Analytical Assessment of the Longitudinal Ridging of CANDU Type Fuel Element
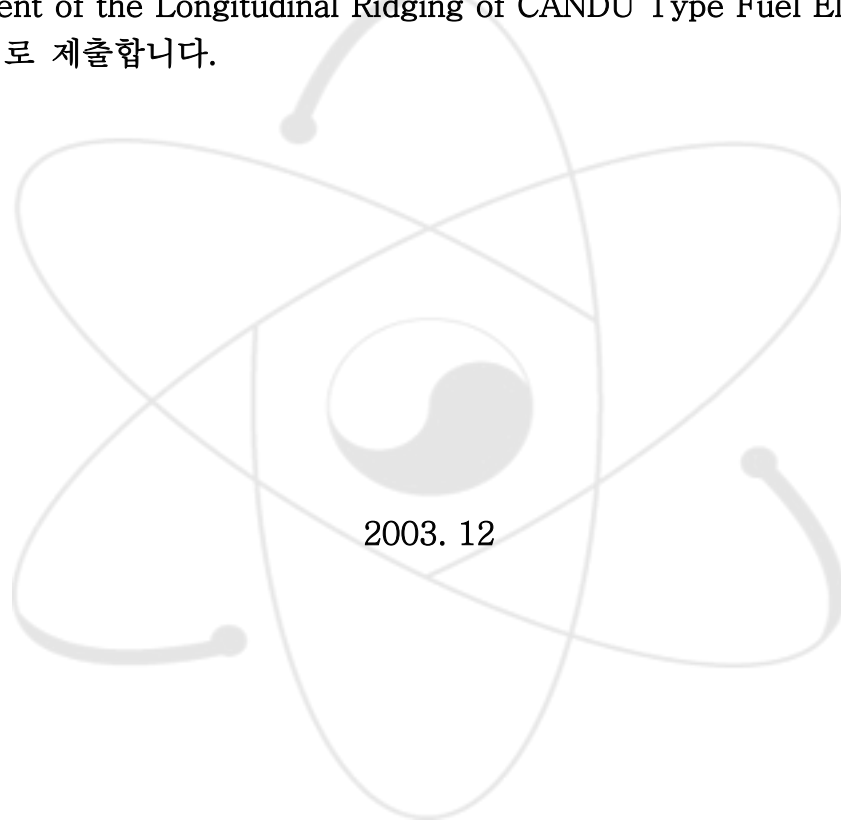
2003. 12

한 국 원 자 력 연 구 소

제 출 문

한국원자력연구소장 귀하

　　본 보고서를 이상유동 핵연료관 건전성 기술개발과제의 "An Analytical Assessment of the Longitudinal Ridging of CANDU Type Fuel Element" 기술 보고서로 제출합니다.

2003. 12

주저자 : 조 문 성
공동저자 : 석 호 천

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1. INTRODUCTION

To describe quantitatively how the various fuel design parameters affect the longitudinal ridging behavior of fuel cladding, an empirical correlation that predicts the external pressure corresponding to instantaneous plastic collapse was developed by WCL in 1975 and has been used so far [1]. However, some drawbacks were discovered in the process of assessing the critical longitudinal ridging pressure of CANFLEX fuel. They are summarized as follows:

(1) As the correlation was mainly fitted to the Pickering type fuel cladding, an erratic prediction of collapse pressure is resulted for the fuel cladding with CANFLEX size thickness and diametral clearance (Figure 13). It does not appear in Pickering type cladding within the application range of the correlation.

(2) This correlation calculates the pellet-to-diametral clearance (ψ) of collapsed tube using a theoretical equation applicable to an elastic problem. The application of external pressure to the thin wall circular tube may cause an instability failure due to stresses even lower than the elastic limit, and in such a case this formula does not apply [2]. Magnitude of the external pressure (ρ) that causes critical ridging is, of course, greater than the elastic limit. The longitudinal ridging is an example of the instability failure and the application of the equation to the ridging problem is not appropriate.

Therefore, in this study, a new correlation has been developed based on an analytical method to alleviate the probable bias due to the uneven distribution of test specimen parameters and the logical discrepancy in ψ calculation. A static analysis, finite-element (FE) model was developed to simulate the longitudinal ridging of the fuel element with use of the structural analysis computer code ABAQUS [3]. Collapse pressures were calculated for the fifty-one cases for which test results of WCL in 1973 [4] and 1975 [1] are available. Calculation results under-predicted the critical collapse pressure. The trend of under-prediction was corrected in accordance with the measured data of WCL 1973 and 1975 test. Based on the corrected predictions, a new correlation that describes the longitudinal ridging behavior of CANFLEX type fuel elements was derived. It predicts the collapse pressure with an overall average error of - 0.14% and a root-mean-square error of 5.9%, which are smaller than those of the existing correlation that present an overall average error of 0.53% and a root-mean-square error of 6.41%.

2. FE Model Description

2.1 FE Model and Boundary Condition

The FE model of the fuel sheath and the pellet was developed with two-dimensional 6-node triangle element and 4-node quadrilateral element, respectively. As the configuration of the longitudinal ridge shows symmetry, only one half of the element cross-section is modeled as shown in Figure 1. Pellet is placed eccentrically inside the sheath and contacts with the sheath on one side and the ridge is induced to occur on the other side. Pellet is fixed by constraining all degrees of freedom in all nodes on the symmetry line. As for the sheath, all nodes on the symmetry line are restrained in circumferential direction due to its symmetrical configuration and one node on the right extreme is fixed to prevent its rigid body motion.

2.2 Material

Tensile properties at 300°C and 400°C are used for the analysis because the collapse tests in 1973 and 1975 were performed at those temperatures. Fuel sheaths used in the tests consist of various types of materials and they have different mechanical properties from each other. Materials of the fuel sheath and their mechanical properties are summarized in Table 1.

Table 1   Fuel sheath materials and their properties [1]

Component	Material / Test temperature	Young's modulus (MPa)	Yield strength (MPa)	UTS (MPa)	Poisson's ratio
Sheath	Fully-annealed Zr-4 300°C	80,830	134.4	237	0.4
	Fully-annealed Zr-4 400°C	75,230	131	233.6	0.4
	Stress relieved Zr-4 300°C	80,830	186.1	288.7	0.4
	Stress relieved Zr-4 400°C	75,230	158.5	261.1	0.4
	Stress relieved Zr-2.5% Nb 300°C	77,050	207	309.6	0.4
Pellet	Sintered UO_2	.17E6	250	-	0.3

2.3 Applied loads

External pressure was applied to the fuel sheath and then removed to obtain plastic strain. This process was repeated increasing magnitude of the pressure by 1.724 MPa until the specimen present 0.5% strain because this strain value is always very close to the pressure at which strain very rapidly increases. This is an adaptation to the test procedure, which is described in section 2.1.

3. Application to the 1973 and the 1975 WCL tests

3.1. Description of the tests [1] [4]

In the 1973 and the 1975 WCL tests, test specimens were heated in an autoclave containing argon at low pressure for about 4 to 5 hours to ensure that they are in thermal equilibrium. The autoclave was then pressurized to the test pressure in about two minutes using preheated argon. The pressure was maintained for 100 minutes and it was vented off and the heaters turned off. After being cooled to room temperature, the specimens were profiled at cross-sections using the profilometer. This process was repeated increasing the pressure by 1.724 MPa (250 psi) until the specimen present 0.5% strain. To estimate critical ridging pressure, the strain history of each individual case was plotted by connecting calculated data points with straight line on linear scales of pressure and strain as illustrated in Figure 2. The critical pressure for each specimen was taken as the pressure associated with 0.5% plastic strain because this strain value is always very close to the pressure at which ridge strain very rapidly increases. However, since a linear interpolation may not be a very good approximation to the real ε-ρ behavior for strain values that are not near an observed strain, no critical pressure was estimated for specimens which do not have an observed strain value in the range $.0025 \leq \varepsilon \leq .01$. Also, if no strain greater 0.5% was observed, no extrapolations were done to arrive at a critical pressure.

3.2 Correction of the prediction

3.2.1 Critical collapse pressure

Development of an accurate analytical model for critical ridging pressure based wholly on the calculation results is not possible due to the inevitable error in calculation

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whether it is big or small. Therefore, the calculation results were corrected in accordance with the measured data of WCL 1973 and 1975 tests.

Figure 3 compares the measured and the predicted critical collapse pressures for fifty-one cases for which test results of WCL 1973 and 1975 are available. Note that different scales are used in the x- and the y-axes. In spite of the trend of under-prediction, this comparison presents that a significant correlation exists between the measurements and the predictions. A least square analysis resulted in a quadratic regression equation and a regression curve as shown in figure 3.

It is obvious that the four points on the upper right side made the best regression line to be quadratic instead of linear. The four points are all associated with the four stress relieved Zr-2.5% Nb (300°C) sheaths, which has the biggest yield strength among the materials used in this analysis. Considering that they have no dimensional peculiarity, it is suspected that its material property is given higher in reference [1] than it really is.

The predicted critical collapse pressures were corrected to the regression equation and compared to the measured collapse pressures in Figure 4. An overall average error of 0.43% was obtained.

Figure 5 shows correction magnitudes as a function of material yield strength. In four material types, magnitude of correction is about 3.6 MPa on average whereas 2.3 MPa is obtained for the stress relieved Zr-2.5% Nb (300°C) sheaths.

3.2.2 Longitudinal ridge curve

Figure 6 shows the predicted and the measured longitudinal ridge curve for fully-annealed Zr-4 fuel element. The measurement data was quoted from the 1982 WCI (Westinghouse Canada Inc.) report [5]. Ovality of the fuel sheath is presented as a function of applied pressure. The rapid increase of ovality is observed at lower pressure in the prediction than in the measurement. It was expected as such because the same trend was observed in the prediction of the critical collapse pressures in section 2.2.1. When the correction magnitude obtained in section 2.2.1 (3.5 MPa for fully-annealed Zr-4 sheath) is added to the predicted ridge curve, the dotted line is obtained. According to the calculation, 0.5% strain is obtained at the ovality of 0.3mm. The corrected prediction and the measurement curves coincide at that ovality. It suggests that quite accurate prediction of critical ridge pressure is obtained using this FE model, even though the predicted ridge curve does not present a strong agreement with the measured curve.

Qualitatively, however, both the predicted and the measured ridge curves have the

same shape. That is, an initial plateau where the tube maintains the same initial out of roundness; an increase in ovality and height of the ridge with increasing pressure, then a new plateau where the saturation of the plastic deformation has been reached and the ridging remains constant with increasing pressure. A small decrease in ridge height at the end of the 2nd plateau is because the ridge becomes shaper as the pressure increases.

4. Data Correlation

Least square analysis is performed based on the corrected predictions. The readily identifiable parameters that are expected to determine the critical collapse pressure (P) for a fuel sheath are outside diameter (d), wall thickness (t), diametral clearance (δ), elastic modulus (E), and yield stress (σ). d, t and δ define the geometry of a fuel element, E characterizes the elastic deformation that can be exhibited by the clad and σ is a measure of how readily plastic deformation occur. Hence the conditions corresponding to collapse instability for fuel elements should be able to expressed as a function of these five parameters.

$$P = f(d, t, \delta, E, \sigma)$$

which can be rewritten by using dimensional analysis in the non-dimensional form:

$$P/E = f(t/d, \delta/t, \sigma/E)$$

In fitting the collapse data to an equation of the above form, the true diametral clearance at test temperature was taken for δ and calculated from :

$$\delta = \Delta + (I.D.)(T-20)(3.11 \times 10^{-6} + 7.78 \times 10^{-9}(T-20) - \alpha)$$

in which Δ is the as-assembled room temperature diametral clearance. α represents the difference in diametral expansion of sheath and pellet and was taken to be $10^{-5}/°C$ for UO_2 pellet and $1.18 \times 10^{-5}/°C$ for steel pellets [1].

Plots of the critical collapse pressure (P) vs. one of t, δ and σ were drawn for constant values of the other two parameters, as is shown in Figure 6. Please note that inverse of the clearance ($1/\delta$) are used for x-axis in Figure 7(b). Coupled effects of the three parameters on the critical collapse pressure are under investigation and the results will be presented later. Based on these graphs, P/E is represented as linear functions of t/d, t/δ and σ/E for the range of parameter values studied in the collapse calculation.

A least square correlation of the collapse data resulted in the following definition for the external pressure corresponding to instantaneous plastic collapse:

$$P = E/10^6 [-610 + 2841(t/d)^{0.8} + 458(t/\delta)^{0.1}] + 0.03699\sigma$$
$$\delta = \Delta - (I.D)(T-20) [\alpha - \{ 3.11 \times 10^{-6} + 7.78 \times 10^{-9}(T-20)\}]$$

Figure 8 compares the predicted critical ridging pressures with the fifty-one measured critical ridging pressures. An overall average error of - 0.14% and a root-mean-square error of 5.9% is presented. These values are smaller than those of the existing correlation that presents an overall average error of 0.53% and a root-mean-square error of 6.41% as shown in Figure 9.

Figure 10 shows deviations in critical ridging pressure prediction of the new correlation for each of the three non-dimensional parameters. These graphs indicate that within the range of test specimen parameters used for its validation (0.25 mm < t < 0.45 mm, 13 mm < d < 20 mm, 0 mm < Δ <0.2 mm, 130 MPa < σ < 210 MPa) [1], the correlation is unbiased and hence is expected to be a reasonable description for the longitudinal ridging behavior of CANDU type fuel elements.

5. Comparison of the new to the existing correlation

5.1 Form of correlation

For the purpose of comparison with the new correlation, the existing correlation is presented below [1].

$$P = E/10^7 [-1560 + 80600\ t/d + 29.1\ (d/(100\psi))^2] + 0.0300\ \sigma$$
$$\psi = \delta - (d^2\rho)/(2Et)$$
$$\delta = \Delta - (I.D)\ (T-20)\ [\ \alpha - \{\ 3.11 \times 10^{-6} + 7.78 \times 10^{-9}(T-20)\}]$$

ψ, which was considered to be the true pellet-to-clad diametral clearance at the test temperature and pressure, was calculated from equation (5) where $(d^2\rho)/(2Et)$ is the diameter decrease for an unsupported thin wall circular tube acted upon by the external pressure. However, it should be noted that the application of external pressure to the thin wall circular tube may cause an instability failure due to stresses even lower than the elastic limit, and in such a case this formula do not apply.[Ref.] Magnitude of the external pressure (ρ) that causes critical ridging is, of course, greater than the elastic limit. Therefore, it is not appropriate to calculate the diameter decrease of the fuel sheath subjected to the ridging pressure using equation (5) and the non-dimensional term of ψ should be excluded from the ridging correlation.

In new correlation, the diametral clearance at test temperature (δ) was chosen as a dimensional parameter. As the critical ridging pressure is proportional to the inverse of the clearance ($1/\delta$) as is shown in Figure 7(b), its non-dimensional form became t/δ. Compared to d/δ, t/δ resulted in more accurate correlation because parameter d is inverse proportional to the critical ridging pressure.

5.2 Comparison in collapse pressure prediction

Figure 11 compares predictions of the new and the existing correlation as a function of diametral clearance. Parameter values used are: σ = 167 MPa, t = 0.36 mm, OD = 13.5 mm. Dimensions of CANFLEX fuel are used. Please note that 167 MPa for σ is randomly chosen value. When the diametral clearance is 0.13mm, the new correlation gives collapse pressure of 11.03 MPa, which is bigger than that of the existing correlation by 0.57 MPa.

Figure 12 compares predictions of the new and the existing correlation as a function of yield strength. Parameter values used are: Δ = 0.13 mm, t = 0.36 mm, OD = 13.5 mm. At the yield strength of 174.3 MPa, 11.3 MPa of critical collapse pressure is obtained. It is higher than that of the existing correlation by 0.62 MPa.

Figure 13 compares predictions of the new and the existing correlation as a function of element OD. Parameter values used are: σ = 167 MPa, t = 0.36 mm, Δ = 0.13 mm. New correlation predicted the critical collapse pressure higher than the existing correlation for the range of O.D between 12.2 mm and 17.7 mm.

The existing correlation resulted in an erratic increase in ridging pressure for the sheath larger than 16.6 mm in diameter. As the correlation was mainly fitted to the Pickering type fuel cladding, the quadratic term of the correlation, $(d/(100\psi))^2$ resulted in an inflection of a curve when applied to the fuel cladding with CANFLEX size thickness and diametral clearance. It does not appear in Pickering type cladding within the application range of the correlation.

Figure 14 compares predictions of the new and the existing correlation as a function of sheath thickness. Parameter values used are: σ = 167 MPa, OD = 13.5 mm, Δ = 0.13 mm. New correlation predicted the critical collapse pressure higher than the existing correlation to the thickness of 0.43mm.

6. Efforts for FE Model Improvement and Discussions

Various efforts were made to improve the ABAQUS model for better prediction of the longitudinal ridge behavior of the CANDU fuel sheath that is instantaneously exposed to the external pressure in the CANDU pressure tube. Several modifications of the FE model were tried to accurately predict the longitudinal ridge behavior, but the prediction was not satisfactory as expected:

1) Removal of the Initial ovality of the sheath

The average ovality of actual tubes (0.0075 mm Radial ovality) was removed to alleviate under-prediction. It resulted some differences from the previous work.   The differences were too small to cover up the trend of under-prediction.

2) Re-evaluation of the material properties

A number of material properties were tested aiming for the ridge to occur at higher pressure. Higher yield strength resulted higher ridge pressure. However, over some level of the strength value, the ridge didn't form at all. And as the strength value became bigger, the ridge strain resulted not to agree with test data.

3) Restraining of the rotation at the ridge end of the sheath

The elements used at the ridge end of the sheath were found not to have rotational degree of freedom at the nodes.

4) Measurement of the calculated ridge strain using the same method as was used in the measurement

It didn't provide better results.

The key difference between the prediction and the measurement are:
   a) The ridge is predicted to form at lower pressure than the actual test results.
   b) The maximum strain value is smaller in the prediction than in the test.

The basis of the difference a) as mentioned above could be reasoned many different ways.   However, what I would like to concern at this time is the difference b) as mentioned above. Figure 15 shows the 10,000-minutes creep strain vs. instantaneous collapse strain for the test cases in table 5 of the 1973 WCL test report[1]. The instantaneous ridge strains are much smaller than the 10,000-minutes creep strain as we expect. The deformation increases with time under constant load of external pressure.

However, Figure 16 shows different results from the results shown in Figure 15. Figure 16 shows the same plot for the test cases in table 1, 3 and 4 of the 1973 WCL test report[1]. Test cases performed at lower pressure (less than 12.166 MPa) are not included in this consideration. This figure shows that the instantaneous ridge strains are almost equal to the 10,000-minutes creep strain in average. The procedure adopted in 1973 WCL test that consists of iterative pressurizing and depressurizing of the fuel sheath up to 12.166 MPa resulted in almost the same amount of ridge strain as the 10,000-minutes creep test.

This phenomenon is more conspicuous for the cases tested at higher pressure. Figure 17 shows the 10,000-minutes creep strain vs. instantaneous collapse strain for the tests performed to the pressure step of 13.889 MPa. In this figure, the instantaneous ridge strains are, in average, rather bigger than the 10,000-minutes creep strain.

It is not clear why they show different results as shown in Figure 15 and Figures 16 and 17 in spite of the same test procedure. However, the fact that instantaneous collapse shows the same amount of ridge strain as in the 10,000-minutes creep test might be one reason that the simple static analysis cannot provide an accurate prediction for the longitudinal ridge test performed in WCL in 1973. I suggest that an accurate prediction of the longitudinal ridge strain should be left for future work.

References

[1] W.R.Clendening, A. Mehmi, "An empirical model for the longitudinal ridging of thin wall fuel elements", CWAPD-293, 1976

[2] C.Warren Young, "Roark's formula for stress and strain", Sixth edition, McGraw-Hill Book Company, 1989.

[3] Hibbit, Karlson, Sorenson, 1989, ABAQUS/Standard Users Manual, Ver.5.8.

[4] M. Tayal, W.R.Clendening, "An empirical model for the longitudinal ridging of thin wall fuel elements", CWAPD-260, 1974

[5] C.C.Cappelo, B.E.Harris,"Instantaneous Inelastic Longitudinal Ridging of Thin Wall Fuel Cladding", CWAPD-401, 1982.

Step: Step-7, STEP7
Increment 33: Step Time = 1.000

(a) FE Model

Step: Step-7, STEP7
Increment 33: Step Time = 1.000

Deformed Var: U   Deformation Scale Factor: +1.000e+00
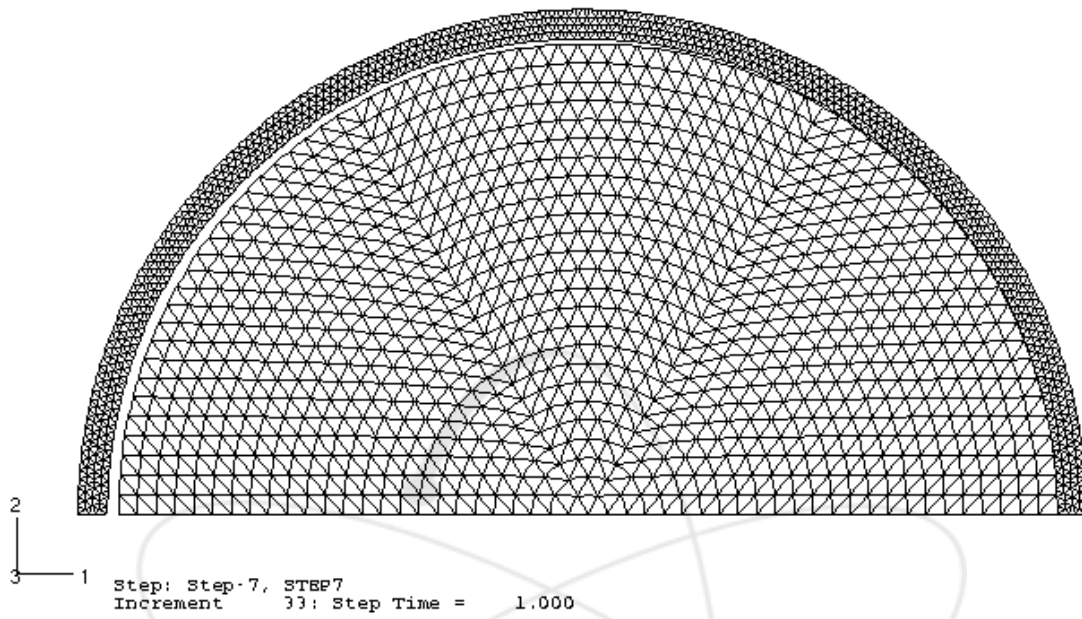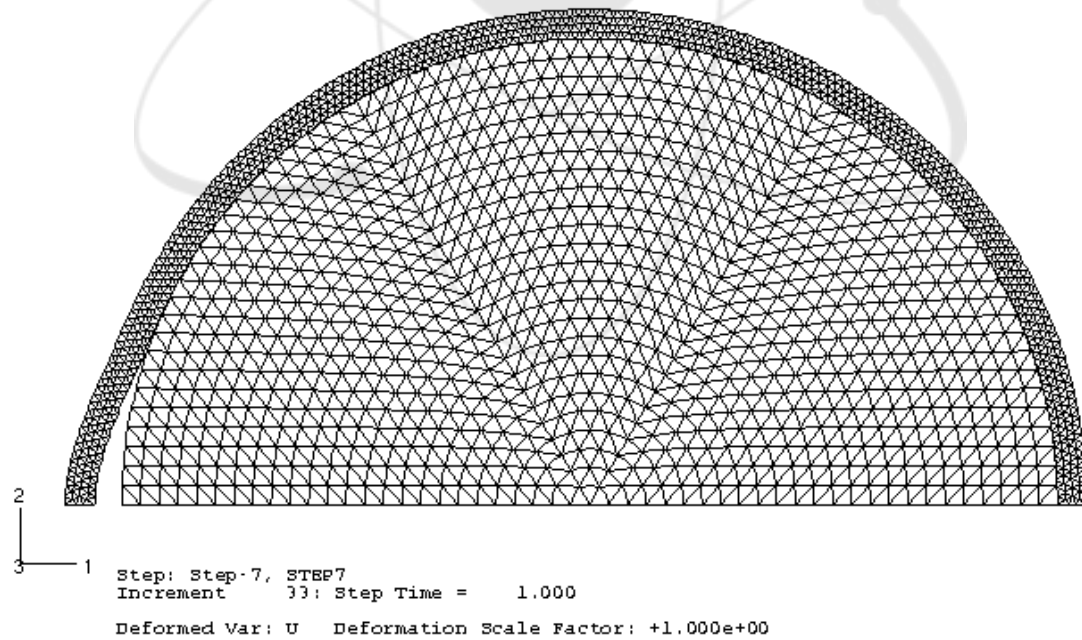
(b) Deformed shape

Figure 1. FE model for longitudinal ridge analysis and its deformed shape

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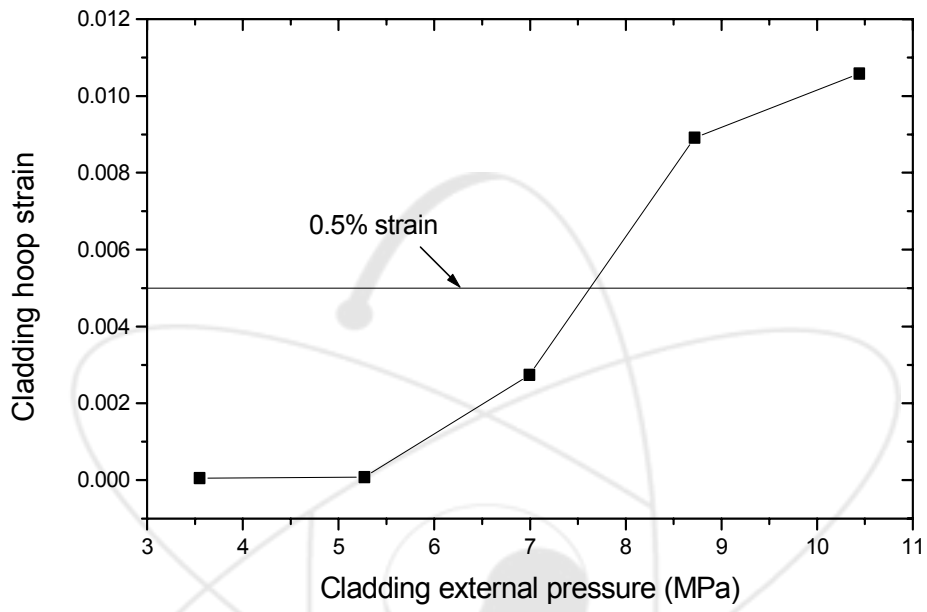
Figure 2. Illustration of critical ridging pressure estimation
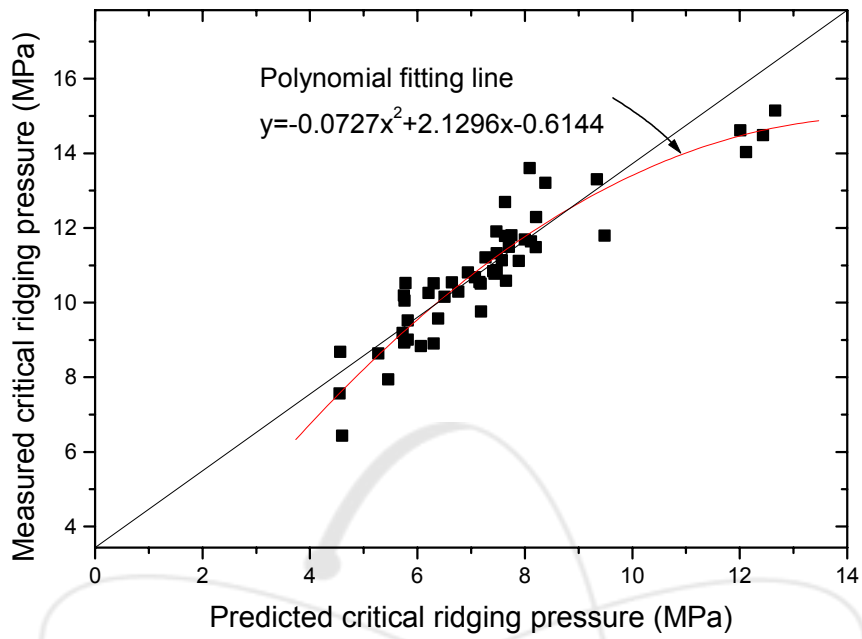
Figure 3. The measured vs. the predicted critical ridging pressure
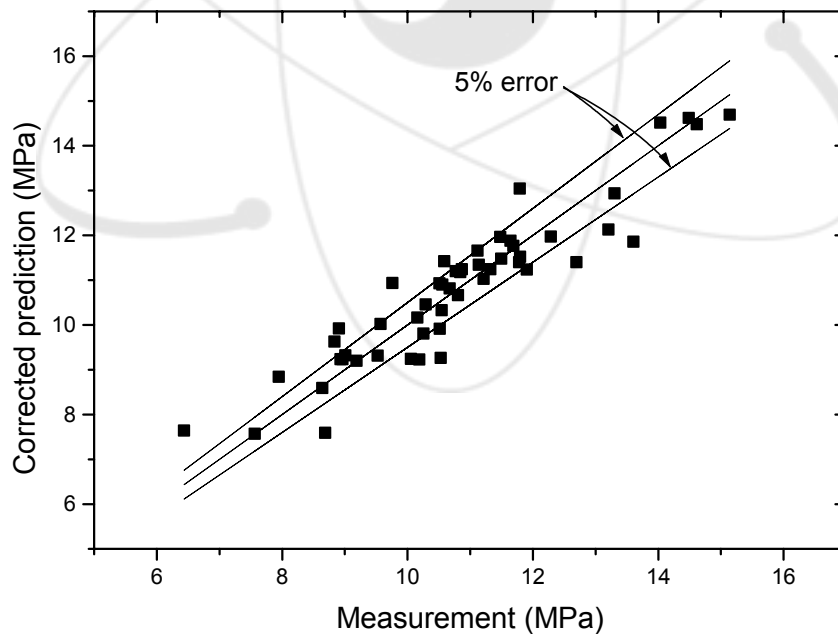
Figure 4. Corrected predictions vs. measurements
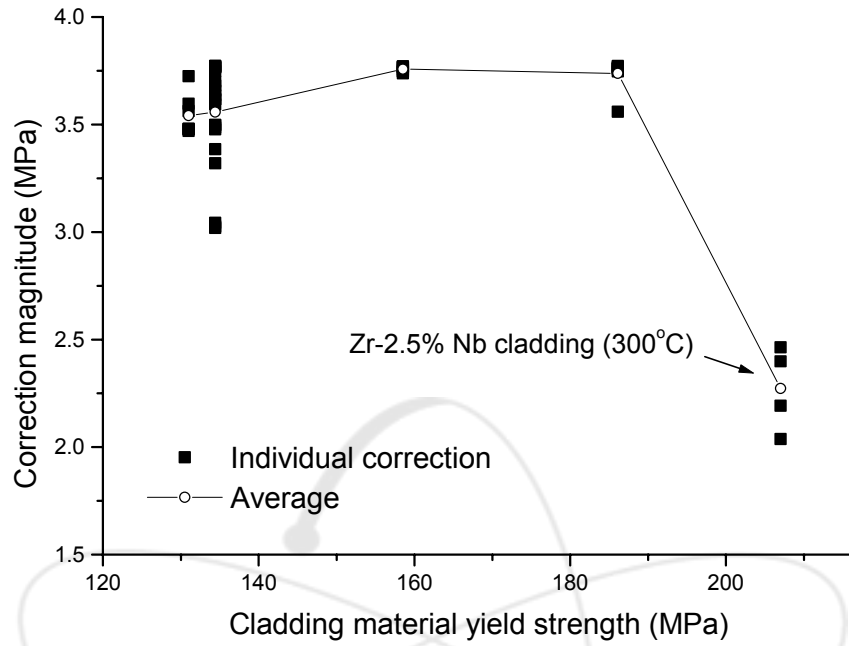
Figure 5 Correction magnitudes vs. material yield strength
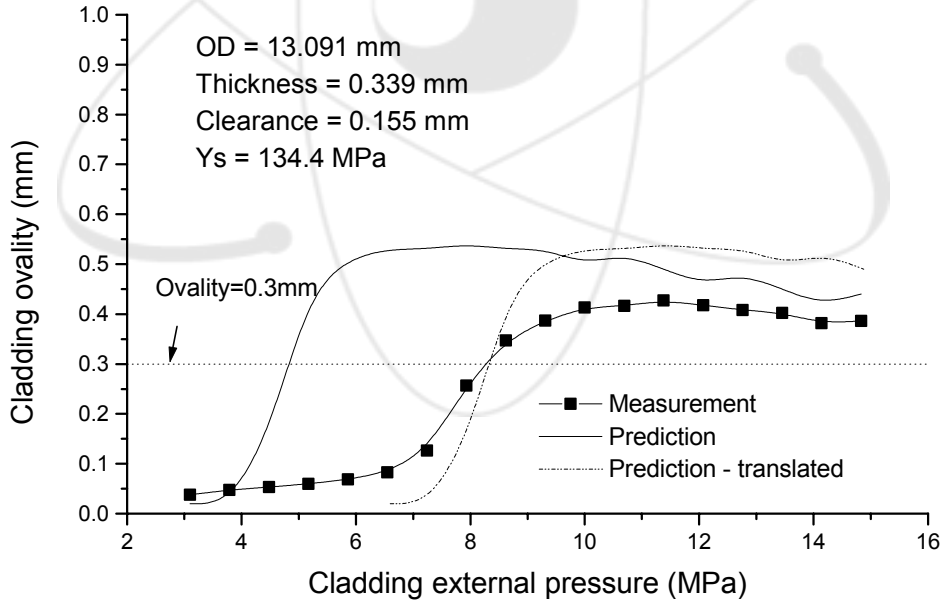
Figure 6. Longitudinal ridge curve for fully annealed Zr-4

16
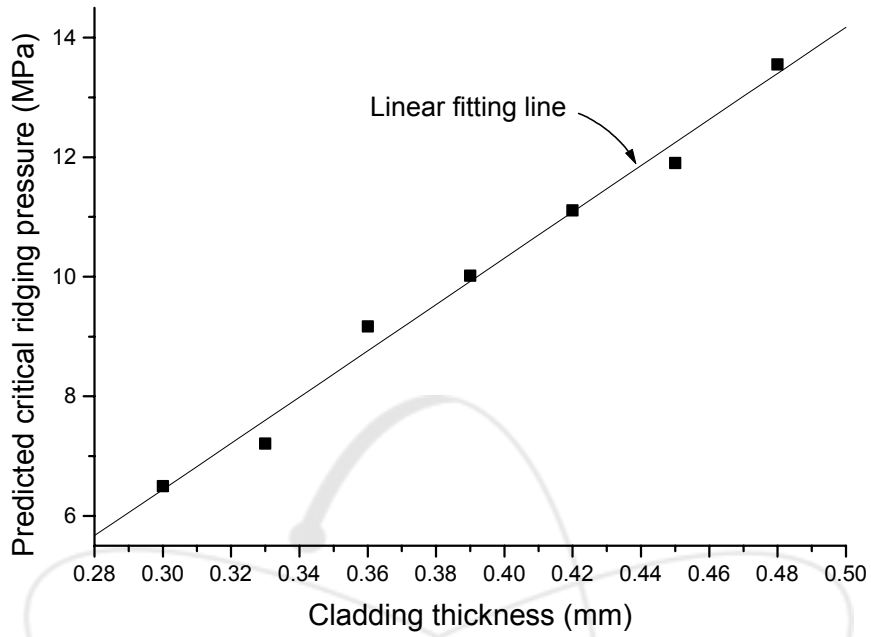
7(a) Effect of the cladding thickness variation on the critical ridging pressure
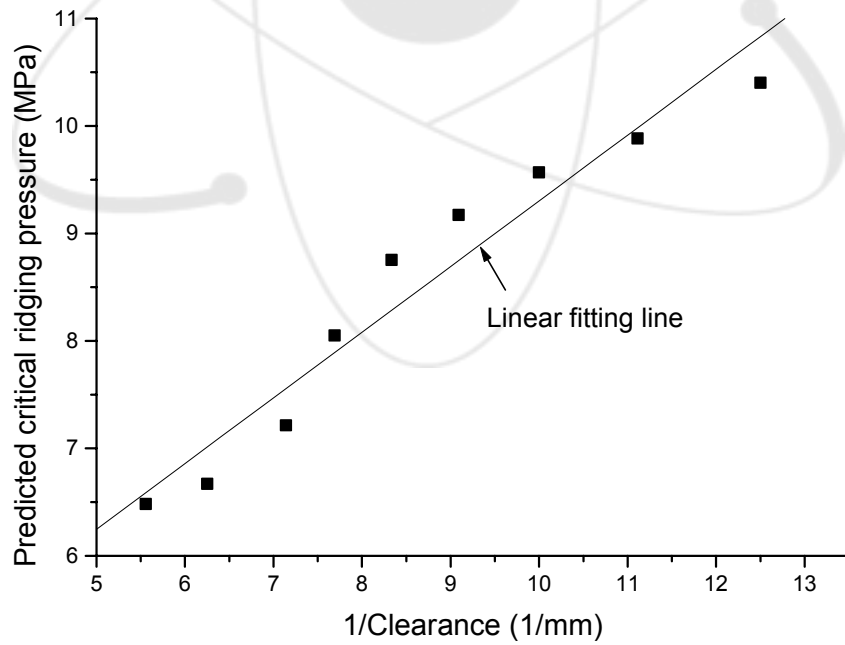
7(b) Effect of the clearance variation on the critical ridging pressure

17
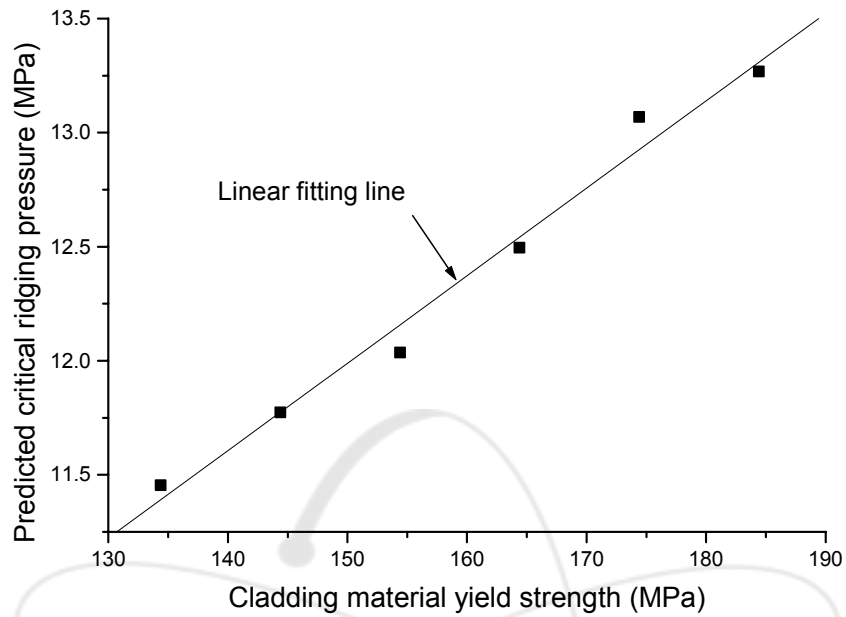
7(c) Effect of the material yield strength variation on the critical ridging pressure

Figure 7 Effect of parameter variation on the critical ridging pressure
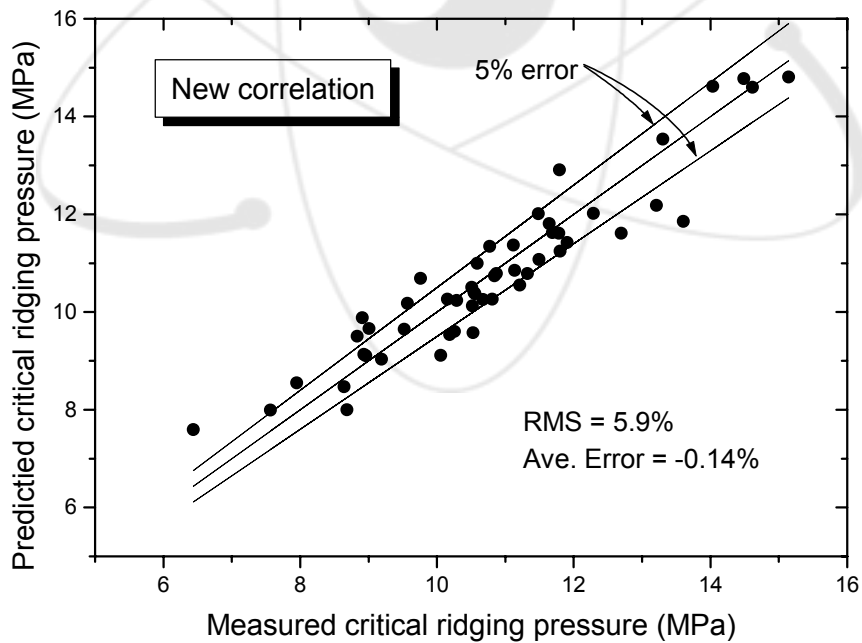
Figure 8 Comparison between the prediction by the new correlation and the measurement
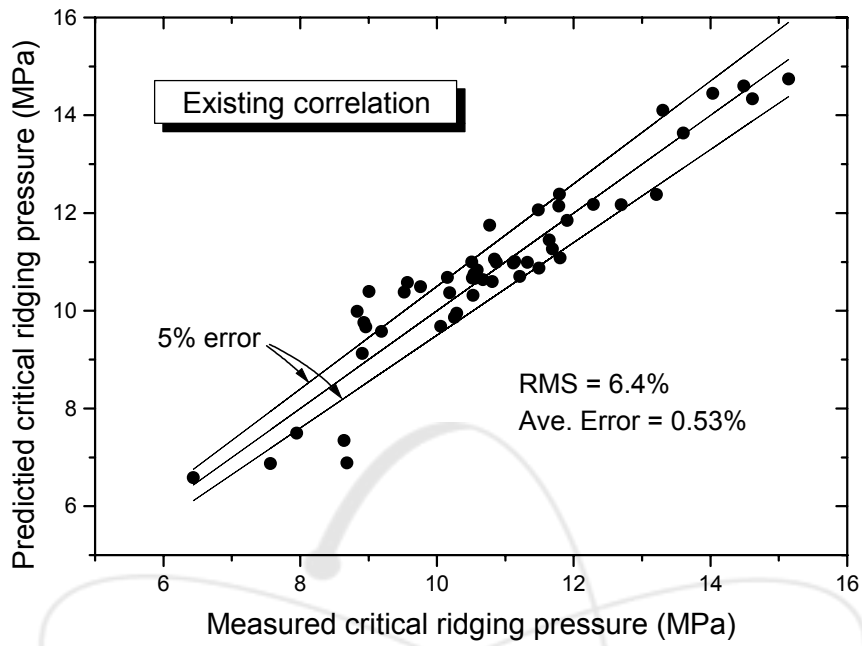
Figure 9 Comparison between the prediction by the existing correlation and the measurement
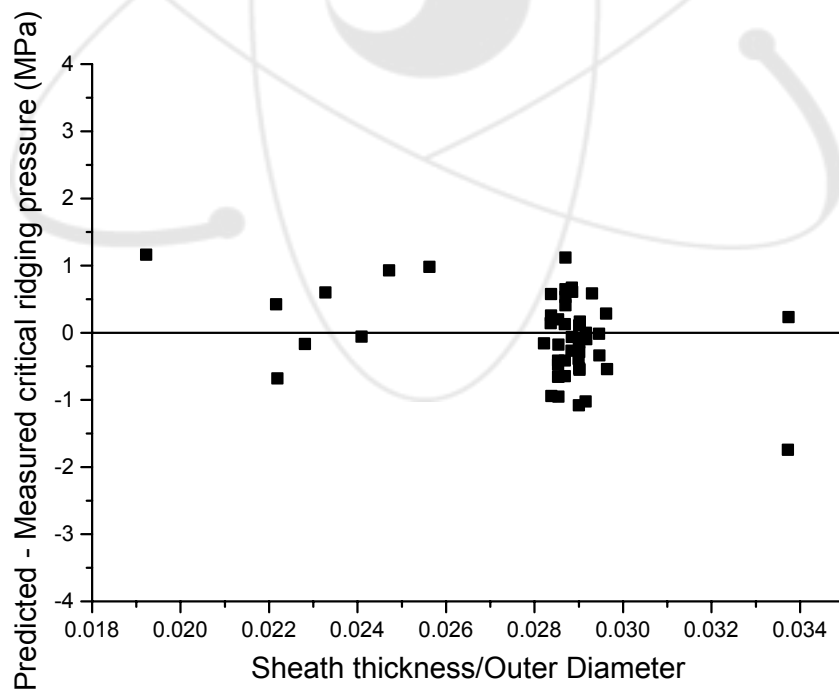
10(a) Prediction error vs. non-dimensional cladding thickness
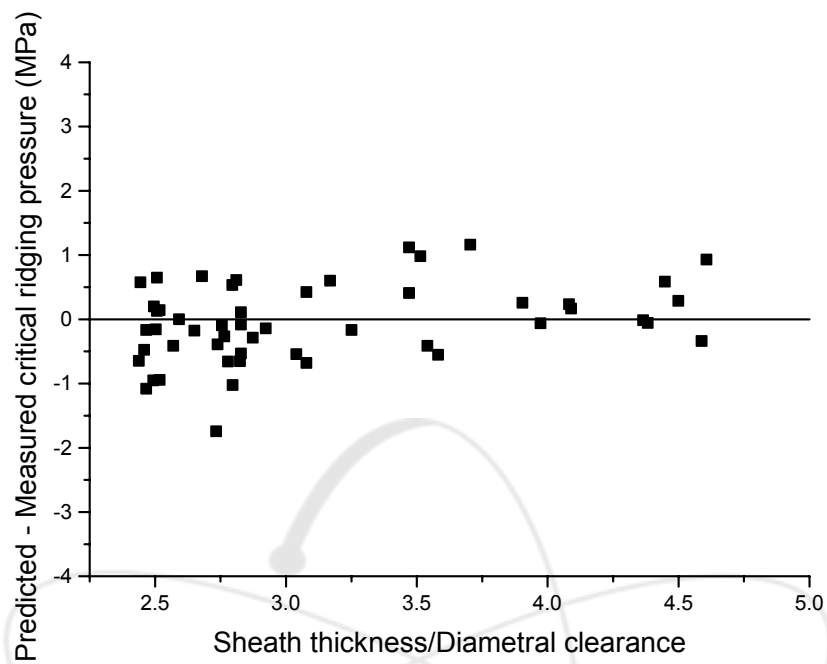
10(b) Prediction error vs. non-dimensional diametral clearance
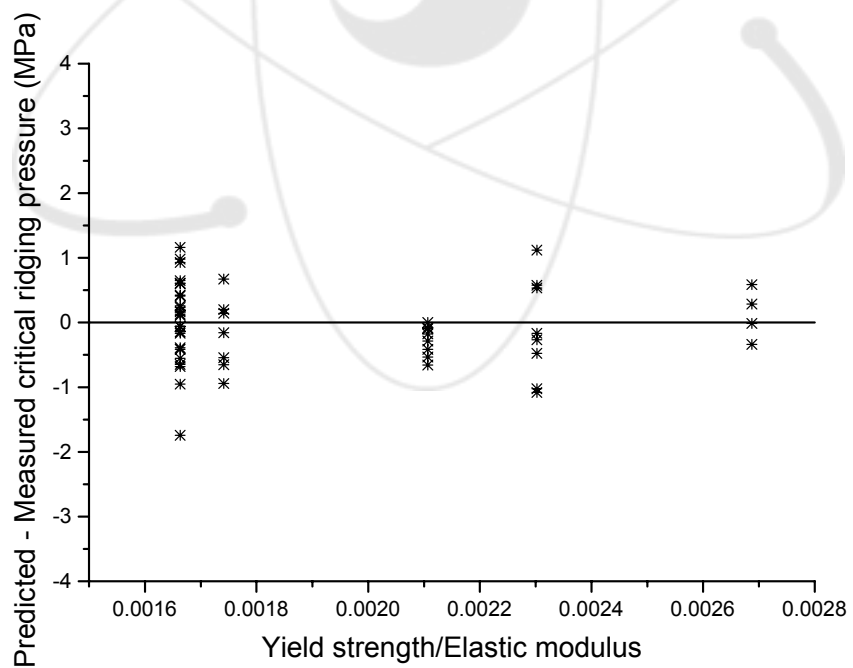
10(c) Prediction error vs. non-dimensional cladding yield strength

Figure 10 Prediction error vs. non-dimensional parameters
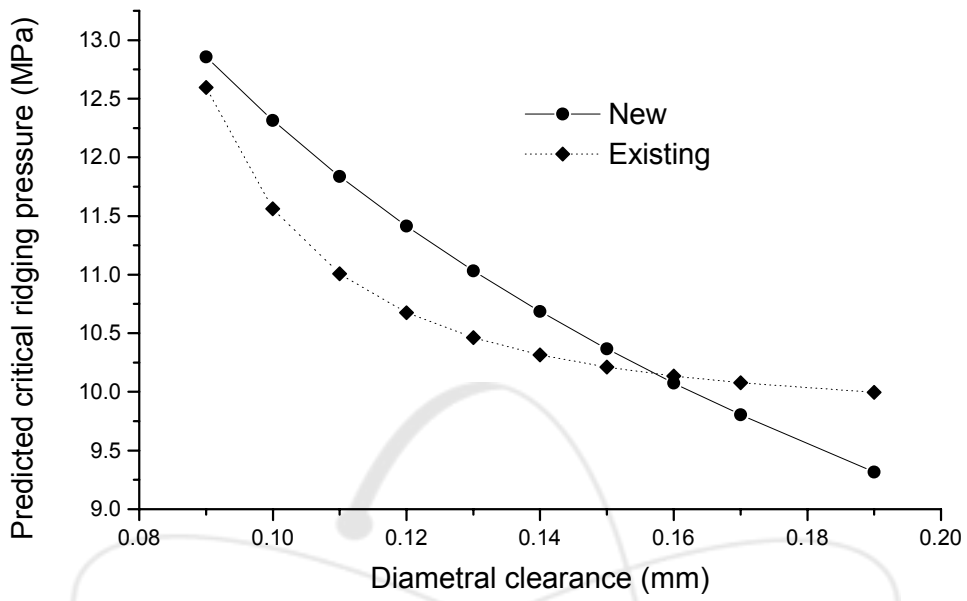
Figure 11. Predicted critical ridging pressures vs. cladding diametral clearance
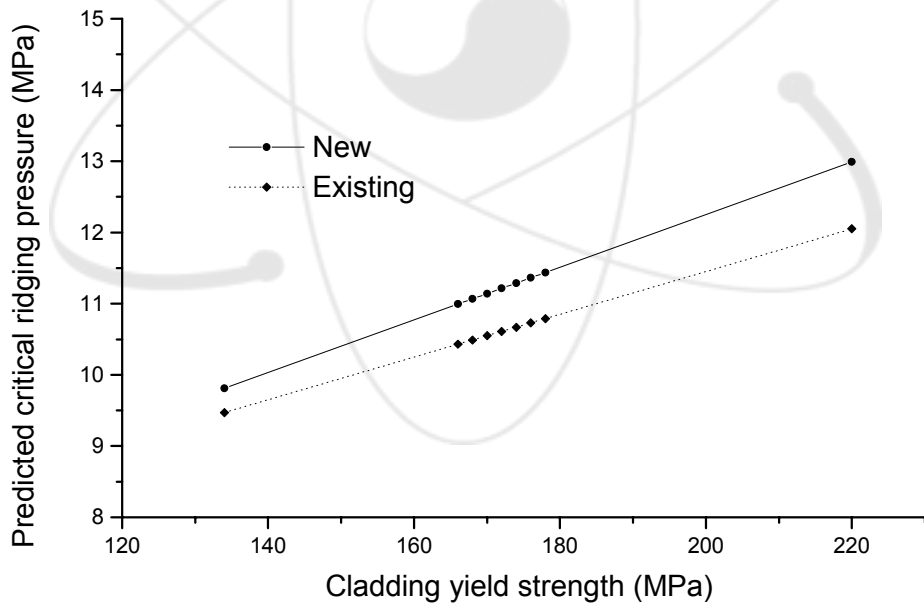
Figure 12. Predicted critical ridging pressures vs. cladding yield strength

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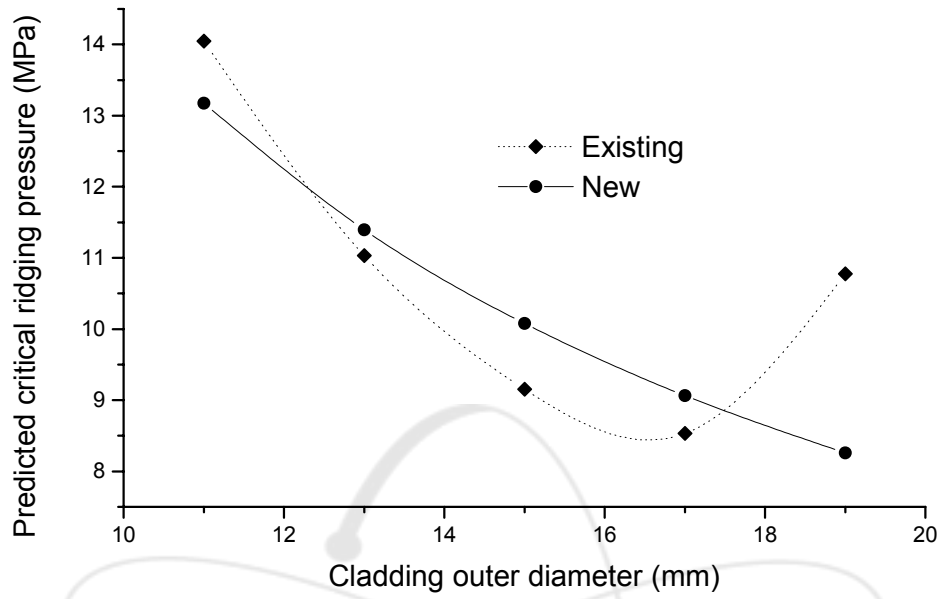
Figure 13. Predicted critical ridging pressures vs. cladding outer diameter
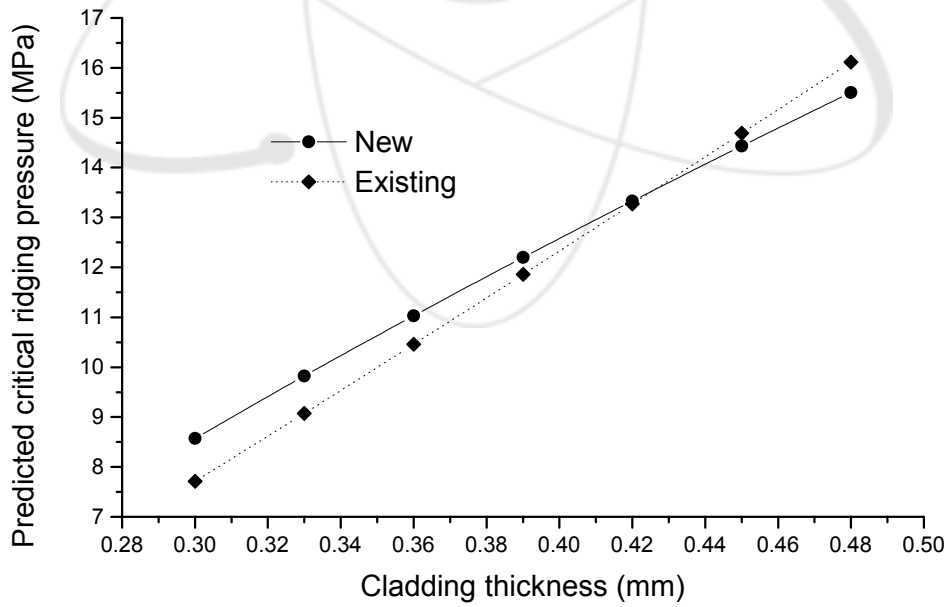
Figure 14. Predicted critical ridging pressures vs. cladding thickness
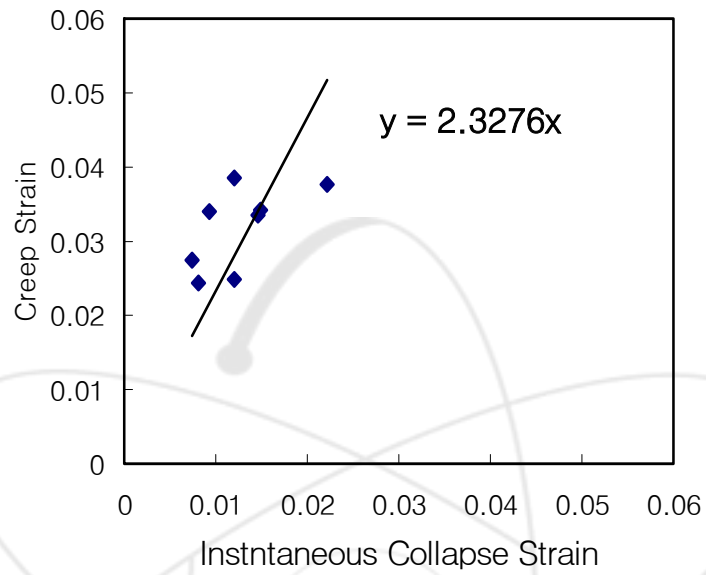
Fig. 15 Instntaneous Collapse Strain vs.
Creep Strain
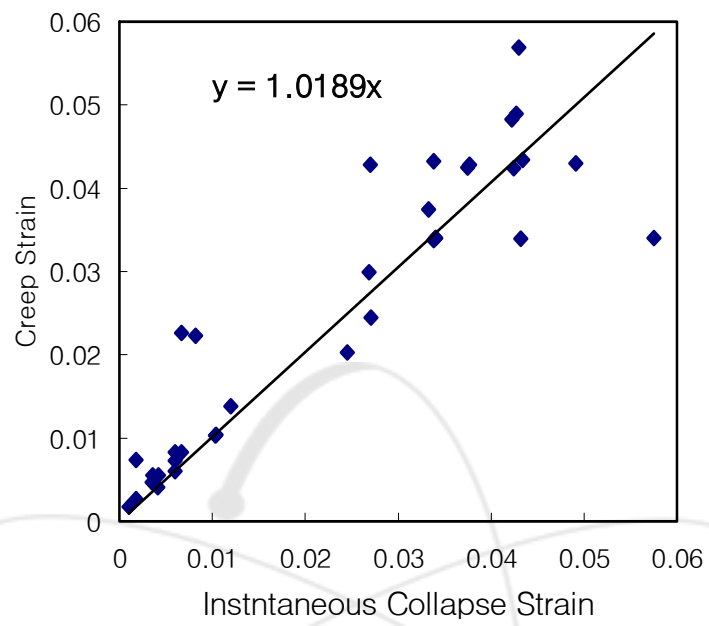
Fig.16 Instntaneous Collapse Strain vs.
Creep Strain
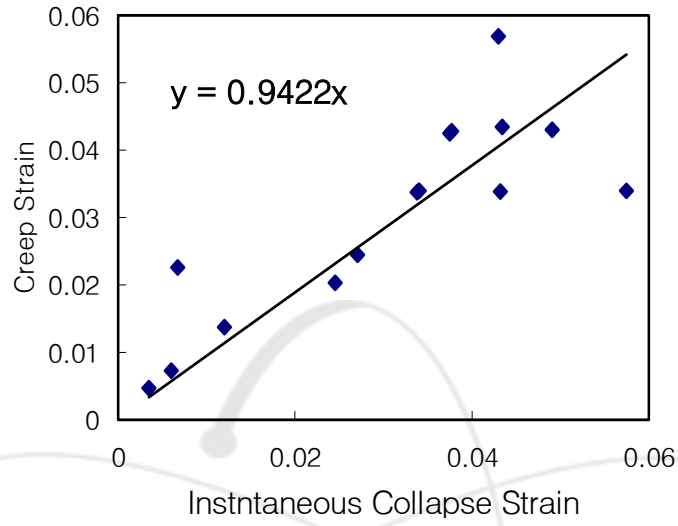
Fig.17 Instntaneous Collapse Strain vs.
Creep Strain

부록 1. 축방향주름 해석 입력자료 (ABAQUS 6.2)
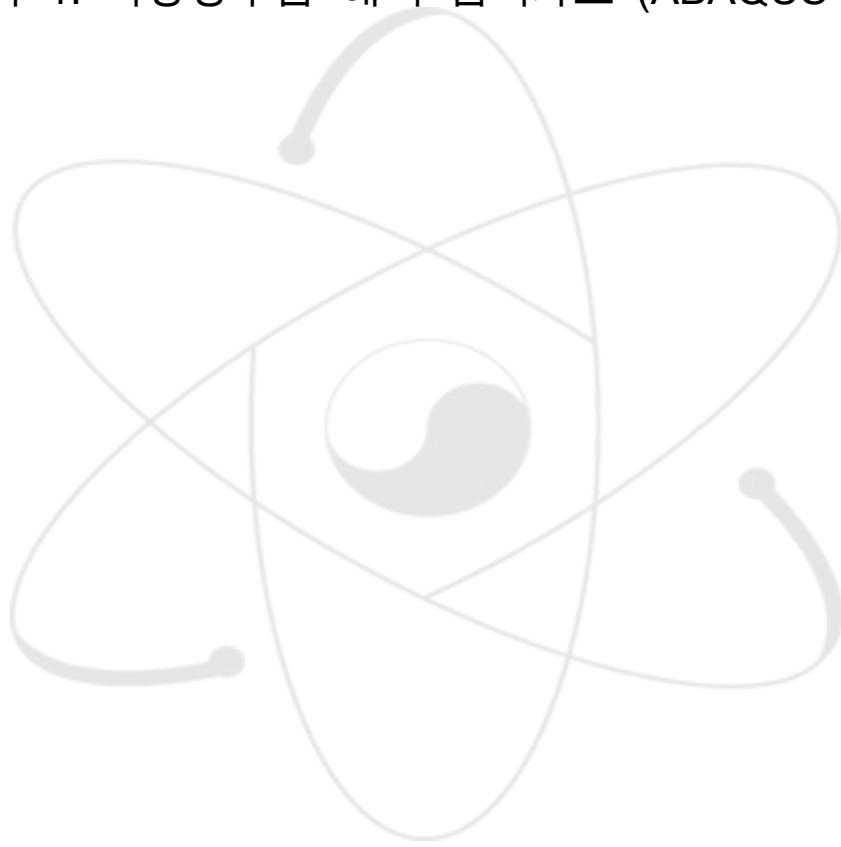
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                              *HEADING
**
** ABAQUS INPUT FILE UPGRADE: This input file was upgraded from
** version 5.8 or later to version 6.2 with 0 warning(s) and 0
** error(s).
** Poisson ratio=0.3, 0.1
**
CANFLEX LONGITUDINAL RIDGE ANALYSIS(13.5MM, HALF MESH)
NON-LINEAR MATERIAL PROPERTIES DEFINED - plastic modulus modified
SI UNITS
OVALITY REMOVED
*PREPRINT,ECHO=YES,MODEL=NO,HISTORY=NO
**
**MODEL DEFINITION
**
**OUTER RING
*NODE,NSET=NTUBE,SYSTEM=C
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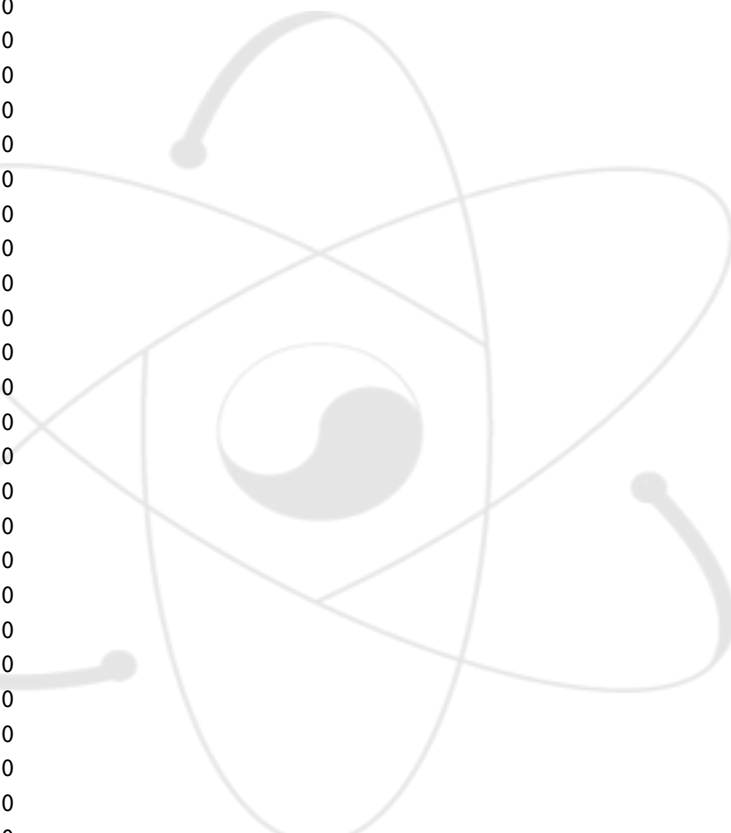
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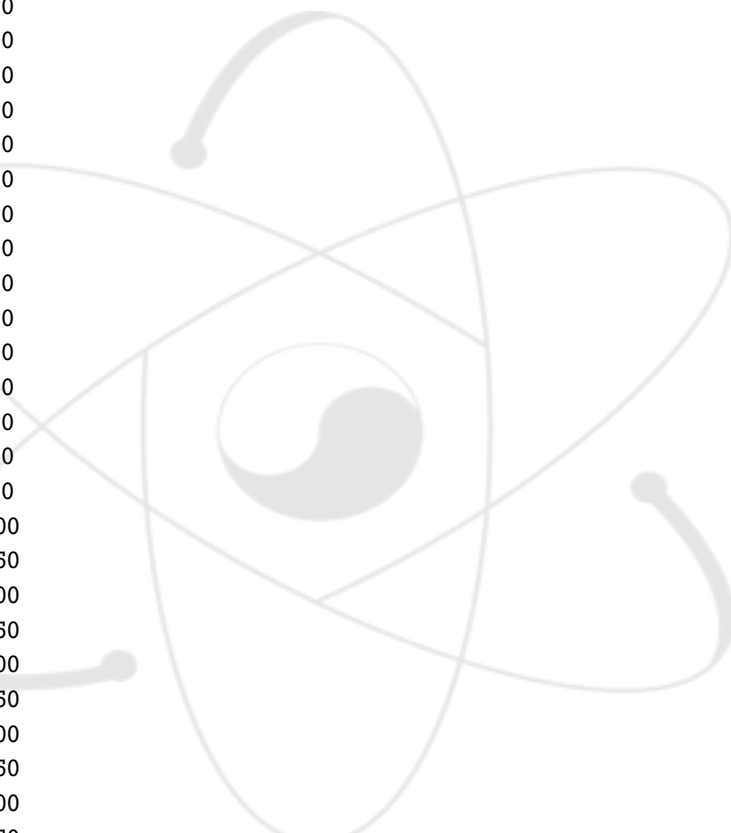
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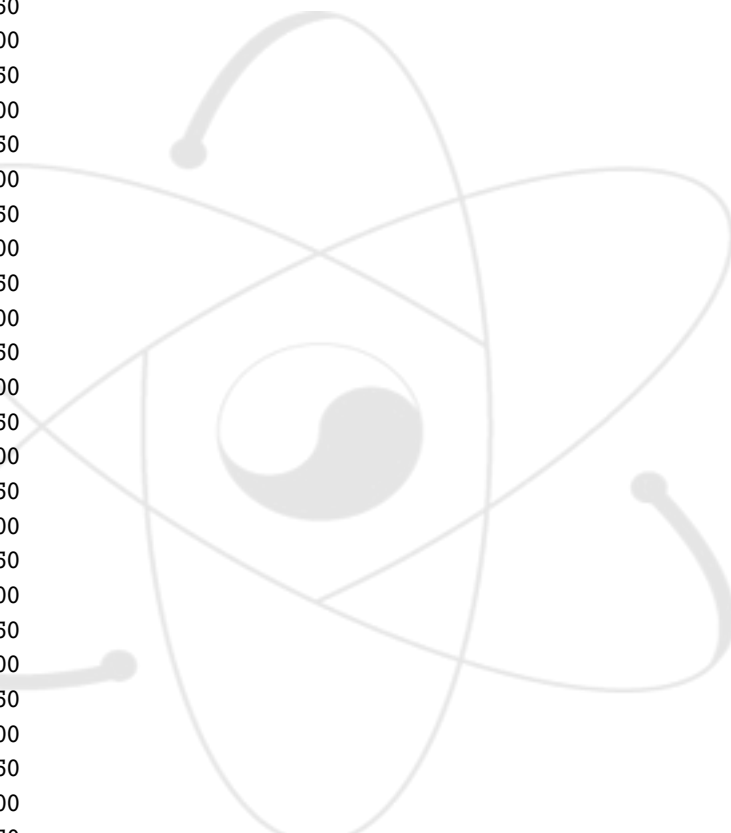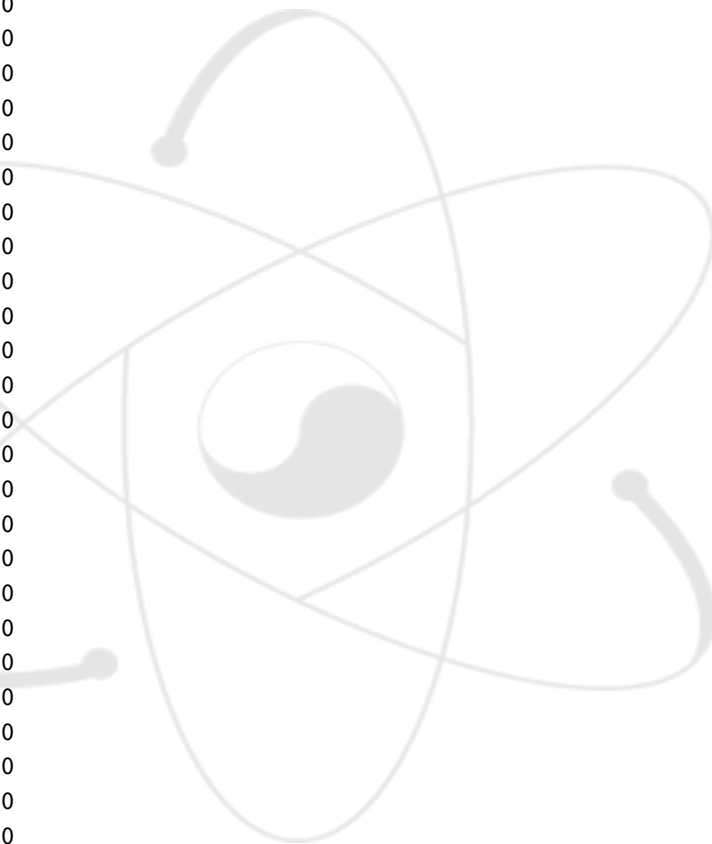
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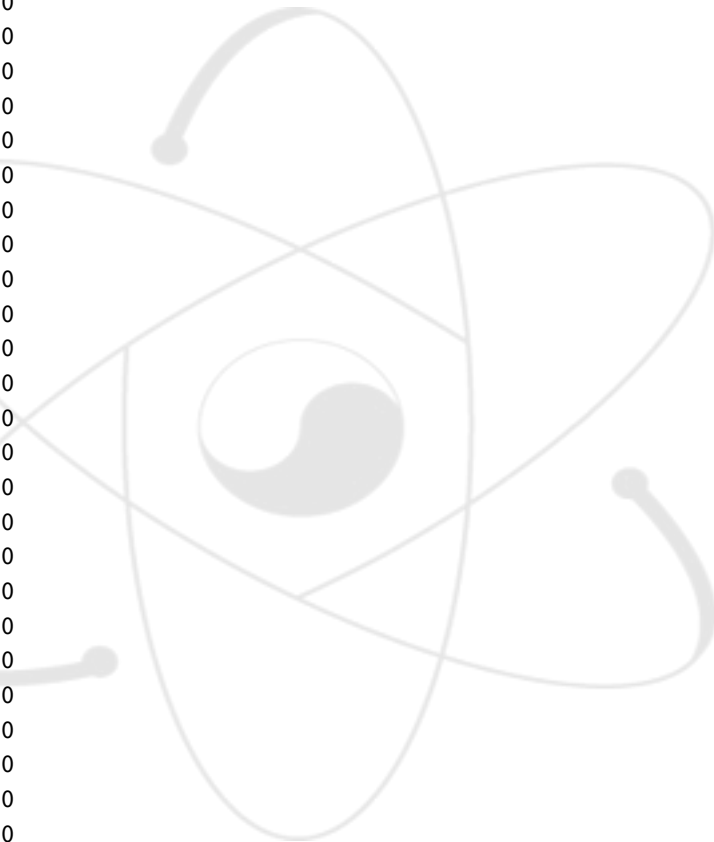
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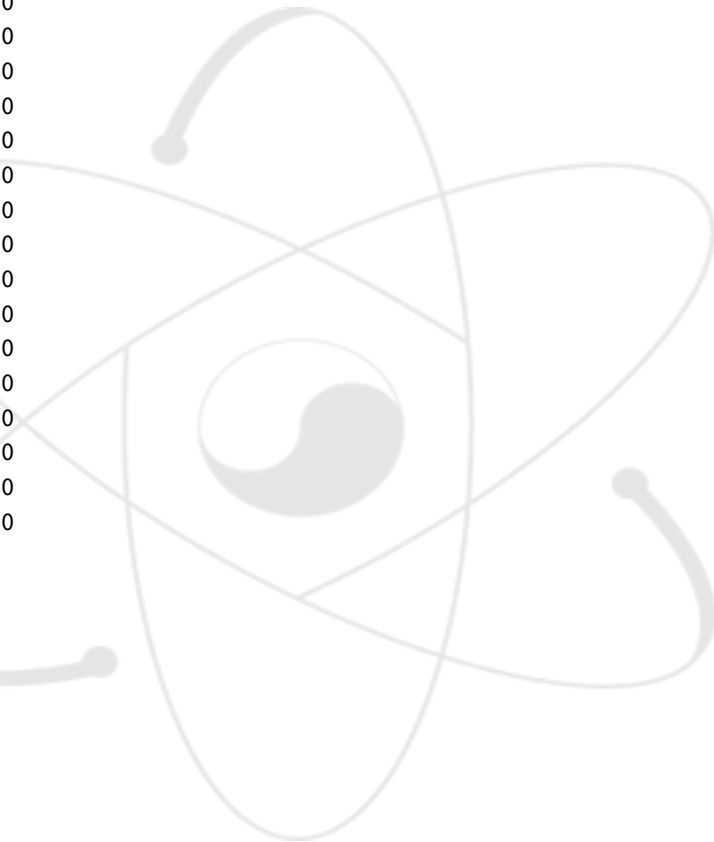
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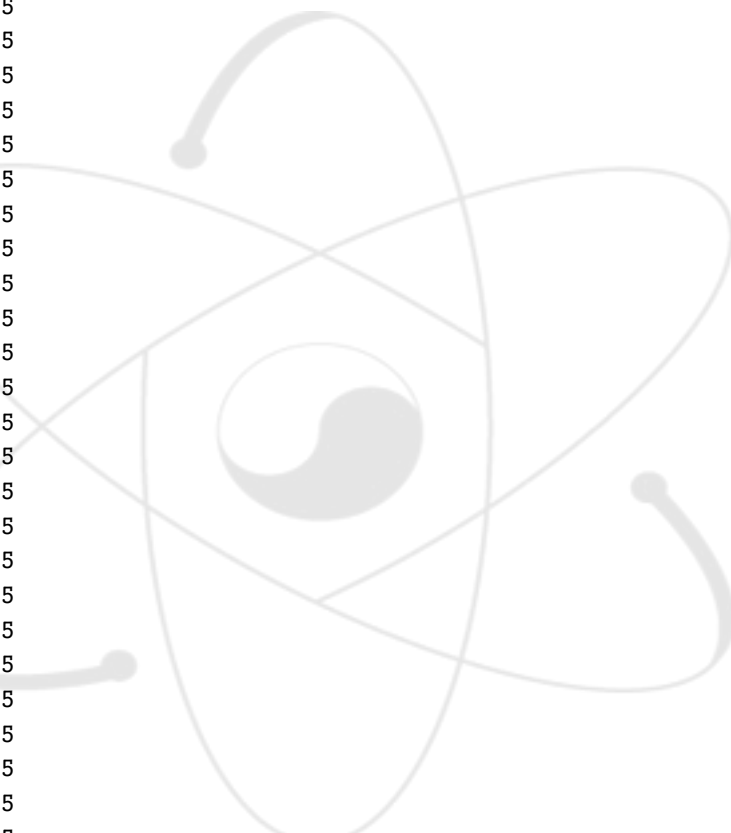
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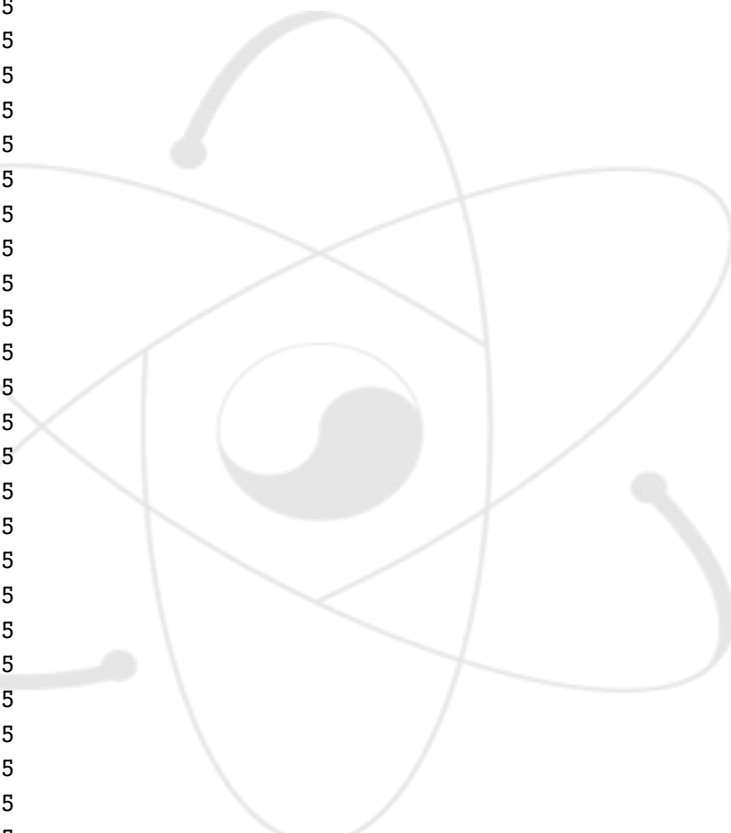
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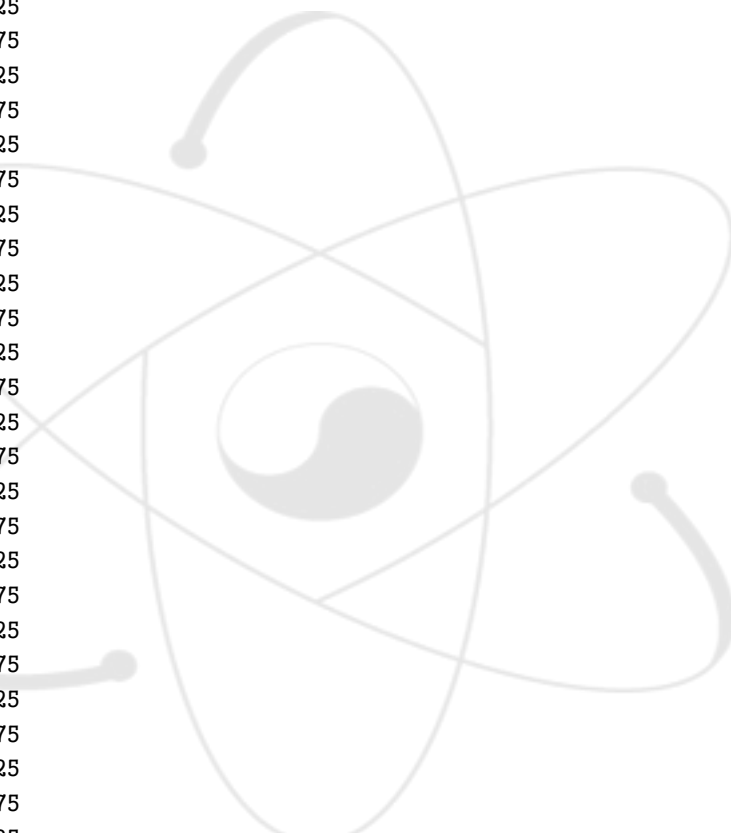
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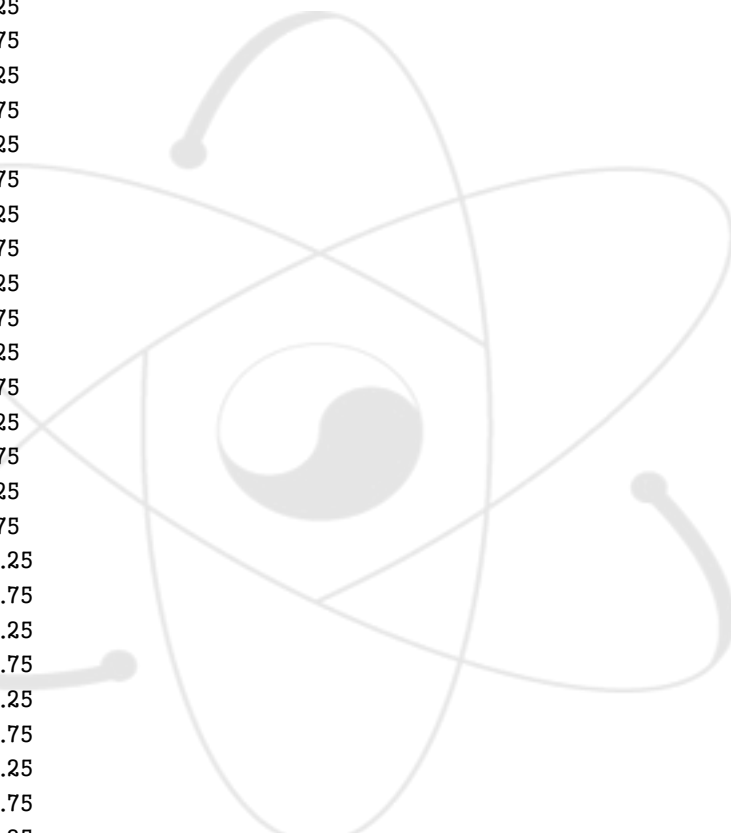
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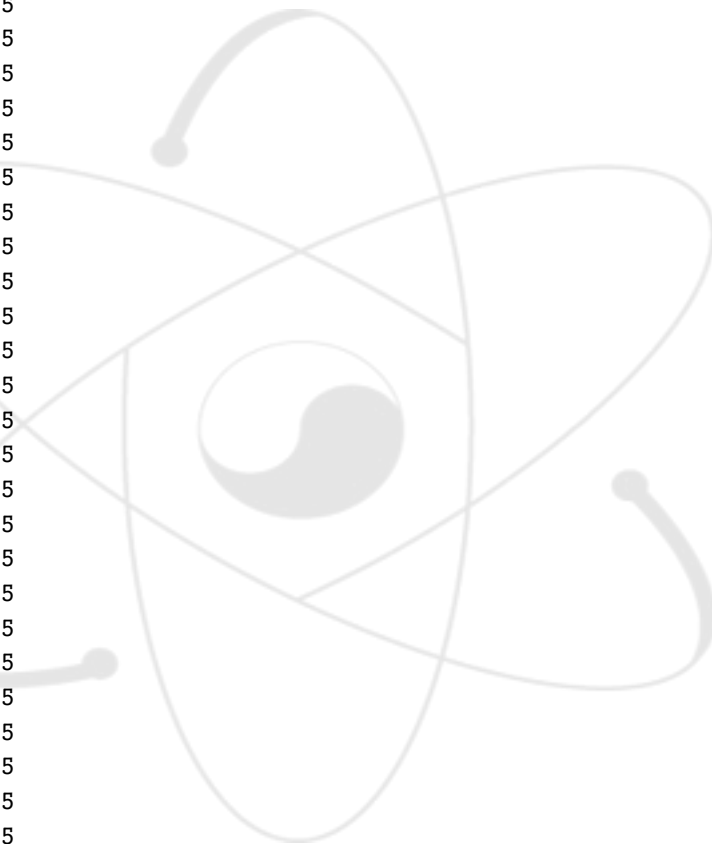
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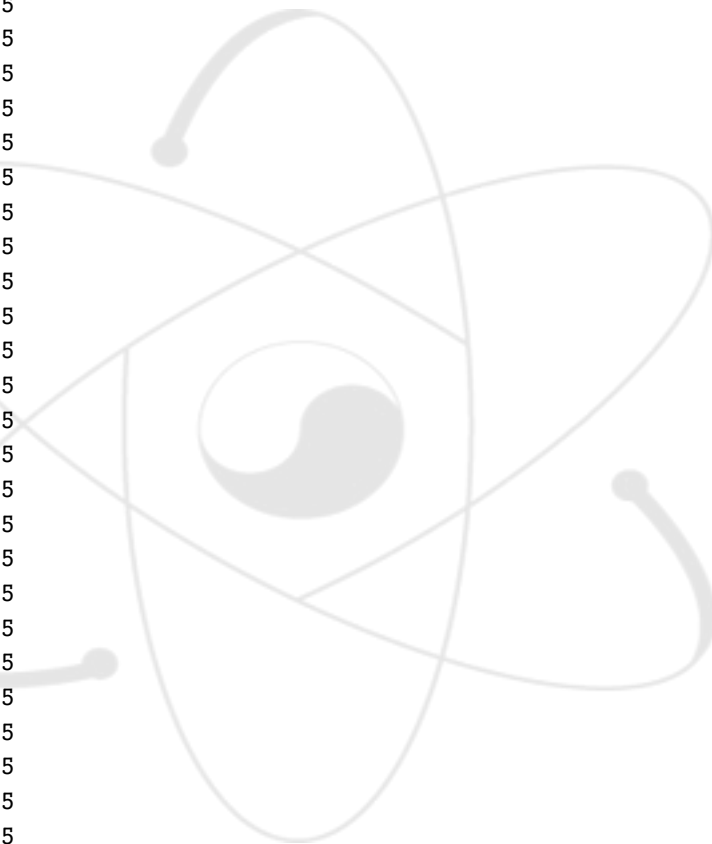
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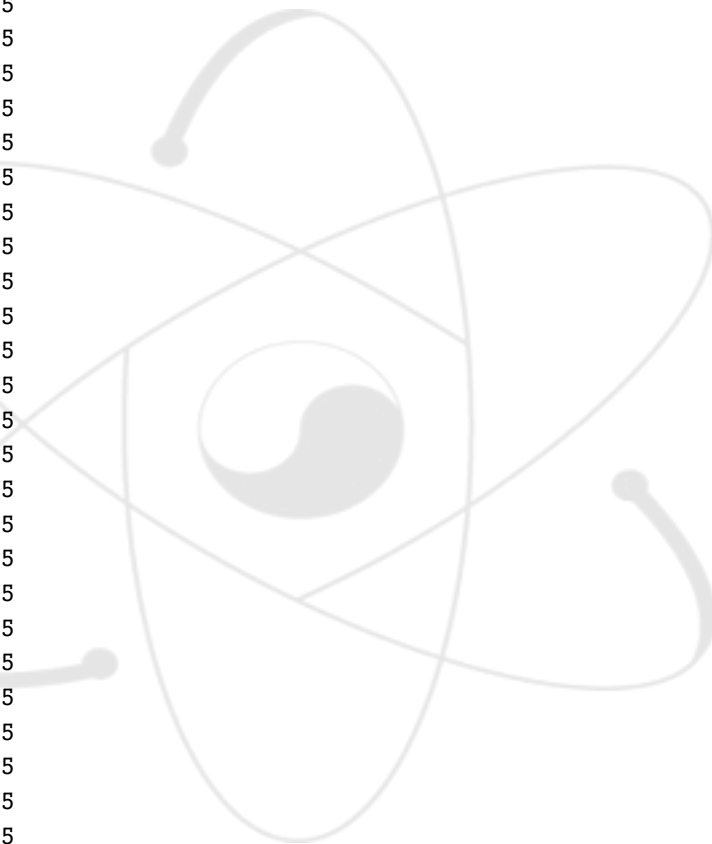
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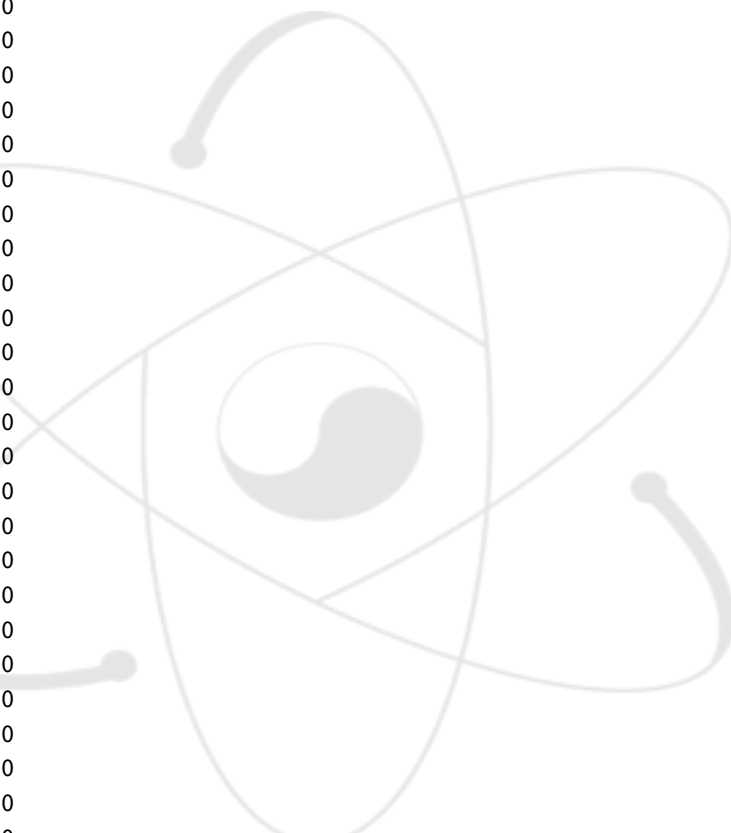
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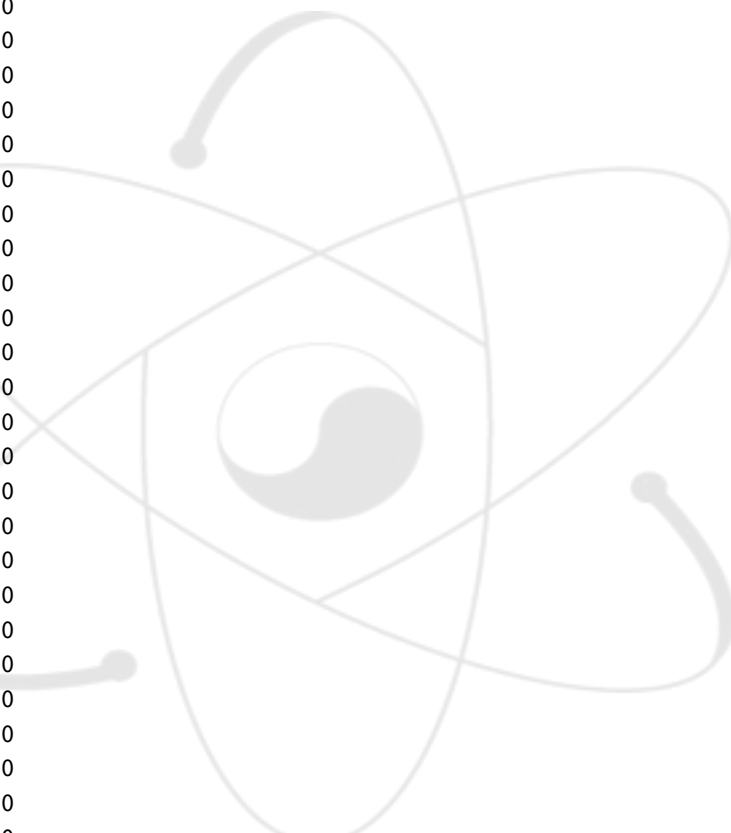
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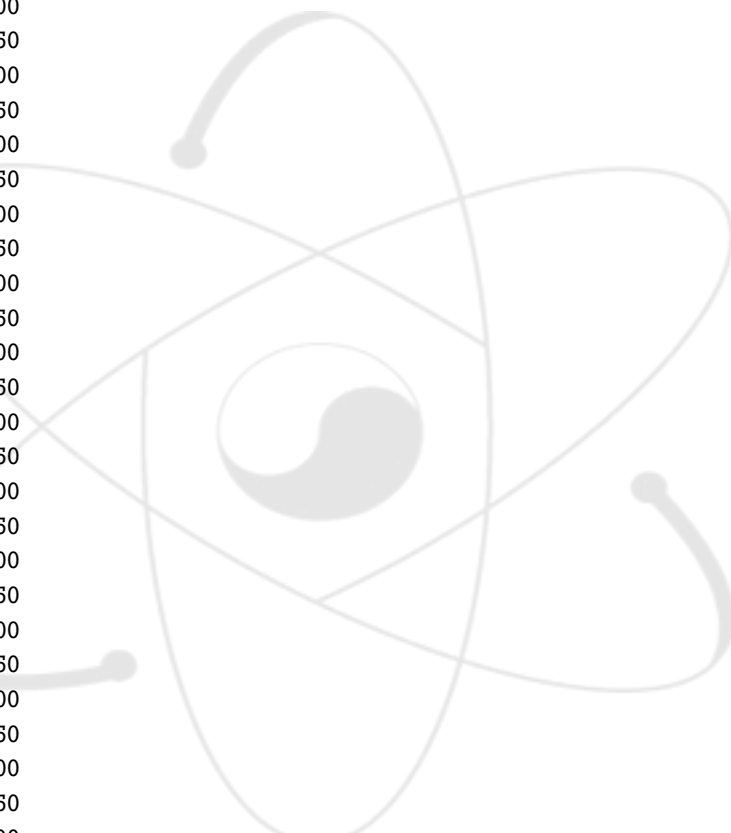
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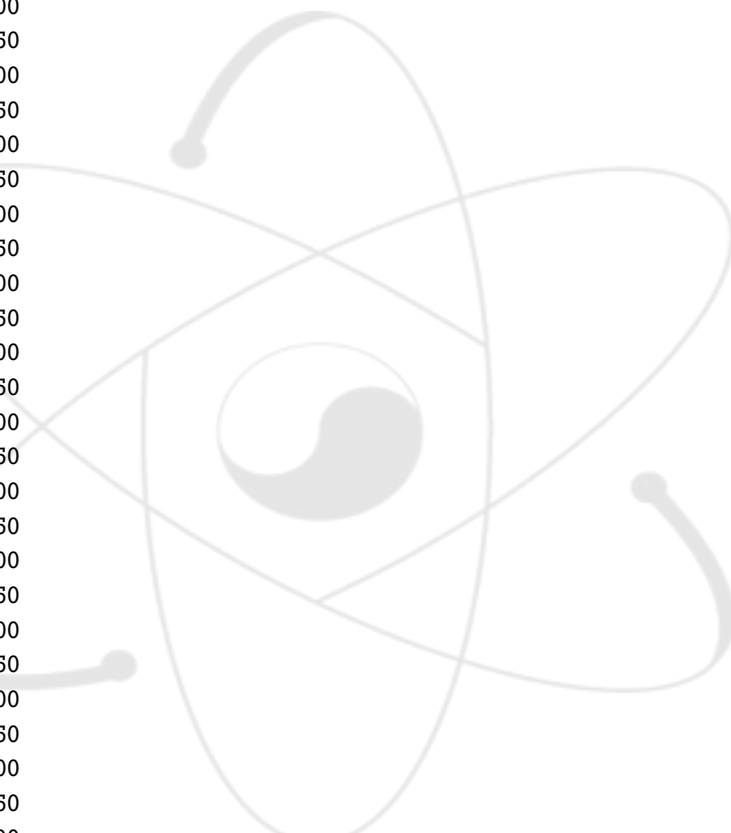
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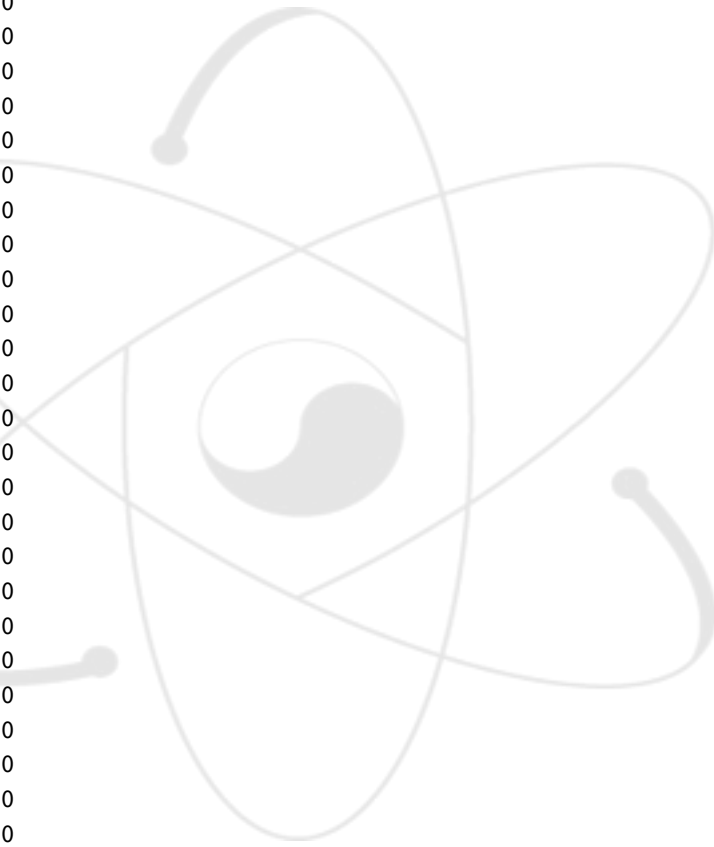
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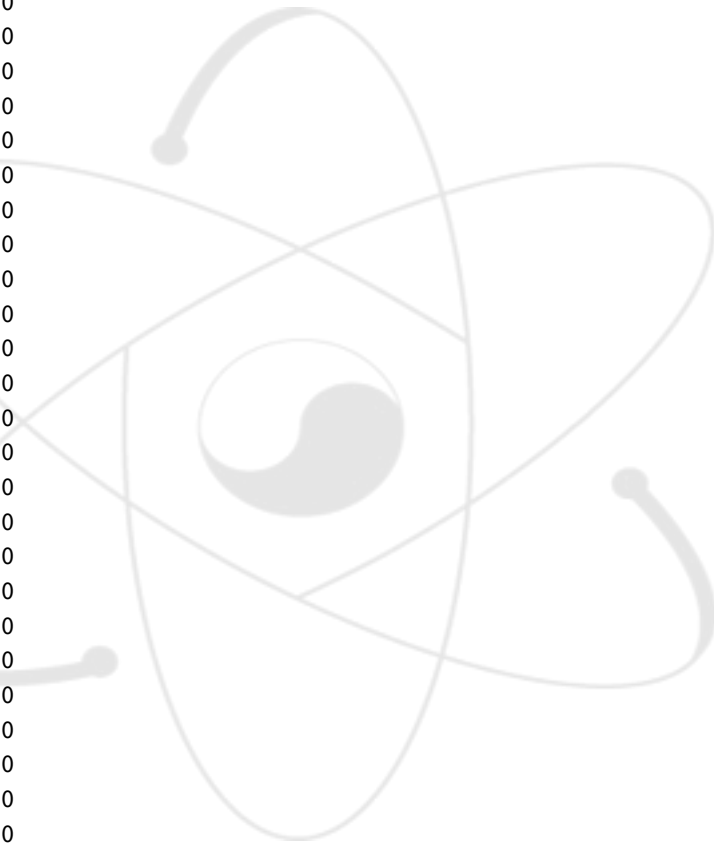
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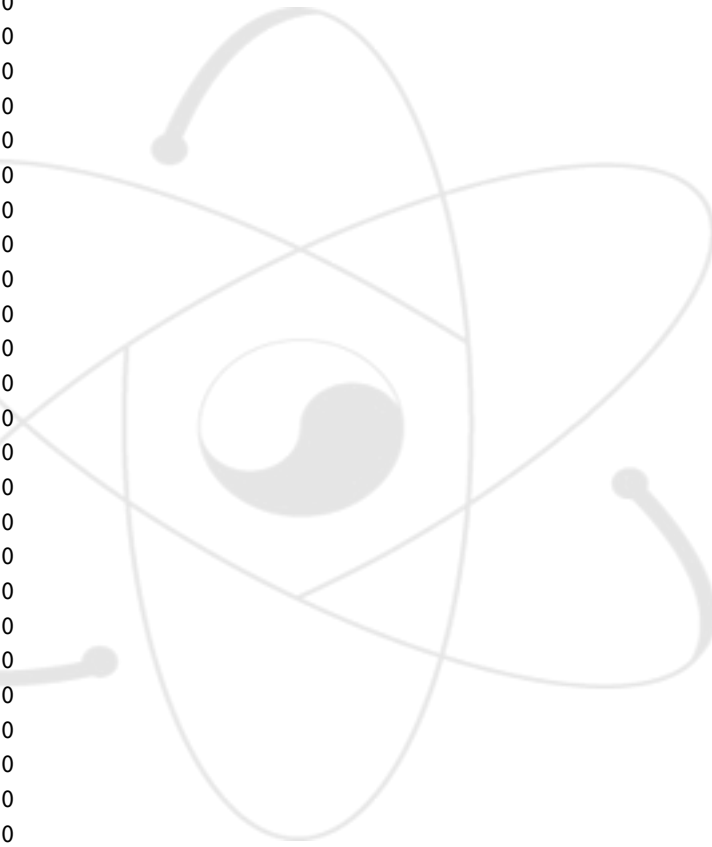
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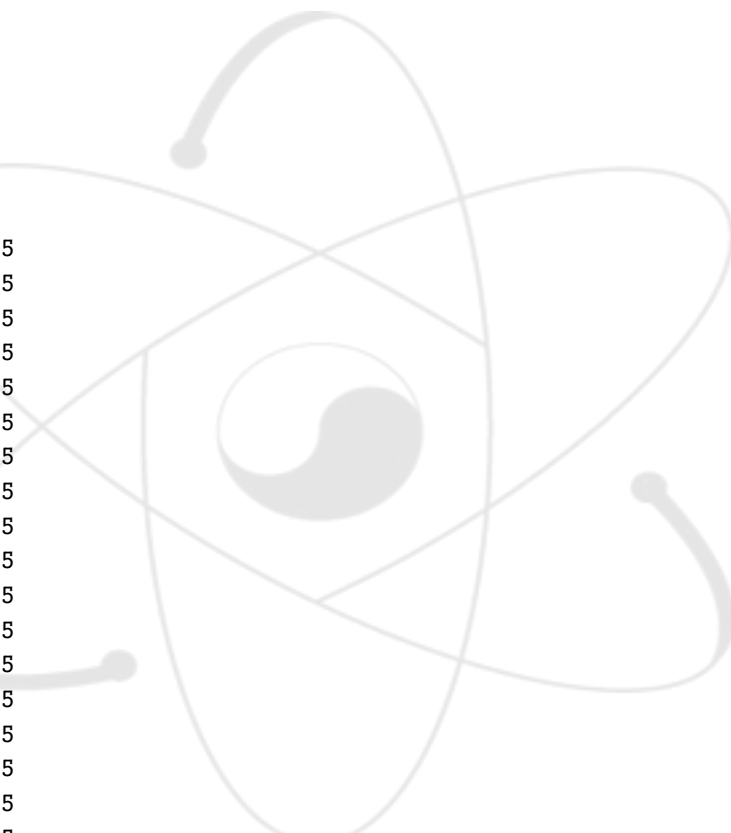
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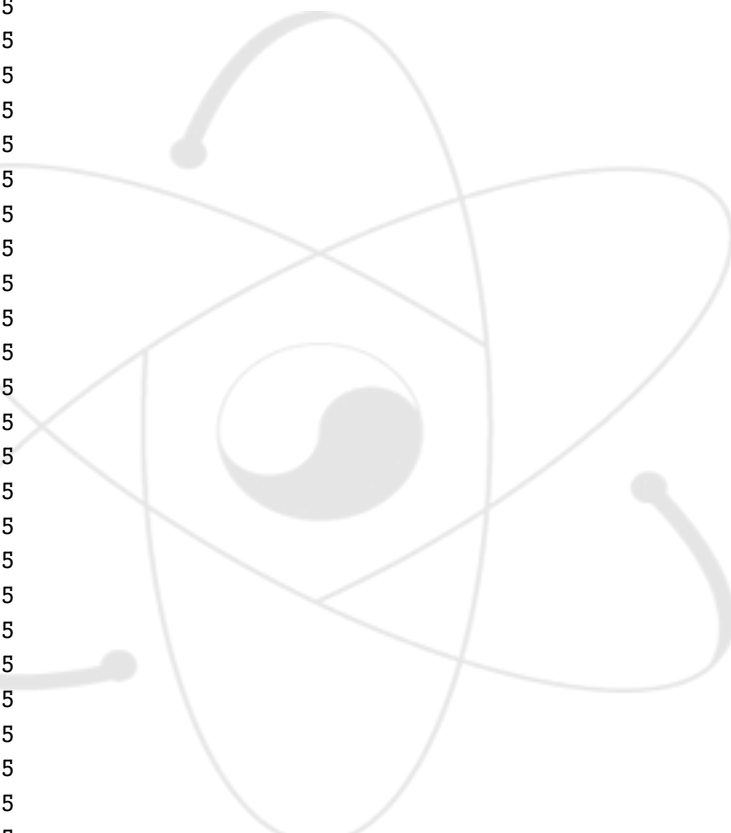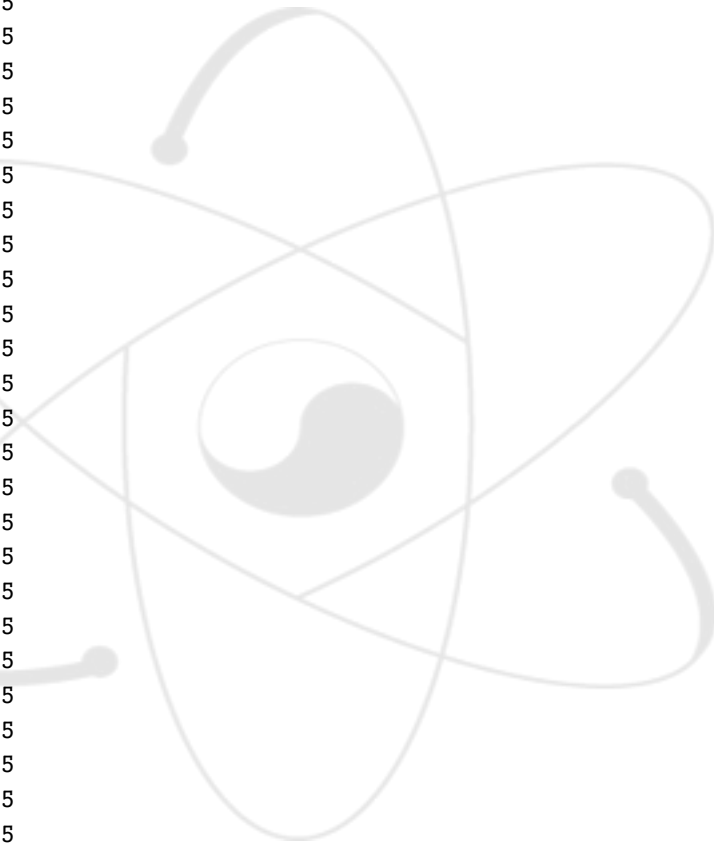
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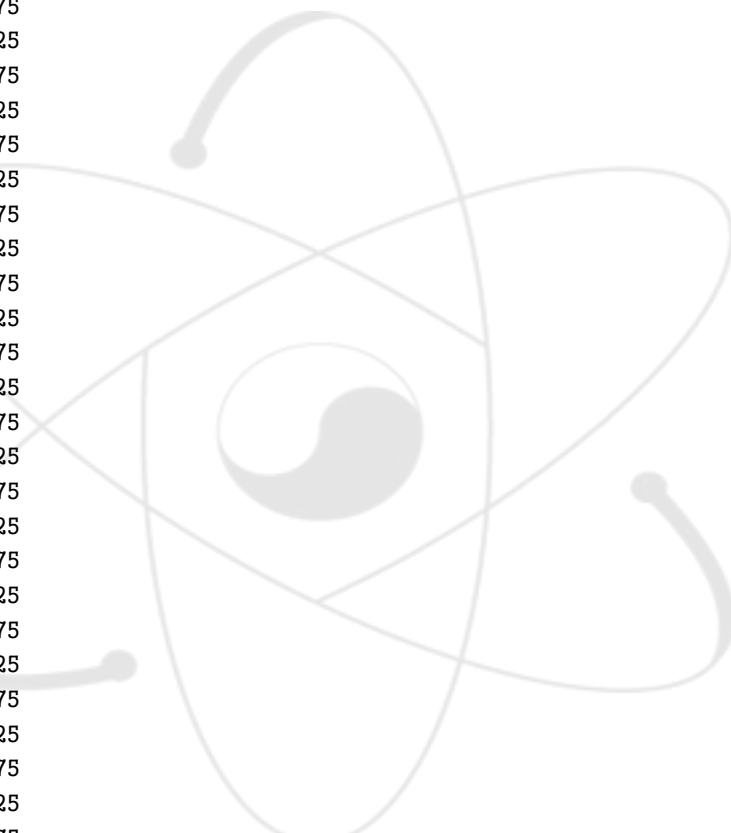
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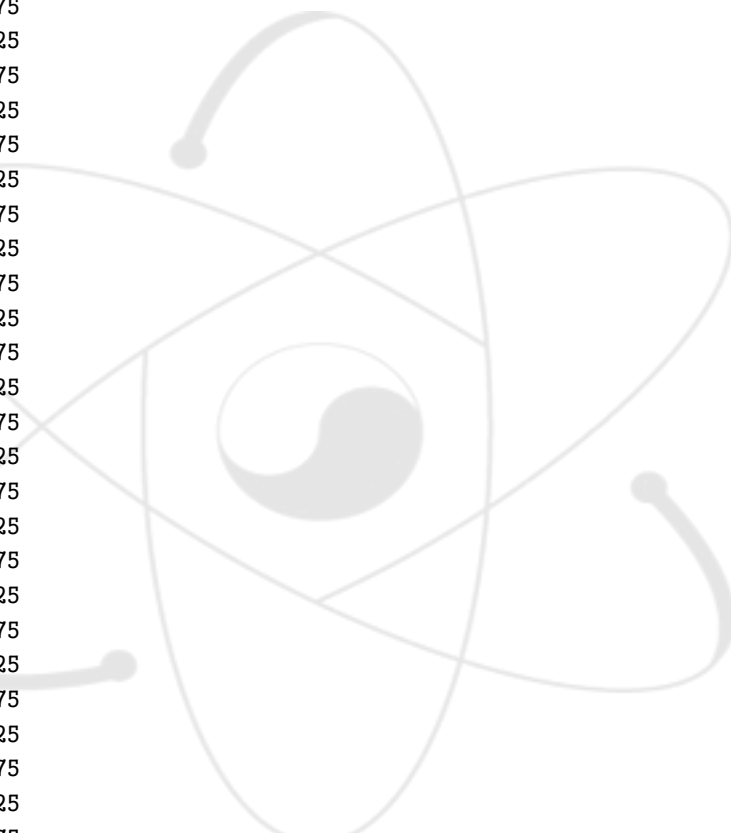
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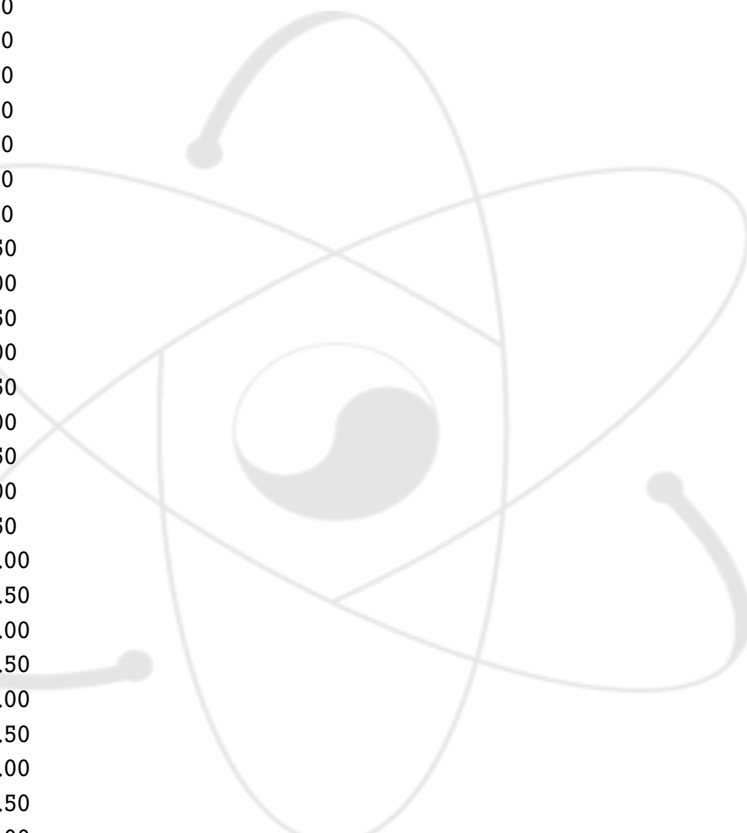
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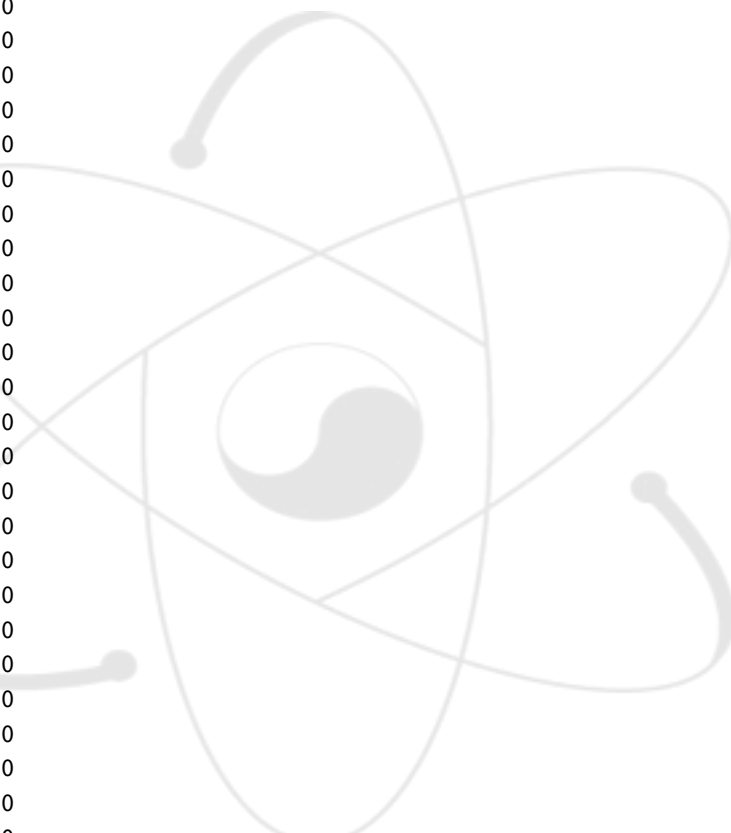
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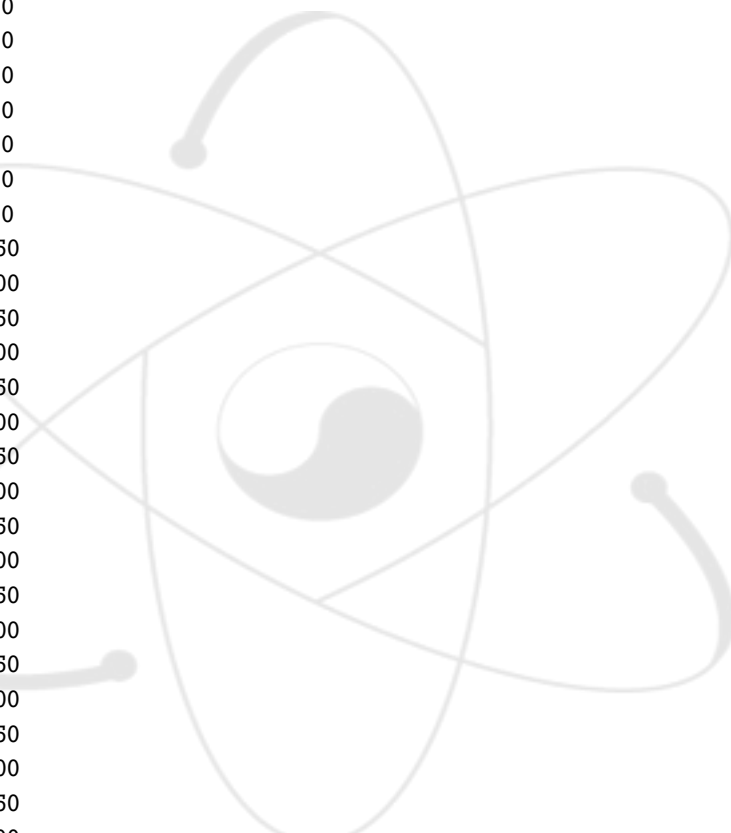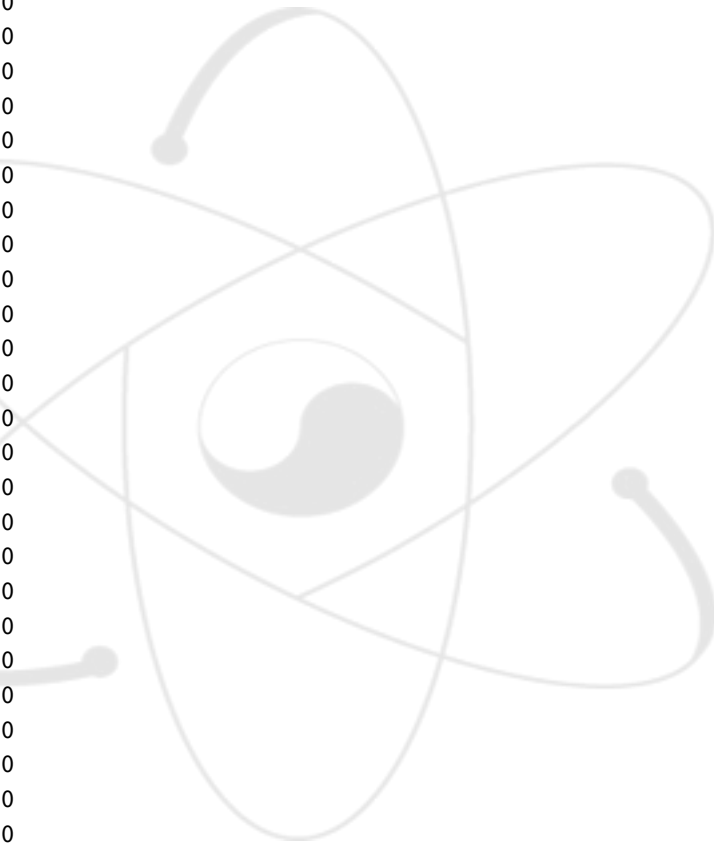
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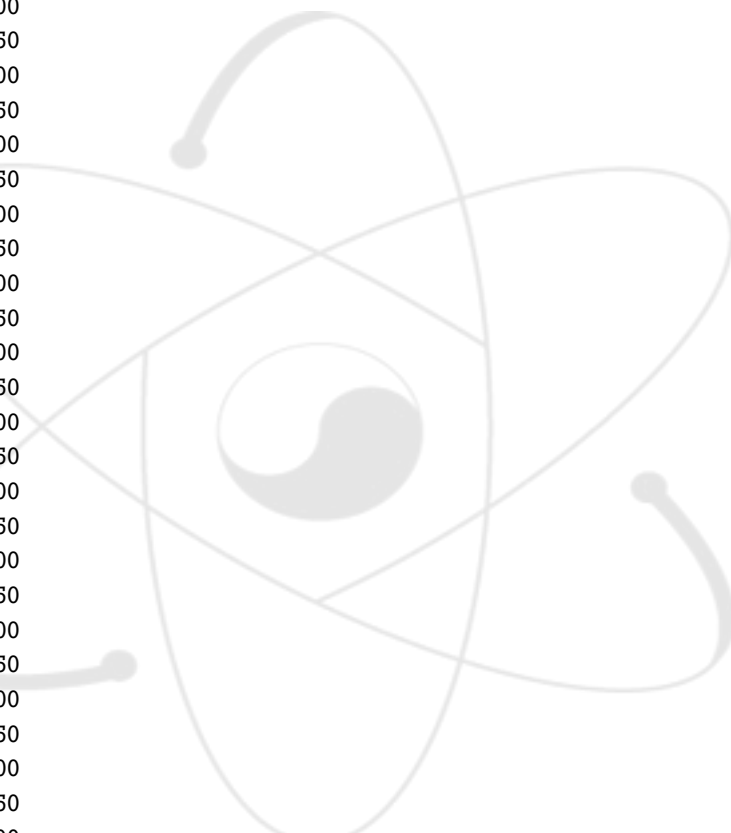
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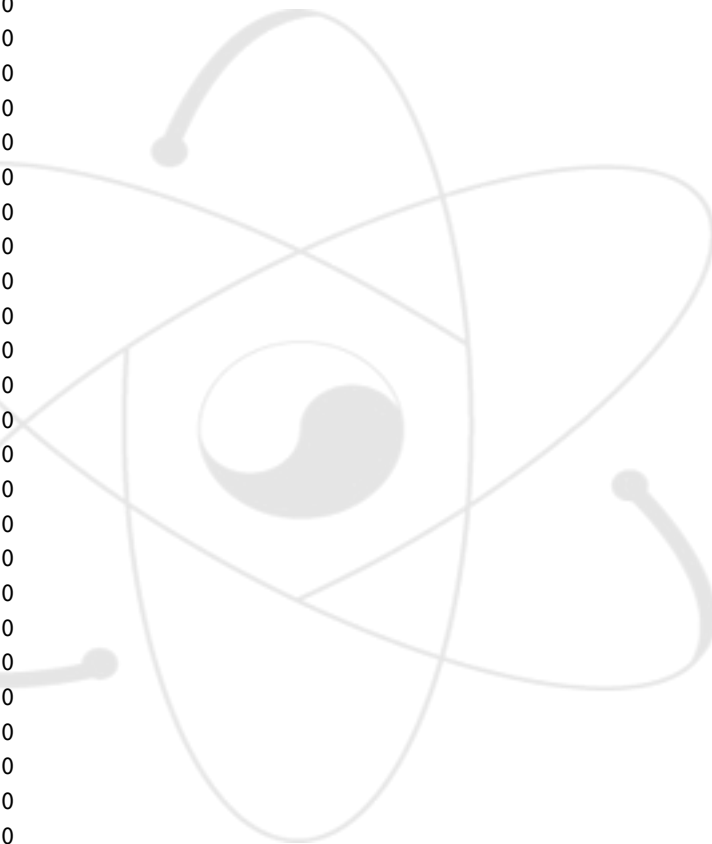
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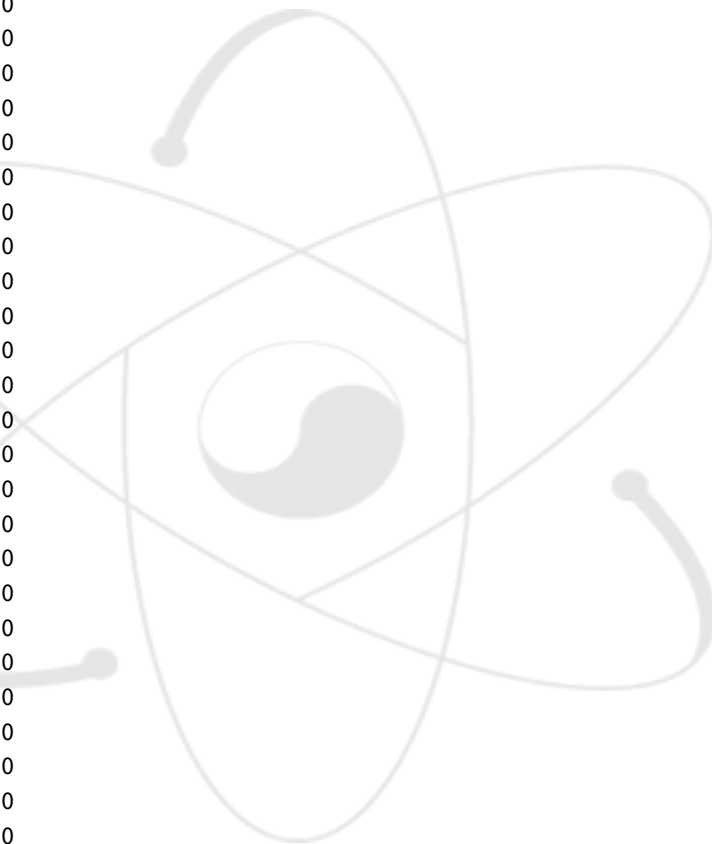
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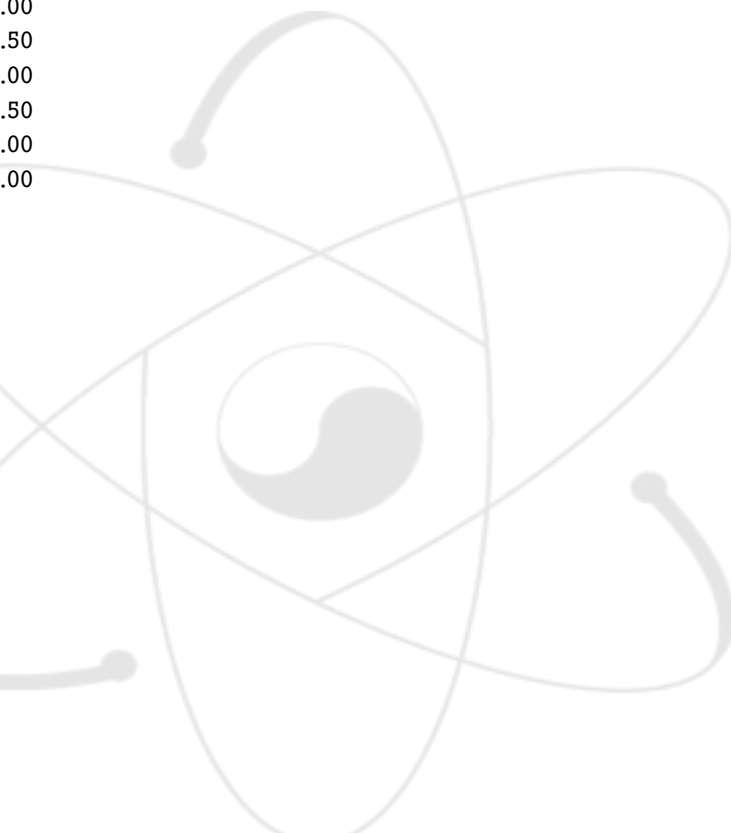
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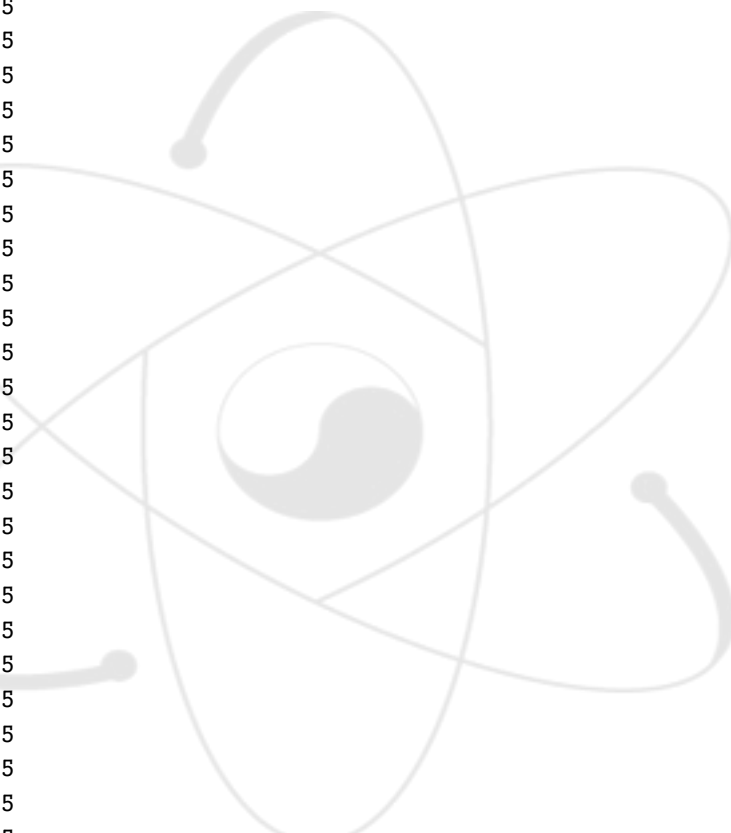
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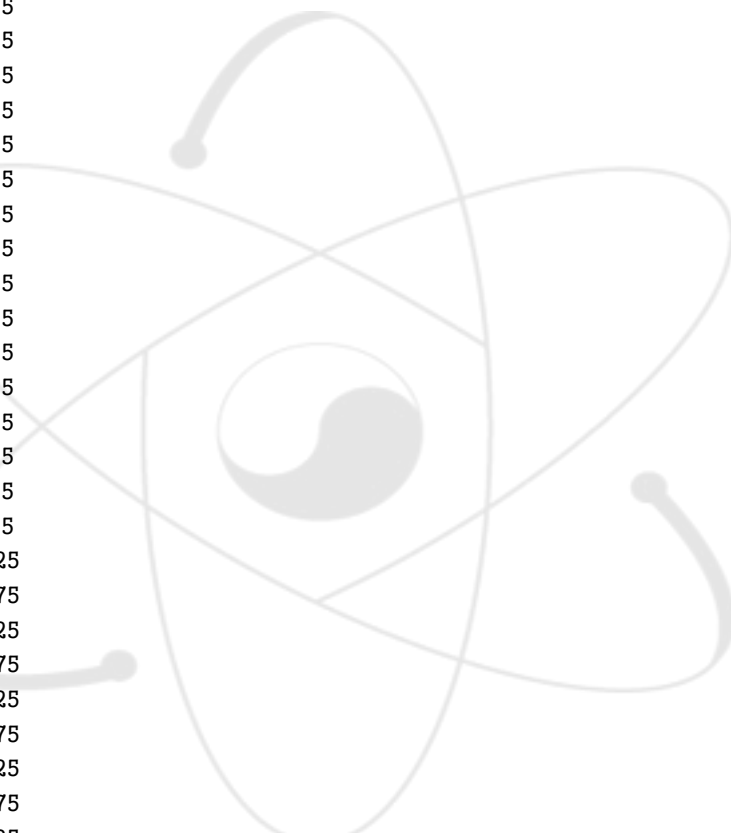
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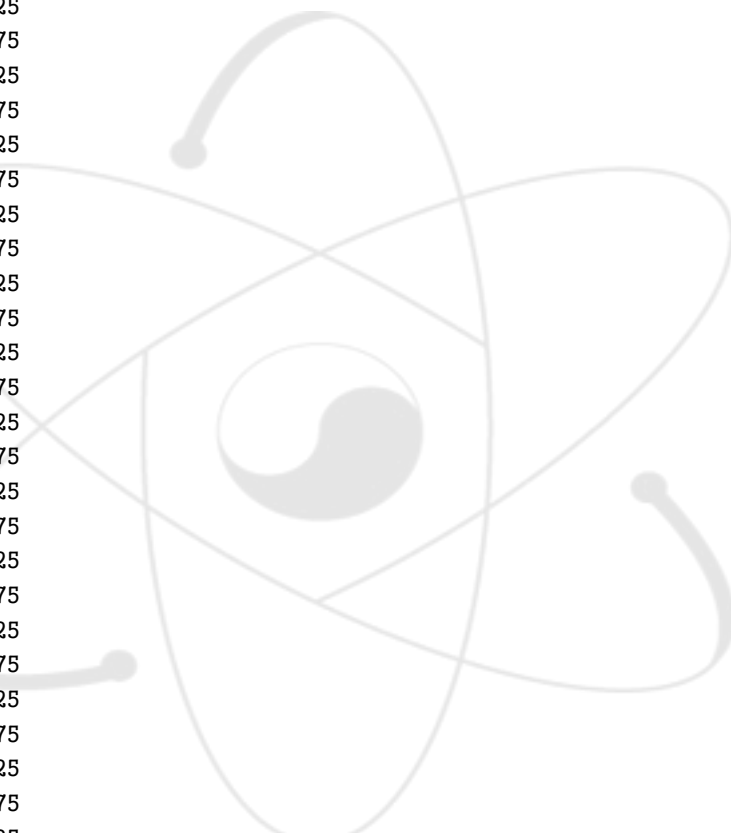
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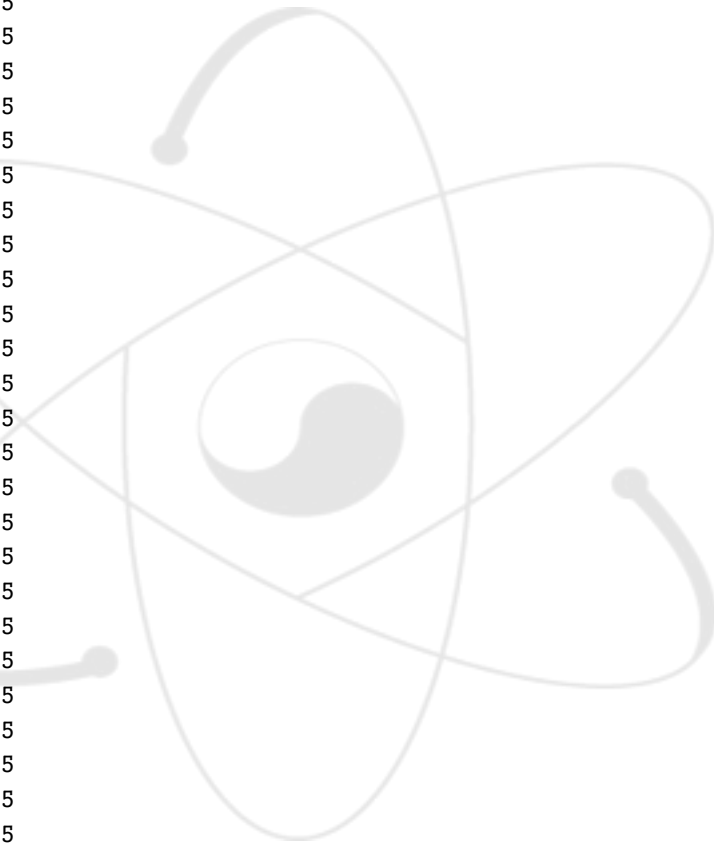
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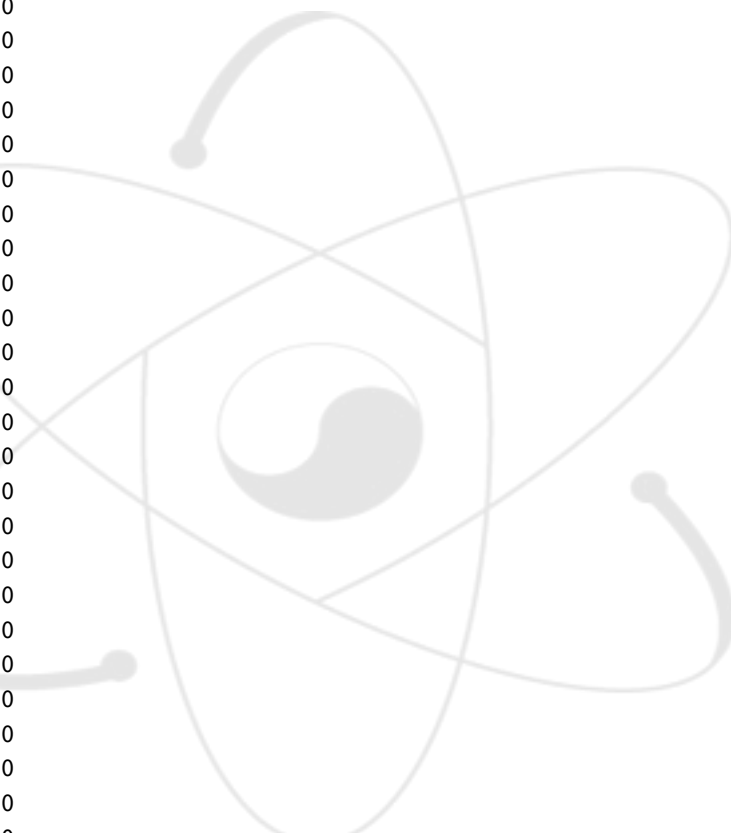
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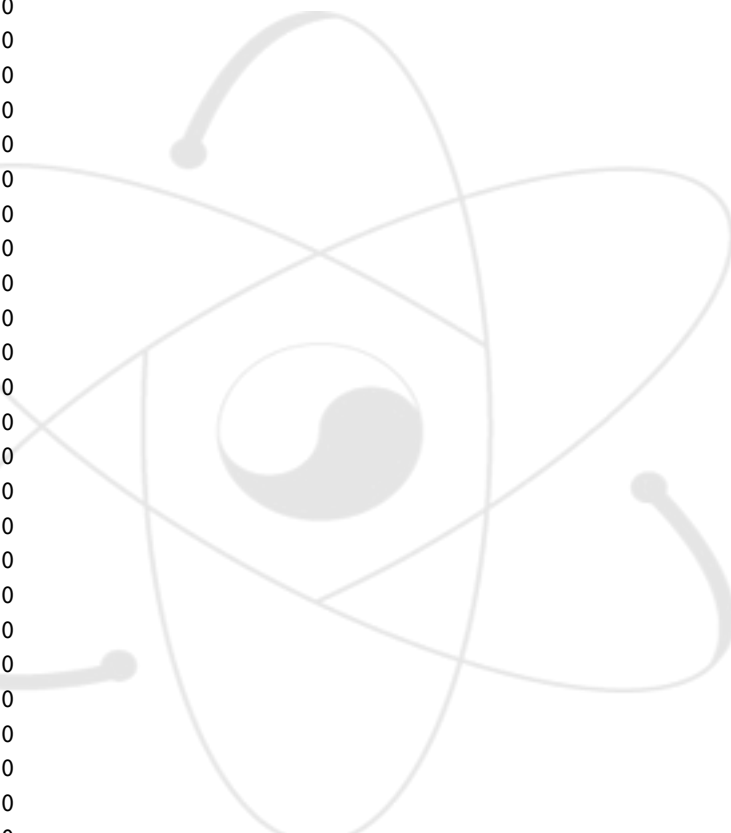
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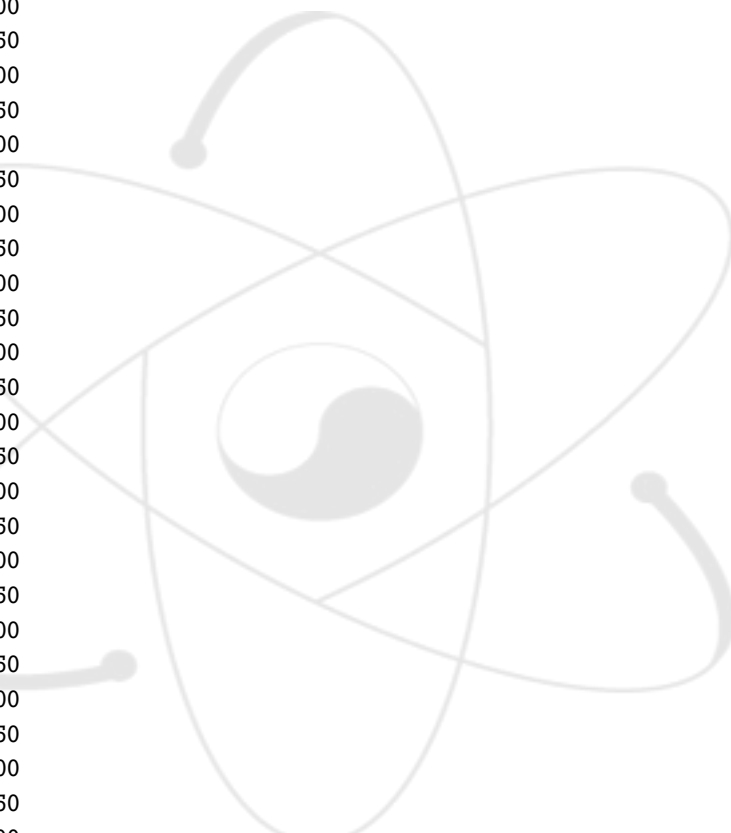
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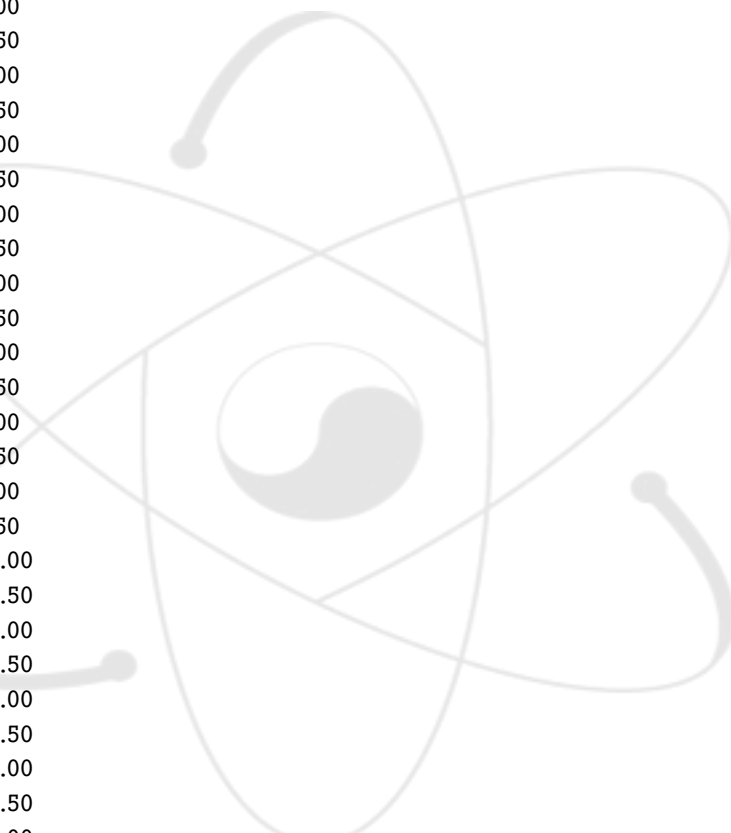
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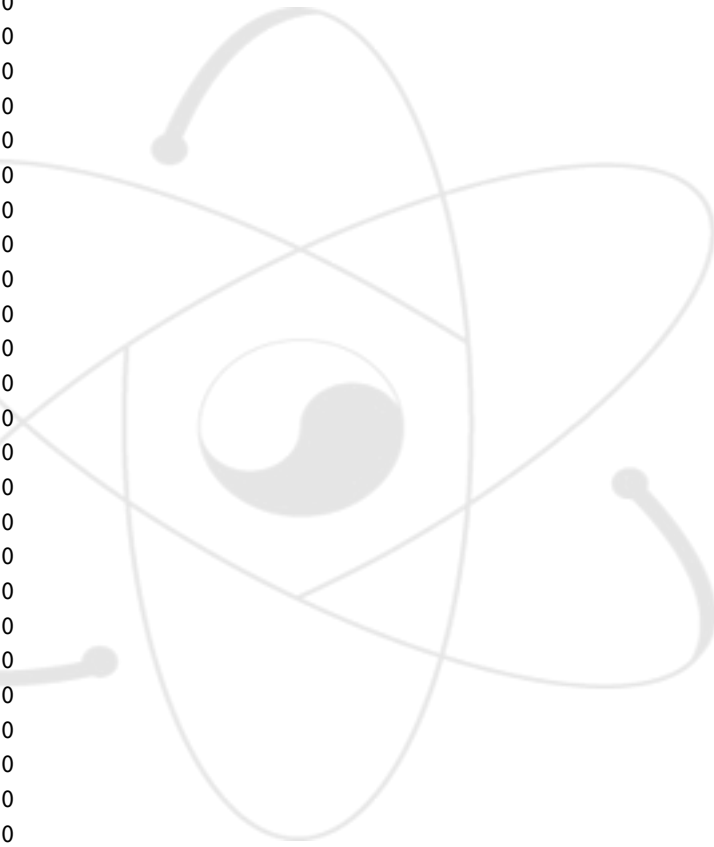
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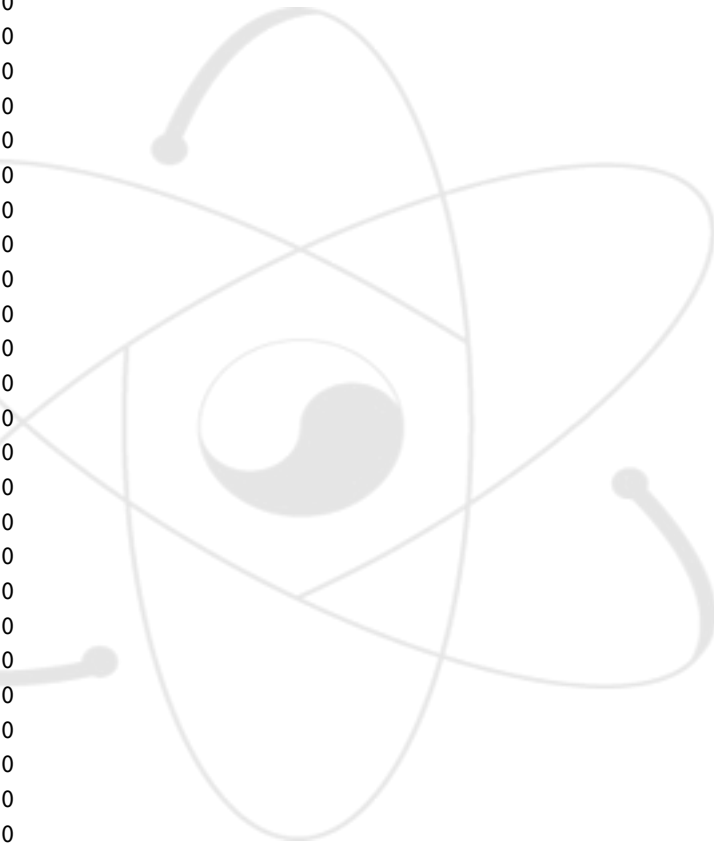
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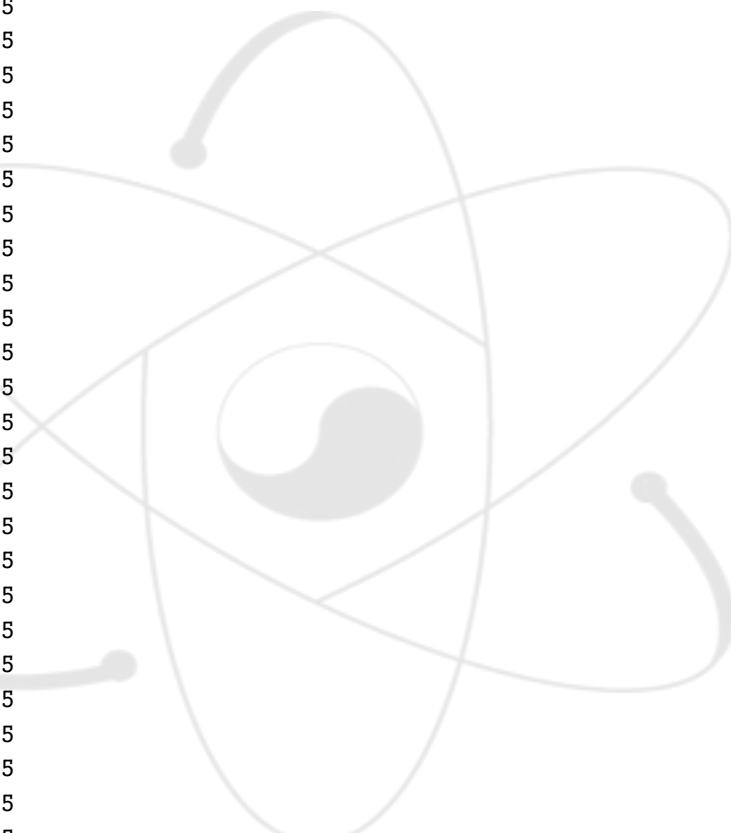
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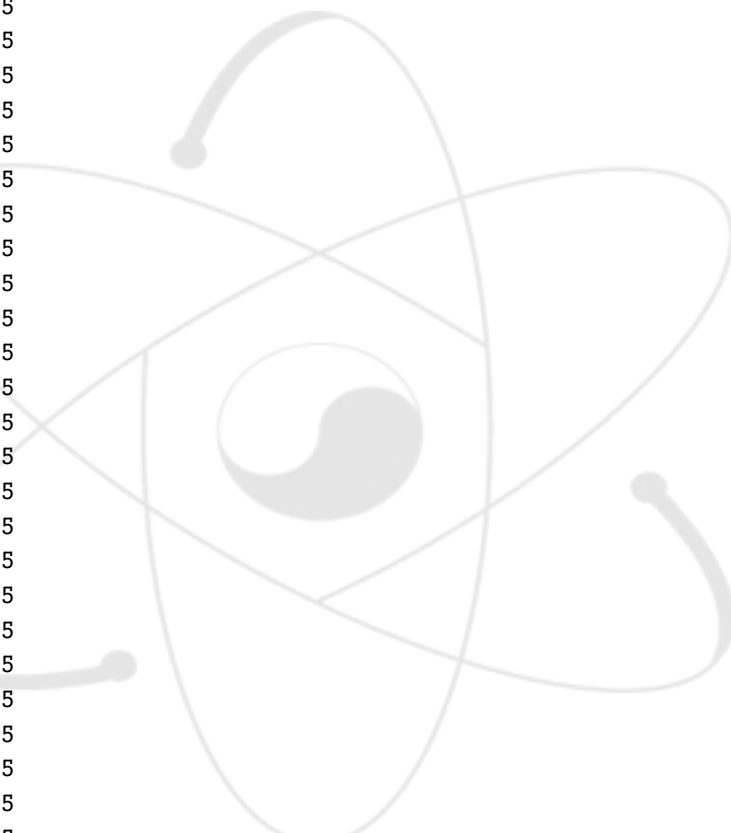
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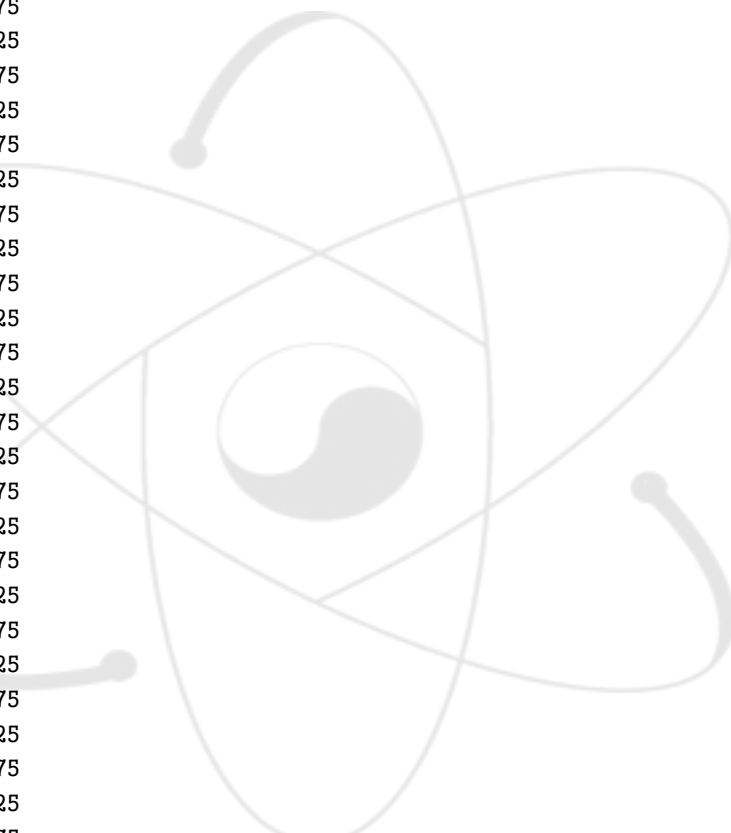
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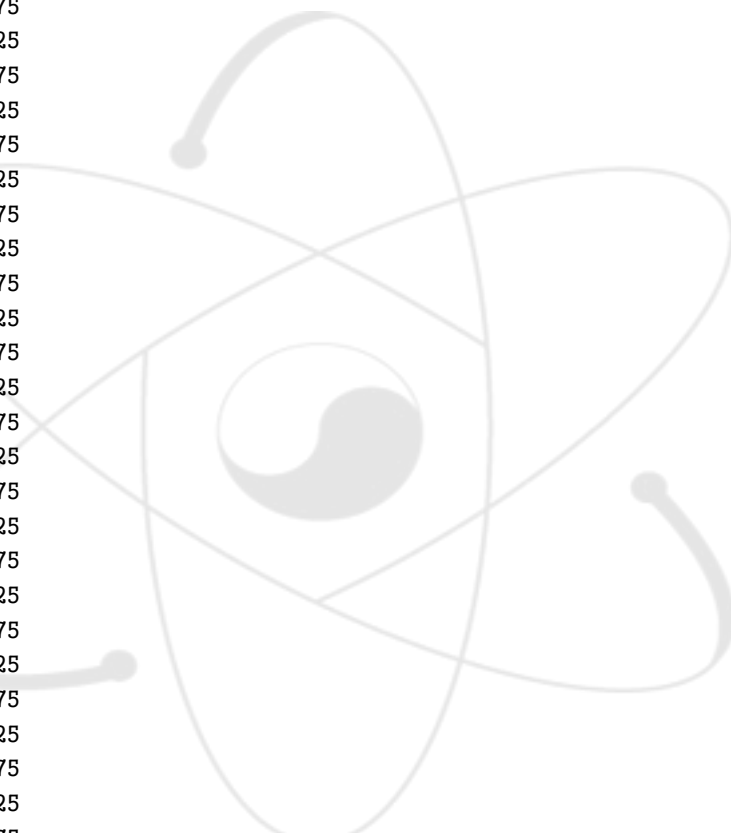
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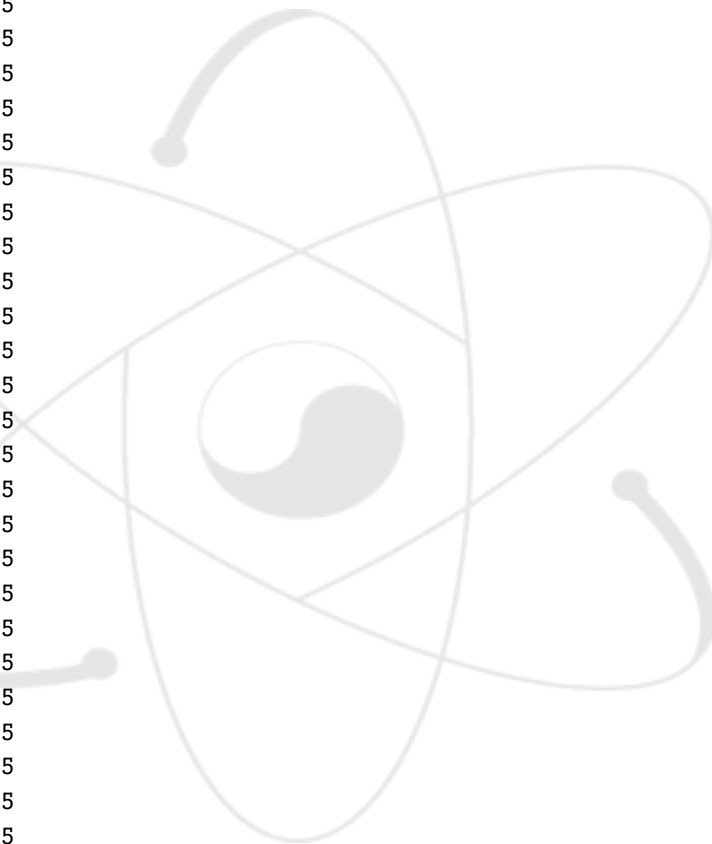
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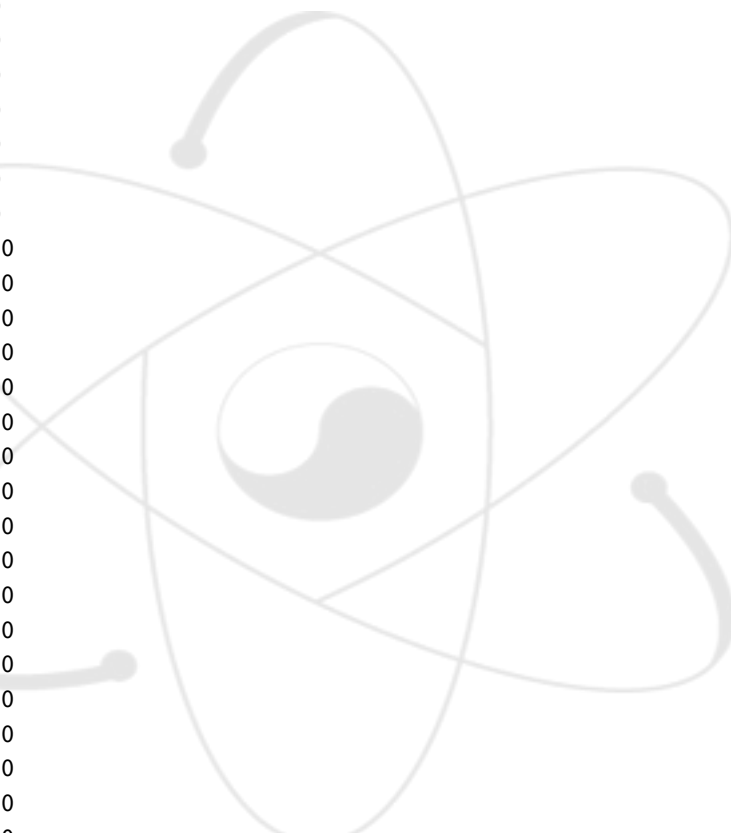
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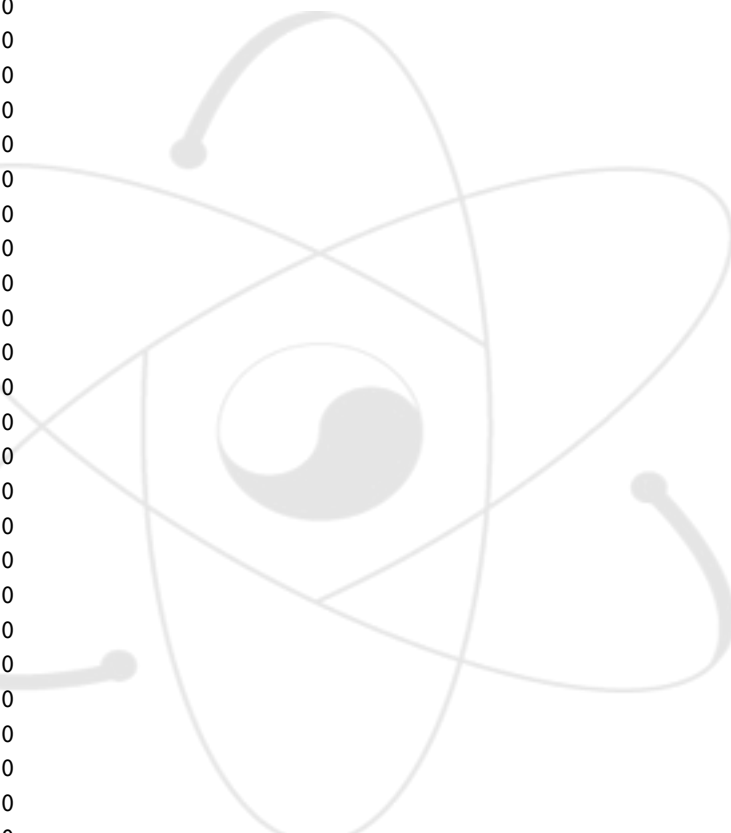
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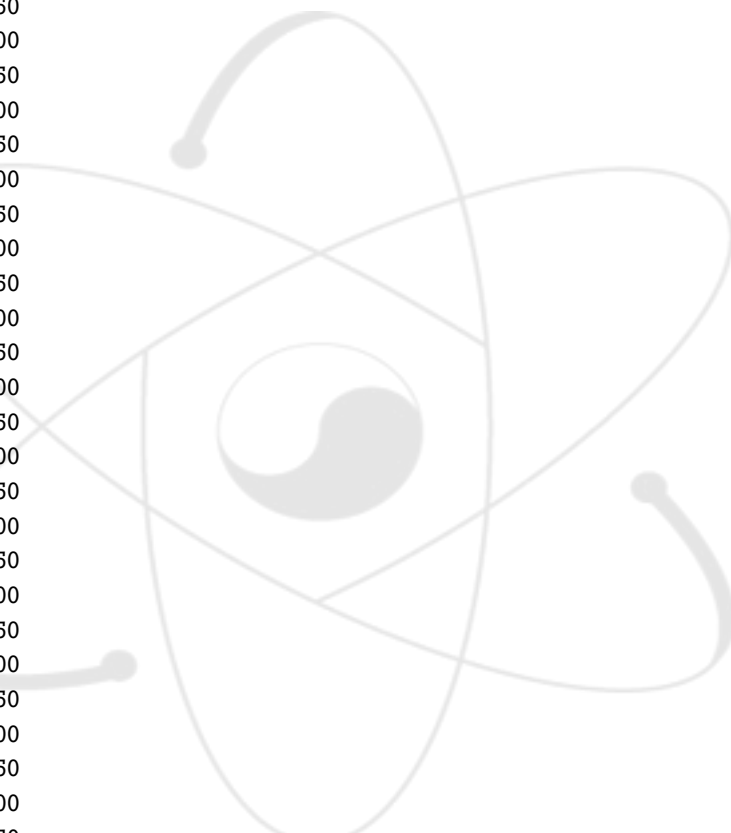
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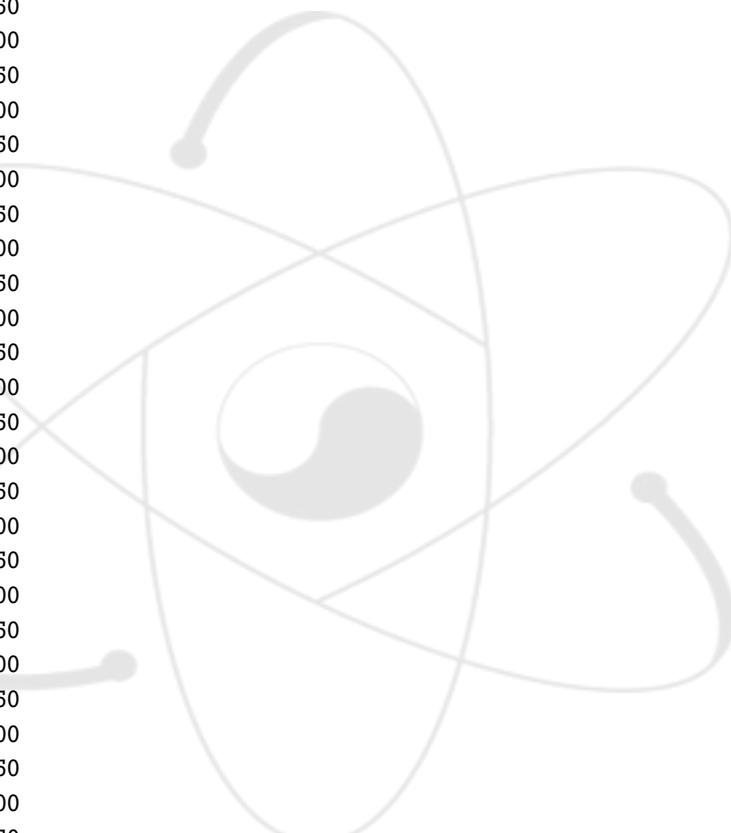
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1845,7.176651321,101.50
1854,7.176680744,102.00
1863,7.176711345,102.50
1872,7.176743113,103.00
1881,7.176776039,103.50
1890,7.176810113,104.00
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1926,7.176957677,106.00
1935,7.176997329,106.50
1944,7.177038063,107.00
1953,7.177079864,107.50
1962,7.177122722,108.00
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1980,7.177211553,109.00
1989,7.177257499,109.50
1998,7.177304447,110.00
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2043,7.177553708,112.50
2052,7.177606358,113.00
2061,7.177659905,113.50
2070,7.177714332,114.00
2079,7.177769622,114.50
2088,7.177825758,115.00
2097,7.177882724,115.50
2106,7.177940503,116.00
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2124,7.178058426,117.00
2133,7.178118535,117.50
2142,7.178179385,118.00
2151,7.178240956,118.50
2160,7.178303232,119.00
2169,7.178366191,119.50
2178,7.178429817,120.00
2187,7.178494088,120.50
2196,7.178558986,121.00
2205,7.178624491,121.50
2214,7.178690583,122.00
2223,7.178757242,122.50
2232,7.178824447,123.00
2241,7.178892178,123.50
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2259,7.179029137,124.50
2268,7.179098323,125.00
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2277,7.179167952,125.50
2286,7.179238003,126.00
2295,7.179308454,126.50
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2313,7.179450472,127.50
2322,7.179521995,128.00
2331,7.179593833,128.50
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2367,7.179883885,130.50
2376,7.179956964,131.00
2385,7.180030224,131.50
2394,7.180103643,132.00
2403,7.180177200,132.50
2412,7.180250871,133.00
2421,7.180324635,133.50
2430,7.180398468,134.00
2439,7.180472348,134.50
2448,7.180546254,135.00
2457,7.180620161,135.50
2466,7.180694049,136.00
2475,7.180767894,136.50
2484,7.180841673,137.00
2493,7.180915365,137.50
2502,7.180988946,138.00
2511,7.181062395,138.50
2520,7.181135689,139.00
2529,7.181208806,139.50
2538,7.181281723,140.00
2547,7.181354418,140.50
2556,7.181426869,141.00
2565,7.181499054,141.50
2574,7.181570951,142.00
2583,7.181642538,142.50
2592,7.181713793,143.00
2601,7.181784694,143.50
2610,7.181855220,144.00
2619,7.181925350,144.50
2628,7.181995061,145.00
2637,7.182064332,145.50
2646,7.182133144,146.00
2655,7.182201473,146.50
2664,7.182269300,147.00
2673,7.182336604,147.50
2682,7.182403365,148.00
2691,7.182469561,148.50
2700,7.182535173,149.00
2709,7.182600180,149.50
2718,7.182664564,150.00
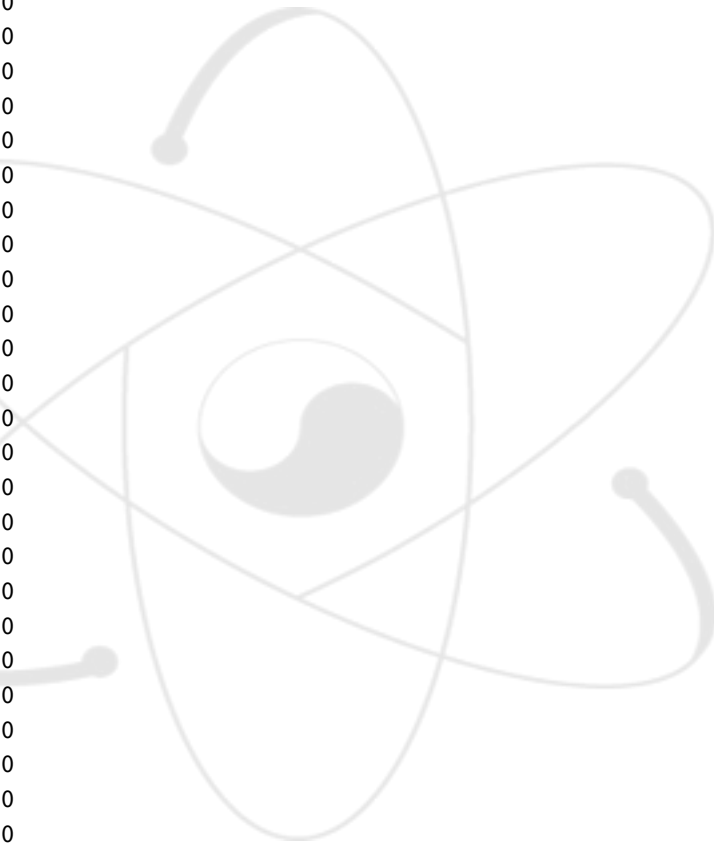
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2772,7.183036670,153.00
2781,7.183096145,153.50
2790,7.183154845,154.00
2799,7.183212751,154.50
2808,7.183269845,155.00
2817,7.183326111,155.50
2826,7.183381531,156.00
2835,7.183436087,156.50
2844,7.183489765,157.00
2853,7.183542546,157.50
2862,7.183594415,158.00
2871,7.183645356,158.50
2880,7.183695354,159.00
2889,7.183744393,159.50
2898,7.183792458,160.00
2907,7.183839534,160.50
2916,7.183885607,161.00
2925,7.183930664,161.50
2934,7.183974689,162.00
2943,7.184017671,162.50
2952,7.184059594,163.00
2961,7.184100448,163.50
2970,7.184140219,164.00
2979,7.184178895,164.50
2988,7.184216464,165.00
2997,7.184252915,165.50
3006,7.184288236,166.00
3015,7.184322417,166.50
3024,7.184355448,167.00
3033,7.184387317,167.50
3042,7.184418016,168.00
3051,7.184447535,168.50
3060,7.184475866,169.00
3069,7.184502998,169.50
3078,7.184528925,170.00
3087,7.184553637,170.50
3096,7.184577129,171.00
3105,7.184599391,171.50
3114,7.184620418,172.00
3123,7.184640203,172.50
3132,7.184658740,173.00
3141,7.184676024,173.50
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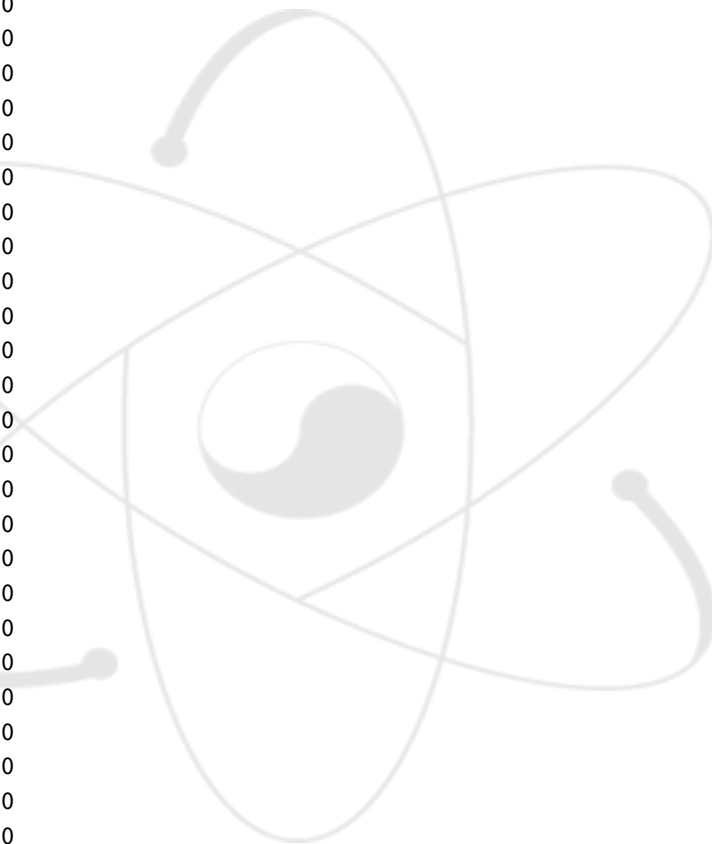
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3222,7.184774416,178.00
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3240,7.184782166,179.00
3249,7.184784104,179.50
3258,7.184784750,180.00
1,  7.488659750,0.25
2,  7.433409750,0.50
3,  7.378159750,0.50
4,  7.322909750,0.25
3261,7.488659750,179.75
3262,7.433409750,179.50
3263,7.378159750,179.50
3264,7.322909750,179.75
**PELLET NODES
*PARAMETER
co_move=0.08493
r=7.09985
r1=r/50.
r2=r*2./50.
r3=r*3./50.
r4=r*4./50.
r5=r*5./50.
r6=r*6./50.
r7=r*7./50.
r8=r*8./50.
r9=r*9./50.
r10=r*10./50.
r11=r*11./50.
r12=r*12./50.
r13=r*13./50.
r14=r*14./50.
r15=r*15./50.
r16=r*16./50.
r17=r*17./50.
r18=r*18./50.
r19=r*19./50.
r20=r*20./50.
r21=r*21./50.
r22=r*22./50.
r23=r*23./50.
r24=r*24./50.
r25=r*25./50.
r26=r*26./50.
r27=r*27./50.
r28=r*28./50.
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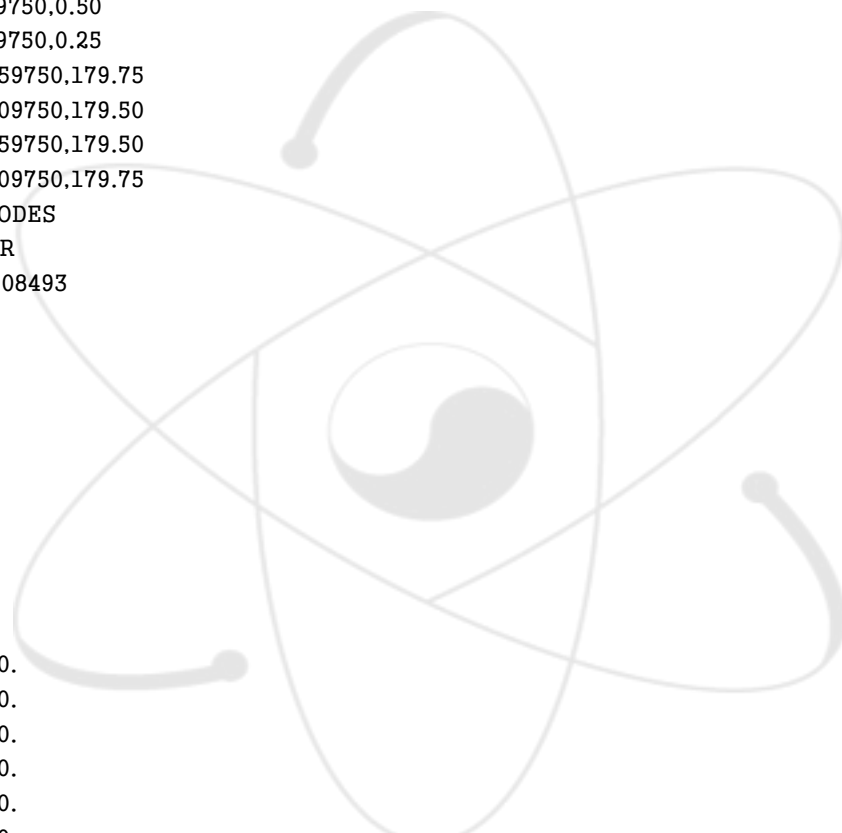
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r29=r*29./50.
r30=r*30./50.
r31=r*31./50.
r32=r*32./50.
r33=r*33./50.
r34=r*34./50.
r35=r*35./50.
r36=r*36./50.
r37=r*37./50.
r38=r*38./50.
r39=r*39./50.
r40=r*40./50.
r41=r*41./50.
r42=r*42./50.
r43=r*43./50.
r44=r*44./50.
r45=r*45./50.
r46=r*46./50.
r47=r*47./50.
r48=r*48./50.
r49=r*49./50.
r50=r*50./50.
g1=180./3.
g2=180./6.
g3=180./9.
g4=180./12.
g5=180./15.
g6=180./18.
g7=180./21.
g8=180./24.
g9=180./27.
g10=180./30.
g11=180./33.
g12=180./36.
g13=180./39.
g14=180./42.
g15=180./45.
g16=180./48.
g17=180./51.
g18=180./54.
g19=180./57.
g20=180./60.
g21=180./63.
g22=180./66.
g23=180./69.
g24=180./72.
g25=180./75.
g26=180./78.
g27=180./81.
g28=180./84.
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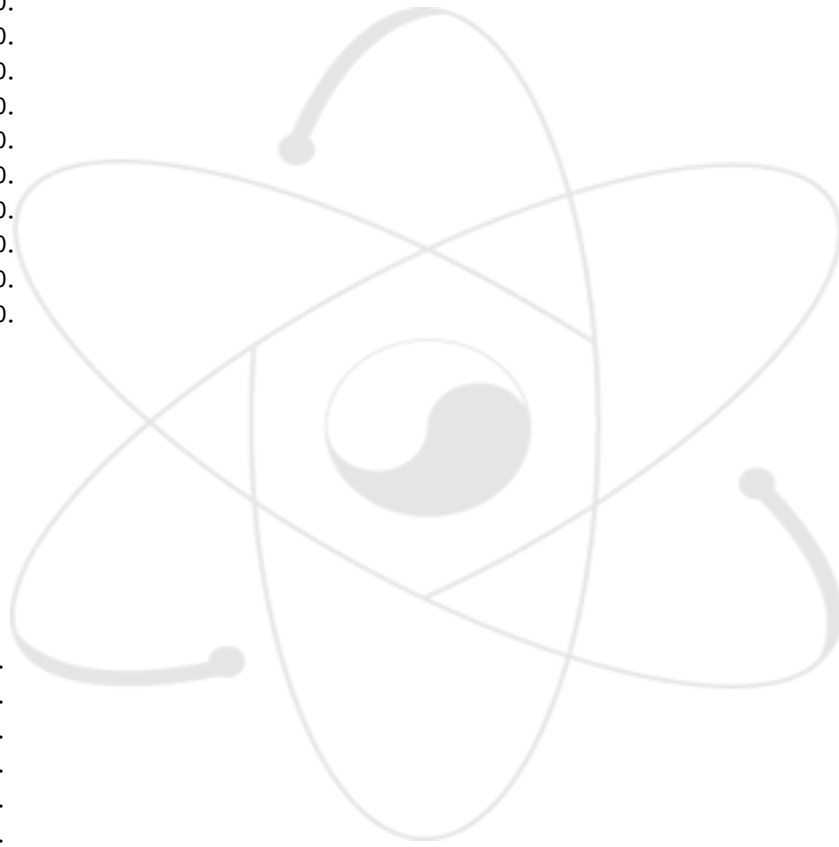
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g29=180./87.
g30=180./90.
g31=180./93.
g32=180./96.
g33=180./99.
g34=180./102.
g35=180./105.
g36=180./108.
g37=180./111.
g38=180./114.
g39=180./117.
g40=180./120.
g41=180./123.
g42=180./126.
g43=180./129.
g44=180./132.
g45=180./135.
g46=180./138.
g47=180./141.
g48=180./144.
g49=180./147.
g50=180./150.
*SYSTEM
<co_move>, 0., 0.
*NODE, NSET=NP10, SYSTEM=C
4001, 0.0, 0.0
*NODE, NSET=NP11, SYSTEM=C
4002, <r1>, 0.0
*NCOPY, SHIFT, NEW SET=NP12, OLD SET=NP11, CHANGE NUMBER=1, MULTIPLE=3
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 60.
*NODE, NSET=NP21, SYSTEM=C
4006, <r2>, 0.0
*NCOPY, SHIFT, NEW SET=NP22, OLD SET=NP21, CHANGE NUMBER=1, MULTIPLE=6
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 30.
*NODE, NSET=NP31, SYSTEM=C
4013, <r3>, 0.0
*NCOPY, SHIFT, NEW SET=NP32, OLD SET=NP31, CHANGE NUMBER=1, MULTIPLE=9
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 20.
*NODE, NSET=NP41, SYSTEM=C
4023, <r4>, 0.0
*NCOPY, SHIFT, NEW SET=NP42, OLD SET=NP41, CHANGE NUMBER=1, MULTIPLE=12
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 15.
*NODE, NSET=NP51, SYSTEM=C
4036, <r5>, 0.0
*NCOPY, SHIFT, NEW SET=NP52, OLD SET=NP51, CHANGE NUMBER=1, MULTIPLE=15
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0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 12.
*NODE, NSET=NP61, SYSTEM=C
4052, <r6>, 0.0
*NCOPY, SHIFT, NEW SET=NP62, OLD SET=NP61, CHANGE NUMBER=1, MULTIPLE=18
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 10.
*NODE, NSET=NP71, SYSTEM=C
4071, <r7>, 0.0
*NCOPY, SHIFT, NEW SET=NP72, OLD SET=NP71, CHANGE NUMBER=1, MULTIPLE=21
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 8.571428571
*NODE, NSET=NP81, SYSTEM=C
4093, <r8>, 0.0
*NCOPY, SHIFT, NEW SET=NP82, OLD SET=NP81, CHANGE NUMBER=1, MULTIPLE=24
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 7.5
*NODE, NSET=NP91
4118, <r9>, 0.0
*NCOPY, SHIFT, NEW SET=NP92, OLD SET=NP91, CHANGE NUMBER=1, MULTIPLE=27
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 6.666666667
*NODE, NSET=NP101
4146, <r10>, 0.0
*NCOPY, SHIFT, NEW SET=NP102, OLD SET=NP101, CHANGE NUMBER=1, MULTIPLE=30
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 6.
*NODE, NSET=NP111
4177, <r11>, 0.0
*NCOPY, SHIFT, NEW SET=NP112, OLD SET=NP111, CHANGE NUMBER=1, MULTIPLE=33
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 5.454545455
*NODE, NSET=NP121
4211, <r12>, 0.0
*NCOPY, SHIFT, NEW SET=NP122, OLD SET=NP121, CHANGE NUMBER=1, MULTIPLE=36
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 5.
*NODE, NSET=NP131
4248, <r13>, 0.0
*NCOPY, SHIFT, NEW SET=NP132, OLD SET=NP131, CHANGE NUMBER=1, MULTIPLE=39
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 4.615384615

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*NODE, NSET=NP141
4288, <r14>, 0.0
*NCOPY, SHIFT, NEW SET=NP142, OLD SET=NP141, CHANGE NUMBER=1, MULTIPLE=42
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 4.285714286
*NODE, NSET=NP151
4331, <r15>, 0.0
*NCOPY, SHIFT, NEW SET=NP152, OLD SET=NP151, CHANGE NUMBER=1, MULTIPLE=45
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 4.
*NODE, NSET=NP161
4377, <r16>, 0.0
*NCOPY, SHIFT, NEW SET=NP162, OLD SET=NP161, CHANGE NUMBER=1, MULTIPLE=48
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 3.75
*NODE, NSET=NP171
4426, <r17>, 0.0
*NCOPY, SHIFT, NEW SET=NP172, OLD SET=NP171, CHANGE NUMBER=1, MULTIPLE=51
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 3.529411765
*NODE, NSET=NP181
4478, <r18>, 0.0
*NCOPY, SHIFT, NEW SET=NP182, OLD SET=NP181, CHANGE NUMBER=1, MULTIPLE=54
0., 0., 0.
<co_move>, 0., 0., <co_move>, 0., 1., 3.333333333
*NODE, NSET=NP191
4533, <r19>, 0.0
*NCOPY, SHIFT, NEW SET=NP192, OLD SET=NP191, CHANGE NUMBER=1, MULTIPLE=57
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., 3.157894737
*NODE, NSET=NP201
4591, <r20>, 0.0
*NCOPY, SHIFT, NEW SET=NP202, OLD SET=NP201, CHANGE NUMBER=1, MULTIPLE=60
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., 3.0
*NODE, NSET=NP211
4652, <r21>, 0.0
*NCOPY, SHIFT, NEW SET=NP212, OLD SET=NP211, CHANGE NUMBER=1, MULTIPLE=63
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., 2.857142857
*NODE, NSET=NP221
4716, <r22>, 0.0
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*NCOPY, SHIFT, NEW SET=NP222, OLD SET=NP221, CHANGE NUMBER=1, MULTIPLE=66

0., 0., 0

<co_move>, 0., 0., <co_move>, 0., 1., 2.727272727

*NODE, NSET=NP231

4783, <r23>, 0.0

*NCOPY, SHIFT, NEW SET=NP232, OLD SET=NP231, CHANGE NUMBER=1, MULTIPLE=69

0., 0., 0

<co_move>, 0., 0., <co_move>, 0., 1., 2.608695652

*NODE, NSET=NP241

4853, <r24>, 0.0

*NCOPY, SHIFT, NEW SET=NP242, OLD SET=NP241, CHANGE NUMBER=1, MULTIPLE=72

0., 0., 0

<co_move>, 0., 0., <co_move>, 0., 1., 2.5

*NODE, NSET=NP251

4926, <r25>, 0.0

*NCOPY, SHIFT, NEW SET=NP252, OLD SET=NP251, CHANGE NUMBER=1, MULTIPLE=75

0., 0., 0

<co_move>, 0., 0., <co_move>, 0., 1., 2.4

*NODE, NSET=NP261

5002, <r26>, 0.0

*NCOPY, SHIFT, NEW SET=NP262, OLD SET=NP261, CHANGE NUMBER=1, MULTIPLE=78

0., 0., 0

<co_move>, 0., 0., <co_move>, 0., 1., <g26>

*NODE, NSET=NP271

5081, <r27>, 0.0

*NCOPY, SHIFT, NEW SET=NP272, OLD SET=NP271, CHANGE NUMBER=1, MULTIPLE=81

0., 0., 0

<co_move>, 0., 0., <co_move>, 0., 1., <g27>

*NODE, NSET=NP281

5163, <r28>, 0.0

*NCOPY, SHIFT, NEW SET=NP282, OLD SET=NP281, CHANGE NUMBER=1, MULTIPLE=84

0., 0., 0

<co_move>, 0., 0., <co_move>, 0., 1., <g28>

*NODE, NSET=NP291

5248, <r29>, 0.0

*NCOPY, SHIFT, NEW SET=NP292, OLD SET=NP291, CHANGE NUMBER=1, MULTIPLE=87

0., 0., 0

<co_move>, 0., 0., <co_move>, 0., 1., <g29>

*NODE, NSET=NP301

5336, <r30>, 0.0

*NCOPY, SHIFT, NEW SET=NP302, OLD SET=NP301, CHANGE NUMBER=1, MULTIPLE=90

0., 0., 0

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<co_move>, 0., 0., <co_move>, 0., 1., <g30>
*NODE, NSET=NP311
5427, <r31>, 0.0
*NCOPY, SHIFT, NEW SET=NP312, OLD SET=NP311, CHANGE NUMBER=1, MULTIPLE=93
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g31>
*NODE, NSET=NP321
5521, <r32>, 0.0
*NCOPY, SHIFT, NEW SET=NP322, OLD SET=NP321, CHANGE NUMBER=1, MULTIPLE=96
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g32>
*NODE, NSET=NP331
5618, <r33>, 0.0
*NCOPY, SHIFT, NEW SET=NP332, OLD SET=NP331, CHANGE NUMBER=1, MULTIPLE=99
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g33>
*NODE, NSET=NP341
5718, <r34>, 0.0
*NCOPY, SHIFT, NEW SET=NP342, OLD SET=NP341, CHANGE NUMBER=1, MULTIPLE=102
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g34>
*NODE, NSET=NP351
5821, <r35>, 0.0
*NCOPY, SHIFT, NEW SET=NP352, OLD SET=NP351, CHANGE NUMBER=1, MULTIPLE=105
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g35>
*NODE, NSET=NP361
5927, <r36>, 0.0
*NCOPY, SHIFT, NEW SET=NP362, OLD SET=NP361, CHANGE NUMBER=1, MULTIPLE=108
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g36>
*NODE, NSET=NP371
6036, <r37>, 0.0
*NCOPY, SHIFT, NEW SET=NP372, OLD SET=NP371, CHANGE NUMBER=1, MULTIPLE=111
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g37>
*NODE, NSET=NP381
6148, <r38>, 0.0
*NCOPY, SHIFT, NEW SET=NP382, OLD SET=NP381, CHANGE NUMBER=1, MULTIPLE=114
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g38>
*NODE, NSET=NP391
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6263, <r39>, 0.0
*NCOPY, SHIFT, NEW SET=NP392, OLD SET=NP391, CHANGE NUMBER=1, MULTIPLE=117
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g39>
*NODE, NSET=NP401
6381, <r40>, 0.0
*NCOPY, SHIFT, NEW SET=NP402, OLD SET=NP401, CHANGE NUMBER=1, MULTIPLE=120
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g40>
*NODE, NSET=NP411
6502, <r41>, 0.0
*NCOPY, SHIFT, NEW SET=NP412, OLD SET=NP411, CHANGE NUMBER=1, MULTIPLE=123
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g41>
*NODE, NSET=NP421
6626, <r42>, 0.0
*NCOPY, SHIFT, NEW SET=NP422, OLD SET=NP421, CHANGE NUMBER=1, MULTIPLE=126
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g42>
*NODE, NSET=NP431
6753, <r43>, 0.0
*NCOPY, SHIFT, NEW SET=NP432, OLD SET=NP431, CHANGE NUMBER=1, MULTIPLE=129
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g43>
*NODE, NSET=NP441
6883, <r44>, 0.0
*NCOPY, SHIFT, NEW SET=NP442, OLD SET=NP441, CHANGE NUMBER=1, MULTIPLE=132
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g44>
*NODE, NSET=NP451
7016, <r45>, 0.0
*NCOPY, SHIFT, NEW SET=NP452, OLD SET=NP451, CHANGE NUMBER=1, MULTIPLE=135
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g45>
*NODE, NSET=NP461
7152, <r46>, 0.0
*NCOPY, SHIFT, NEW SET=NP462, OLD SET=NP461, CHANGE NUMBER=1, MULTIPLE=138
0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g46>
*NODE, NSET=NP471
7291, <r47>, 0.0
*NCOPY, SHIFT, NEW SET=NP472, OLD SET=NP471, CHANGE NUMBER=1, MULTIPLE=141

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0., 0., 0
<co_move>, 0., 0., <co_move>, 0., 1., <g47>
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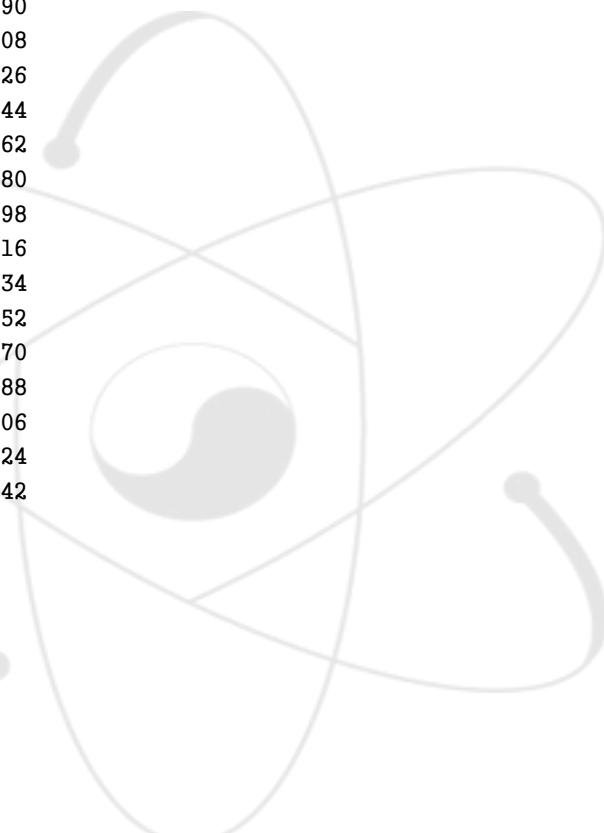
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3875,7575,7874,7577,7723,7724,7576
**
*SOLID SECTION,MATERIAL=MPELLET,ELSET=EPELLET
1.0    ,      ,
*MATERIAL,NAME=MPELLET
*ELASTIC
0.17E6, 0.1
*PLASTIC
250.0,  0.0
**SPRING ELEMENT
**ELEMENT,ELSET=ESPRING,TYPE=SPRINGA
**4000, 15, 9000
**SPRING,ELSET=ESPRING
**
**1.0,
**APPLY BOUNDARY CONDITIONS
*NSET,NSET=NFIX
4001, 16
**(Attach to the above line when needed − ", 9000")
*NSET,NSET=NROLLER
10,12,13,14,15,16,18,3258,3256,3246,3236,3244,3252,3250,4002,
4006,4013,4023,4036,4052,4071,4093,4118,4146,4177,4211,4248,
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6035,6147,6262,6380,6501,6625,6752,6882,7015,7151,7290,7432,
7577,7725,7876
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*BOUNDARY
NFIX,1,2
NROLLER,ysymm
**ELEMENTS FOR PRESSURE APPLICATION
*ELSET,GENERATE,ELSET=ELOAD
6, 185, 1
**CONTACT DEFINITION
*ELSET,GENERATE,ELSET=EINNER
1258, 1437, 1
*ELSET,GENERATE,ELSET=EOUTER
2301,2325,1
2626,2650,1
2951,2975,1
*SURFACE,NAME=SHEATH,TYPE=ELEMENT
EINNER, S1
*SURFACE,NAME=PELLET,TYPE=ELEMENT
EOUTER, S2
*CONTACT PAIR,INTERACTION=NOFRIC
SHEATH, PELLET
*SURFACE INTERACTION,NAME=NOFRIC
1.0     ,      ,
**SURFACE BEHAVIOR, PRESSURE-OVERCLOSURE=exponential
**0.2, 3.0,
*RESTART,FREQUENCY=100,WRITE
*NSET,NSET=NPRINT,generate
3187, 3250, 9
1603, 1657, 9
*ELSET,GENERATE,ELSET=EPRINT
1430, 1437, 1
180, 185, 1
**
*STEP,INC=200,nlgeom
STEP1
*STATIC,stabilize
0.01, 1.0
*DLOAD
ELOAD, P2, 6.995
*NODE PRINT,FREQUENCY=100,NSET=NPRINT
U1, U2
*EL PRINT,FREQUENCY=100,ELSET=EPRINT
E11, E22, E12, S11, S22, S12, MISES
*END STEP
**
*STEP,INC=200,nlgeom
STEP2
*STATIC,stabilize
0.01, 1.0
*DLOAD,OP=NEW
*END STEP
**
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*STEP,INC=200,nlgeom
STEP3
*STATIC,stabilize
0.01, 1.0
*DLOAD
ELOAD, P2, 8.719
*END STEP
**
*STEP,INC=200,nlgeom
STEP4
*STATIC,stabilize
0.01, 1.0
*DLOAD,OP=NEW
*END STEP
**
*STEP,INC=200,nlgeom
STEP5
*STATIC,stabilize
0.01, 1.0
*DLOAD
ELOAD, P2, 10.442
*END STEP
**
*STEP,INC=200,nlgeom
STEP6
*STATIC,stabilize
0.01, 1.0
*DLOAD,OP=NEW
*END STEP
**
*STEP,INC=200,nlgeom
STEP7
*STATIC,stabilize
0.01, 1.0
*DLOAD
ELOAD, P2, 12.166
*END STEP
**
*STEP,INC=200,nlgeom
STEP8
*STATIC,stabilize
0.01, 1.0
*DLOAD,OP=NEW
*END STEP
**
*STEP,INC=200,nlgeom
STEP9
*STATIC,stabilize
0.01, 1.0
*DLOAD
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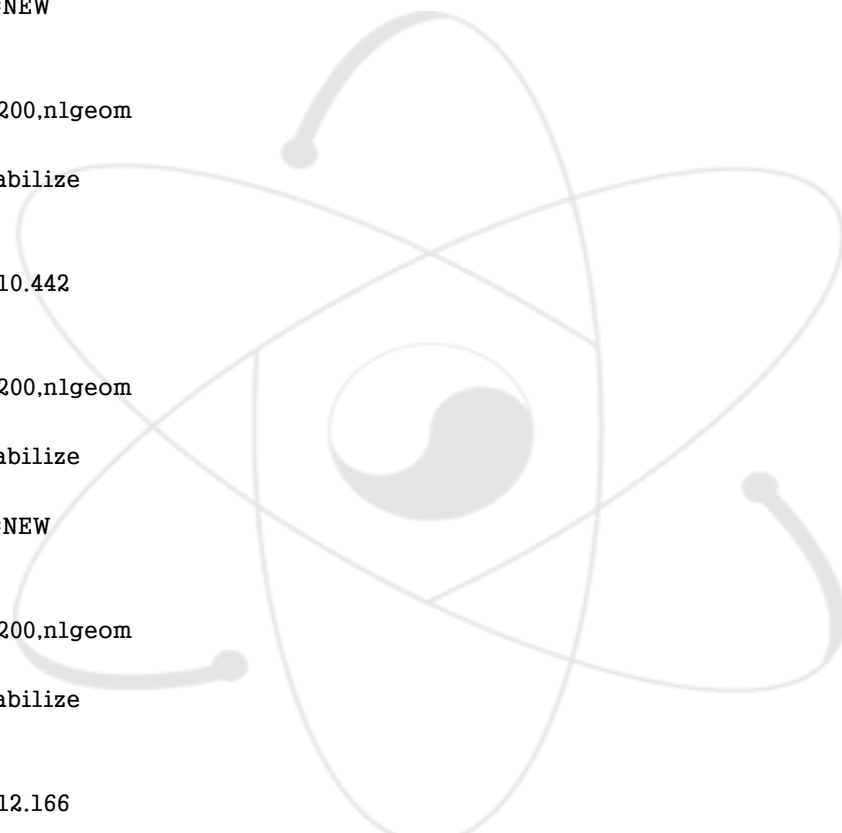
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ELOAD, P2, 13.889
*END STEP
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*STEP,INC=200,nlgeom
STEP10
*STATIC,stabilize
0.01, 1.0
*DLOAD,OP=NEW
*END STEP
```

부록 2. EXCEL 을 이용한 유한요소모델 질점 좌표 생산

(FEAST Input for Longitudinal Ridge Calculation)

Outer Diameter =		15.24510		Coord. Move=	0.08493		
Thickness =		0.44200		Node 1001 =	7.09985		original
Max. Diametral Gap =		0.16140		Material Property	134.4	0.00000	0.00000
Inner Radius =		7.18055			180.0	0.01	0.01000
Pellet Radius =		7.09985			209.0	0.05	0.04000
Radius of Cntr. Circumference =		7.40155			237.0	0.21	0.16000
Radial Ovality/2 =		0.00423	0.00423	Young's Modulus	80830		

	Outer Circumf.				Cntr.				Inner
	4.000000	3.000000	2.000000	1.000000	0.000000	-1.000000	-2.000000	-3.000000	-4.000000
Ovality(+)	7.626785	7.571535	7.516285	7.461035	7.405785	7.350535	7.295285	7.240035	7.184785
Ovality(-)	7.618315	7.563065	7.507815	7.452565	7.397315	7.342065	7.286815	7.231565	7.176315

Node #	Radius	Theta(degree)	Theta(radian)	
10	7.626784750	0.00	0.000000000	제 1 원주
19	7.626784104	0.50	0.008726646	
28	7.626782166	1.00	0.017453293	
37	7.626778937	1.50	0.026179939	
46	7.626774417	2.00	0.034906585	
55	7.626768609	2.50	0.043633231	
64	7.626761513	3.00	0.052359878	
73	7.626753132	3.50	0.061086524	
82	7.626743469	4.00	0.069813170	
91	7.626732527	4.50	0.078539816	
100	7.626720308	5.00	0.087266463	
109	7.626706817	5.50	0.095993109	
118	7.626692058	6.00	0.104719755	
127	7.626676035	6.50	0.113446401	
136	7.626658753	7.00	0.122173048	
145	7.626640218	7.50	0.130899694	
154	7.626620435	8.00	0.139626340	
163	7.626599410	8.50	0.148352986	
172	7.626577149	9.00	0.157079633	
181	7.626553660	9.50	0.165806279	

Verification	Norm	Norm+Oval
Outer Dia.	15.24510	15.25357
Thick.	0.44200	
Gap	0.16140	0.16987

e =	-0.000046
theta/2 =	2.5
B =	13.8
r =	7.63385

190	7.626528950	10.00	0.174532925
199	7.626503026	10.50	0.183259571
208	7.626475896	11.00	0.191986218
217	7.626447569	11.50	0.200712864
226	7.626418052	12.00	0.209439510
235	7.626387356	12.50	0.218166156
244	7.626355489	13.00	0.226892803
253	7.626322462	13.50	0.235619449
262	7.626288284	14.00	0.244346095
271	7.626252966	14.50	0.253072742
280	7.626216518	15.00	0.261799388
289	7.626178952	15.50	0.270526034
298	7.626140280	16.00	0.279252680
307	7.626100513	16.50	0.287979327
316	7.626059663	17.00	0.296705973
325	7.626017742	17.50	0.305432619
334	7.625974765	18.00	0.314159265
343	7.625930743	18.50	0.322885912
352	7.625885690	19.00	0.331612558
361	7.625839620	19.50	0.340339204
370	7.625792548	20.00	0.349065850
379	7.625744486	20.50	0.357792497
388	7.625695451	21.00	0.366519143
397	7.625645458	21.50	0.375245789
406	7.625594520	22.00	0.383972435
415	7.625542655	22.50	0.392699082
424	7.625489877	23.00	0.401425728
433	7.625436204	23.50	0.410152374
442	7.625381651	24.00	0.418879020
451	7.625326235	24.50	0.427605667
460	7.625269973	25.00	0.436332313
469	7.625212882	25.50	0.445058959
478	7.625154980	26.00	0.453785606
487	7.625096284	26.50	0.462512252
496	7.625036813	27.00	0.471238898
505	7.624976584	27.50	0.479965544
514	7.624915615	28.00	0.488692191
523	7.624853927	28.50	0.497418837
532	7.624791536	29.00	0.506145483
541	7.624728463	29.50	0.514872129
550	7.624664727	30.00	0.523598776
559	7.624600347	30.50	0.532325422
568	7.624535342	31.00	0.541052068
577	7.624469733	31.50	0.549778714
586	7.624403540	32.00	0.558505361
595	7.624336783	32.50	0.567232007
604	7.624269482	33.00	0.575958653
613	7.624201657	33.50	0.584685299
622	7.624133330	34.00	0.593411946
631	7.624064522	34.50	0.602138592
640	7.623995253	35.00	0.610865238
649	7.623925544	35.50	0.619591884
658	7.623855417	36.00	0.628318531
667	7.623784893	36.50	0.637045177
676	7.623713994	37.00	0.645771823
685	7.623642741	37.50	0.654498469
694	7.623571156	38.00	0.663225116

703	7.623499260	38.50	0.671951762
712	7.623427077	39.00	0.680678408
721	7.623354627	39.50	0.689405055
730	7.623281934	40.00	0.698131701
739	7.623209018	40.50	0.706858347
748	7.623135902	41.00	0.715584993
757	7.623062609	41.50	0.724311640
766	7.622989161	42.00	0.733038286
775	7.622915580	42.50	0.741764932
784	7.622841889	43.00	0.750491578
793	7.622768110	43.50	0.759218225
802	7.622694266	44.00	0.767944871
811	7.622620379	44.50	0.776671517
820	7.622546471	45.00	0.785398163
829	7.622472566	45.50	0.794124810
838	7.622398685	46.00	0.802851456
847	7.622324851	46.50	0.811578102
856	7.622251087	47.00	0.820304748
865	7.622177415	47.50	0.829031395
874	7.622103858	48.00	0.837758041
883	7.622030438	48.50	0.846484687
892	7.621957177	49.00	0.855211333
901	7.621884097	49.50	0.863937980
910	7.621811221	50.00	0.872664626
919	7.621738572	50.50	0.881391272
928	7.621666170	51.00	0.890117919
937	7.621594039	51.50	0.898844565
946	7.621522200	52.00	0.907571211
955	7.621450674	52.50	0.916297857
964	7.621379485	53.00	0.925024504
973	7.621308652	53.50	0.933751150
982	7.621238199	54.00	0.942477796
991	7.621168146	54.50	0.951204442
1000	7.621098515	55.00	0.959931089
1009	7.621029327	55.50	0.968657735
1018	7.620960602	56.00	0.977384381
1027	7.620892362	56.50	0.986111027
1036	7.620824628	57.00	0.994837674
1045	7.620757420	57.50	1.003564320
1054	7.620690758	58.00	1.012290966
1063	7.620624663	58.50	1.021017612
1072	7.620559155	59.00	1.029744259
1081	7.620494254	59.50	1.038470905
1090	7.620429980	60.00	1.047197551
1099	7.620366351	60.50	1.055924197
1108	7.620303388	61.00	1.064650844
1117	7.620241109	61.50	1.073377490
1126	7.620179534	62.00	1.082104136
1135	7.620118680	62.50	1.090830782
1144	7.620058568	63.00	1.099557429
1153	7.619999214	63.50	1.108284075
1162	7.619940637	64.00	1.117010721
1171	7.619882855	64.50	1.125737368
1180	7.619825886	65.00	1.134464014
1189	7.619769745	65.50	1.143190660
1198	7.619714451	66.00	1.151917306
1207	7.619660021	66.50	1.160643953

1216	7.619606471	67.00	1.169370599
1225	7.619553816	67.50	1.178097245
1234	7.619502074	68.00	1.186823891
1243	7.619451260	68.50	1.195550538
1252	7.619401388	69.00	1.204277184
1261	7.619352476	69.50	1.213003830
1270	7.619304536	70.00	1.221730476
1279	7.619257585	70.50	1.230457123
1288	7.619211635	71.00	1.239183769
1297	7.619166701	71.50	1.247910415
1306	7.619122797	72.00	1.256637061
1315	7.619079936	72.50	1.265363708
1324	7.619038130	73.00	1.274090354
1333	7.618997394	73.50	1.282817000
1342	7.618957738	74.00	1.291543646
1351	7.618919175	74.50	1.300270293
1360	7.618881717	75.00	1.308996939
1369	7.618845375	75.50	1.317723585
1378	7.618810161	76.00	1.326450232
1387	7.618776083	76.50	1.335176878
1396	7.618743154	77.00	1.343903524
1405	7.618711383	77.50	1.352630170
1414	7.618680780	78.00	1.361356817
1423	7.618651354	78.50	1.370083463
1432	7.618623113	79.00	1.378810109
1441	7.618596067	79.50	1.387536755
1450	7.618570224	80.00	1.396263402
1459	7.618545591	80.50	1.404990048
1468	7.618522177	81.00	1.413716694
1477	7.618499987	81.50	1.422443340
1486	7.618479029	82.00	1.431169987
1495	7.618459309	82.50	1.439896633
1504	7.618440834	83.00	1.448623279
1513	7.618423608	83.50	1.457349925
1522	7.618407637	84.00	1.466076572
1531	7.618392926	84.50	1.474803218
1540	7.618379479	85.00	1.483529864
1549	7.618367301	85.50	1.492256510
1558	7.618356394	86.00	1.500983157
1567	7.618346763	86.50	1.509709803
1576	7.618338410	87.00	1.518436449
1585	7.618331338	87.50	1.527163095
1594	7.618325548	88.00	1.535889742
1603	7.618321044	88.50	1.544616388
1612	7.618317825	89.00	1.553343034
1621	7.618315894	89.50	1.562069681
1630	7.618315250	90.00	1.570796327
1639	7.618315894	90.50	1.579522973
1648	7.618317825	91.00	1.588249619
1657	7.618321044	91.50	1.596976266
1666	7.618325548	92.00	1.605702912
1675	7.618331338	92.50	1.614429558
1684	7.618338410	93.00	1.623156204
1693	7.618346763	93.50	1.631882851
1702	7.618356394	94.00	1.640609497
1711	7.618367301	94.50	1.649336143
1720	7.618379479	95.00	1.658062789

1729	7.618392926	95.50	1.666789436
1738	7.618407637	96.00	1.675516082
1747	7.618423608	96.50	1.684242728
1756	7.618440834	97.00	1.692969374
1765	7.618459309	97.50	1.701696021
1774	7.618479029	98.00	1.710422667
1783	7.618499987	98.50	1.719149313
1792	7.618522177	99.00	1.727875959
1801	7.618545591	99.50	1.736602606
1810	7.618570224	100.00	1.745329252
1819	7.618596067	100.50	1.754055898
1828	7.618623113	101.00	1.762782545
1837	7.618651354	101.50	1.771509191
1846	7.618680780	102.00	1.780235837
1855	7.618711383	102.50	1.788962483
1864	7.618743154	103.00	1.797689130
1873	7.618776083	103.50	1.806415776
1882	7.618810161	104.00	1.815142422
1891	7.618845375	104.50	1.823869068
1900	7.618881717	105.00	1.832595715
1909	7.618919175	105.50	1.841322361
1918	7.618957738	106.00	1.850049007
1927	7.618997394	106.50	1.858775653
1936	7.619038130	107.00	1.867502300
1945	7.619079936	107.50	1.876228946
1954	7.619122797	108.00	1.884955592
1963	7.619166701	108.50	1.893682238
1972	7.619211635	109.00	1.902408885
1981	7.619257585	109.50	1.911135531
1990	7.619304536	110.00	1.919862177
1999	7.619352476	110.50	1.928588823
2008	7.619401388	111.00	1.937315470
2017	7.619451260	111.50	1.946042116
2026	7.619502074	112.00	1.954768762
2035	7.619553816	112.50	1.963495408
2044	7.619606471	113.00	1.972222055
2053	7.619660021	113.50	1.980948701
2062	7.619714451	114.00	1.989675347
2071	7.619769745	114.50	1.998401994
2080	7.619825886	115.00	2.007128640
2089	7.619882855	115.50	2.015855286
2098	7.619940637	116.00	2.024581932
2107	7.619999214	116.50	2.033308579
2116	7.620058568	117.00	2.042035225
2125	7.620118680	117.50	2.050761871
2134	7.620179534	118.00	2.059488517
2143	7.620241109	118.50	2.068215164
2152	7.620303388	119.00	2.076941810
2161	7.620366351	119.50	2.085668456
2170	7.620429980	120.00	2.094395102
2179	7.620494254	120.50	2.103121749
2188	7.620559155	121.00	2.111848395
2197	7.620624663	121.50	2.120575041
2206	7.620690758	122.00	2.129301687
2215	7.620757420	122.50	2.138028334
2224	7.620824628	123.00	2.146754980
2233	7.620892362	123.50	2.155481626

2242	7.620960602	124.00	2.164208272
2251	7.621029327	124.50	2.172934919
2260	7.621098515	125.00	2.181661565
2269	7.621168146	125.50	2.190388211
2278	7.621238199	126.00	2.199114858
2287	7.621308652	126.50	2.207841504
2296	7.621379485	127.00	2.216568150
2305	7.621450674	127.50	2.225294796
2314	7.621522200	128.00	2.234021443
2323	7.621594039	128.50	2.242748089
2332	7.621666170	129.00	2.251474735
2341	7.621738572	129.50	2.260201381
2350	7.621811221	130.00	2.268928028
2359	7.621884097	130.50	2.277654674
2368	7.621957177	131.00	2.286381320
2377	7.622030438	131.50	2.295107966
2386	7.622103858	132.00	2.303834613
2395	7.622177415	132.50	2.312561259
2404	7.622251087	133.00	2.321287905
2413	7.622324851	133.50	2.330014551
2422	7.622398685	134.00	2.338741198
2431	7.622472566	134.50	2.347467844
2440	7.622546471	135.00	2.356194490
2449	7.622620379	135.50	2.364921136
2458	7.622694266	136.00	2.373647783
2467	7.622768110	136.50	2.382374429
2476	7.622841889	137.00	2.391101075
2485	7.622915580	137.50	2.399827721
2494	7.622989161	138.00	2.408554368
2503	7.623062609	138.50	2.417281014
2512	7.623135902	139.00	2.426007660
2521	7.623209018	139.50	2.434734307
2530	7.623281934	140.00	2.443460953
2539	7.623354627	140.50	2.452187599
2548	7.623427077	141.00	2.460914245
2557	7.623499260	141.50	2.469640892
2566	7.623571156	142.00	2.478367538
2575	7.623642741	142.50	2.487094184
2584	7.623713994	143.00	2.495820830
2593	7.623784893	143.50	2.504547477
2602	7.623855417	144.00	2.513274123
2611	7.623925544	144.50	2.522000769
2620	7.623995253	145.00	2.530727415
2629	7.624064522	145.50	2.539454062
2638	7.624133330	146.00	2.548180708
2647	7.624201657	146.50	2.556907354
2656	7.624269482	147.00	2.565634000
2665	7.624336783	147.50	2.574360647
2674	7.624403540	148.00	2.583087293
2683	7.624469733	148.50	2.591813939
2692	7.624535342	149.00	2.600540585
2701	7.624600347	149.50	2.609267232
2710	7.624664727	150.00	2.617993878
2719	7.624728463	150.50	2.626720524
2728	7.624791536	151.00	2.635447171
2737	7.624853927	151.50	2.644173817
2746	7.624915615	152.00	2.652900463

2755	7.624976584	152.50	2.661627109
2764	7.625036813	153.00	2.670353756
2773	7.625096284	153.50	2.679080402
2782	7.625154980	154.00	2.687807048
2791	7.625212882	154.50	2.696533694
2800	7.625269973	155.00	2.705260341
2809	7.625326235	155.50	2.713986987
2818	7.625381651	156.00	2.722713633
2827	7.625436204	156.50	2.731440279
2836	7.625489877	157.00	2.740166926
2845	7.625542655	157.50	2.748893572
2854	7.625594520	158.00	2.757620218
2863	7.625645458	158.50	2.766346864
2872	7.625695451	159.00	2.775073511
2881	7.625744486	159.50	2.783800157
2890	7.625792548	160.00	2.792526803
2899	7.625839620	160.50	2.801253449
2908	7.625885690	161.00	2.809980096
2917	7.625930743	161.50	2.818706742
2926	7.625974765	162.00	2.827433388
2935	7.626017742	162.50	2.836160034
2944	7.626059663	163.00	2.844886681
2953	7.626100513	163.50	2.853613327
2962	7.626140280	164.00	2.862339973
2971	7.626178952	164.50	2.871066620
2980	7.626216518	165.00	2.879793266
2989	7.626252966	165.50	2.888519912
2998	7.626288284	166.00	2.897246558
3007	7.626322462	166.50	2.905973205
3016	7.626355489	167.00	2.914699851
3025	7.626387356	167.50	2.923426497
3034	7.626418052	168.00	2.932153143
3043	7.626447569	168.50	2.940879790
3052	7.626475896	169.00	2.949606436
3061	7.626503026	169.50	2.958333082
3070	7.626528950	170.00	2.967059728
3079	7.626553660	170.50	2.975786375
3088	7.626577149	171.00	2.984513021
3097	7.626599410	171.50	2.993239667
3106	7.626620435	172.00	3.001966313
3115	7.626640218	172.50	3.010692960
3124	7.626658753	173.00	3.019419606
3133	7.626676035	173.50	3.028146252
3142	7.626692058	174.00	3.036872898
3151	7.626706817	174.50	3.045599545
3160	7.626720308	175.00	3.054326191
3169	7.626732527	175.50	3.063052837
3178	7.626743469	176.00	3.071779484
3187	7.626753132	176.50	3.080506130
3196	7.626761513	177.00	3.089232776
3205	7.626768609	177.50	3.097959422
3214	7.626774417	178.00	3.106686069
3223	7.626778937	178.50	3.115412715
3232	7.626782166	179.00	3.124139361
3241	7.626784104	179.50	3.132866007
3250	7.626784750	180.00	3.141592654
11	7.571534588	0.25	0.004363323	제 2 반원주

20	7.571533296	0.75	0.013089969
29	7.571530713	1.25	0.021816616
38	7.571526838	1.75	0.030543262
47	7.571521674	2.25	0.039269908
56	7.571515221	2.75	0.047996554
65	7.571507483	3.25	0.056723201
74	7.571498461	3.75	0.065449847
83	7.571488157	4.25	0.074176493
92	7.571476576	4.75	0.082903139
101	7.571463721	5.25	0.091629786
110	7.571449595	5.75	0.100356432
119	7.571434203	6.25	0.109083078
128	7.571417550	6.75	0.117809725
137	7.571399640	7.25	0.126536371
146	7.571380480	7.75	0.135263017
155	7.571360075	8.25	0.143989663
164	7.571338431	8.75	0.152716310
173	7.571315555	9.25	0.161442956
182	7.571291455	9.75	0.170169602
191	7.571266136	10.25	0.178896248
200	7.571239608	10.75	0.187622895
209	7.571211878	11.25	0.196349541
218	7.571182954	11.75	0.205076187
227	7.571152847	12.25	0.213802833
236	7.571121564	12.75	0.222529480
245	7.571089115	13.25	0.231256126
254	7.571055511	13.75	0.239982772
263	7.571020761	14.25	0.248709418
272	7.570984876	14.75	0.257436065
281	7.570947868	15.25	0.266162711
290	7.570909747	15.75	0.274889357
299	7.570870525	16.25	0.283616003
308	7.570830214	16.75	0.292342650
317	7.570788827	17.25	0.301069296
326	7.570746376	17.75	0.309795942
335	7.570702874	18.25	0.318522588
344	7.570658335	18.75	0.327249235
353	7.570612771	19.25	0.335975881
362	7.570566198	19.75	0.344702527
371	7.570518629	20.25	0.353429174
380	7.570470078	20.75	0.362155820
389	7.570420562	21.25	0.370882466
398	7.570370094	21.75	0.379609112
407	7.570318690	22.25	0.388335759
416	7.570266366	22.75	0.397062405
425	7.570213138	23.25	0.405789051
434	7.570159022	23.75	0.414515697
443	7.570104035	24.25	0.423242344
452	7.570048193	24.75	0.431968990
461	7.569991514	25.25	0.440695636
470	7.569934015	25.75	0.449422282
479	7.569875714	26.25	0.458148929
488	7.569816628	26.75	0.466875575
497	7.569756775	27.25	0.475602221
506	7.569696173	27.75	0.484328867
515	7.569634842	28.25	0.493055514
524	7.569572800	28.75	0.501782160

533	7.569510065	29.25	0.510508806
542	7.569446658	29.75	0.519235452
551	7.569382597	30.25	0.527962099
560	7.569317901	30.75	0.536688745
569	7.569252592	31.25	0.545415391
578	7.569186688	31.75	0.554142038
587	7.569120210	32.25	0.562868684
596	7.569053178	32.75	0.571595330
605	7.568985612	33.25	0.580321976
614	7.568917533	33.75	0.589048623
623	7.568848963	34.25	0.597775269
632	7.568779921	34.75	0.606501915
641	7.568710429	35.25	0.615228561
650	7.568640508	35.75	0.623955208
659	7.568570180	36.25	0.632681854
668	7.568499465	36.75	0.641408500
677	7.568428386	37.25	0.650135146
686	7.568356964	37.75	0.658861793
695	7.568285221	38.25	0.667588439
704	7.568213179	38.75	0.676315085
713	7.568140859	39.25	0.685041731
722	7.568068285	39.75	0.693768378
731	7.567995477	40.25	0.702495024
740	7.567922458	40.75	0.711221670
749	7.567849251	41.25	0.719948316
758	7.567775878	41.75	0.728674963
767	7.567702360	42.25	0.737401609
776	7.567628722	42.75	0.746128255
785	7.567554984	43.25	0.754854901
794	7.567481169	43.75	0.763581548
803	7.567407300	44.25	0.772308194
812	7.567333400	44.75	0.781034840
821	7.567259491	45.25	0.789761487
830	7.567185595	45.75	0.798488133
839	7.567111735	46.25	0.807214779
848	7.567037933	46.75	0.815941425
857	7.566964213	47.25	0.824668072
866	7.566890595	47.75	0.833394718
875	7.566817104	48.25	0.842121364
884	7.566743760	48.75	0.850848010
893	7.566670588	49.25	0.859574657
902	7.566597607	49.75	0.868301303
911	7.566524842	50.25	0.877027949
920	7.566452314	50.75	0.885754595
929	7.566380045	51.25	0.894481242
938	7.566308057	51.75	0.903207888
947	7.566236372	52.25	0.911934534
956	7.566165012	52.75	0.920661180
965	7.566093999	53.25	0.929387827
974	7.566023354	53.75	0.938114473
983	7.565953098	54.25	0.946841119
992	7.565883254	54.75	0.955567765
1001	7.565813842	55.25	0.964294412
1010	7.565744883	55.75	0.973021058
1019	7.565676398	56.25	0.981747704
1028	7.565608409	56.75	0.990474351
1037	7.565540936	57.25	0.999200997

1046	7.565473998	57.75	1.007927643
1055	7.565407618	58.25	1.016654289
1064	7.565341814	58.75	1.025380936
1073	7.565276608	59.25	1.034107582
1082	7.565212018	59.75	1.042834228
1091	7.565148064	60.25	1.051560874
1100	7.565084766	60.75	1.060287521
1109	7.565022143	61.25	1.069014167
1118	7.564960214	61.75	1.077740813
1127	7.564898998	62.25	1.086467459
1136	7.564838513	62.75	1.095194106
1145	7.564778778	63.25	1.103920752
1154	7.564719811	63.75	1.112647398
1163	7.564661630	64.25	1.121374044
1172	7.564604253	64.75	1.130100691
1181	7.564547696	65.25	1.138827337
1190	7.564491977	65.75	1.147553983
1199	7.564437113	66.25	1.156280629
1208	7.564383121	66.75	1.165007276
1217	7.564330017	67.25	1.173733922
1226	7.564277817	67.75	1.182460568
1235	7.564226538	68.25	1.191187214
1244	7.564176193	68.75	1.199913861
1253	7.564126800	69.25	1.208640507
1262	7.564078373	69.75	1.217367153
1271	7.564030926	70.25	1.226093800
1280	7.563984474	70.75	1.234820446
1289	7.563939031	71.25	1.243547092
1298	7.563894610	71.75	1.252273738
1307	7.563851227	72.25	1.261000385
1316	7.563808892	72.75	1.269727031
1325	7.563767620	73.25	1.278453677
1334	7.563727423	73.75	1.287180323
1343	7.563688312	74.25	1.295906970
1352	7.563650301	74.75	1.304633616
1361	7.563613400	75.25	1.313360262
1370	7.563577621	75.75	1.322086908
1379	7.563542974	76.25	1.330813555
1388	7.563509470	76.75	1.339540201
1397	7.563477119	77.25	1.348266847
1406	7.563445931	77.75	1.356993493
1415	7.563415915	78.25	1.365720140
1424	7.563387081	78.75	1.374446786
1433	7.563359437	79.25	1.383173432
1442	7.563332992	79.75	1.391900078
1451	7.563307753	80.25	1.400626725
1460	7.563283729	80.75	1.409353371
1469	7.563260926	81.25	1.418080017
1478	7.563239352	81.75	1.426806664
1487	7.563219012	82.25	1.435533310
1496	7.563199914	82.75	1.444259956
1505	7.563182063	83.25	1.452986602
1514	7.563165464	83.75	1.461713249
1523	7.563150123	84.25	1.470439895
1532	7.563136043	84.75	1.479166541
1541	7.563123230	85.25	1.487893187
1550	7.563111687	85.75	1.496619834

1559	7.563101418	86.25	1.505346480
1568	7.563092426	86.75	1.514073126
1577	7.563084713	87.25	1.522799772
1586	7.563078282	87.75	1.531526419
1595	7.563073135	88.25	1.540253065
1604	7.563069274	88.75	1.548979711
1613	7.563066699	89.25	1.557706357
1622	7.563065411	89.75	1.566433004
1631	7.563065411	90.25	1.575159650
1640	7.563066699	90.75	1.583886296
1649	7.563069274	91.25	1.592612942
1658	7.563073135	91.75	1.601339589
1667	7.563078282	92.25	1.610066235
1676	7.563084713	92.75	1.618792881
1685	7.563092426	93.25	1.627519527
1694	7.563101418	93.75	1.636246174
1703	7.563111687	94.25	1.644972820
1712	7.563123230	94.75	1.653699466
1721	7.563136043	95.25	1.662426113
1730	7.563150123	95.75	1.671152759
1739	7.563165464	96.25	1.679879405
1748	7.563182063	96.75	1.688606051
1757	7.563199914	97.25	1.697332698
1766	7.563219012	97.75	1.706059344
1775	7.563239352	98.25	1.714785990
1784	7.563260926	98.75	1.723512636
1793	7.563283729	99.25	1.732239283
1802	7.563307753	99.75	1.740965929
1811	7.563332992	100.25	1.749692575
1820	7.563359437	100.75	1.758419221
1829	7.563387081	101.25	1.767145868
1838	7.563415915	101.75	1.775872514
1847	7.563445931	102.25	1.784599160
1856	7.563477119	102.75	1.793325806
1865	7.563509470	103.25	1.802052453
1874	7.563542974	103.75	1.810779099
1883	7.563577621	104.25	1.819505745
1892	7.563613400	104.75	1.828232391
1901	7.563650301	105.25	1.836959038
1910	7.563688312	105.75	1.845685684
1919	7.563727423	106.25	1.854412330
1928	7.563767620	106.75	1.863138977
1937	7.563808892	107.25	1.871865623
1946	7.563851227	107.75	1.880592269
1955	7.563894610	108.25	1.889318915
1964	7.563939031	108.75	1.898045562
1973	7.563984474	109.25	1.906772208
1982	7.564030926	109.75	1.915498854
1991	7.564078373	110.25	1.924225500
2000	7.564126800	110.75	1.932952147
2009	7.564176193	111.25	1.941678793
2018	7.564226538	111.75	1.950405439
2027	7.564277817	112.25	1.959132085
2036	7.564330017	112.75	1.967858732
2045	7.564383121	113.25	1.976585378
2054	7.564437113	113.75	1.985312024
2063	7.564491977	114.25	1.994038670

2072	7.564547696	114.75	2.002765317
2081	7.564604253	115.25	2.011491963
2090	7.564661630	115.75	2.020218609
2099	7.564719811	116.25	2.028945255
2108	7.564778778	116.75	2.037671902
2117	7.564838513	117.25	2.046398548
2126	7.564898998	117.75	2.055125194
2135	7.564960214	118.25	2.063851840
2144	7.565022143	118.75	2.072578487
2153	7.565084766	119.25	2.081305133
2162	7.565148064	119.75	2.090031779
2171	7.565212018	120.25	2.098758426
2180	7.565276608	120.75	2.107485072
2189	7.565341814	121.25	2.116211718
2198	7.565407618	121.75	2.124938364
2207	7.565473998	122.25	2.133665011
2216	7.565540936	122.75	2.142391657
2225	7.565608409	123.25	2.151118303
2234	7.565676398	123.75	2.159844949
2243	7.565744883	124.25	2.168571596
2252	7.565813842	124.75	2.177298242
2261	7.565883254	125.25	2.186024888
2270	7.565953098	125.75	2.194751534
2279	7.566023354	126.25	2.203478181
2288	7.566093999	126.75	2.212204827
2297	7.566165012	127.25	2.220931473
2306	7.566236372	127.75	2.229658119
2315	7.566308057	128.25	2.238384766
2324	7.566380045	128.75	2.247111412
2333	7.566452314	129.25	2.255838058
2342	7.566524842	129.75	2.264564704
2351	7.566597607	130.25	2.273291351
2360	7.566670588	130.75	2.282017997
2369	7.566743760	131.25	2.290744643
2378	7.566817104	131.75	2.299471290
2387	7.566890595	132.25	2.308197936
2396	7.566964213	132.75	2.316924582
2405	7.567037933	133.25	2.325651228
2414	7.567111735	133.75	2.334377875
2423	7.567185595	134.25	2.343104521
2432	7.567259491	134.75	2.351831167
2441	7.567333400	135.25	2.360557813
2450	7.567407300	135.75	2.369284460
2459	7.567481169	136.25	2.378011106
2468	7.567554984	136.75	2.386737752
2477	7.567628722	137.25	2.395464398
2486	7.567702360	137.75	2.404191045
2495	7.567775878	138.25	2.412917691
2504	7.567849251	138.75	2.421644337
2513	7.567922458	139.25	2.430370983
2522	7.567995477	139.75	2.439097630
2531	7.568068285	140.25	2.447824276
2540	7.568140859	140.75	2.456550922
2549	7.568213179	141.25	2.465277568
2558	7.568285221	141.75	2.474004215
2567	7.568356964	142.25	2.482730861
2576	7.568428386	142.75	2.491457507

2585	7.568499465	143.25	2.500184153
2594	7.568570180	143.75	2.508910800
2603	7.568640508	144.25	2.517637446
2612	7.568710429	144.75	2.526364092
2621	7.568779921	145.25	2.535090739
2630	7.568848963	145.75	2.543817385
2639	7.568917533	146.25	2.552544031
2648	7.568985612	146.75	2.561270677
2657	7.569053178	147.25	2.569997324
2666	7.569120210	147.75	2.578723970
2675	7.569186688	148.25	2.587450616
2684	7.569252592	148.75	2.596177262
2693	7.569317901	149.25	2.604903909
2702	7.569382597	149.75	2.613630555
2711	7.569446658	150.25	2.622357201
2720	7.569510065	150.75	2.631083847
2729	7.569572800	151.25	2.639810494
2738	7.569634842	151.75	2.648537140
2747	7.569696173	152.25	2.657263786
2756	7.569756775	152.75	2.665990432
2765	7.569816628	153.25	2.674717079
2774	7.569875714	153.75	2.683443725
2783	7.569934015	154.25	2.692170371
2792	7.569991514	154.75	2.700897017
2801	7.570048193	155.25	2.709623664
2810	7.570104035	155.75	2.718350310
2819	7.570159022	156.25	2.727076956
2828	7.570213138	156.75	2.735803603
2837	7.570266366	157.25	2.744530249
2846	7.570318690	157.75	2.753256895
2855	7.570370094	158.25	2.761983541
2864	7.570420562	158.75	2.770710188
2873	7.570470078	159.25	2.779436834
2882	7.570518629	159.75	2.788163480
2891	7.570566198	160.25	2.796890126
2900	7.570612771	160.75	2.805616773
2909	7.570658335	161.25	2.814343419
2918	7.570702874	161.75	2.823070065
2927	7.570746376	162.25	2.831796711
2936	7.570788827	162.75	2.840523358
2945	7.570830214	163.25	2.849250004
2954	7.570870525	163.75	2.857976650
2963	7.570909747	164.25	2.866703296
2972	7.570947868	164.75	2.875429943
2981	7.570984876	165.25	2.884156589
2990	7.571020761	165.75	2.892883235
2999	7.571055511	166.25	2.901609881
3008	7.571089115	166.75	2.910336528
3017	7.571121564	167.25	2.919063174
3026	7.571152847	167.75	2.927789820
3035	7.571182954	168.25	2.936516466
3044	7.571211878	168.75	2.945243113
3053	7.571239608	169.25	2.953969759
3062	7.571266136	169.75	2.962696405
3071	7.571291455	170.25	2.971423052
3080	7.571315555	170.75	2.980149698
3089	7.571338431	171.25	2.988876344

3098	7.571360075	171.75	2.997602990
3107	7.571380480	172.25	3.006329637
3116	7.571399640	172.75	3.015056283
3125	7.571417550	173.25	3.023782929
3134	7.571434203	173.75	3.032509575
3143	7.571449595	174.25	3.041236222
3152	7.571463721	174.75	3.049962868
3161	7.571476576	175.25	3.058689514
3170	7.571488157	175.75	3.067416160
3179	7.571498461	176.25	3.076142807
3188	7.571507483	176.75	3.084869453
3197	7.571515221	177.25	3.093596099
3206	7.571521674	177.75	3.102322745
3215	7.571526838	178.25	3.111049392
3224	7.571530713	178.75	3.119776038
3233	7.571533296	179.25	3.128502684
3242	7.571534588	179.75	3.137229330
12	7.516284750	0.00	0.000000000	제 3 원주
21	7.516284104	0.50	0.008726646
30	7.516282166	1.00	0.017453293
39	7.516278937	1.50	0.026179939
48	7.516274417	2.00	0.034906585
57	7.516268608	2.50	0.043633231
66	7.516261512	3.00	0.052359878
75	7.516253132	3.50	0.061086524
84	7.516243468	4.00	0.069813170
93	7.516232525	4.50	0.078539816
102	7.516220307	5.00	0.087266463
111	7.516206815	5.50	0.095993109
120	7.516192056	6.00	0.104719755
129	7.516176032	6.50	0.113446401
138	7.516158750	7.00	0.122173048
147	7.516140214	7.50	0.130899694
156	7.516120431	8.00	0.139626340
165	7.516099405	8.50	0.148352986
174	7.516077144	9.00	0.157079633
183	7.516053655	9.50	0.165806279
192	7.516028944	10.00	0.174532925
201	7.516003019	10.50	0.183259571
210	7.515975889	11.00	0.191986218
219	7.515947561	11.50	0.200712864
228	7.515918044	12.00	0.209439510
237	7.515887347	12.50	0.218166156
246	7.515855479	13.00	0.226892803
255	7.515822451	13.50	0.235619449
264	7.515788272	14.00	0.244346095
273	7.515752953	14.50	0.253072742
282	7.515716505	15.00	0.261799388
291	7.515678939	15.50	0.270526034
300	7.515640265	16.00	0.279252680
309	7.515600497	16.50	0.287979327
318	7.515559646	17.00	0.296705973
327	7.515517725	17.50	0.305432619
336	7.515474747	18.00	0.314159265
345	7.515430724	18.50	0.322885912
354	7.515385670	19.00	0.331612558
363	7.515339600	19.50	0.340339204

372	7.515292526	20.00	0.349065850
381	7.515244464	20.50	0.357792497
390	7.515195428	21.00	0.366519143
399	7.515145433	21.50	0.375245789
408	7.515094495	22.00	0.383972435
417	7.515042629	22.50	0.392699082
426	7.514989850	23.00	0.401425728
435	7.514936176	23.50	0.410152374
444	7.514881622	24.00	0.418879020
453	7.514826205	24.50	0.427605667
462	7.514769942	25.00	0.436332313
471	7.514712851	25.50	0.445058959
480	7.514654948	26.00	0.453785606
489	7.514596251	26.50	0.462512252
498	7.514536779	27.00	0.471238898
507	7.514476549	27.50	0.479965544
516	7.514415580	28.00	0.488692191
525	7.514353890	28.50	0.497418837
534	7.514291499	29.00	0.506145483
543	7.514228425	29.50	0.514872129
552	7.514164688	30.00	0.523598776
561	7.514100307	30.50	0.532325422
570	7.514035302	31.00	0.541052068
579	7.513969692	31.50	0.549778714
588	7.513903498	32.00	0.558505361
597	7.513836740	32.50	0.567232007
606	7.513769438	33.00	0.575958653
615	7.513701613	33.50	0.584685299
624	7.513633286	34.00	0.593411946
633	7.513564477	34.50	0.602138592
642	7.513495207	35.00	0.610865238
651	7.513425497	35.50	0.619591884
660	7.513355370	36.00	0.628318531
669	7.513284845	36.50	0.637045177
678	7.513213946	37.00	0.645771823
687	7.513142692	37.50	0.654498469
696	7.513071107	38.00	0.663225116
705	7.512999211	38.50	0.671951762
714	7.512927027	39.00	0.680678408
723	7.512854577	39.50	0.689405055
732	7.512781883	40.00	0.698131701
741	7.512708967	40.50	0.706858347
750	7.512635851	41.00	0.715584993
759	7.512562558	41.50	0.724311640
768	7.512489110	42.00	0.733038286
777	7.512415529	42.50	0.741764932
786	7.512341838	43.00	0.750491578
795	7.512268058	43.50	0.759218225
804	7.512194214	44.00	0.767944871
813	7.512120327	44.50	0.776671517
822	7.512046419	45.00	0.785398163
831	7.511972514	45.50	0.794124810
840	7.511898633	46.00	0.802851456
849	7.511824799	46.50	0.811578102
858	7.511751036	47.00	0.820304748
867	7.511677364	47.50	0.829031395
876	7.511603807	48.00	0.837758041

885	7.511530387	48.50	0.846484687
894	7.511457126	49.00	0.855211333
903	7.511384046	49.50	0.863937980
912	7.511311171	50.00	0.872664626
921	7.511238522	50.50	0.881391272
930	7.511166121	51.00	0.890117919
939	7.511093990	51.50	0.898844565
948	7.511022151	52.00	0.907571211
957	7.510950626	52.50	0.916297857
966	7.510879437	53.00	0.925024504
975	7.510808605	53.50	0.933751150
984	7.510738152	54.00	0.942477796
993	7.510668100	54.50	0.951204442
1002	7.510598469	55.00	0.959931089
1011	7.510529281	55.50	0.968657735
1020	7.510460557	56.00	0.977384381
1029	7.510392318	56.50	0.986111027
1038	7.510324585	57.00	0.994837674
1047	7.510257377	57.50	1.003564320
1056	7.510190716	58.00	1.012290966
1065	7.510124622	58.50	1.021017612
1074	7.510059115	59.00	1.029744259
1083	7.509994214	59.50	1.038470905
1092	7.509929941	60.00	1.047197551
1101	7.509866313	60.50	1.055924197
1110	7.509803350	61.00	1.064650844
1119	7.509741072	61.50	1.073377490
1128	7.509679498	62.00	1.082104136
1137	7.509618646	62.50	1.090830782
1146	7.509558534	63.00	1.099557429
1155	7.509499181	63.50	1.108284075
1164	7.509440605	64.00	1.117010721
1173	7.509382824	64.50	1.125737368
1182	7.509325855	65.00	1.134464014
1191	7.509269716	65.50	1.143190660
1200	7.509214423	66.00	1.151917306
1209	7.509159993	66.50	1.160643953
1218	7.509106444	67.00	1.169370599
1227	7.509053790	67.50	1.178097245
1236	7.509002049	68.00	1.186823891
1245	7.508951236	68.50	1.195550538
1254	7.508901365	69.00	1.204277184
1263	7.508852453	69.50	1.213003830
1272	7.508804515	70.00	1.221730476
1281	7.508757564	70.50	1.230457123
1290	7.508711615	71.00	1.239183769
1299	7.508666682	71.50	1.247910415
1308	7.508622779	72.00	1.256637061
1317	7.508579919	72.50	1.265363708
1326	7.508538114	73.00	1.274090354
1335	7.508497378	73.50	1.282817000
1344	7.508457724	74.00	1.291543646
1353	7.508419162	74.50	1.300270293
1362	7.508381704	75.00	1.308996939
1371	7.508345363	75.50	1.317723585
1380	7.508310149	76.00	1.326450232
1389	7.508276073	76.50	1.335176878

1398	7.508243144	77.00	1.343903524
1407	7.508211374	77.50	1.352630170
1416	7.508180771	78.00	1.361356817
1425	7.508151346	78.50	1.370083463
1434	7.508123106	79.00	1.378810109
1443	7.508096061	79.50	1.387536755
1452	7.508070218	80.00	1.396263402
1461	7.508045586	80.50	1.404990048
1470	7.508022172	81.00	1.413716694
1479	7.507999983	81.50	1.422443340
1488	7.507979025	82.00	1.431169987
1497	7.507959306	82.50	1.439896633
1506	7.507940831	83.00	1.448623279
1515	7.507923605	83.50	1.457349925
1524	7.507907635	84.00	1.466076572
1533	7.507892924	84.50	1.474803218
1542	7.507879477	85.00	1.483529864
1551	7.507867299	85.50	1.492256510
1560	7.507856393	86.00	1.500983157
1569	7.507846762	86.50	1.509709803
1578	7.507838409	87.00	1.518436449
1587	7.507831337	87.50	1.527163095
1596	7.507825548	88.00	1.535889742
1605	7.507821044	88.50	1.544616388
1614	7.507817825	89.00	1.553343034
1623	7.507815894	89.50	1.562069681
1632	7.507815250	90.00	1.570796327
1641	7.507815894	90.50	1.579522973
1650	7.507817825	91.00	1.588249619
1659	7.507821044	91.50	1.596976266
1668	7.507825548	92.00	1.605702912
1677	7.507831337	92.50	1.614429558
1686	7.507838409	93.00	1.623156204
1695	7.507846762	93.50	1.631882851
1704	7.507856393	94.00	1.640609497
1713	7.507867299	94.50	1.649336143
1722	7.507879477	95.00	1.658062789
1731	7.507892924	95.50	1.666789436
1740	7.507907635	96.00	1.675516082
1749	7.507923605	96.50	1.684242728
1758	7.507940831	97.00	1.692969374
1767	7.507959306	97.50	1.701696021
1776	7.507979025	98.00	1.710422667
1785	7.507999983	98.50	1.719149313
1794	7.508022172	99.00	1.727875959
1803	7.508045586	99.50	1.736602606
1812	7.508070218	100.00	1.745329252
1821	7.508096061	100.50	1.754055898
1830	7.508123106	101.00	1.762782545
1839	7.508151346	101.50	1.771509191
1848	7.508180771	102.00	1.780235837
1857	7.508211374	102.50	1.788962483
1866	7.508243144	103.00	1.797689130
1875	7.508276073	103.50	1.806415776
1884	7.508310149	104.00	1.815142422
1893	7.508345363	104.50	1.823869068
1902	7.508381704	105.00	1.832595715

1911	7.508419162	105.50	1.841322361
1920	7.508457724	106.00	1.850049007
1929	7.508497378	106.50	1.858775653
1938	7.508538114	107.00	1.867502300
1947	7.508579919	107.50	1.876228946
1956	7.508622779	108.00	1.884955592
1965	7.508666682	108.50	1.893682238
1974	7.508711615	109.00	1.902408885
1983	7.508757564	109.50	1.911135531
1992	7.508804515	110.00	1.919862177
2001	7.508852453	110.50	1.928588823
2010	7.508901365	111.00	1.937315470
2019	7.508951236	111.50	1.946042116
2028	7.509002049	112.00	1.954768762
2037	7.509053790	112.50	1.963495408
2046	7.509106444	113.00	1.972222055
2055	7.509159993	113.50	1.980948701
2064	7.509214423	114.00	1.989675347
2073	7.509269716	114.50	1.998401994
2082	7.509325855	115.00	2.007128640
2091	7.509382824	115.50	2.015855286
2100	7.509440605	116.00	2.024581932
2109	7.509499181	116.50	2.033308579
2118	7.509558534	117.00	2.042035225
2127	7.509618646	117.50	2.050761871
2136	7.509679498	118.00	2.059488517
2145	7.509741072	118.50	2.068215164
2154	7.509803350	119.00	2.076941810
2163	7.509866313	119.50	2.085668456
2172	7.509929941	120.00	2.094395102
2181	7.509994214	120.50	2.103121749
2190	7.510059115	121.00	2.111848395
2199	7.510124622	121.50	2.120575041
2208	7.510190716	122.00	2.129301687
2217	7.510257377	122.50	2.138028334
2226	7.510324585	123.00	2.146754980
2235	7.510392318	123.50	2.155481626
2244	7.510460557	124.00	2.164208272
2253	7.510529281	124.50	2.172934919
2262	7.510598469	125.00	2.181661565
2271	7.510668100	125.50	2.190388211
2280	7.510738152	126.00	2.199114858
2289	7.510808605	126.50	2.207841504
2298	7.510879437	127.00	2.216568150
2307	7.510950626	127.50	2.225294796
2316	7.511022151	128.00	2.234021443
2325	7.511093990	128.50	2.242748089
2334	7.511166121	129.00	2.251474735
2343	7.511238522	129.50	2.260201381
2352	7.511311171	130.00	2.268928028
2361	7.511384046	130.50	2.277654674
2370	7.511457126	131.00	2.286381320
2379	7.511530387	131.50	2.295107966
2388	7.511603807	132.00	2.303834613
2397	7.511677364	132.50	2.312561259
2406	7.511751036	133.00	2.321287905
2415	7.511824799	133.50	2.330014551

2424	7.511898633	134.00	2.338741198
2433	7.511972514	134.50	2.347467844
2442	7.512046419	135.00	2.356194490
2451	7.512120327	135.50	2.364921136
2460	7.512194214	136.00	2.373647783
2469	7.512268058	136.50	2.382374429
2478	7.512341838	137.00	2.391101075
2487	7.512415529	137.50	2.399827721
2496	7.512489110	138.00	2.408554368
2505	7.512562558	138.50	2.417281014
2514	7.512635851	139.00	2.426007660
2523	7.512708967	139.50	2.434734307
2532	7.512781883	140.00	2.443460953
2541	7.512854577	140.50	2.452187599
2550	7.512927027	141.00	2.460914245
2559	7.512999211	141.50	2.469640892
2568	7.513071107	142.00	2.478367538
2577	7.513142692	142.50	2.487094184
2586	7.513213946	143.00	2.495820830
2595	7.513284845	143.50	2.504547477
2604	7.513355370	144.00	2.513274123
2613	7.513425497	144.50	2.522000769
2622	7.513495207	145.00	2.530727415
2631	7.513564477	145.50	2.539454062
2640	7.513633286	146.00	2.548180708
2649	7.513701613	146.50	2.556907354
2658	7.513769438	147.00	2.565634000
2667	7.513836740	147.50	2.574360647
2676	7.513903498	148.00	2.583087293
2685	7.513969692	148.50	2.591813939
2694	7.514035302	149.00	2.600540585
2703	7.514100307	149.50	2.609267232
2712	7.514164688	150.00	2.617993878
2721	7.514228425	150.50	2.626720524
2730	7.514291499	151.00	2.635447171
2739	7.514353890	151.50	2.644173817
2748	7.514415580	152.00	2.652900463
2757	7.514476549	152.50	2.661627109
2766	7.514536779	153.00	2.670353756
2775	7.514596251	153.50	2.679080402
2784	7.514654948	154.00	2.687807048
2793	7.514712851	154.50	2.696533694
2802	7.514769942	155.00	2.705260341
2811	7.514826205	155.50	2.713986987
2820	7.514881622	156.00	2.722713633
2829	7.514936176	156.50	2.731440279
2838	7.514989850	157.00	2.740166926
2847	7.515042629	157.50	2.748893572
2856	7.515094495	158.00	2.757620218
2865	7.515145433	158.50	2.766346864
2874	7.515195428	159.00	2.775073511
2883	7.515244464	159.50	2.783800157
2892	7.515292526	160.00	2.792526803
2901	7.515339600	160.50	2.801253449
2910	7.515385670	161.00	2.809980096
2919	7.515430724	161.50	2.818706742
2928	7.515474747	162.00	2.827433388

2937	7.515517725	162.50	2.836160034
2946	7.515559646	163.00	2.844886681
2955	7.515600497	163.50	2.853613327
2964	7.515640265	164.00	2.862339973
2973	7.515678939	164.50	2.871066620
2982	7.515716505	165.00	2.879793266
2991	7.515752953	165.50	2.888519912
3000	7.515788272	166.00	2.897246558
3009	7.515822451	166.50	2.905973205
3018	7.515855479	167.00	2.914699851
3027	7.515887347	167.50	2.923426497
3036	7.515918044	168.00	2.932153143
3045	7.515947561	168.50	2.940879790
3054	7.515975889	169.00	2.949606436
3063	7.516003019	169.50	2.958333082
3072	7.516028944	170.00	2.967059728
3081	7.516053655	170.50	2.975786375
3090	7.516077144	171.00	2.984513021
3099	7.516099405	171.50	2.993239667
3108	7.516120431	172.00	3.001966313
3117	7.516140214	172.50	3.010692960
3126	7.516158750	173.00	3.019419606
3135	7.516176032	173.50	3.028146252
3144	7.516192056	174.00	3.036872898
3153	7.516206815	174.50	3.045599545
3162	7.516220307	175.00	3.054326191
3171	7.516232525	175.50	3.063052837
3180	7.516243468	176.00	3.071779484
3189	7.516253132	176.50	3.080506130
3198	7.516261512	177.00	3.089232776
3207	7.516268608	177.50	3.097959422
3216	7.516274417	178.00	3.106686069
3225	7.516278937	178.50	3.115412715
3234	7.516282166	179.00	3.124139361
3243	7.516284104	179.50	3.132866007
3252	7.516284750	180.00	3.141592654
13	7.461034750	0.00	0.000000000
22	7.461033296	0.75	0.013089969
31	7.461030713	1.25	0.021816616
40	7.461026838	1.75	0.030543262
49	7.461021673	2.25	0.039269908
58	7.461015221	2.75	0.047996554
67	7.461007482	3.25	0.056723201
76	7.460998460	3.75	0.065449847
85	7.460988156	4.25	0.074176493
94	7.460976575	4.75	0.082903139
103	7.460963719	5.25	0.091629786
112	7.460949593	5.75	0.100356432
121	7.460934200	6.25	0.109083078
130	7.460917547	6.75	0.117809725
139	7.460899637	7.25	0.126536371
148	7.460880476	7.75	0.135263017
157	7.460860071	8.25	0.143989663
166	7.460838426	8.75	0.152716310
175	7.460815550	9.25	0.161442956
184	7.460791449	9.75	0.170169602
193	7.460766130	10.25	0.178896248

제 4 원주

202	7.460739601	10.75	0.187622895
211	7.460711870	11.25	0.196349541
220	7.460682946	11.75	0.205076187
229	7.460652838	12.25	0.213802833
238	7.460621554	12.75	0.222529480
247	7.460589104	13.25	0.231256126
256	7.460555499	13.75	0.239982772
265	7.460520749	14.25	0.248709418
274	7.460484863	14.75	0.257436065
283	7.460447854	15.25	0.266162711
292	7.460409732	15.75	0.274889357
301	7.460370510	16.25	0.283616003
310	7.460330198	16.75	0.292342650
319	7.460288810	17.25	0.301069296
328	7.460246358	17.75	0.309795942
337	7.460202856	18.25	0.318522588
346	7.460158315	18.75	0.327249235
355	7.460112751	19.25	0.335975881
364	7.460066177	19.75	0.344702527
373	7.460018607	20.25	0.353429174
382	7.459970055	20.75	0.362155820
391	7.459920538	21.25	0.370882466
400	7.459870069	21.75	0.379609112
409	7.459818664	22.25	0.388335759
418	7.459766339	22.75	0.397062405
427	7.459713110	23.25	0.405789051
436	7.459658993	23.75	0.414515697
445	7.459604005	24.25	0.423242344
454	7.459548163	24.75	0.431968990
463	7.459491483	25.25	0.440695636
472	7.459433983	25.75	0.449422282
481	7.459375681	26.25	0.458148929
490	7.459316593	26.75	0.466875575
499	7.459256740	27.25	0.475602221
508	7.459196137	27.75	0.484328867
517	7.459134805	28.25	0.493055514
526	7.459072762	28.75	0.501782160
535	7.459010027	29.25	0.510508806
544	7.458946619	29.75	0.519235452
553	7.458882557	30.25	0.527962099
562	7.458817861	30.75	0.536688745
571	7.458752550	31.25	0.545415391
580	7.458686646	31.75	0.554142038
589	7.458620167	32.25	0.562868684
598	7.458553134	32.75	0.571595330
607	7.458485568	33.25	0.580321976
616	7.458417488	33.75	0.589048623
625	7.458348917	34.25	0.597775269
634	7.458279875	34.75	0.606501915
643	7.458210382	35.25	0.615228561
652	7.458140461	35.75	0.623955208
661	7.458070132	36.25	0.632681854
670	7.457999417	36.75	0.641408500
679	7.457928337	37.25	0.650135146
688	7.457856915	37.75	0.658861793
697	7.457785171	38.25	0.667588439
706	7.457713129	38.75	0.676315085

715	7.457640809	39.25	0.685041731
724	7.457568234	39.75	0.693768378
733	7.457495426	40.25	0.702495024
742	7.457422407	40.75	0.711221670
751	7.457349199	41.25	0.719948316
760	7.457275826	41.75	0.728674963
769	7.457202308	42.25	0.737401609
778	7.457128669	42.75	0.746128255
787	7.457054931	43.25	0.754854901
796	7.456981117	43.75	0.763581548
805	7.456907248	44.25	0.772308194
814	7.456833348	44.75	0.781034840
823	7.456759438	45.25	0.789761487
832	7.456685542	45.75	0.798488133
841	7.456611682	46.25	0.807214779
850	7.456537881	46.75	0.815941425
859	7.456464160	47.25	0.824668072
868	7.456390543	47.75	0.833394718
877	7.456317052	48.25	0.842121364
886	7.456243709	48.75	0.850848010
895	7.456170536	49.25	0.859574657
904	7.456097556	49.75	0.868301303
913	7.456024791	50.25	0.877027949
922	7.455952263	50.75	0.885754595
931	7.455879995	51.25	0.894481242
940	7.455808007	51.75	0.903207888
949	7.455736323	52.25	0.911934534
958	7.455664963	52.75	0.920661180
967	7.455593951	53.25	0.929387827
976	7.455523306	53.75	0.938114473
985	7.455453051	54.25	0.946841119
994	7.455383207	54.75	0.955567765
1003	7.455313795	55.25	0.964294412
1012	7.455244837	55.75	0.973021058
1021	7.455176353	56.25	0.981747704
1030	7.455108365	56.75	0.990474351
1039	7.455040892	57.25	0.999200997
1048	7.454973956	57.75	1.007927643
1057	7.454907576	58.25	1.016654289
1066	7.454841773	58.75	1.025380936
1075	7.454776567	59.25	1.034107582
1084	7.454711978	59.75	1.042834228
1093	7.454648025	60.25	1.051560874
1102	7.454584728	60.75	1.060287521
1111	7.454522106	61.25	1.069014167
1120	7.454460178	61.75	1.077740813
1129	7.454398962	62.25	1.086467459
1138	7.454338479	62.75	1.095194106
1147	7.454278744	63.25	1.103920752
1156	7.454219778	63.75	1.112647398
1165	7.454161598	64.25	1.121374044
1174	7.454104221	64.75	1.130100691
1183	7.454047665	65.25	1.138827337
1192	7.453991948	65.75	1.147553983
1201	7.453937085	66.25	1.156280629
1210	7.453883094	66.75	1.165007276
1219	7.453829991	67.25	1.173733922

1228	7.453777792	67.75	1.182460568
1237	7.453726513	68.25	1.191187214
1246	7.453676169	68.75	1.199913861
1255	7.453626777	69.25	1.208640507
1264	7.453578350	69.75	1.217367153
1273	7.453530904	70.25	1.226093800
1282	7.453484453	70.75	1.234820446
1291	7.453439011	71.25	1.243547092
1300	7.453394592	71.75	1.252273738
1309	7.453351209	72.25	1.261000385
1318	7.453308875	72.75	1.269727031
1327	7.453267604	73.25	1.278453677
1336	7.453227407	73.75	1.287180323
1345	7.453188298	74.25	1.295906970
1354	7.453150287	74.75	1.304633616
1363	7.453113387	75.25	1.313360262
1372	7.453077609	75.75	1.322086908
1381	7.453042962	76.25	1.330813555
1390	7.453009459	76.75	1.339540201
1399	7.452977109	77.25	1.348266847
1408	7.452945922	77.75	1.356993493
1417	7.452915907	78.25	1.365720140
1426	7.452887073	78.75	1.374446786
1435	7.452859430	79.25	1.383173432
1444	7.452832985	79.75	1.391900078
1453	7.452807747	80.25	1.400626725
1462	7.452783724	80.75	1.409353371
1471	7.452760921	81.25	1.418080017
1480	7.452739347	81.75	1.426806664
1489	7.452719009	82.25	1.435533310
1498	7.452699911	82.75	1.444259956
1507	7.452682060	83.25	1.452986602
1516	7.452665462	83.75	1.461713249
1525	7.452650121	84.25	1.470439895
1534	7.452636042	84.75	1.479166541
1543	7.452623229	85.25	1.487893187
1552	7.452611686	85.75	1.496619834
1561	7.452601417	86.25	1.505346480
1570	7.452592425	86.75	1.514073126
1579	7.452584713	87.25	1.522799772
1588	7.452578282	87.75	1.531526419
1597	7.452573135	88.25	1.540253065
1606	7.452569274	88.75	1.548979711
1615	7.452566699	89.25	1.557706357
1624	7.452565411	89.75	1.566433004
1633	7.452565411	90.25	1.575159650
1642	7.452566699	90.75	1.583886296
1651	7.452569274	91.25	1.592612942
1660	7.452573135	91.75	1.601339589
1669	7.452578282	92.25	1.610066235
1678	7.452584713	92.75	1.618792881
1687	7.452592425	93.25	1.627519527
1696	7.452601417	93.75	1.636246174
1705	7.452611686	94.25	1.644972820
1714	7.452623229	94.75	1.653699466
1723	7.452636042	95.25	1.662426113
1732	7.452650121	95.75	1.671152759

1741	7.452665462	96.25	1.679879405
1750	7.452682060	96.75	1.688606051
1759	7.452699911	97.25	1.697332698
1768	7.452719009	97.75	1.706059344
1777	7.452739347	98.25	1.714785990
1786	7.452760921	98.75	1.723512636
1795	7.452783724	99.25	1.732239283
1804	7.452807747	99.75	1.740965929
1813	7.452832985	100.25	1.749692575
1822	7.452859430	100.75	1.758419221
1831	7.452887073	101.25	1.767145868
1840	7.452915907	101.75	1.775872514
1849	7.452945922	102.25	1.784599160
1858	7.452977109	102.75	1.793325806
1867	7.453009459	103.25	1.802052453
1876	7.453042962	103.75	1.810779099
1885	7.453077609	104.25	1.819505745
1894	7.453113387	104.75	1.828232391
1903	7.453150287	105.25	1.836959038
1912	7.453188298	105.75	1.845685684
1921	7.453227407	106.25	1.854412330
1930	7.453267604	106.75	1.863138977
1939	7.453308875	107.25	1.871865623
1948	7.453351209	107.75	1.880592269
1957	7.453394592	108.25	1.889318915
1966	7.453439011	108.75	1.898045562
1975	7.453484453	109.25	1.906772208
1984	7.453530904	109.75	1.915498854
1993	7.453578350	110.25	1.924225500
2002	7.453626777	110.75	1.932952147
2011	7.453676169	111.25	1.941678793
2020	7.453726513	111.75	1.950405439
2029	7.453777792	112.25	1.959132085
2038	7.453829991	112.75	1.967858732
2047	7.453883094	113.25	1.976585378
2056	7.453937085	113.75	1.985312024
2065	7.453991948	114.25	1.994038670
2074	7.454047665	114.75	2.002765317
2083	7.454104221	115.25	2.011491963
2092	7.454161598	115.75	2.020218609
2101	7.454219778	116.25	2.028945255
2110	7.454278744	116.75	2.037671902
2119	7.454338479	117.25	2.046398548
2128	7.454398962	117.75	2.055125194
2137	7.454460178	118.25	2.063851840
2146	7.454522106	118.75	2.072578487
2155	7.454584728	119.25	2.081305133
2164	7.454648025	119.75	2.090031779
2173	7.454711978	120.25	2.098758426
2182	7.454776567	120.75	2.107485072
2191	7.454841773	121.25	2.116211718
2200	7.454907576	121.75	2.124938364
2209	7.454973956	122.25	2.133665011
2218	7.455040892	122.75	2.142391657
2227	7.455108365	123.25	2.151118303
2236	7.455176353	123.75	2.159844949
2245	7.455244837	124.25	2.168571596

2254	7.455313795	124.75	2.177298242
2263	7.455383207	125.25	2.186024888
2272	7.455453051	125.75	2.194751534
2281	7.455523306	126.25	2.203478181
2290	7.455593951	126.75	2.212204827
2299	7.455664963	127.25	2.220931473
2308	7.455736323	127.75	2.229658119
2317	7.455808007	128.25	2.238384766
2326	7.455879995	128.75	2.247111412
2335	7.455952263	129.25	2.255838058
2344	7.456024791	129.75	2.264564704
2353	7.456097556	130.25	2.273291351
2362	7.456170536	130.75	2.282017997
2371	7.456243709	131.25	2.290744643
2380	7.456317052	131.75	2.299471290
2389	7.456390543	132.25	2.308197936
2398	7.456464160	132.75	2.316924582
2407	7.456537881	133.25	2.325651228
2416	7.456611682	133.75	2.334377875
2425	7.456685542	134.25	2.343104521
2434	7.456759438	134.75	2.351831167
2443	7.456833348	135.25	2.360557813
2452	7.456907248	135.75	2.369284460
2461	7.456981117	136.25	2.378011106
2470	7.457054931	136.75	2.386737752
2479	7.457128669	137.25	2.395464398
2488	7.457202308	137.75	2.404191045
2497	7.457275826	138.25	2.412917691
2506	7.457349199	138.75	2.421644337
2515	7.457422407	139.25	2.430370983
2524	7.457495426	139.75	2.439097630
2533	7.457568234	140.25	2.447824276
2542	7.457640809	140.75	2.456550922
2551	7.457713129	141.25	2.465277568
2560	7.457785171	141.75	2.474004215
2569	7.457856915	142.25	2.482730861
2578	7.457928337	142.75	2.491457507
2587	7.457999417	143.25	2.500184153
2596	7.458070132	143.75	2.508910800
2605	7.458140461	144.25	2.517637446
2614	7.458210382	144.75	2.526364092
2623	7.458279875	145.25	2.535090739
2632	7.458348917	145.75	2.543817385
2641	7.458417488	146.25	2.552544031
2650	7.458485568	146.75	2.561270677
2659	7.458553134	147.25	2.569997324
2668	7.458620167	147.75	2.578723970
2677	7.458686646	148.25	2.587450616
2686	7.458752550	148.75	2.596177262
2695	7.458817861	149.25	2.604903909
2704	7.458882557	149.75	2.613630555
2713	7.458946619	150.25	2.622357201
2722	7.459010027	150.75	2.631083847
2731	7.459072762	151.25	2.639810494
2740	7.459134805	151.75	2.648537140
2749	7.459196137	152.25	2.657263786
2758	7.459256740	152.75	2.665990432

2767	7.459316593	153.25	2.674717079
2776	7.459375681	153.75	2.683443725
2785	7.459433983	154.25	2.692170371
2794	7.459491483	154.75	2.700897017
2803	7.459548163	155.25	2.709623664
2812	7.459604005	155.75	2.718350310
2821	7.459658993	156.25	2.727076956
2830	7.459713110	156.75	2.735803603
2839	7.459766339	157.25	2.744530249
2848	7.459818664	157.75	2.753256895
2857	7.459870069	158.25	2.761983541
2866	7.459920538	158.75	2.770710188
2875	7.459970055	159.25	2.779436834
2884	7.460018607	159.75	2.788163480
2893	7.460066177	160.25	2.796890126
2902	7.460112751	160.75	2.805616773
2911	7.460158315	161.25	2.814343419
2920	7.460202856	161.75	2.823070065
2929	7.460246358	162.25	2.831796711
2938	7.460288810	162.75	2.840523358
2947	7.460330198	163.25	2.849250004
2956	7.460370510	163.75	2.857976650
2965	7.460409732	164.25	2.866703296
2974	7.460447854	164.75	2.875429943
2983	7.460484863	165.25	2.884156589
2992	7.460520749	165.75	2.892883235
3001	7.460555499	166.25	2.901609881
3010	7.460589104	166.75	2.910336528
3019	7.460621554	167.25	2.919063174
3028	7.460652838	167.75	2.927789820
3037	7.460682946	168.25	2.936516466
3046	7.460711870	168.75	2.945243113
3055	7.460739601	169.25	2.953969759
3064	7.460766130	169.75	2.962696405
3073	7.460791449	170.25	2.971423052
3082	7.460815550	170.75	2.980149698
3091	7.460838426	171.25	2.988876344
3100	7.460860071	171.75	2.997602990
3109	7.460880476	172.25	3.006329637
3118	7.460899637	172.75	3.015056283
3127	7.460917547	173.25	3.023782929
3136	7.460934200	173.75	3.032509575
3145	7.460949593	174.25	3.041236222
3154	7.460963719	174.75	3.049962868
3163	7.460976575	175.25	3.058689514
3172	7.460988156	175.75	3.067416160
3181	7.460998460	176.25	3.076142807
3190	7.461007482	176.75	3.084869453
3199	7.461015221	177.25	3.093596099
3208	7.461021673	177.75	3.102322745
3217	7.461026838	178.25	3.111049392
3226	7.461030713	178.75	3.119776038
3235	7.461033296	179.25	3.128502684
3244	7.461034750	180.00	3.141592654
14	7.405784750	0.00	0.000000000	제 5 원주
23	7.405782166	1.00	0.017453293
32	7.405778936	1.50	0.026179939

41	7.405774417	2.00	0.034906585
50	7.405768608	2.50	0.043633231
59	7.405761512	3.00	0.052359878
68	7.405753131	3.50	0.061086524
77	7.405743467	4.00	0.069813170
86	7.405732524	4.50	0.078539816
95	7.405720305	5.00	0.087266463
104	7.405706813	5.50	0.095993109
113	7.405692053	6.00	0.104719755
122	7.405676030	6.50	0.113446401
131	7.405658747	7.00	0.122173048
140	7.405640211	7.50	0.130899694
149	7.405620427	8.00	0.139626340
158	7.405599401	8.50	0.148352986
167	7.405577139	9.00	0.157079633
176	7.405553649	9.50	0.165806279
185	7.405528938	10.00	0.174532925
194	7.405503013	10.50	0.183259571
203	7.405475881	11.00	0.191986218
212	7.405447553	11.50	0.200712864
221	7.405418035	12.00	0.209439510
230	7.405387337	12.50	0.218166156
239	7.405355469	13.00	0.226892803
248	7.405322440	13.50	0.235619449
257	7.405288261	14.00	0.244346095
266	7.405252941	14.50	0.253072742
275	7.405216492	15.00	0.261799388
284	7.405178924	15.50	0.270526034
293	7.405140250	16.00	0.279252680
302	7.405100481	16.50	0.287979327
311	7.405059630	17.00	0.296705973
320	7.405017708	17.50	0.305432619
329	7.404974728	18.00	0.314159265
338	7.404930704	18.50	0.322885912
347	7.404885650	19.00	0.331612558
356	7.404839578	19.50	0.340339204
365	7.404792504	20.00	0.349065850
374	7.404744441	20.50	0.357792497
383	7.404695404	21.00	0.366519143
392	7.404645409	21.50	0.375245789
401	7.404594469	22.00	0.383972435
410	7.404542602	22.50	0.392699082
419	7.404489823	23.00	0.401425728
428	7.404436147	23.50	0.410152374
437	7.404381592	24.00	0.418879020
446	7.404326175	24.50	0.427605667
455	7.404269911	25.00	0.436332313
464	7.404212818	25.50	0.445058959
473	7.404154914	26.00	0.453785606
482	7.404096217	26.50	0.462512252
491	7.404036744	27.00	0.471238898
500	7.403976513	27.50	0.479965544
509	7.403915543	28.00	0.488692191
518	7.403853853	28.50	0.497418837
527	7.403791461	29.00	0.506145483
536	7.403728386	29.50	0.514872129
545	7.403664648	30.00	0.523598776

554	7.403600266	30.50	0.532325422
563	7.403535260	31.00	0.541052068
572	7.403469650	31.50	0.549778714
581	7.403403455	32.00	0.558505361
590	7.403336696	32.50	0.567232007
599	7.403269394	33.00	0.575958653
608	7.403201568	33.50	0.584685299
617	7.403133240	34.00	0.593411946
626	7.403064430	34.50	0.602138592
635	7.402995160	35.00	0.610865238
644	7.402925450	35.50	0.619591884
653	7.402855321	36.00	0.628318531
662	7.402784796	36.50	0.637045177
671	7.402713896	37.00	0.645771823
680	7.402642642	37.50	0.654498469
689	7.402571056	38.00	0.663225116
698	7.402499160	38.50	0.671951762
707	7.402426976	39.00	0.680678408
716	7.402354526	39.50	0.689405055
725	7.402281831	40.00	0.698131701
734	7.402208915	40.50	0.706858347
743	7.402135799	41.00	0.715584993
752	7.402062505	41.50	0.724311640
761	7.401989057	42.00	0.733038286
770	7.401915476	42.50	0.741764932
779	7.401841784	43.00	0.750491578
788	7.401768005	43.50	0.759218225
797	7.401694161	44.00	0.767944871
806	7.401620273	44.50	0.776671517
815	7.401546366	45.00	0.785398163
824	7.401472460	45.50	0.794124810
833	7.401398580	46.00	0.802851456
842	7.401324746	46.50	0.811578102
851	7.401250982	47.00	0.820304748
860	7.401177311	47.50	0.829031395
869	7.401103754	48.00	0.837758041
878	7.401030334	48.50	0.846484687
887	7.400957073	49.00	0.855211333
896	7.400883994	49.50	0.863937980
905	7.400811119	50.00	0.872664626
914	7.400738470	50.50	0.881391272
923	7.400666069	51.00	0.890117919
932	7.400593939	51.50	0.898844565
941	7.400522100	52.00	0.907571211
950	7.400450576	52.50	0.916297857
959	7.400379387	53.00	0.925024504
968	7.400308556	53.50	0.933751150
977	7.400238104	54.00	0.942477796
986	7.400168052	54.50	0.951204442
995	7.400098422	55.00	0.959931089
1004	7.400029235	55.50	0.968657735
1013	7.399960512	56.00	0.977384381
1022	7.399892273	56.50	0.986111027
1031	7.399824540	57.00	0.994837674
1040	7.399757333	57.50	1.003564320
1049	7.399690673	58.00	1.012290966
1058	7.399624580	58.50	1.021017612

1067	7.399559073	59.00	1.029744259
1076	7.399494174	59.50	1.038470905
1085	7.399429901	60.00	1.047197551
1094	7.399366274	60.50	1.055924197
1103	7.399303312	61.00	1.064650844
1112	7.399241035	61.50	1.073377490
1121	7.399179461	62.00	1.082104136
1130	7.399118610	62.50	1.090830782
1139	7.399058499	63.00	1.099557429
1148	7.398999147	63.50	1.108284075
1157	7.398940572	64.00	1.117010721
1166	7.398882792	64.50	1.125737368
1175	7.398825824	65.00	1.134464014
1184	7.398769685	65.50	1.143190660
1193	7.398714393	66.00	1.151917306
1202	7.398659965	66.50	1.160643953
1211	7.398606416	67.00	1.169370599
1220	7.398553764	67.50	1.178097245
1229	7.398502023	68.00	1.186823891
1238	7.398451211	68.50	1.195550538
1247	7.398401341	69.00	1.204277184
1256	7.398352430	69.50	1.213003830
1265	7.398304493	70.00	1.221730476
1274	7.398257543	70.50	1.230457123
1283	7.398211595	71.00	1.239183769
1292	7.398166663	71.50	1.247910415
1301	7.398122761	72.00	1.256637061
1310	7.398079901	72.50	1.265363708
1319	7.398038098	73.00	1.274090354
1328	7.397997363	73.50	1.282817000
1337	7.397957709	74.00	1.291543646
1346	7.397919148	74.50	1.300270293
1355	7.397881691	75.00	1.308996939
1364	7.397845351	75.50	1.317723585
1373	7.397810137	76.00	1.326450232
1382	7.397776062	76.50	1.335176878
1391	7.397743134	77.00	1.343903524
1400	7.397711365	77.50	1.352630170
1409	7.397680763	78.00	1.361356817
1418	7.397651338	78.50	1.370083463
1427	7.397623099	79.00	1.378810109
1436	7.397596054	79.50	1.387536755
1445	7.397570212	80.00	1.396263402
1454	7.397545580	80.50	1.404990048
1463	7.397522167	81.00	1.413716694
1472	7.397499978	81.50	1.422443340
1481	7.397479021	82.00	1.431169987
1490	7.397459302	82.50	1.439896633
1499	7.397440828	83.00	1.448623279
1508	7.397423603	83.50	1.457349925
1517	7.397407632	84.00	1.466076572
1526	7.397392922	84.50	1.474803218
1535	7.397379476	85.00	1.483529864
1544	7.397367298	85.50	1.492256510
1553	7.397356392	86.00	1.500983157
1562	7.397346761	86.50	1.509709803
1571	7.397338409	87.00	1.518436449

1580	7.397331337	87.50	1.527163095
1589	7.397325548	88.00	1.535889742
1598	7.397321044	88.50	1.544616388
1607	7.397317825	89.00	1.553343034
1616	7.397315894	89.50	1.562069681
1625	7.397315250	90.00	1.570796327
1634	7.397315894	90.50	1.579522973
1643	7.397317825	91.00	1.588249619
1652	7.397321044	91.50	1.596976266
1661	7.397325548	92.00	1.605702912
1670	7.397331337	92.50	1.614429558
1679	7.397338409	93.00	1.623156204
1688	7.397346761	93.50	1.631882851
1697	7.397356392	94.00	1.640609497
1706	7.397367298	94.50	1.649336143
1715	7.397379476	95.00	1.658062789
1724	7.397392922	95.50	1.666789436
1733	7.397407632	96.00	1.675516082
1742	7.397423603	96.50	1.684242728
1751	7.397440828	97.00	1.692969374
1760	7.397459302	97.50	1.701696021
1769	7.397479021	98.00	1.710422667
1778	7.397499978	98.50	1.719149313
1787	7.397522167	99.00	1.727875959
1796	7.397545580	99.50	1.736602606
1805	7.397570212	100.00	1.745329252
1814	7.397596054	100.50	1.754055898
1823	7.397623099	101.00	1.762782545
1832	7.397651338	101.50	1.771509191
1841	7.397680763	102.00	1.780235837
1850	7.397711365	102.50	1.788962483
1859	7.397743134	103.00	1.797689130
1868	7.397776062	103.50	1.806415776
1877	7.397810137	104.00	1.815142422
1886	7.397845351	104.50	1.823869068
1895	7.397881691	105.00	1.832595715
1904	7.397919148	105.50	1.841322361
1913	7.397957709	106.00	1.850049007
1922	7.397997363	106.50	1.858775653
1931	7.398038098	107.00	1.867502300
1940	7.398079901	107.50	1.876228946
1949	7.398122761	108.00	1.884955592
1958	7.398166663	108.50	1.893682238
1967	7.398211595	109.00	1.902408885
1976	7.398257543	109.50	1.911135531
1985	7.398304493	110.00	1.919862177
1994	7.398352430	110.50	1.928588823
2003	7.398401341	111.00	1.937315470
2012	7.398451211	111.50	1.946042116
2021	7.398502023	112.00	1.954768762
2030	7.398553764	112.50	1.963495408
2039	7.398606416	113.00	1.972222055
2048	7.398659965	113.50	1.980948701
2057	7.398714393	114.00	1.989675347
2066	7.398769685	114.50	1.998401994
2075	7.398825824	115.00	2.007128640
2084	7.398882792	115.50	2.015855286

2093	7.398940572	116.00	2.024581932
2102	7.398999147	116.50	2.033308579
2111	7.399058499	117.00	2.042035225
2120	7.399118610	117.50	2.050761871
2129	7.399179461	118.00	2.059488517
2138	7.399241035	118.50	2.068215164
2147	7.399303312	119.00	2.076941810
2156	7.399366274	119.50	2.085668456
2165	7.399429901	120.00	2.094395102
2174	7.399494174	120.50	2.103121749
2183	7.399559073	121.00	2.111848395
2192	7.399624580	121.50	2.120575041
2201	7.399690673	122.00	2.129301687
2210	7.399757333	122.50	2.138028334
2219	7.399824540	123.00	2.146754980
2228	7.399892273	123.50	2.155481626
2237	7.399960512	124.00	2.164208272
2246	7.400029235	124.50	2.172934919
2255	7.400098422	125.00	2.181661565
2264	7.400168052	125.50	2.190388211
2273	7.400238104	126.00	2.199114858
2282	7.400308556	126.50	2.207841504
2291	7.400379387	127.00	2.216568150
2300	7.400450576	127.50	2.225294796
2309	7.400522100	128.00	2.234021443
2318	7.400593939	128.50	2.242748089
2327	7.400666069	129.00	2.251474735
2336	7.400738470	129.50	2.260201381
2345	7.400811119	130.00	2.268928028
2354	7.400883994	130.50	2.277654674
2363	7.400957073	131.00	2.286381320
2372	7.401030334	131.50	2.295107966
2381	7.401103754	132.00	2.303834613
2390	7.401177311	132.50	2.312561259
2399	7.401250982	133.00	2.321287905
2408	7.401324746	133.50	2.330014551
2417	7.401398580	134.00	2.338741198
2426	7.401472460	134.50	2.347467844
2435	7.401546366	135.00	2.356194490
2444	7.401620273	135.50	2.364921136
2453	7.401694161	136.00	2.373647783
2462	7.401768005	136.50	2.382374429
2471	7.401841784	137.00	2.391101075
2480	7.401915476	137.50	2.399827721
2489	7.401989057	138.00	2.408554368
2498	7.402062505	138.50	2.417281014
2507	7.402135799	139.00	2.426007660
2516	7.402208915	139.50	2.434734307
2525	7.402281831	140.00	2.443460953
2534	7.402354526	140.50	2.452187599
2543	7.402426976	141.00	2.460914245
2552	7.402499160	141.50	2.469640892
2561	7.402571056	142.00	2.478367538
2570	7.402642642	142.50	2.487094184
2579	7.402713896	143.00	2.495820830
2588	7.402784796	143.50	2.504547477
2597	7.402855321	144.00	2.513274123

2606	7.402925450	144.50	2.522000769
2615	7.402995160	145.00	2.530727415
2624	7.403064430	145.50	2.539454062
2633	7.403133240	146.00	2.548180708
2642	7.403201568	146.50	2.556907354
2651	7.403269394	147.00	2.565634000
2660	7.403336696	147.50	2.574360647
2669	7.403403455	148.00	2.583087293
2678	7.403469650	148.50	2.591813939
2687	7.403535260	149.00	2.600540585
2696	7.403600266	149.50	2.609267232
2705	7.403664648	150.00	2.617993878
2714	7.403728386	150.50	2.626720524
2723	7.403791461	151.00	2.635447171
2732	7.403853853	151.50	2.644173817
2741	7.403915543	152.00	2.652900463
2750	7.403976513	152.50	2.661627109
2759	7.404036744	153.00	2.670353756
2768	7.404096217	153.50	2.679080402
2777	7.404154914	154.00	2.687807048
2786	7.404212818	154.50	2.696533694
2795	7.404269911	155.00	2.705260341
2804	7.404326175	155.50	2.713986987
2813	7.404381592	156.00	2.722713633
2822	7.404436147	156.50	2.731440279
2831	7.404489823	157.00	2.740166926
2840	7.404542602	157.50	2.748893572
2849	7.404594469	158.00	2.757620218
2858	7.404645409	158.50	2.766346864
2867	7.404695404	159.00	2.775073511
2876	7.404744441	159.50	2.783800157
2885	7.404792504	160.00	2.792526803
2894	7.404839578	160.50	2.801253449
2903	7.404885650	161.00	2.809980096
2912	7.404930704	161.50	2.818706742
2921	7.404974728	162.00	2.827433388
2930	7.405017708	162.50	2.836160034
2939	7.405059630	163.00	2.844886681
2948	7.405100481	163.50	2.853613327
2957	7.405140250	164.00	2.862339973
2966	7.405178924	164.50	2.871066620
2975	7.405216492	165.00	2.879793266
2984	7.405252941	165.50	2.888519912
2993	7.405288261	166.00	2.897246558
3002	7.405322440	166.50	2.905973205
3011	7.405355469	167.00	2.914699851
3020	7.405387337	167.50	2.923426497
3029	7.405418035	168.00	2.932153143
3038	7.405447553	168.50	2.940879790
3047	7.405475881	169.00	2.949606436
3056	7.405503013	169.50	2.958333082
3065	7.405528938	170.00	2.967059728
3074	7.405553649	170.50	2.975786375
3083	7.405577139	171.00	2.984513021
3092	7.405599401	171.50	2.993239667
3101	7.405620427	172.00	3.001966313
3110	7.405640211	172.50	3.010692960

3119	7.405658747	173.00	3.019419606
3128	7.405676030	173.50	3.028146252
3137	7.405692053	174.00	3.036872898
3146	7.405706813	174.50	3.045599545
3155	7.405720305	175.00	3.054326191
3164	7.405732524	175.50	3.063052837
3173	7.405743467	176.00	3.071779484
3182	7.405753131	176.50	3.080506130
3191	7.405761512	177.00	3.089232776
3200	7.405768608	177.50	3.097959422
3209	7.405774417	178.00	3.106686069
3218	7.405778936	178.50	3.115412715
3227	7.405782166	179.00	3.124139361
3236	7.405784750	180.00	3.141592654
15	7.350534750	0.00	0.000000000
24	7.350533296	0.75	0.013089969
33	7.350530712	1.25	0.021816616
42	7.350526838	1.75	0.030543262
51	7.350521673	2.25	0.039269908
60	7.350515220	2.75	0.047996554
69	7.350507481	3.25	0.056723201
78	7.350498459	3.75	0.065449847
87	7.350488155	4.25	0.074176493
96	7.350476573	4.75	0.082903139
105	7.350463717	5.25	0.091629786
114	7.350449590	5.75	0.100356432
123	7.350434198	6.25	0.109083078
132	7.350417544	6.75	0.117809725
141	7.350399633	7.25	0.126536371
150	7.350380472	7.75	0.135263017
159	7.350360066	8.25	0.143989663
168	7.350338421	8.75	0.152716310
177	7.350315545	9.25	0.161442956
186	7.350291443	9.75	0.170169602
195	7.350266123	10.25	0.178896248
204	7.350239594	10.75	0.187622895
213	7.350211862	11.25	0.196349541
222	7.350182937	11.75	0.205076187
231	7.350152828	12.25	0.213802833
240	7.350121544	12.75	0.222529480
249	7.350089094	13.25	0.231256126
258	7.350055488	13.75	0.239982772
267	7.350020736	14.25	0.248709418
276	7.349984850	14.75	0.257436065
285	7.349947840	15.25	0.266162711
294	7.349909717	15.75	0.274889357
303	7.349870494	16.25	0.283616003
312	7.349830182	16.75	0.292342650
321	7.349788793	17.25	0.301069296
330	7.349746340	17.75	0.309795942
339	7.349702836	18.25	0.318522588
348	7.349658295	18.75	0.327249235
357	7.349612730	19.25	0.335975881
366	7.349566155	19.75	0.344702527
375	7.349518584	20.25	0.353429174
384	7.349470031	20.75	0.362155820
393	7.349420513	21.25	0.370882466

제 6 원주

402	7.349370043	21.75	0.379609112
411	7.349318637	22.25	0.388335759
420	7.349266311	22.75	0.397062405
429	7.349213082	23.25	0.405789051
438	7.349158964	23.75	0.414515697
447	7.349103975	24.25	0.423242344
456	7.349048132	24.75	0.431968990
465	7.348991451	25.25	0.440695636
474	7.348933950	25.75	0.449422282
483	7.348875646	26.25	0.458148929
492	7.348816558	26.75	0.466875575
501	7.348756704	27.25	0.475602221
510	7.348696101	27.75	0.484328867
519	7.348634768	28.25	0.493055514
528	7.348572724	28.75	0.501782160
537	7.348509987	29.25	0.510508806
546	7.348446578	29.75	0.519235452
555	7.348382516	30.25	0.527962099
564	7.348317819	30.75	0.536688745
573	7.348252508	31.25	0.545415391
582	7.348186602	31.75	0.554142038
591	7.348120123	32.25	0.562868684
600	7.348053089	32.75	0.571595330
609	7.347985522	33.25	0.580321976
618	7.347917442	33.75	0.589048623
627	7.347848870	34.25	0.597775269
636	7.347779827	34.75	0.606501915
645	7.347710334	35.25	0.615228561
654	7.347640412	35.75	0.623955208
663	7.347570082	36.25	0.632681854
672	7.347499367	36.75	0.641408500
681	7.347428287	37.25	0.650135146
690	7.347356864	37.75	0.658861793
699	7.347285120	38.25	0.667588439
708	7.347213077	38.75	0.676315085
717	7.347140757	39.25	0.685041731
726	7.347068181	39.75	0.693768378
735	7.346995373	40.25	0.702495024
744	7.346922354	40.75	0.711221670
753	7.346849146	41.25	0.719948316
762	7.346775772	41.75	0.728674963
771	7.346702254	42.25	0.737401609
780	7.346628615	42.75	0.746128255
789	7.346554877	43.25	0.754854901
798	7.346481062	43.75	0.763581548
807	7.346407194	44.25	0.772308194
816	7.346333293	44.75	0.781034840
825	7.346259384	45.25	0.789761487
834	7.346185488	45.75	0.798488133
843	7.346111628	46.25	0.807214779
852	7.346037827	46.75	0.815941425
861	7.345964106	47.25	0.824668072
870	7.345890490	47.75	0.833394718
879	7.345816998	48.25	0.842121364
888	7.345743655	48.75	0.850848010
897	7.345670483	49.25	0.859574657
906	7.345597503	49.75	0.868301303

915	7.345524739	50.25	0.877027949
924	7.345452211	50.75	0.885754595
933	7.345379943	51.25	0.894481242
942	7.345307956	51.75	0.903207888
951	7.345236272	52.25	0.911934534
960	7.345164913	52.75	0.920661180
969	7.345093901	53.25	0.929387827
978	7.345023257	53.75	0.938114473
987	7.344953002	54.25	0.946841119
996	7.344883159	54.75	0.955567765
1005	7.344813748	55.25	0.964294412
1014	7.344744790	55.75	0.973021058
1023	7.344676307	56.25	0.981747704
1032	7.344608319	56.75	0.990474351
1041	7.344540847	57.25	0.999200997
1050	7.344473911	57.75	1.007927643
1059	7.344407532	58.25	1.016654289
1068	7.344341730	58.75	1.025380936
1077	7.344276525	59.25	1.034107582
1086	7.344211937	59.75	1.042834228
1095	7.344147985	60.25	1.051560874
1104	7.344084689	60.75	1.060287521
1113	7.344022067	61.25	1.069014167
1122	7.343960140	61.75	1.077740813
1131	7.343898926	62.25	1.086467459
1140	7.343838443	62.75	1.095194106
1149	7.343778709	63.25	1.103920752
1158	7.343719744	63.75	1.112647398
1167	7.343661565	64.25	1.121374044
1176	7.343604189	64.75	1.130100691
1185	7.343547634	65.25	1.138827337
1194	7.343491917	65.75	1.147553983
1203	7.343437055	66.25	1.156280629
1212	7.343383065	66.75	1.165007276
1221	7.343329963	67.25	1.173733922
1230	7.343277765	67.75	1.182460568
1239	7.343226487	68.25	1.191187214
1248	7.343176145	68.75	1.199913861
1257	7.343126753	69.25	1.208640507
1266	7.343078328	69.75	1.217367153
1275	7.343030882	70.25	1.226093800
1284	7.342984432	70.75	1.234820446
1293	7.342938991	71.25	1.243547092
1302	7.342894573	71.75	1.252273738
1311	7.342851191	72.25	1.261000385
1320	7.342808858	72.75	1.269727031
1329	7.342767587	73.25	1.278453677
1338	7.342727392	73.75	1.287180323
1347	7.342688283	74.25	1.295906970
1356	7.342650273	74.75	1.304633616
1365	7.342613374	75.25	1.313360262
1374	7.342577596	75.75	1.322086908
1383	7.342542951	76.25	1.330813555
1392	7.342509448	76.75	1.339540201
1401	7.342477099	77.25	1.348266847
1410	7.342445912	77.75	1.356993493
1419	7.342415898	78.25	1.365720140

1428	7.342387065	78.75	1.374446786
1437	7.342359423	79.25	1.383173432
1446	7.342332979	79.75	1.391900078
1455	7.342307741	80.25	1.400626725
1464	7.342283718	80.75	1.409353371
1473	7.342260916	81.25	1.418080017
1482	7.342239343	81.75	1.426806664
1491	7.342219005	82.25	1.435533310
1500	7.342199907	82.75	1.444259956
1509	7.342182057	83.25	1.452986602
1518	7.342165459	83.75	1.461713249
1527	7.342150118	84.25	1.470439895
1536	7.342136040	84.75	1.479166541
1545	7.342123227	85.25	1.487893187
1554	7.342111685	85.75	1.496619834
1563	7.342101417	86.25	1.505346480
1572	7.342092425	86.75	1.514073126
1581	7.342084712	87.25	1.522799772
1590	7.342078282	87.75	1.531526419
1599	7.342073135	88.25	1.540253065
1608	7.342069274	88.75	1.548979711
1617	7.342066699	89.25	1.557706357
1626	7.342065411	89.75	1.566433004
1635	7.342065411	90.25	1.575159650
1644	7.342066699	90.75	1.583886296
1653	7.342069274	91.25	1.592612942
1662	7.342073135	91.75	1.601339589
1671	7.342078282	92.25	1.610066235
1680	7.342084712	92.75	1.618792881
1689	7.342092425	93.25	1.627519527
1698	7.342101417	93.75	1.636246174
1707	7.342111685	94.25	1.644972820
1716	7.342123227	94.75	1.653699466
1725	7.342136040	95.25	1.662426113
1734	7.342150118	95.75	1.671152759
1743	7.342165459	96.25	1.679879405
1752	7.342182057	96.75	1.688606051
1761	7.342199907	97.25	1.697332698
1770	7.342219005	97.75	1.706059344
1779	7.342239343	98.25	1.714785990
1788	7.342260916	98.75	1.723512636
1797	7.342283718	99.25	1.732239283
1806	7.342307741	99.75	1.740965929
1815	7.342332979	100.25	1.749692575
1824	7.342359423	100.75	1.758419221
1833	7.342387065	101.25	1.767145868
1842	7.342415898	101.75	1.775872514
1851	7.342445912	102.25	1.784599160
1860	7.342477099	102.75	1.793325806
1869	7.342509448	103.25	1.802052453
1878	7.342542951	103.75	1.810779099
1887	7.342577596	104.25	1.819505745
1896	7.342613374	104.75	1.828232391
1905	7.342650273	105.25	1.836959038
1914	7.342688283	105.75	1.845685684
1923	7.342727392	106.25	1.854412330
1932	7.342767587	106.75	1.863138977

1941	7.342808858	107.25	1.871865623
1950	7.342851191	107.75	1.880592269
1959	7.342894573	108.25	1.889318915
1968	7.342938991	108.75	1.898045562
1977	7.342984432	109.25	1.906772208
1986	7.343030882	109.75	1.915498854
1995	7.343078328	110.25	1.924225500
2004	7.343126753	110.75	1.932952147
2013	7.343176145	111.25	1.941678793
2022	7.343226487	111.75	1.950405439
2031	7.343277765	112.25	1.959132085
2040	7.343329963	112.75	1.967858732
2049	7.343383065	113.25	1.976585378
2058	7.343437055	113.75	1.985312024
2067	7.343491917	114.25	1.994038670
2076	7.343547634	114.75	2.002765317
2085	7.343604189	115.25	2.011491963
2094	7.343661565	115.75	2.020218609
2103	7.343719744	116.25	2.028945255
2112	7.343778709	116.75	2.037671902
2121	7.343838443	117.25	2.046398548
2130	7.343898926	117.75	2.055125194
2139	7.343960140	118.25	2.063851840
2148	7.344022067	118.75	2.072578487
2157	7.344084689	119.25	2.081305133
2166	7.344147985	119.75	2.090031779
2175	7.344211937	120.25	2.098758426
2184	7.344276525	120.75	2.107485072
2193	7.344341730	121.25	2.116211718
2202	7.344407532	121.75	2.124938364
2211	7.344473911	122.25	2.133665011
2220	7.344540847	122.75	2.142391657
2229	7.344608319	123.25	2.151118303
2238	7.344676307	123.75	2.159844949
2247	7.344744790	124.25	2.168571596
2256	7.344813748	124.75	2.177298242
2265	7.344883159	125.25	2.186024888
2274	7.344953002	125.75	2.194751534
2283	7.345023257	126.25	2.203478181
2292	7.345093901	126.75	2.212204827
2301	7.345164913	127.25	2.220931473
2310	7.345236272	127.75	2.229658119
2319	7.345307956	128.25	2.238384766
2328	7.345379943	128.75	2.247111412
2337	7.345452211	129.25	2.255838058
2346	7.345524739	129.75	2.264564704
2355	7.345597503	130.25	2.273291351
2364	7.345670483	130.75	2.282017997
2373	7.345743655	131.25	2.290744643
2382	7.345816998	131.75	2.299471290
2391	7.345890490	132.25	2.308197936
2400	7.345964106	132.75	2.316924582
2409	7.346037827	133.25	2.325651228
2418	7.346111628	133.75	2.334377875
2427	7.346185488	134.25	2.343104521
2436	7.346259384	134.75	2.351831167
2445	7.346333293	135.25	2.360557813

2454	7.346407194	135.75	2.369284460
2463	7.346481062	136.25	2.378011106
2472	7.346554877	136.75	2.386737752
2481	7.346628615	137.25	2.395464398
2490	7.346702254	137.75	2.404191045
2499	7.346775772	138.25	2.412917691
2508	7.346849146	138.75	2.421644337
2517	7.346922354	139.25	2.430370983
2526	7.346995373	139.75	2.439097630
2535	7.347068181	140.25	2.447824276
2544	7.347140757	140.75	2.456550922
2553	7.347213077	141.25	2.465277568
2562	7.347285120	141.75	2.474004215
2571	7.347356864	142.25	2.482730861
2580	7.347428287	142.75	2.491457507
2589	7.347499367	143.25	2.500184153
2598	7.347570082	143.75	2.508910800
2607	7.347640412	144.25	2.517637446
2616	7.347710334	144.75	2.526364092
2625	7.347779827	145.25	2.535090739
2634	7.347848870	145.75	2.543817385
2643	7.347917442	146.25	2.552544031
2652	7.347985522	146.75	2.561270677
2661	7.348053089	147.25	2.569997324
2670	7.348120123	147.75	2.578723970
2679	7.348186602	148.25	2.587450616
2688	7.348252508	148.75	2.596177262
2697	7.348317819	149.25	2.604903909
2706	7.348382516	149.75	2.613630555
2715	7.348446578	150.25	2.622357201
2724	7.348509987	150.75	2.631083847
2733	7.348572724	151.25	2.639810494
2742	7.348634768	151.75	2.648537140
2751	7.348696101	152.25	2.657263786
2760	7.348756704	152.75	2.665990432
2769	7.348816558	153.25	2.674717079
2778	7.348875646	153.75	2.683443725
2787	7.348933950	154.25	2.692170371
2796	7.348991451	154.75	2.700897017
2805	7.349048132	155.25	2.709623664
2814	7.349103975	155.75	2.718350310
2823	7.349158964	156.25	2.727076956
2832	7.349213082	156.75	2.735803603
2841	7.349266311	157.25	2.744530249
2850	7.349318637	157.75	2.753256895
2859	7.349370043	158.25	2.761983541
2868	7.349420513	158.75	2.770710188
2877	7.349470031	159.25	2.779436834
2886	7.349518584	159.75	2.788163480
2895	7.349566155	160.25	2.796890126
2904	7.349612730	160.75	2.805616773
2913	7.349658295	161.25	2.814343419
2922	7.349702836	161.75	2.823070065
2931	7.349746340	162.25	2.831796711
2940	7.349788793	162.75	2.840523358
2949	7.349830182	163.25	2.849250004
2958	7.349870494	163.75	2.857976650

2967	7.349909717	164.25	2.866703296
2976	7.349947840	164.75	2.875429943
2985	7.349984850	165.25	2.884156589
2994	7.350020736	165.75	2.892883235
3003	7.350055488	166.25	2.901609881
3012	7.350089094	166.75	2.910336528
3021	7.350121544	167.25	2.919063174
3030	7.350152828	167.75	2.927789820
3039	7.350182937	168.25	2.936516466
3048	7.350211862	168.75	2.945243113
3057	7.350239594	169.25	2.953969759
3066	7.350266123	169.75	2.962696405
3075	7.350291443	170.25	2.971423052
3084	7.350315545	170.75	2.980149698
3093	7.350338421	171.25	2.988876344
3102	7.350360066	171.75	2.997602990
3111	7.350380472	172.25	3.006329637
3120	7.350399633	172.75	3.015056283
3129	7.350417544	173.25	3.023782929
3138	7.350434198	173.75	3.032509575
3147	7.350449590	174.25	3.041236222
3156	7.350463717	174.75	3.049962868
3165	7.350476573	175.25	3.058689514
3174	7.350488155	175.75	3.067416160
3183	7.350498459	176.25	3.076142807
3192	7.350507481	176.75	3.084869453
3201	7.350515220	177.25	3.093596099
3210	7.350521673	177.75	3.102322745
3219	7.350526838	178.25	3.111049392
3228	7.350530712	178.75	3.119776038
3237	7.350533296	179.25	3.128502684
3246	7.350534750	180.00	3.141592654
16	7.295284750	0.00	0.000000000
25	7.295284104	0.50	0.008726646
34	7.295282166	1.00	0.017453293
43	7.295278936	1.50	0.026179939
52	7.295274416	2.00	0.034906585
61	7.295268607	2.50	0.043633231
70	7.295261511	3.00	0.052359878
79	7.295253130	3.50	0.061086524
88	7.295243466	4.00	0.069813170
97	7.295232523	4.50	0.078539816
106	7.295220303	5.00	0.087266463
115	7.295206811	5.50	0.095993109
124	7.295192051	6.00	0.104719755
133	7.295176027	6.50	0.113446401
142	7.295158744	7.00	0.122173048
151	7.295140207	7.50	0.130899694
160	7.295120422	8.00	0.139626340
169	7.295099396	8.50	0.148352986
178	7.295077134	9.00	0.157079633
187	7.295053643	9.50	0.165806279
196	7.295028931	10.00	0.174532925
205	7.295003005	10.50	0.183259571
214	7.294975874	11.00	0.191986218
223	7.294947544	11.50	0.200712864
232	7.294918026	12.00	0.209439510

제 7 원주

241	7.294887327	12.50	0.218166156
250	7.294855458	13.00	0.226892803
259	7.294822429	13.50	0.235619449
268	7.294788248	14.00	0.244346095
277	7.294752928	14.50	0.253072742
286	7.294716478	15.00	0.261799388
295	7.294678910	15.50	0.270526034
304	7.294640235	16.00	0.279252680
313	7.294600465	16.50	0.287979327
322	7.294559612	17.00	0.296705973
331	7.294517689	17.50	0.305432619
340	7.294474709	18.00	0.314159265
349	7.294430684	18.50	0.322885912
358	7.294385629	19.00	0.331612558
367	7.294339557	19.50	0.340339204
376	7.294292481	20.00	0.349065850
385	7.294244417	20.50	0.357792497
394	7.294195379	21.00	0.366519143
403	7.294145383	21.50	0.375245789
412	7.294094443	22.00	0.383972435
421	7.294042574	22.50	0.392699082
430	7.293989794	23.00	0.401425728
439	7.293936118	23.50	0.410152374
448	7.293881562	24.00	0.418879020
457	7.293826143	24.50	0.427605667
466	7.293769878	25.00	0.436332313
475	7.293712785	25.50	0.445058959
484	7.293654880	26.00	0.453785606
493	7.293596182	26.50	0.462512252
502	7.293536707	27.00	0.471238898
511	7.293476476	27.50	0.479965544
520	7.293415505	28.00	0.488692191
529	7.293353814	28.50	0.497418837
538	7.293291421	29.00	0.506145483
547	7.293228345	29.50	0.514872129
556	7.293164607	30.00	0.523598776
565	7.293100224	30.50	0.532325422
574	7.293035217	31.00	0.541052068
583	7.292969606	31.50	0.549778714
592	7.292903411	32.00	0.558505361
601	7.292836651	32.50	0.567232007
610	7.292769348	33.00	0.575958653
619	7.292701521	33.50	0.584685299
628	7.292633192	34.00	0.593411946
637	7.292564382	34.50	0.602138592
646	7.292495111	35.00	0.610865238
655	7.292425400	35.50	0.619591884
664	7.292355272	36.00	0.628318531
673	7.292284746	36.50	0.637045177
682	7.292213845	37.00	0.645771823
691	7.292142591	37.50	0.654498469
700	7.292071004	38.00	0.663225116
709	7.291999108	38.50	0.671951762
718	7.291926923	39.00	0.680678408
727	7.291854473	39.50	0.689405055
736	7.291781778	40.00	0.698131701
745	7.291708861	40.50	0.706858347

754	7.291635745	41.00	0.715584993
763	7.291562451	41.50	0.724311640
772	7.291489002	42.00	0.733038286
781	7.291415421	42.50	0.741764932
790	7.291341730	43.00	0.750491578
799	7.291267950	43.50	0.759218225
808	7.291194106	44.00	0.767944871
817	7.291120218	44.50	0.776671517
826	7.291046311	45.00	0.785398163
835	7.290972405	45.50	0.794124810
844	7.290898525	46.00	0.802851456
853	7.290824691	46.50	0.811578102
862	7.290750928	47.00	0.820304748
871	7.290677256	47.50	0.829031395
880	7.290603699	48.00	0.837758041
889	7.290530280	48.50	0.846484687
898	7.290457019	49.00	0.855211333
907	7.290383941	49.50	0.863937980
916	7.290311066	50.00	0.872664626
925	7.290238417	50.50	0.881391272
934	7.290166017	51.00	0.890117919
943	7.290093887	51.50	0.898844565
952	7.290022049	52.00	0.907571211
961	7.289950525	52.50	0.916297857
970	7.289879337	53.00	0.925024504
979	7.289808506	53.50	0.933751150
988	7.289738054	54.00	0.942477796
997	7.289668003	54.50	0.951204442
1006	7.289598373	55.00	0.959931089
1015	7.289529187	55.50	0.968657735
1024	7.289460464	56.00	0.977384381
1033	7.289392226	56.50	0.986111027
1042	7.289324494	57.00	0.994837674
1051	7.289257288	57.50	1.003564320
1060	7.289190629	58.00	1.012290966
1069	7.289124536	58.50	1.021017612
1078	7.289059030	59.00	1.029744259
1087	7.288994132	59.50	1.038470905
1096	7.288929859	60.00	1.047197551
1105	7.288866233	60.50	1.055924197
1114	7.288803272	61.00	1.064650844
1123	7.288740996	61.50	1.073377490
1132	7.288679423	62.00	1.082104136
1141	7.288618573	62.50	1.090830782
1150	7.288558463	63.00	1.099557429
1159	7.288499112	63.50	1.108284075
1168	7.288440538	64.00	1.117010721
1177	7.288382759	64.50	1.125737368
1186	7.288325791	65.00	1.134464014
1195	7.288269654	65.50	1.143190660
1204	7.288214363	66.00	1.151917306
1213	7.288159935	66.50	1.160643953
1222	7.288106388	67.00	1.169370599
1231	7.288053736	67.50	1.178097245
1240	7.288001997	68.00	1.186823891
1249	7.287951185	68.50	1.195550538
1258	7.287901317	69.00	1.204277184

1267	7.287852407	69.50	1.213003830
1276	7.287804470	70.00	1.221730476
1285	7.287757521	70.50	1.230457123
1294	7.287711574	71.00	1.239183769
1303	7.287666643	71.50	1.247910415
1312	7.287622742	72.00	1.256637061
1321	7.287579883	72.50	1.265363708
1330	7.287538080	73.00	1.274090354
1339	7.287497346	73.50	1.282817000
1348	7.287457693	74.00	1.291543646
1357	7.287419133	74.50	1.300270293
1366	7.287381677	75.00	1.308996939
1375	7.287345338	75.50	1.317723585
1384	7.287310125	76.00	1.326450232
1393	7.287276050	76.50	1.335176878
1402	7.287243124	77.00	1.343903524
1411	7.287211355	77.50	1.352630170
1420	7.287180754	78.00	1.361356817
1429	7.287151329	78.50	1.370083463
1438	7.287123091	79.00	1.378810109
1447	7.287096047	79.50	1.387536755
1456	7.287070205	80.00	1.396263402
1465	7.287045575	80.50	1.404990048
1474	7.287022161	81.00	1.413716694
1483	7.286999973	81.50	1.422443340
1492	7.286979017	82.00	1.431169987
1501	7.286959299	82.50	1.439896633
1510	7.286940824	83.00	1.448623279
1519	7.286923600	83.50	1.457349925
1528	7.286907630	84.00	1.466076572
1537	7.286892920	84.50	1.474803218
1546	7.286879474	85.00	1.483529864
1555	7.286867297	85.50	1.492256510
1564	7.286856391	86.00	1.500983157
1573	7.286846760	86.50	1.509709803
1582	7.286838408	87.00	1.518436449
1591	7.286831337	87.50	1.527163095
1600	7.286825548	88.00	1.535889742
1609	7.286821043	88.50	1.544616388
1618	7.286817825	89.00	1.553343034
1627	7.286815894	89.50	1.562069681
1636	7.286815250	90.00	1.570796327
1645	7.286815894	90.50	1.579522973
1654	7.286817825	91.00	1.588249619
1663	7.286821043	91.50	1.596976266
1672	7.286825548	92.00	1.605702912
1681	7.286831337	92.50	1.614429558
1690	7.286838408	93.00	1.623156204
1699	7.286846760	93.50	1.631882851
1708	7.286856391	94.00	1.640609497
1717	7.286867297	94.50	1.649336143
1726	7.286879474	95.00	1.658062789
1735	7.286892920	95.50	1.666789436
1744	7.286907630	96.00	1.675516082
1753	7.286923600	96.50	1.684242728
1762	7.286940824	97.00	1.692969374
1771	7.286959299	97.50	1.701696021

1780	7.286979017	98.00	1.710422667
1789	7.286999973	98.50	1.719149313
1798	7.287022161	99.00	1.727875959
1807	7.287045575	99.50	1.736602606
1816	7.287070205	100.00	1.745329252
1825	7.287096047	100.50	1.754055898
1834	7.287123091	101.00	1.762782545
1843	7.287151329	101.50	1.771509191
1852	7.287180754	102.00	1.780235837
1861	7.287211355	102.50	1.788962483
1870	7.287243124	103.00	1.797689130
1879	7.287276050	103.50	1.806415776
1888	7.287310125	104.00	1.815142422
1897	7.287345338	104.50	1.823869068
1906	7.287381677	105.00	1.832595715
1915	7.287419133	105.50	1.841322361
1924	7.287457693	106.00	1.850049007
1933	7.287497346	106.50	1.858775653
1942	7.287538080	107.00	1.867502300
1951	7.287579883	107.50	1.876228946
1960	7.287622742	108.00	1.884955592
1969	7.287666643	108.50	1.893682238
1978	7.287711574	109.00	1.902408885
1987	7.287757521	109.50	1.911135531
1996	7.287804470	110.00	1.919862177
2005	7.287852407	110.50	1.928588823
2014	7.287901317	111.00	1.937315470
2023	7.287951185	111.50	1.946042116
2032	7.288001997	112.00	1.954768762
2041	7.288053736	112.50	1.963495408
2050	7.288106388	113.00	1.972222055
2059	7.288159935	113.50	1.980948701
2068	7.288214363	114.00	1.989675347
2077	7.288269654	114.50	1.998401994
2086	7.288325791	115.00	2.007128640
2095	7.288382759	115.50	2.015855286
2104	7.288440538	116.00	2.024581932
2113	7.288499112	116.50	2.033308579
2122	7.288558463	117.00	2.042035225
2131	7.288618573	117.50	2.050761871
2140	7.288679423	118.00	2.059488517
2149	7.288740996	118.50	2.068215164
2158	7.288803272	119.00	2.076941810
2167	7.288866233	119.50	2.085668456
2176	7.288929859	120.00	2.094395102
2185	7.288994132	120.50	2.103121749
2194	7.289059030	121.00	2.111848395
2203	7.289124536	121.50	2.120575041
2212	7.289190629	122.00	2.129301687
2221	7.289257288	122.50	2.138028334
2230	7.289324494	123.00	2.146754980
2239	7.289392226	123.50	2.155481626
2248	7.289460464	124.00	2.164208272
2257	7.289529187	124.50	2.172934919
2266	7.289598373	125.00	2.181661565
2275	7.289668003	125.50	2.190388211
2284	7.289738054	126.00	2.199114858

2293	7.289808506	126.50	2.207841504
2302	7.289879337	127.00	2.216568150
2311	7.289950525	127.50	2.225294796
2320	7.290022049	128.00	2.234021443
2329	7.290093887	128.50	2.242748089
2338	7.290166017	129.00	2.251474735
2347	7.290238417	129.50	2.260201381
2356	7.290311066	130.00	2.268928028
2365	7.290383941	130.50	2.277654674
2374	7.290457019	131.00	2.286381320
2383	7.290530280	131.50	2.295107966
2392	7.290603699	132.00	2.303834613
2401	7.290677256	132.50	2.312561259
2410	7.290750928	133.00	2.321287905
2419	7.290824691	133.50	2.330014551
2428	7.290898525	134.00	2.338741198
2437	7.290972405	134.50	2.347467844
2446	7.291046311	135.00	2.356194490
2455	7.291120218	135.50	2.364921136
2464	7.291194106	136.00	2.373647783
2473	7.291267950	136.50	2.382374429
2482	7.291341730	137.00	2.391101075
2491	7.291415421	137.50	2.399827721
2500	7.291489002	138.00	2.408554368
2509	7.291562451	138.50	2.417281014
2518	7.291635745	139.00	2.426007660
2527	7.291708861	139.50	2.434734307
2536	7.291781778	140.00	2.443460953
2545	7.291854473	140.50	2.452187599
2554	7.291926923	141.00	2.460914245
2563	7.291999108	141.50	2.469640892
2572	7.292071004	142.00	2.478367538
2581	7.292142591	142.50	2.487094184
2590	7.292213845	143.00	2.495820830
2599	7.292284746	143.50	2.504547477
2608	7.292355272	144.00	2.513274123
2617	7.292425400	144.50	2.522000769
2626	7.292495111	145.00	2.530727415
2635	7.292564382	145.50	2.539454062
2644	7.292633192	146.00	2.548180708
2653	7.292701521	146.50	2.556907354
2662	7.292769348	147.00	2.565634000
2671	7.292836651	147.50	2.574360647
2680	7.292903411	148.00	2.583087293
2689	7.292969606	148.50	2.591813939
2698	7.293035217	149.00	2.600540585
2707	7.293100224	149.50	2.609267232
2716	7.293164607	150.00	2.617993878
2725	7.293228345	150.50	2.626720524
2734	7.293291421	151.00	2.635447171
2743	7.293353814	151.50	2.644173817
2752	7.293415505	152.00	2.652900463
2761	7.293476476	152.50	2.661627109
2770	7.293536707	153.00	2.670353756
2779	7.293596182	153.50	2.679080402
2788	7.293654880	154.00	2.687807048
2797	7.293712785	154.50	2.696533694

2806	7.293769878	155.00	2.705260341
2815	7.293826143	155.50	2.713986987
2824	7.293881562	156.00	2.722713633
2833	7.293936118	156.50	2.731440279
2842	7.293989794	157.00	2.740166926
2851	7.294042574	157.50	2.748893572
2860	7.294094443	158.00	2.757620218
2869	7.294145383	158.50	2.766346864
2878	7.294195379	159.00	2.775073511
2887	7.294244417	159.50	2.783800157
2896	7.294292481	160.00	2.792526803
2905	7.294339557	160.50	2.801253449
2914	7.294385629	161.00	2.809980096
2923	7.294430684	161.50	2.818706742
2932	7.294474709	162.00	2.827433388
2941	7.294517689	162.50	2.836160034
2950	7.294559612	163.00	2.844886681
2959	7.294600465	163.50	2.853613327
2968	7.294640235	164.00	2.862339973
2977	7.294678910	164.50	2.871066620
2986	7.294716478	165.00	2.879793266
2995	7.294752928	165.50	2.888519912
3004	7.294788248	166.00	2.897246558
3013	7.294822429	166.50	2.905973205
3022	7.294855458	167.00	2.914699851
3031	7.294887327	167.50	2.923426497
3040	7.294918026	168.00	2.932153143
3049	7.294947544	168.50	2.940879790
3058	7.294975874	169.00	2.949606436
3067	7.295003005	169.50	2.958333082
3076	7.295028931	170.00	2.967059728
3085	7.295053643	170.50	2.975786375
3094	7.295077134	171.00	2.984513021
3103	7.295099396	171.50	2.993239667
3112	7.295120422	172.00	3.001966313
3121	7.295140207	172.50	3.010692960
3130	7.295158744	173.00	3.019419606
3139	7.295176027	173.50	3.028146252
3148	7.295192051	174.00	3.036872898
3157	7.295206811	174.50	3.045599545
3166	7.295220303	175.00	3.054326191
3175	7.295232523	175.50	3.063052837
3184	7.295243466	176.00	3.071779484
3193	7.295253130	176.50	3.080506130
3202	7.295261511	177.00	3.089232776
3211	7.295268607	177.50	3.097959422
3220	7.295274416	178.00	3.106686069
3229	7.295278936	178.50	3.115412715
3238	7.295282166	179.00	3.124139361
3247	7.295284104	179.50	3.132866007
3256	7.295284750	180.00	3.141592654
17	7.240034588	0.25	0.004363323	제 8 원주
26	7.240033296	0.75	0.013089969
35	7.240030712	1.25	0.021816616
44	7.240026837	1.75	0.030543262
53	7.240021673	2.25	0.039269908
62	7.240015220	2.75	0.047996554

71	7.240007481	3.25	0.056723201
80	7.239998458	3.75	0.065449847
89	7.239988154	4.25	0.074176493
98	7.239976572	4.75	0.082903139
107	7.239963715	5.25	0.091629786
116	7.239949588	5.75	0.100356432
125	7.239934195	6.25	0.109083078
134	7.239917541	6.75	0.117809725
143	7.239899630	7.25	0.126536371
152	7.239880468	7.75	0.135263017
161	7.239860062	8.25	0.143989663
170	7.239838416	8.75	0.152716310
179	7.239815539	9.25	0.161442956
188	7.239791436	9.75	0.170169602
197	7.239766116	10.25	0.178896248
206	7.239739586	10.75	0.187622895
215	7.239711854	11.25	0.196349541
224	7.239682929	11.75	0.205076187
233	7.239652819	12.25	0.213802833
242	7.239621533	12.75	0.222529480
251	7.239589082	13.25	0.231256126
260	7.239555476	13.75	0.239982772
269	7.239520724	14.25	0.248709418
278	7.239484837	14.75	0.257436065
287	7.239447826	15.25	0.266162711
296	7.239409702	15.75	0.274889357
305	7.239370478	16.25	0.283616003
314	7.239330165	16.75	0.292342650
323	7.239288775	17.25	0.301069296
332	7.239246321	17.75	0.309795942
341	7.239202816	18.25	0.318522588
350	7.239158274	18.75	0.327249235
359	7.239112708	19.25	0.335975881
368	7.239066132	19.75	0.344702527
377	7.239018560	20.25	0.353429174
386	7.238970007	20.75	0.362155820
395	7.238920487	21.25	0.370882466
404	7.238870016	21.75	0.379609112
413	7.238818610	22.25	0.388335759
422	7.238766283	22.75	0.397062405
431	7.238713052	23.25	0.405789051
440	7.238658934	23.75	0.414515697
449	7.238603944	24.25	0.423242344
458	7.238548099	24.75	0.431968990
467	7.238491417	25.25	0.440695636
476	7.238433916	25.75	0.449422282
485	7.238375611	26.25	0.458148929
494	7.238316522	26.75	0.466875575
503	7.238256666	27.25	0.475602221
512	7.238196062	27.75	0.484328867
521	7.238134729	28.25	0.493055514
530	7.238072684	28.75	0.501782160
539	7.238009947	29.25	0.510508806
548	7.237946537	29.75	0.519235452
557	7.237882473	30.25	0.527962099
566	7.237817776	30.75	0.536688745
575	7.237752464	31.25	0.545415391

584	7.237686557	31.75	0.554142038
593	7.237620077	32.25	0.562868684
602	7.237553043	32.75	0.571595330
611	7.237485475	33.25	0.580321976
620	7.237417394	33.75	0.589048623
629	7.237348822	34.25	0.597775269
638	7.237279778	34.75	0.606501915
647	7.237210284	35.25	0.615228561
656	7.237140362	35.75	0.623955208
665	7.237070031	36.25	0.632681854
674	7.236999315	36.75	0.641408500
683	7.236928235	37.25	0.650135146
692	7.236856811	37.75	0.658861793
701	7.236785067	38.25	0.667588439
710	7.236713023	38.75	0.676315085
719	7.236640703	39.25	0.685041731
728	7.236568127	39.75	0.693768378
737	7.236495318	40.25	0.702495024
746	7.236422299	40.75	0.711221670
755	7.236349091	41.25	0.719948316
764	7.236275717	41.75	0.728674963
773	7.236202199	42.25	0.737401609
782	7.236128560	42.75	0.746128255
791	7.236054821	43.25	0.754854901
800	7.235981007	43.75	0.763581548
809	7.235907138	44.25	0.772308194
818	7.235833237	44.75	0.781034840
827	7.235759328	45.25	0.789761487
836	7.235685432	45.75	0.798488133
845	7.235611572	46.25	0.807214779
854	7.235537771	46.75	0.815941425
863	7.235464051	47.25	0.824668072
872	7.235390434	47.75	0.833394718
881	7.235316943	48.25	0.842121364
890	7.235243600	48.75	0.850848010
899	7.235170428	49.25	0.859574657
908	7.235097449	49.75	0.868301303
917	7.235024685	50.25	0.877027949
926	7.234952158	50.75	0.885754595
935	7.234879890	51.25	0.894481242
944	7.234807903	51.75	0.903207888
953	7.234736220	52.25	0.911934534
962	7.234664861	52.75	0.920661180
971	7.234593849	53.25	0.929387827
980	7.234523206	53.75	0.938114473
989	7.234452952	54.25	0.946841119
998	7.234383109	54.75	0.955567765
1007	7.234313699	55.25	0.964294412
1016	7.234244742	55.75	0.973021058
1025	7.234176259	56.25	0.981747704
1034	7.234108272	56.75	0.990474351
1043	7.234040801	57.25	0.999200997
1052	7.233973866	57.75	1.007927643
1061	7.233907488	58.25	1.016654289
1070	7.233841686	58.75	1.025380936
1079	7.233776482	59.25	1.034107582
1088	7.233711895	59.75	1.042834228

1097	7.233647943	60.25	1.051560874
1106	7.233584648	60.75	1.060287521
1115	7.233522028	61.25	1.069014167
1124	7.233460101	61.75	1.077740813
1133	7.233398888	62.25	1.086467459
1142	7.233338406	62.75	1.095194106
1151	7.233278673	63.25	1.103920752
1160	7.233219709	63.75	1.112647398
1169	7.233161531	64.25	1.121374044
1178	7.233104156	64.75	1.130100691
1187	7.233047602	65.25	1.138827337
1196	7.232991886	65.75	1.147553983
1205	7.232937025	66.25	1.156280629
1214	7.232883036	66.75	1.165007276
1223	7.232829935	67.25	1.173733922
1232	7.232777738	67.75	1.182460568
1241	7.232726461	68.25	1.191187214
1250	7.232676119	68.75	1.199913861
1259	7.232626729	69.25	1.208640507
1268	7.232578304	69.75	1.217367153
1277	7.232530860	70.25	1.226093800
1286	7.232484411	70.75	1.234820446
1295	7.232438970	71.25	1.243547092
1304	7.232394553	71.75	1.252273738
1313	7.232351172	72.25	1.261000385
1322	7.232308840	72.75	1.269727031
1331	7.232267570	73.25	1.278453677
1340	7.232227376	73.75	1.287180323
1349	7.232188268	74.25	1.295906970
1358	7.232150259	74.75	1.304633616
1367	7.232113361	75.25	1.313360262
1376	7.232077584	75.75	1.322086908
1385	7.232042939	76.25	1.330813555
1394	7.232009437	76.75	1.339540201
1403	7.231977089	77.25	1.348266847
1412	7.231945903	77.75	1.356993493
1421	7.231915889	78.25	1.365720140
1430	7.231887057	78.75	1.374446786
1439	7.231859415	79.25	1.383173432
1448	7.231832972	79.75	1.391900078
1457	7.231807735	80.25	1.400626725
1466	7.231783712	80.75	1.409353371
1475	7.231760911	81.25	1.418080017
1484	7.231739339	81.75	1.426806664
1493	7.231719001	82.25	1.435533310
1502	7.231699904	82.75	1.444259956
1511	7.231682054	83.25	1.452986602
1520	7.231665456	83.75	1.461713249
1529	7.231650116	84.25	1.470439895
1538	7.231636038	84.75	1.479166541
1547	7.231623226	85.25	1.487893187
1556	7.231611684	85.75	1.496619834
1565	7.231601416	86.25	1.505346480
1574	7.231592424	86.75	1.514073126
1583	7.231584712	87.25	1.522799772
1592	7.231578281	87.75	1.531526419
1601	7.231573135	88.25	1.540253065

1610	7.231569273	88.75	1.548979711
1619	7.231566699	89.25	1.557706357
1628	7.231565411	89.75	1.566433004
1637	7.231565411	90.25	1.575159650
1646	7.231566699	90.75	1.583886296
1655	7.231569273	91.25	1.592612942
1664	7.231573135	91.75	1.601339589
1673	7.231578281	92.25	1.610066235
1682	7.231584712	92.75	1.618792881
1691	7.231592424	93.25	1.627519527
1700	7.231601416	93.75	1.636246174
1709	7.231611684	94.25	1.644972820
1718	7.231623226	94.75	1.653699466
1727	7.231636038	95.25	1.662426113
1736	7.231650116	95.75	1.671152759
1745	7.231665456	96.25	1.679879405
1754	7.231682054	96.75	1.688606051
1763	7.231699904	97.25	1.697332698
1772	7.231719001	97.75	1.706059344
1781	7.231739339	98.25	1.714785990
1790	7.231760911	98.75	1.723512636
1799	7.231783712	99.25	1.732239283
1808	7.231807735	99.75	1.740965929
1817	7.231832972	100.25	1.749692575
1826	7.231859415	100.75	1.758419221
1835	7.231887057	101.25	1.767145868
1844	7.231915889	101.75	1.775872514
1853	7.231945903	102.25	1.784599160
1862	7.231977089	102.75	1.793325806
1871	7.232009437	103.25	1.802052453
1880	7.232042939	103.75	1.810779099
1889	7.232077584	104.25	1.819505745
1898	7.232113361	104.75	1.828232391
1907	7.232150259	105.25	1.836959038
1916	7.232188268	105.75	1.845685684
1925	7.232227376	106.25	1.854412330
1934	7.232267570	106.75	1.863138977
1943	7.232308840	107.25	1.871865623
1952	7.232351172	107.75	1.880592269
1961	7.232394553	108.25	1.889318915
1970	7.232438970	108.75	1.898045562
1979	7.232484411	109.25	1.906772208
1988	7.232530860	109.75	1.915498854
1997	7.232578304	110.25	1.924225500
2006	7.232626729	110.75	1.932952147
2015	7.232676119	111.25	1.941678793
2024	7.232726461	111.75	1.950405439
2033	7.232777738	112.25	1.959132085
2042	7.232829935	112.75	1.967858732
2051	7.232883036	113.25	1.976585378
2060	7.232937025	113.75	1.985312024
2069	7.232991886	114.25	1.994038670
2078	7.233047602	114.75	2.002765317
2087	7.233104156	115.25	2.011491963
2096	7.233161531	115.75	2.020218609
2105	7.233219709	116.25	2.028945255
2114	7.233278673	116.75	2.037671902

2123	7.233338406	117.25	2.046398548
2132	7.233398888	117.75	2.055125194
2141	7.233460101	118.25	2.063851840
2150	7.233522028	118.75	2.072578487
2159	7.233584648	119.25	2.081305133
2168	7.233647943	119.75	2.090031779
2177	7.233711895	120.25	2.098758426
2186	7.233776482	120.75	2.107485072
2195	7.233841686	121.25	2.116211718
2204	7.233907488	121.75	2.124938364
2213	7.233973866	122.25	2.133665011
2222	7.234040801	122.75	2.142391657
2231	7.234108272	123.25	2.151118303
2240	7.234176259	123.75	2.159844949
2249	7.234244742	124.25	2.168571596
2258	7.234313699	124.75	2.177298242
2267	7.234383109	125.25	2.186024888
2276	7.234452952	125.75	2.194751534
2285	7.234523206	126.25	2.203478181
2294	7.234593849	126.75	2.212204827
2303	7.234664861	127.25	2.220931473
2312	7.234736220	127.75	2.229658119
2321	7.234807903	128.25	2.238384766
2330	7.234879890	128.75	2.247111412
2339	7.234952158	129.25	2.255838058
2348	7.235024685	129.75	2.264564704
2357	7.235097449	130.25	2.273291351
2366	7.235170428	130.75	2.282017997
2375	7.235243600	131.25	2.290744643
2384	7.235316943	131.75	2.299471290
2393	7.235390434	132.25	2.308197936
2402	7.235464051	132.75	2.316924582
2411	7.235537771	133.25	2.325651228
2420	7.235611572	133.75	2.334377875
2429	7.235685432	134.25	2.343104521
2438	7.235759328	134.75	2.351831167
2447	7.235833237	135.25	2.360557813
2456	7.235907138	135.75	2.369284460
2465	7.235981007	136.25	2.378011106
2474	7.236054821	136.75	2.386737752
2483	7.236128560	137.25	2.395464398
2492	7.236202199	137.75	2.404191045
2501	7.236275717	138.25	2.412917691
2510	7.236349091	138.75	2.421644337
2519	7.236422299	139.25	2.430370983
2528	7.236495318	139.75	2.439097630
2537	7.236568127	140.25	2.447824276
2546	7.236640703	140.75	2.456550922
2555	7.236713023	141.25	2.465277568
2564	7.236785067	141.75	2.474004215
2573	7.236856811	142.25	2.482730861
2582	7.236928235	142.75	2.491457507
2591	7.236999315	143.25	2.500184153
2600	7.237070031	143.75	2.508910800
2609	7.237140362	144.25	2.517637446
2618	7.237210284	144.75	2.526364092
2627	7.237279778	145.25	2.535090739

2636	7.237348822	145.75	2.543817385
2645	7.237417394	146.25	2.552544031
2654	7.237485475	146.75	2.561270677
2663	7.237553043	147.25	2.569997324
2672	7.237620077	147.75	2.578723970
2681	7.237686557	148.25	2.587450616
2690	7.237752464	148.75	2.596177262
2699	7.237817776	149.25	2.604903909
2708	7.237882473	149.75	2.613630555
2717	7.237946537	150.25	2.622357201
2726	7.238009947	150.75	2.631083847
2735	7.238072684	151.25	2.639810494
2744	7.238134729	151.75	2.648537140
2753	7.238196062	152.25	2.657263786
2762	7.238256666	152.75	2.665990432
2771	7.238316522	153.25	2.674717079
2780	7.238375611	153.75	2.683443725
2789	7.238433916	154.25	2.692170371
2798	7.238491417	154.75	2.700897017
2807	7.238548099	155.25	2.709623664
2816	7.238603944	155.75	2.718350310
2825	7.238658934	156.25	2.727076956
2834	7.238713052	156.75	2.735803603
2843	7.238766283	157.25	2.744530249
2852	7.238818610	157.75	2.753256895
2861	7.238870016	158.25	2.761983541
2870	7.238920487	158.75	2.770710188
2879	7.238970007	159.25	2.779436834
2888	7.239018560	159.75	2.788163480
2897	7.239066132	160.25	2.796890126
2906	7.239112708	160.75	2.805616773
2915	7.239158274	161.25	2.814343419
2924	7.239202816	161.75	2.823070065
2933	7.239246321	162.25	2.831796711
2942	7.239288775	162.75	2.840523358
2951	7.239330165	163.25	2.849250004
2960	7.239370478	163.75	2.857976650
2969	7.239409702	164.25	2.866703296
2978	7.239447826	164.75	2.875429943
2987	7.239484837	165.25	2.884156589
2996	7.239520724	165.75	2.892883235
3005	7.239555476	166.25	2.901609881
3014	7.239589082	166.75	2.910336528
3023	7.239621533	167.25	2.919063174
3032	7.239652819	167.75	2.927789820
3041	7.239682929	168.25	2.936516466
3050	7.239711854	168.75	2.945243113
3059	7.239739586	169.25	2.953969759
3068	7.239766116	169.75	2.962696405
3077	7.239791436	170.25	2.971423052
3086	7.239815539	170.75	2.980149698
3095	7.239838416	171.25	2.988876344
3104	7.239860062	171.75	2.997602990
3113	7.239880468	172.25	3.006329637
3122	7.239899630	172.75	3.015056283
3131	7.239917541	173.25	3.023782929
3140	7.239934195	173.75	3.032509575

3149	7.239949588	174.25	3.041236222	
3158	7.239963715	174.75	3.049962868	
3167	7.239976572	175.25	3.058689514	
3176	7.239988154	175.75	3.067416160	
3185	7.239998458	176.25	3.076142807	
3194	7.240007481	176.75	3.084869453	
3203	7.240015220	177.25	3.093596099	
3212	7.240021673	177.75	3.102322745	
3221	7.240026837	178.25	3.111049392	
3230	7.240030712	178.75	3.119776038	
3239	7.240033296	179.25	3.128502684	
3248	7.240034588	179.75	3.137229330	
18	7.184784750	0.00	0.000000000	제 9 원주
27	7.184784104	0.50	0.008726646	
36	7.184782166	1.00	0.017453293	
45	7.184778936	1.50	0.026179939	
54	7.184774416	2.00	0.034906585	
63	7.184768607	2.50	0.043633231	
72	7.184761511	3.00	0.052359878	
81	7.184753129	3.50	0.061086524	
90	7.184743465	4.00	0.069813170	
99	7.184732521	4.50	0.078539816	
108	7.184720302	5.00	0.087266463	
117	7.184706809	5.50	0.095993109	
126	7.184692048	6.00	0.104719755	
135	7.184676024	6.50	0.113446401	
144	7.184658740	7.00	0.122173048	
153	7.184640203	7.50	0.130899694	
162	7.184620418	8.00	0.139626340	
171	7.184599391	8.50	0.148352986	
180	7.184577129	9.00	0.157079633	
189	7.184553637	9.50	0.165806279	
198	7.184528925	10.00	0.174532925	
207	7.184502998	10.50	0.183259571	
216	7.184475866	11.00	0.191986218	
225	7.184447535	11.50	0.200712864	
234	7.184418016	12.00	0.209439510	
243	7.184387317	12.50	0.218166156	
252	7.184355448	13.00	0.226892803	
261	7.184322417	13.50	0.235619449	
270	7.184288236	14.00	0.244346095	
279	7.184252915	14.50	0.253072742	
288	7.184216464	15.00	0.261799388	
297	7.184178895	15.50	0.270526034	
306	7.184140219	16.00	0.279252680	
315	7.184100448	16.50	0.287979327	
324	7.184059594	17.00	0.296705973	
333	7.184017671	17.50	0.305432619	
342	7.183974689	18.00	0.314159265	
351	7.183930664	18.50	0.322885912	
360	7.183885607	19.00	0.331612558	
369	7.183839534	19.50	0.340339204	
378	7.183792458	20.00	0.349065850	
387	7.183744393	20.50	0.357792497	
396	7.183695354	21.00	0.366519143	
405	7.183645356	21.50	0.375245789	
414	7.183594415	22.00	0.383972435	

423	7.183542546	22.50	0.392699082
432	7.183489765	23.00	0.401425728
441	7.183436087	23.50	0.410152374
450	7.183381531	24.00	0.418879020
459	7.183326111	24.50	0.427605667
468	7.183269845	25.00	0.436332313
477	7.183212751	25.50	0.445058959
486	7.183154845	26.00	0.453785606
495	7.183096145	26.50	0.462512252
504	7.183036670	27.00	0.471238898
513	7.182976438	27.50	0.479965544
522	7.182915466	28.00	0.488692191
531	7.182853774	28.50	0.497418837
540	7.182791380	29.00	0.506145483
549	7.182728304	29.50	0.514872129
558	7.182664564	30.00	0.523598776
567	7.182600180	30.50	0.532325422
576	7.182535173	31.00	0.541052068
585	7.182469561	31.50	0.549778714
594	7.182403365	32.00	0.558505361
603	7.182336604	32.50	0.567232007
612	7.182269300	33.00	0.575958653
621	7.182201473	33.50	0.584685299
630	7.182133144	34.00	0.593411946
639	7.182064332	34.50	0.602138592
648	7.181995061	35.00	0.610865238
657	7.181925350	35.50	0.619591884
666	7.181855220	36.00	0.628318531
675	7.181784694	36.50	0.637045177
684	7.181713793	37.00	0.645771823
693	7.181642538	37.50	0.654498469
702	7.181570951	38.00	0.663225116
711	7.181499054	38.50	0.671951762
720	7.181426869	39.00	0.680678408
729	7.181354418	39.50	0.689405055
738	7.181281723	40.00	0.698131701
747	7.181208806	40.50	0.706858347
756	7.181135689	41.00	0.715584993
765	7.181062395	41.50	0.724311640
774	7.180988946	42.00	0.733038286
783	7.180915365	42.50	0.741764932
792	7.180841673	43.00	0.750491578
801	7.180767894	43.50	0.759218225
810	7.180694049	44.00	0.767944871
819	7.180620161	44.50	0.776671517
828	7.180546254	45.00	0.785398163
837	7.180472348	45.50	0.794124810
846	7.180398468	46.00	0.802851456
855	7.180324635	46.50	0.811578102
864	7.180250871	47.00	0.820304748
873	7.180177200	47.50	0.829031395
882	7.180103643	48.00	0.837758041
891	7.180030224	48.50	0.846484687
900	7.179956964	49.00	0.855211333
909	7.179883885	49.50	0.863937980
918	7.179811011	50.00	0.872664626
927	7.179738362	50.50	0.881391272

936	7.179665962	51.00	0.890117919
945	7.179593833	51.50	0.898844565
954	7.179521995	52.00	0.907571211
963	7.179450472	52.50	0.916297857
972	7.179379284	53.00	0.925024504
981	7.179308454	53.50	0.933751150
990	7.179238003	54.00	0.942477796
999	7.179167952	54.50	0.951204442
1008	7.179098323	55.00	0.959931089
1017	7.179029137	55.50	0.968657735
1026	7.178960415	56.00	0.977384381
1035	7.178892178	56.50	0.986111027
1044	7.178824447	57.00	0.994837674
1053	7.178757242	57.50	1.003564320
1062	7.178690583	58.00	1.012290966
1071	7.178624491	58.50	1.021017612
1080	7.178558986	59.00	1.029744259
1089	7.178494088	59.50	1.038470905
1098	7.178429817	60.00	1.047197551
1107	7.178366191	60.50	1.055924197
1116	7.178303232	61.00	1.064650844
1125	7.178240956	61.50	1.073377490
1134	7.178179385	62.00	1.082104136
1143	7.178118535	62.50	1.090830782
1152	7.178058426	63.00	1.099557429
1161	7.177999076	63.50	1.108284075
1170	7.177940503	64.00	1.117010721
1179	7.177882724	64.50	1.125737368
1188	7.177825758	65.00	1.134464014
1197	7.177769622	65.50	1.143190660
1206	7.177714332	66.00	1.151917306
1215	7.177659905	66.50	1.160643953
1224	7.177606358	67.00	1.169370599
1233	7.177553708	67.50	1.178097245
1242	7.177501969	68.00	1.186823891
1251	7.177451159	68.50	1.195550538
1260	7.177401291	69.00	1.204277184
1269	7.177352382	69.50	1.213003830
1278	7.177304447	70.00	1.221730476
1287	7.177257499	70.50	1.230457123
1296	7.177211553	71.00	1.239183769
1305	7.177166623	71.50	1.247910415
1314	7.177122722	72.00	1.256637061
1323	7.177079864	72.50	1.265363708
1332	7.177038063	73.00	1.274090354
1341	7.176997329	73.50	1.282817000
1350	7.176957677	74.00	1.291543646
1359	7.176919118	74.50	1.300270293
1368	7.176881663	75.00	1.308996939
1377	7.176845324	75.50	1.317723585
1386	7.176810113	76.00	1.326450232
1395	7.176776039	76.50	1.335176878
1404	7.176743113	77.00	1.343903524
1413	7.176711345	77.50	1.352630170
1422	7.176680744	78.00	1.361356817
1431	7.176651321	78.50	1.370083463
1440	7.176623083	79.00	1.378810109

1449	7.176596040	79.50	1.387536755
1458	7.176570199	80.00	1.396263402
1467	7.176545569	80.50	1.404990048
1476	7.176522156	81.00	1.413716694
1485	7.176499969	81.50	1.422443340
1494	7.176479013	82.00	1.431169987
1503	7.176459295	82.50	1.439896633
1512	7.176440821	83.00	1.448623279
1521	7.176423597	83.50	1.457349925
1530	7.176407628	84.00	1.466076572
1539	7.176392918	84.50	1.474803218
1548	7.176379473	85.00	1.483529864
1557	7.176367295	85.50	1.492256510
1566	7.176356390	86.00	1.500983157
1575	7.176346760	86.50	1.509709803
1584	7.176338408	87.00	1.518436449
1593	7.176331336	87.50	1.527163095
1602	7.176325547	88.00	1.535889742
1611	7.176321043	88.50	1.544616388
1620	7.176317825	89.00	1.553343034
1629	7.176315894	89.50	1.562069681
1638	7.176315250	90.00	1.570796327
1647	7.176315894	90.50	1.579522973
1656	7.176317825	91.00	1.588249619
1665	7.176321043	91.50	1.596976266
1674	7.176325547	92.00	1.605702912
1683	7.176331336	92.50	1.614429558
1692	7.176338408	93.00	1.623156204
1701	7.176346760	93.50	1.631882851
1710	7.176356390	94.00	1.640609497
1719	7.176367295	94.50	1.649336143
1728	7.176379473	95.00	1.658062789
1737	7.176392918	95.50	1.666789436
1746	7.176407628	96.00	1.675516082
1755	7.176423597	96.50	1.684242728
1764	7.176440821	97.00	1.692969374
1773	7.176459295	97.50	1.701696021
1782	7.176479013	98.00	1.710422667
1791	7.176499969	98.50	1.719149313
1800	7.176522156	99.00	1.727875959
1809	7.176545569	99.50	1.736602606
1818	7.176570199	100.00	1.745329252
1827	7.176596040	100.50	1.754055898
1836	7.176623083	101.00	1.762782545
1845	7.176651321	101.50	1.771509191
1854	7.176680744	102.00	1.780235837
1863	7.176711345	102.50	1.788962483
1872	7.176743113	103.00	1.797689130
1881	7.176776039	103.50	1.806415776
1890	7.176810113	104.00	1.815142422
1899	7.176845324	104.50	1.823869068
1908	7.176881663	105.00	1.832595715
1917	7.176919118	105.50	1.841322361
1926	7.176957677	106.00	1.850049007
1935	7.176997329	106.50	1.858775653
1944	7.177038063	107.00	1.867502300
1953	7.177079864	107.50	1.876228946

1962	7.177122722	108.00	1.884955592
1971	7.177166623	108.50	1.893682238
1980	7.177211553	109.00	1.902408885
1989	7.177257499	109.50	1.911135531
1998	7.177304447	110.00	1.919862177
2007	7.177352382	110.50	1.928588823
2016	7.177401291	111.00	1.937315470
2025	7.177451159	111.50	1.946042116
2034	7.177501969	112.00	1.954768762
2043	7.177553708	112.50	1.963495408
2052	7.177606358	113.00	1.972222055
2061	7.177659905	113.50	1.980948701
2070	7.177714332	114.00	1.989675347
2079	7.177769622	114.50	1.998401994
2088	7.177825758	115.00	2.007128640
2097	7.177882724	115.50	2.015855286
2106	7.177940503	116.00	2.024581932
2115	7.177999076	116.50	2.033308579
2124	7.178058426	117.00	2.042035225
2133	7.178118535	117.50	2.050761871
2142	7.178179385	118.00	2.059488517
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2160	7.178303232	119.00	2.076941810
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2187	7.178494088	120.50	2.103121749
2196	7.178558986	121.00	2.111848395
2205	7.178624491	121.50	2.120575041
2214	7.178690583	122.00	2.129301687
2223	7.178757242	122.50	2.138028334
2232	7.178824447	123.00	2.146754980
2241	7.178892178	123.50	2.155481626
2250	7.178960415	124.00	2.164208272
2259	7.179029137	124.50	2.172934919
2268	7.179098323	125.00	2.181661565
2277	7.179167952	125.50	2.190388211
2286	7.179238003	126.00	2.199114858
2295	7.179308454	126.50	2.207841504
2304	7.179379284	127.00	2.216568150
2313	7.179450472	127.50	2.225294796
2322	7.179521995	128.00	2.234021443
2331	7.179593833	128.50	2.242748089
2340	7.179665962	129.00	2.251474735
2349	7.179738362	129.50	2.260201381
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2367	7.179883885	130.50	2.277654674
2376	7.179956964	131.00	2.286381320
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2394	7.180103643	132.00	2.303834613
2403	7.180177200	132.50	2.312561259
2412	7.180250871	133.00	2.321287905
2421	7.180324635	133.50	2.330014551
2430	7.180398468	134.00	2.338741198
2439	7.180472348	134.50	2.347467844
2448	7.180546254	135.00	2.356194490
2457	7.180620161	135.50	2.364921136
2466	7.180694049	136.00	2.373647783

2475	7.180767894	136.50	2.382374429
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2520	7.181135689	139.00	2.426007660
2529	7.181208806	139.50	2.434734307
2538	7.181281723	140.00	2.443460953
2547	7.181354418	140.50	2.452187599
2556	7.181426869	141.00	2.460914245
2565	7.181499054	141.50	2.469640892
2574	7.181570951	142.00	2.478367538
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2628	7.181995061	145.00	2.530727415
2637	7.182064332	145.50	2.539454062
2646	7.182133144	146.00	2.548180708
2655	7.182201473	146.50	2.556907354
2664	7.182269300	147.00	2.565634000
2673	7.182336604	147.50	2.574360647
2682	7.182403365	148.00	2.583087293
2691	7.182469561	148.50	2.591813939
2700	7.182535173	149.00	2.600540585
2709	7.182600180	149.50	2.609267232
2718	7.182664564	150.00	2.617993878
2727	7.182728304	150.50	2.626720524
2736	7.182791380	151.00	2.635447171
2745	7.182853774	151.50	2.644173817
2754	7.182915466	152.00	2.652900463
2763	7.182976438	152.50	2.661627109
2772	7.183036670	153.00	2.670353756
2781	7.183096145	153.50	2.679080402
2790	7.183154845	154.00	2.687807048
2799	7.183212751	154.50	2.696533694
2808	7.183269845	155.00	2.705260341
2817	7.183326111	155.50	2.713986987
2826	7.183381531	156.00	2.722713633
2835	7.183436087	156.50	2.731440279
2844	7.183489765	157.00	2.740166926
2853	7.183542546	157.50	2.748893572
2862	7.183594415	158.00	2.757620218
2871	7.183645356	158.50	2.766346864
2880	7.183695354	159.00	2.775073511
2889	7.183744393	159.50	2.783800157
2898	7.183792458	160.00	2.792526803
2907	7.183839534	160.50	2.801253449
2916	7.183885607	161.00	2.809980096
2925	7.183930664	161.50	2.818706742
2934	7.183974689	162.00	2.827433388
2943	7.184017671	162.50	2.836160034
2952	7.184059594	163.00	2.844886681
2961	7.184100448	163.50	2.853613327
2970	7.184140219	164.00	2.862339973
2979	7.184178895	164.50	2.871066620

2988	7.184216464	165.00	2.879793266	
2997	7.184252915	165.50	2.888519912	
3006	7.184288236	166.00	2.897246558	
3015	7.184322417	166.50	2.905973205	
3024	7.184355448	167.00	2.914699851	
3033	7.184387317	167.50	2.923426497	
3042	7.184418016	168.00	2.932153143	
3051	7.184447535	168.50	2.940879790	
3060	7.184475866	169.00	2.949606436	
3069	7.184502998	169.50	2.958333082	
3078	7.184528925	170.00	2.967059728	
3087	7.184553637	170.50	2.975786375	
3096	7.184577129	171.00	2.984513021	
3105	7.184599391	171.50	2.993239667	
3114	7.184620418	172.00	3.001966313	
3123	7.184640203	172.50	3.010692960	
3132	7.184658740	173.00	3.019419606	
3141	7.184676024	173.50	3.028146252	
3150	7.184692048	174.00	3.036872898	
3159	7.184706809	174.50	3.045599545	
3168	7.184720302	175.00	3.054326191	
3177	7.184732521	175.50	3.063052837	
3186	7.184743465	176.00	3.071779484	
3195	7.184753129	176.50	3.080506130	
3204	7.184761511	177.00	3.089232776	
3213	7.184768607	177.50	3.097959422	
3222	7.184774416	178.00	3.106686069	
3231	7.184778936	178.50	3.115412715	
3240	7.184782166	179.00	3.124139361	
3249	7.184784104	179.50	3.132866007	
3258	7.184784750	180.00	3.141592654	
1	7.488659750	0.25	0.004363323	첨끝
2	7.433409750	0.50	0.008726646	
3	7.378159750	0.50	0.008726646	
4	7.322909750	0.25	0.004363323	
3261	7.488659750	179.75	3.137229330	막끝
3262	7.433409750	179.50	3.132866007	
3263	7.378159750	179.50	3.132866007	
3264	7.322909750	179.75	3.137229330	

서 지 정 보 양 식

수행기관보고서번호	위탁기관보고서번호	표준보고서번호	INIS 주제코드
KAERI/TR-2627/2003			
제목/부제			

CANDU Type 핵연료봉의 축방향주름 해석

주저자 및 부서명	조문성 (미래형원자로연료개발부)
연 구 자 및 부 서 명	석호천 (미래형원자로연료개발부)

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페 이 지		도 표	있음(V), 없음( )	크 기	19 x 26 Cm.
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연구위탁기관				계약 번호	

초록 (15-20 줄 내외)

CANDU-6 원자로에는 380 개의 핵연료 채널이 있으며, 각 핵연료 채널마다 12 개의 핵연료집합체가 장전된다. 채널내 핵연료로부터 발생되는 열을 제거하기 위해 높은 압력을 가진 중수로 냉각재가 핵연료 집합체열을 통과한다. 핵연료가 원자로에 장전된 직후 이러한 가압 냉각수에 의한 압력의 영향으로 피복관이 그 속에 들어 있는 이산화 우라늄 소결체 표면에 붕괴(Collapse)되어 피복관 축방향을 따라 주름이 형성될 수 있다. 본 연구에서는 컴퓨터 구조해석 소프트웨어인 ABAQUS Ver 6.2 를 사용하여 핵연료 피복관의 축방향 주름 현상을 시뮬레이션하기 위한 유한요소해석 모델을 개발하였다. 개발한 모델을 이용하여 1973 년과 1976 년에 WCL 에서 실험한 51 개 케이스에 대한 붕괴압력을 계산하였다. 유한요소해석으로도 붕괴압력을 정확히 예측할 수는 없었으나, 실험 결과와 중요한 상관관계를 가지는 의미 있는 계산결과를 얻었다.

주제명 키워드 (10 단어내외)

CANFLEX 핵연료, 축방향 주름, CANDU-6 원자로, 피복관 붕괴, 임계붕괴압력

Abstract

There are 380 fuel channels in a CANDU-6 reactor, and twelve fuel bundles are loaded into each fuel channel. High-pressure, heavy water coolant passes through the fuel bundle string to remove heat generated from the fuel. Fuel sheath collapses down around the uranium dioxide pellet due to the coolant pressure when the fuel is loaded into the reactor. Longitudinal ridges may form in CANDU fuel element sheaths as a result of sheath collapse onto the pellets. A static analysis, finite-element (FE) model was developed to simulate the longitudinal ridging of the fuel element with use of the structural analysis computer code ABAQUS. Collapse pressures were calculated for the fifty-one cases for which test results of WCL in 1973 and 1975 are available. Calculation results under-predicted the critical collapse pressure but it showed significant relationship against test results.

Subject Keywords
(About 10 words)

CANFLEX Fuel, Longitudinal Ridge, CANDU-6 reactor, Fuel Sheath Collapse, Critical Collapse Pressure