 | 34.93680 | 34.77565 | .00860 | 71261 | .58 | .88 | .34 |
| 1.033 | 16.679 | 17.673 | 16.747 | .50000 | 96 | 6 | 36.17196 | 36.36708 | 36.18457 | .00860 | 71262 | .61 | .94 | .87 |
| 1.022 | 16.433 | 17.425 | 16.545 | .50000 | 97 | 10 | 35.55227 | 35.73362 | 35.58628 | .00860 | 71263 | .64 | .90 | .49 |
| 1.079 | 18.313 | 19.355 | 18.392 | .50000 | 96 | 7 | 36.06552 | 36.26200 | 36.08777 | .00860 | 71264 | .61 | .93 | .61 |
| 1.062 | 17.794 | 18.819 | 17.844 | .50000 | 96 | 4 | 35.87944 | 36.08897 | 35.89373 | .00860 | 72211 | .58 | .96 | .72 |
| 1.040 | 17.555 | 18.562 | 17.610 | .50000 | 96 | 5 | 37.55885 | 37.77300 | 37.56918 | .00860 | 72212 | .58 | .95 | .93 |
| 1.021 | 17.035 | 18.027 | 17.093 | .50000 | 97 | 5 | 35.14353 | 35.35508 | 35.15884 | .00860 | 72213 | .58 | .95 | .73 |
| 1.083 | 17.386 | 18.434 | 17.445 | .50000 | 96 | 5 | 36.84533 | 37.08366 | 36.86103 | .00860 | 72214 | .53 | .95 | .72 |
| 1.039 | 17.756 | 18.756 | 17.821 | .50000 | 96 | 6 | 35.49649 | 35.69653 | 35.51181 | .00860 | 72221 | .60 | .94 | .78 |
| 1.044 | 18.294 | 17.229 | 18.349 | .50000 | 89 | 5 | 36.65868 | 36.86823 | 36.66800 | .00860 | 72222 | .55 | .95 | .97 |
| 1.028 | 18.096 | 19.092 | 18.152 | .50000 | 96 | 5 | 36.16200 | 36.38234 | 36.17856 | .00860 | 72223 | .56 | .95 | .68 |
| 1.086 | 17.216 | 18.267 | 17.282 | .50000 | 96 | 6 | 35.10284 | 35.33000 | 35.12400 | .00860 | 72224 | .55 | .94 | .58 |
| 1.026 | 17.614 | 18.603 | 17.671 | .50000 | 96 | 5 | 36.23069 | 36.44328 | 36.24809 | .00860 | 72231 | .58 | .95 | .65 |
| 1.051 | 17.769 | 18.783 | 17.830 | .50000 | 96 | 5 | 36.81208 | 37.02754 | 36.82900 | .00860 | 72232 | .57 | .95 | .67 |
| 1.024 | 17.130 | 18.122 | 17.200 | .50000 | 96 | 6 | 36.52876 | 36.74603 | 36.54843 | .00860 | 72233 | .57 | .94 | .63 |
| 1.080 | 18.525 | 19.564 | 18.580 | .50000 | 96 | 5 | 36.13752 | 36.38219 | 36.15778 | .00860 | 72234 | .51 | .95 | .53 |
| 1.085 | 17.770 | 18.816 | 17.844 | .50000 | 96 | 6 | 37.13823 | 37.34782 | 37.15868 | .00860 | 72241 | .58 | .94 | .60 |
| 1.090 | 17.980 | 19.038 | 18.038 | .50000 | 97 | 5 | 36.97021 | 37.18669 | 36.98643 | .00860 | 72242 | .57 | .95 | .70 |
| 1.061 | 17.671 | 18.699 | 17.724 | .50000 | 96 | 4 | 39.41683 | 39.64200 | 39.43310 | .00860 | 72243 | .55 | .96 | .62 |
| 1.075 | 17.468 | 18.510 | 17.516 | .50000 | 96 | 4 | 35.52202 | 35.75141 | 35.53579 | .00860 | 72244 | .54 | .96 | .74 |
| 1.056 | 17.509 | 18.526 | 17.614 | .50000 | 96 | 9 | 35.39902 | 35.63119 | 35.43200 | .00860 | 72251 | .54 | .91 | .46 |
| 1.030 | 16.632 | 17.623 | 16.753 | .50000 | 96 | 11 | 36.28826 | 36.52962 | 36.32380 | .00860 | 72252 | .52 | .89 | .51 |
| 1.035 | 17.537 | 18.533 | 17.665 | .50000 | 96 | 12 | 36.39131 | 36.62659 | 36.42988 | .00860 | 72253 | .53 | .88 | .50 |
| 1.093 | 17.313 | 18.361 | 17.463 | .50000 | 95 | 13 | 38.15977 | 38.39913 | 38.19675 | .00860 | 72254 | .52 | .87 | .56 |
| 1.028 | 16.542 | 17.517 | 16.654 | .50000 | 94 | 10 | 35.63880 | 35.89280 | 35.68130 | .00860 | 72261 | .48 | .90 | .32 |
| 1.015 | 17.743 | 18.721 | 17.866 | .50000 | 96 | 12 | 36.49804 | 36.75386 | 36.54192 | .00860 | 72262 | .49 | .88 | .41 |
| 1.023 | 18.303 | 19.289 | 18.438 | .50000 | 96 | 13 | 35.49695 | 35.71979 | 35.54715 | .00860 | 72263 | .56 | .87 | .36 |
| 1.038 | 17.073 | 18.076 | 17.204 | .50000 | 96 | 12 | 37.18972 | 37.41360 | 37.23184 | .00860 | 72264 | .55 | .88 | .44 |
| 1.026 | 19.268 | 20.271 | 19.322 | .50000 | 97 | 5 | 36.37768 | 36.64850 | 36.39649 | .00868 | 73211 | .46 | .95 | .59 |
| 1.035 | 17.411 | 18.426 | 17.472 | .50000 | 98 | 5 | 36.96062 | 37.23527 | 36.97934 | .00868 | 73212 | .46 | .95 | .60 |
| 1.042 | 17.850 | 18.872 | 17.918 | .50000 | 98 | 6 | 35.01630 | 35.28094 | 35.03510 | .00868 | 73213 | .48 | .94 | .66 |
| 1.096 | 16.801 | 17.874 | 16.866 | .50000 | 97 | 5 | 36.43379 | 36.72229 | 36.45495 | .00868 | 73214 | .43 | .95 | .50 |
| 1.027 | 18.452 | 19.453 | 18.518 | .50000 | 97 | 6 | 35.51853 | 35.78119 | 35.53692 | .00868 | 73221 | .48 | .94 | .68 |
| 1.026 | 15.446 | 16.442 | 15.509 | .50000 | 97 | 6 | 37.06993 | 37.34872 | 37.09115 | .00868 | 73222 | .44 | .94 | .58 |
| 1.012 | 17.449 | 18.436 | 17.513 | .50000 | 97 | 6 | 35.40158 | 35.69220 | 35.42614 | .00868 | 73223 | .42 | .94 | .47 |
| 1.013 | 17.460 | 18.444 | 17.522 | .50000 | 97 | 6 | 36.73392 | 37.02912 | 36.75952 | .00868 | 73224 | .41 | .94 | .44 |
| 1.072 | 17.714 | 18.761 | 17.779 | .50000 | 97 | 6 | 37.88389 | 38.15378 | 37.90213 | .00868 | 73231 | .47 | .94 | .68 |
| 1.007 | 17.463 | 18.426 | 17.507 | .50000 | 95 | 4 | 34.74986 | 35.03252 | 34.77025 | .00868 | 73232 | .43 | .96 | .41 |
| 1.008 | 15.886 | 16.871 | 15.955 | .50000 | 97 | 6 | 34.05748 | 34.31626 | 34.07632 | .00868 | 73233 | .49 | .94 | .66 |
| 1.005 | 17.943 | 18.940 | 17.982 | .50000 | 99 | 3 | 37.00844 | 37.29070 | 37.02703 | .00868 | 73234 | .45 | .97 | .34 |
| 1.012 | 16.623 | 17.610 | 16.678 | .50000 | 97 | 5 | 38.87973 | 39.13770 | 38.89900 | .00868 | 73241 | .49 | .95 | .58 |
| 1.059 | 17.832 | 18.865 | 17.881 | .50000 | 97 | 4 | 35.53572 | 35.82870 | 35.55085 | .00868 | 73242 | .42 | .96 | .68 |
| 1.002 | 17.361 | 18.339 | 17.417 | .50000 | 97 | 5 | 36.56137 | 36.81311 | 36.57914 | .00868 | 73243 | .50 | .95 | .64 |
| 1.030 | 16.337 | 17.345 | 16.391 | .50000 | 97 | 5 | 35.42283 | 35.69447 | 35.43800 | .00868 | 73244 | .46 | .95 | .74 |
| 1.010 | 17.963 | 18.941 | 18.068 | .50000 | 96 | 10 | 35.46723 | 35.74241 | 35.50700 | .00868 | 73251 | .45 | .90 | .38 |
| 1.029 | 17.455 | 18.453 | 17.555 | .50000 | 96 | 9 | 34.91964 | 35.19220 | 34.95364 | .00868 | 73252 | .46 | .91 | .44 |
| 1.087 | 18.290 | 19.376 | 18.376 | .50000 | 99 | 7 | 37.06977 | 37.36048 | 37.10917 | .00868 | 73253 | .44 | .93 | .12 |
| 1.087 | 18.214 | 19.244 | 18.290 | .50000 | 94 | 6 | 34.67510 | 34.96970 | 34.70888 | .00868 | 73254 | .40 | .94 | .16 |
| 1.082 | 17.632 | 18.671 | 17.758 | .50000 | 96 | 11 | 34.91534 | 35.18438 | 34.96200 | .00868 | 73261 | .46 | .89 | .31 |
| 1.055 | 16.679 | 17.699 | 16.816 | .50000 | 96 | 12 | 35.49406 | 35.78100 | 35.53689 | .00868 | 73262 | .42 | .88 | .43 |
| 1.066 | 16.443 | 17.474 | 16.583 | .50000 | 96 | 13 | 35.33271 | 35.59922 | 35.38103 | .00868 | 73263 | .47 | .87 | .39 |
| 1.016 | 18.313 | 19.302 | 18.447 | .50000 | 97 | 13 | 36.07728 | 36.40120 | 36.13059 | .00868 | 73264 | .35 | .87 | .31 |

Appendix 2. Continued.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.038 | 17.794 | 18.810 | 17.879 | .50000 | 97 | 8 | 34.91700 | 35.19800 | 34.95322 | .00868 | 74211 | .44 | .92 | .31 |
| 1.074 | 17.555 | 18.603 | 17.625 | .50000 | 97 | 6 | 35.58712 | 35.89817 | 35.62077 | .00868 | 74212 | .38 | .94 | .17 |
| 1.043 | 17.035 | 18.052 | 17.103 | .50000 | 97 | 6 | 35.50887 | 35.80932 | 35.54319 | .00868 | 74213 | .40 | .94 | .15 |
| 1.076 | 17.386 | 18.432 | 17.463 | .50000 | 97 | 7 | 37.93020 | 38.17062 | 37.95639 | .00868 | 74214 | .52 | .93 | .50 |
| 1.036 | 17.756 | 18.769 | 17.836 | .50000 | 97 | 7 | 36.29908 | 36.57241 | 36.32932 | .00868 | 74221 | .46 | .93 | .38 |
| 1.007 | 18.294 | 19.280 | 18.357 | .50000 | 97 | 6 | 37.49715 | 37.81975 | 37.53325 | .00868 | 74222 | .36 | .94 | .09 |
| 1.022 | 18.096 | 19.094 | 18.170 | .50000 | 97 | 7 | 35.81007 | 36.08673 | 35.83793 | .00868 | 74223 | .45 | .93 | .45 |
| 1.019 | 17.216 | 18.208 | 17.293 | .50000 | 97 | 7 | 35.96910 | 36.28365 | 35.99901 | .00868 | 74224 | .37 | .93 | .39 |
| 1.029 | 17.614 | 18.618 | 17.684 | .50000 | 97 | 6 | 36.03966 | 36.33825 | 36.07291 | .00868 | 74231 | .41 | .94 | .18 |
| 1.094 | 17.769 | 18.838 | 17.845 | .50000 | 97 | 6 | 37.66548 | 37.97522 | 37.70258 | .00868 | 74232 | .38 | .94 | .05 |
| 1.085 | 17.130 | 18.189 | 17.207 | .50000 | 97 | 7 | 36.90546 | 37.20609 | 36.93611 | .00868 | 74233 | .40 | .93 | .37 |
| 1.022 | 18.525 | 19.525 | 18.608 | .50000 | 97 | 8 | 38.14434 | 38.46736 | 38.17639 | .00868 | 74234 | .36 | .92 | .42 |
| 1.010 | 17.770 | 18.759 | 17.859 | .50000 | 97 | 8 | 36.03549 | 36.25021 | 36.06289 | .00868 | 74241 | .58 | .92 | .53 |
| 1.005 | 17.980 | 18.885 | 18.060 | .50000 | 90 | 7 | 34.06827 | 34.29582 | 34.09303 | .00868 | 74242 | .51 | .93 | .54 |
| 1.011 | 17.671 | 18.675 | 17.731 | .50000 | 99 | 5 | 35.84740 | 36.04840 | 35.87223 | .00868 | 74243 | .61 | .95 | .35 |
| 1.005 | 17.468 | 18.427 | 17.568 | .50000 | 95 | 9 | 35.57410 | 35.80078 | 35.59785 | .00868 | 74244 | .54 | .91 | .67 |
| 1.012 | 17.509 | 18.494 | 17.618 | .50000 | 97 | 10 | 35.45233 | 35.78603 | 35.50069 | .00868 | 74251 | .33 | .90 | .21 |
| 1.058 | 16.632 | 17.662 | 16.725 | .50000 | 97 | 8 | 36.89407 | 37.23108 | 36.93340 | .00868 | 74252 | .33 | .92 | .23 |
| 1.006 | 17.537 | 18.521 | 17.639 | .50000 | 97 | 10 | 35.45394 | 35.77002 | 35.49616 | .00868 | 74253 | .37 | .90 | .33 |
| 1.082 | 17.313 | 18.370 | 17.428 | .50000 | 97 | 10 | 36.94290 | 37.19112 | 36.98608 | .00868 | 74254 | .51 | .90 | .31 |
| 1.048 | 16.542 | 17.550 | 16.659 | .50000 | 96 | 11 | 36.28555 | 36.60216 | 36.33756 | .00868 | 74261 | .36 | .89 | .21 |
| 1.011 | 17.743 | 18.731 | 17.863 | .50000 | 97 | 11 | 36.39390 | 36.69000 | 36.44765 | .00868 | 74262 | .41 | .89 | .18 |
| 1.027 | 18.303 | 19.305 | 18.419 | .50000 | 97 | 11 | 34.82978 | 35.13543 | 34.87690 | .00868 | 74263 | .39 | .89 | .30 |
| 1.036 | 17.073 | 18.085 | 17.201 | .50000 | 97 | 12 | 37.38430 | 37.70190 | 37.42963 | .00868 | 74264 | .37 | .88 | .39 |
| 1.064 | 19.268 | 20.289 | 19.328 | .50000 | 95 | 5 | 34.68718 | 34.90200 | 34.70700 | .00868 | 81111 | .57 | .95 | .55 |
| 1.005 | 17.411 | 18.376 | 17.503 | .50000 | 96 | 9 | 37.12645 | 37.34257 | 37.13752 | .00868 | 81112 | .57 | .91 | .95 |
| 1.023 | 17.850 | 18.831 | 17.928 | .50000 | 95 | 7 | 35.98955 | 36.20954 | 36.01277 | .00868 | 81113 | .56 | .93 | .58 |
| 1.040 | 16.801 | 17.797 | 16.880 | .50000 | 95 | 7 | 36.81644 | 37.01553 | 36.82955 | .00868 | 81114 | .60 | .93 | .87 |
| 1.072 | 18.452 | 19.483 | 18.534 | .50000 | 96 | 7 | 37.41036 | 37.65908 | 37.43210 | .00868 | 82111 | .50 | .93 | .63 |
| 1.067 | 15.446 | 16.470 | 15.521 | .50000 | 95 | 7 | 36.44154 | 36.68974 | 36.46576 | .00868 | 82112 | .50 | .93 | .56 |
| 1.007 | 17.449 | 18.412 | 17.549 | .50000 | 95 | 9 | 34.75475 | 35.00547 | 34.78100 | .00868 | 82113 | .49 | .91 | .61 |
| 1.017 | 17.460 | 18.435 | 17.549 | .50000 | 95 | 8 | 36.67325 | 36.89615 | 36.69700 | .00868 | 82114 | .55 | .92 | .62 |
| 1.045 | 17.714 | 18.716 | 17.791 | .50000 | 95 | 7 | 37.25390 | 37.51858 | 37.28182 | .00868 | 83111 | .47 | .93 | .45 |
| 1.005 | 17.463 | 18.405 | 17.566 | .50000 | 93 | 10 | 36.61575 | 36.88490 | 36.64460 | .00868 | 83112 | .44 | .90 | .60 |
| 1.057 | 15.886 | 16.900 | 16.015 | .50000 | 95 | 12 | 34.89000 | 35.21842 | 34.91869 | .00868 | 83113 | .33 | .88 | .67 |
| 1.003 | 17.943 | 18.945 | 18.080 | .50000 | 99 | 13 | 36.39739 | 36.68718 | 36.42461 | .00868 | 83114 | .44 | .87 | .71 |
| 1.046 | 16.623 | 17.627 | 16.697 | .50000 | 95 | 7 | 37.07462 | 37.39588 | 37.11261 | .00868 | 84111 | .35 | .93 | .16 |
| 1.021 | 17.832 | 18.813 | 17.901 | .50000 | 96 | 6. | 37.00881 | 37.30124 | 37.04681 | .00868 | 84112 | .41 | .94 | .02 |
| 1.025 | 17.361 | 18.346 | 17.473 | .50000 | 96 | 10 | 34.79514 | 35.08400 | 34.82158 | .00868 | 84113 | .42 | .90 | .64 |
| 1.026 | 16.337 | 17.323 | 16.437 | .50000 | 96 | 9 | 36.65232 | 36.93908 | 36.68170 | .00868 | 84114 | .42 | .91 | .54 |
| 1.029 | 17.963 | 18.953 | 18.047 | .50000 | 96 | 8 | 34.68800 | 34.93512 | 34.71340 | .00868 | 81211 | .50 | .92 | .58 |
| 1.093 | 17.455 | 18.507 | 17.517 | .50000 | 96 | 5 | 37.10394 | 37.35220 | 37.11786 | .00868 | 81212 | .50 | .95 | .79 |
| 1.026 | 18.290 | 19.305 | 18.404 | .50000 | 98 | 11 | 35.99100 | 36.23535 | 36.02128 | .00868 | 81213 | .52 | .89 | .61 |
| 1.045 | 18.214 | 19.191 | 18.271 | .50000 | 93 | 5 | 37.08975 | 37.34961 | 37.11804 | .00868 | 81214 | .46 | .95 | .22 |
| 1.052 | 17.632 | 18.636 | 17.708 | .50000 | 95 | 7 | 37.41003 | 37.74712 | 37.43649 | .00868 | 82211 | .31 | .93 | .49 |
| 1.029 | 16.679 | 17.670 | 16.765 | .50000 | 96 | 8 | 36.89100 | 37.20728 | 36.90982 | .00868 | 82212 | .36 | .92 | .75 |
| 1.012 | 16.443 | 17.417 | 16.525 | .50000 | 96 | 8 | 34.75518 | 35.05559 | 34.79459 | .00868 | 82213 | .39 | .92 | .23 |
| 1.040 | 18.313 | 19.316 | 18.398 | .50000 | 96 | 8 | 36.90179 | 37.21083 | 36.92910 | .00868 | 82214 | .38 | .92 | .53 |
| 1.015 | 17.794 | 18.772 | 17.876 | .50000 | 96 | 8 | 37.25519 | 37.55748 | 37.30062 | .00868 | 83211 | .39 | .92 | .08 |
| 1.059 | 17.555 | 18.576 | 17.647 | .50000 | 96 | 8 | 37.12283 | 37.46495 | 37.14240 | .00868 | 83212 | .31 | .92 | .73 |
| 1.016 | 17.035 | 18.014 | 17.112 | .50000 | 96 | 7 | 34.89047 | 35.20932 | 34.91260 | .00868 | 83213 | .36 | .93 | .62 |
| 1.033 | 17.368 | 18.381 | 17.457 | .50000 | 98 | 8 | 36.48855 | 36.80400 | 36.53314 | .00868 | 83214 | .37 | .92 | .10 |
| 1.024 | 17.756 | 18.745 | 17.835 | .50000 | 96 | 7 | 37.07592 | 37.39590 | 37.10300 | .00868 | 84211 | .36 | .93 | .47 |
| 1.006 | 18.294 | 19.265 | 18.374 | .50000 | 96 | 7 | 37.12656 | 37.48352 | 37.15126 | .00868 | 84212 | .28 | .93 | .54 |
| 1.013 | 18.096 | 19.073 | 18.166 | .50000 | 96 | 6 | 34.79506 | 35.14458 | 34.84074 | .00868 | 84213 | .29 | .94 | -.23 |
| 1.056 | 17.216 | 18.235 | 17.299 | .50000 | 96 | 7 | 36.81504 | 37.16990 | 36.85487 | .00868 | 84214 | .28 | .93 | .11 |

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