

## Polymers 1

A (4p)

What is the difference between the worm-like chain and the freely-jointed chain models? When is the worm-like chain model more applicable?

The freely jointed chain models the polymer as fully stiff segments with a certain length and with full freedom to rotate at the connection points. The worm-like chain bend continuously. It is usually a better model for polymers that are stiff, at least in relation to their contour length.

B (3p)

Why does the persistence length of DNA depend on ionic strength?

DNA contains negatively charged groups on the backbone so it is self-repelling, making it relatively stiff. However, at high ionic strength the charges are screened by counterions, which makes the molecule less stiff (shorter persistence length).

C (3p)

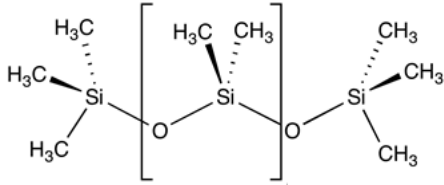
Which three types of “natural polymers” are the most important in biology? What is the building block (monomer type) for each type? (No need for details on the chemistry.)

Ribonucleic acids (DNA and RNA): Consist of four different so called base-pairs in a certain sequence. Proteins: Consist of amino acids (about 20 different types). Polysaccharides, like starch and cellulose: Consist of sugars.

## Polymers 2

A (3p)

Polydimethylsiloxane (PDMS) has the following structure:



The length of a Si – O bond is 2 Å. In an experiment 20 kD PDMS is dissolved in chloroform and the Flory radius is determined to be 10 nm. What is the Flory radius of 50 kD PDMS under these conditions?

Here  $M$  is 2.5 times higher so the scaling relation of  $R_F \sim M^{3/5}$  gives a  $2.5^{0.6}$  times higher end to end distance. This means  $R_F = 17.3$  nm.

Comment: The length of the chemical bond (known) and the Kuhn length (unknown) are not relevant!

B (3p)

A ball consisting of PDMS with average  $M = 20$  kg/mol and a density of  $950$  kgm<sup>-3</sup> is dropped on a hard surface (at room temperature). Assume the friction coefficient of a segment along a chain is  $10^{-8}$  kgs<sup>-1</sup>. Calculate the terminal time and explain what happens to the ball!

Use the information from (A) to see that the monomer length is 4 Å. Calculate the monomer weight of  $74$  gmol<sup>-1</sup> from atomic weights. The number of monomers is  $M/m \approx 270$  and the contour length is then 108 nm. Using the formula for the terminal time from reptation theory then gives 3.9 s. This is obviously longer than the time of contact with the surface for a bouncing ball so the PDMS responds elastically and bounces.

Comment: The density is not needed and there is no need to rescale or know the Kuhn length.

C (4p)

PDMS is exposed to oscillatory strain at 1 kHz. Assume the stress relaxation can be modelled simply as  $G(t) = G_e \exp(-At)$  where  $G_e$  is the plateau modulus and  $A$  is a constant. Determine this constant if the phase delay is 5°.

Using the formula for the dynamic modulus directly and solving the integral should give a dynamic modulus of  $i\omega G_e/[A+i\omega]$ . Solving for the real part gives  $\omega^2 G_e/[A^2+\omega^2]$  and the imaginary part  $A\omega G_e/[A^2+\omega^2]$ . The formula for phase delay then gives that  $\tan(5^\circ) = A/\omega$  which gives  $A = 87$  Hz.

Comment: I forgot to say that  $\omega$  was an angular frequency. It would be OK to multiply it with  $2\pi$  and get a slightly different answer. Note that the plateau modulus is not needed and it cannot be calculated by the density given in (B) since we have no information about entanglement.

Boltzmann's constant:  $k_B = 1.38 \times 10^{-23} \text{ JK}^{-1}$

Avogadro's number:  $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$

$T(^{\circ}\text{C}) = T(\text{K}) - 273.15$

Polydispersity index ( $M_w/M_n$ ):

$$M_n = \frac{\sum_i n_i M_i}{\sum_i n_i} \quad M_w = \sum_i w_i M_i = \frac{\sum_i n_i M_i^2}{\sum_i n_i M_i}$$

Random walk:

$$R = aN^{1/2}$$

Worm-like chain model ( $b = 2l_p$ ):

$$R_{wlc} = \left[ 2l_p r_{\max} \left[ 1 - \frac{l_p}{r_{\max}} \left[ 1 - \exp\left(-\frac{r_{\max}}{l_p}\right) \right] \right] \right]^{1/2}$$

Entropy:

$$S = k_B \log(W)$$

Gibbs' free energy change:

$$\Delta G = \Delta H - T\Delta S$$

Flory radius (in solvent):

$$R_F = [1 - 2\chi]^{1/5} aN^{3/5}$$

Alexander - de Gennes brush height:

$$H = \left[ \frac{1 - 2\chi}{3} \Gamma \right]^{1/3} a^{5/3} N$$

Reptation theory terminal time:

$$t_T = \frac{[aN]^2}{2D_{cIT}} = \frac{\zeta_{\text{segment}} a^2 N^3}{2k_B T}$$

Gelation threshold and gel fraction:

$$f_c = \frac{1}{z-1} \quad p_{\text{gel}} = 1 - p_0^z \quad p_0 = 1 - f + fp_0^{z-1}$$

Rubber elasticity modulus:

$$Y = \frac{3\rho k_B T}{mN_{\text{part}}} \quad G_c = \frac{\rho k_B T}{M_{\text{eff}}}$$

Oscillatory deformation  $e(t) = e_0 \sin(\omega t)$  stress response and dynamic modulus:

$$\sigma(t) = \sigma_0 \sin(\omega t + \delta) \quad \tan(\delta) = \frac{\text{Im}(G_{\text{DM}})}{\text{Re}(G_{\text{DM}})} \quad G_{\text{DM}}(\omega) = i\omega \int_0^{\infty} \exp(-i\omega t) G(t) dt$$

# Los Alamos National Laboratory Chemistry Division

## Periodic Table of the Elements

1A	1 <b>H</b> hydrogen 1.008	2A	4 <b>Be</b> beryllium 9.012	3B	21 <b>Sc</b> scandium 44.96	4B	22 <b>Ti</b> titanium 47.88	5B	23 <b>V</b> vanadium 50.94	6B	24 <b>Cr</b> chromium 52.00	7B	25 <b>Mn</b> manganese 54.94	8B	26 <b>Fe</b> iron 55.85	27 <b>Co</b> cobalt 58.93	28 <b>Ni</b> nickel 58.69	11B	29 <b>Cu</b> copper 63.55	12B	30 <b>Zn</b> zinc 65.39	3A	5 <b>B</b> boron 10.81	4A	6 <b>C</b> carbon 12.01	5A	7 <b>N</b> nitrogen 14.01	6A	8 <b>O</b> oxygen 16.00	7A	9 <b>F</b> fluorine 19.00	8A	2 <b>He</b> helium 4.003																																																																																																																																																																																																																																																																																																																	
	19 <b>K</b> potassium 39.10	20 <b>Ca</b> calcium 40.08	38 <b>Sr</b> strontium 87.62	39 <b>Y</b> yttrium 88.91	40 <b>Zr</b> zirconium 91.22	41 <b>Nb</b> niobium 92.91	42 <b>Mo</b> molybdenum 95.94	43 <b>Tc</b> technetium (98)	44 <b>Ru</b> ruthenium 101.1	45 <b>Rh</b> rhodium 102.9	46 <b>Pd</b> palladium 106.4	47 <b>Ag</b> silver 107.9	48 <b>Cd</b> cadmium 112.4	49 <b>In</b> indium 114.8	50 <b>Sn</b> tin 118.7	51 <b>Sb</b> antimony 121.8	52 <b>Te</b> tellurium 127.6	53 <b>I</b> iodine 126.9	54 <b>Xe</b> xenon 131.3	36 <b>Kr</b> krypton 83.80	37 <b>Rb</b> rubidium 85.47	38 <b>Sr</b> strontium 87.62	57 <b>La*</b> lanthanum 138.9	72 <b>Hf</b> hafnium 178.5	73 <b>Ta</b> tantalum 180.9	74 <b>W</b> tungsten 183.9	75 <b>Re</b> rhenium 186.2	76 <b>Os</b> osmium 190.2	77 <b>Ir</b> iridium 190.2	78 <b>Pt</b> platinum 195.1	79 <b>Au</b> gold 197.0	80 <b>Hg</b> mercury 200.5	81 <b>Tl</b> thallium 204.4	82 <b>Pb</b> lead 207.2	83 <b>Bi</b> bismuth 208.9	84 <b>Po</b> polonium (209)	85 <b>At</b> astatine (210)	86 <b>Rn</b> radon (222)																																																																																																																																																																																																																																																																																																												
	87 <b>Fr</b> francium (223)	88 <b>Ra</b> radium (226)	89 <b>Ac~</b> actinium (227)	104 <b>Rf</b> rutherfordium (261)	105 <b>Db</b> dubnium (262)	106 <b>Sg</b> seaborgium (263)	107 <b>Bh</b> bohrium (262)	108 <b>Hs</b> hassium (265)	109 <b>Mt</b> meitnerium (266)	110 <b>Ds</b> darmstadtium (271)	111 <b>Uuu</b> (272)	112 <b>Uub</b> (277)	113 <b>Uut</b> (284)	114 <b>Uuq</b> (286)	115 <b>Uup</b> (288)	116 <b>Uuh</b> (289)	117 <b>Uuhs</b> (293)	118 <b>Uuo</b> (?)	119 <b>Uue</b> (?)	120 <b>Uufl</b> (?)	121 <b>Uuql</b> (?)	122 <b>Uuqll</b> (?)	123 <b>Uuqlll</b> (?)	124 <b>Uuqllll</b> (?)	125 <b>Uuqlllll</b> (?)	126 <b>Uuqllllll</b> (?)	127 <b>Uuqlllllll</b> (?)	128 <b>Uuqlllllll</b> (?)	129 <b>Uuqllllllll</b> (?)	130 <b>Uuqlllllllll</b> (?)	131 <b>Uuqlllllllll</b> (?)	132 <b>Uuqllllllllll</b> (?)	133 <b>Uuqlllllllllll</b> (?)	134 <b>Uuqlllllllllll</b> (?)	135 <b>Uuqllllllllllll</b> (?)	136 <b>Uuqlllllllllllll</b> (?)	137 <b>Uuqlllllllllllll</b> (?)	138 <b>Uuqllllllllllllll</b> (?)	139 <b>Uuqlllllllllllllll</b> (?)	140 <b>Uuqlllllllllllllll</b> (?)	141 <b>Uuqlllllllllllllll</b> (?)	142 <b>Uuqllllllllllllllll</b> (?)	143 <b>Uuqlllllllllllllllll</b> (?)	144 <b>Uuqlllllllllllllllll</b> (?)	145 <b>Uuqlllllllllllllllll</b> (?)	146 <b>Uuqlllllllllllllllll</b> (?)	147 <b>Uuqlllllllllllllllll</b> (?)	148 <b>Uuqlllllllllllllllll</b> (?)	149 <b>Uuqlllllllllllllllll</b> (?)	150 <b>Uuqlllllllllllllllll</b> (?)	151 <b>Uuqlllllllllllllllll</b> (?)	152 <b>Uuqlllllllllllllllll</b> (?)	153 <b>Uuqlllllllllllllllll</b> (?)	154 <b>Uuqlllllllllllllllll</b> (?)	155 <b>Uuqlllllllllllllllll</b> (?)	156 <b>Uuqlllllllllllllllll</b> (?)	157 <b>Uuqlllllllllllllllll</b> (?)	158 <b>Uuqlllllllllllllllll</b> (?)	159 <b>Uuqlllllllllllllllll</b> (?)	160 <b>Uuqlllllllllllllllll</b> (?)	161 <b>Uuqlllllllllllllllll</b> (?)	162 <b>Uuqlllllllllllllllll</b> (?)	163 <b>Uuqlllllllllllllllll</b> (?)	164 <b>Uuqlllllllllllllllll</b> (?)	165 <b>Uuqlllllllllllllllll</b> (?)	166 <b>Uuqlllllllllllllllll</b> (?)	167 <b>Uuqlllllllllllllllll</b> (?)	168 <b>Uuqlllllllllllllllll</b> (?)	169 <b>Uuqlllllllllllllllll</b> (?)	170 <b>Uuqlllllllllllllllll</b> (?)	171 <b>Uuqlllllllllllllllll</b> (?)	172 <b>Uuqlllllllllllllllll</b> (?)	173 <b>Uuqlllllllllllllllll</b> (?)	174 <b>Uuqlllllllllllllllll</b> (?)	175 <b>Uuqlllllllllllllllll</b> (?)	176 <b>Uuqlllllllllllllllll</b> (?)	177 <b>Uuqlllllllllllllllll</b> (?)	178 <b>Uuqlllllllllllllllll</b> (?)	179 <b>Uuqlllllllllllllllll</b> (?)	180 <b>Uuqlllllllllllllllll</b> (?)	181 <b>Uuqlllllllllllllllll</b> (?)	182 <b>Uuqlllllllllllllllll</b> (?)	183 <b>Uuqlllllllllllllllll</b> (?)	184 <b>Uuqlllllllllllllllll</b> (?)	185 <b>Uuqlllllllllllllllll</b> (?)	186 <b>Uuqlllllllllllllllll</b> (?)	187 <b>Uuqlllllllllllllllll</b> (?)	188 <b>Uuqlllllllllllllllll</b> (?)	189 <b>Uuqlllllllllllllllll</b> (?)	190 <b>Uuqlllllllllllllllll</b> (?)	191 <b>Uuqlllllllllllllllll</b> (?)	192 <b>Uuqlllllllllllllllll</b> (?)	193 <b>Uuqlllllllllllllllll</b> (?)	194 <b>Uuqlllllllllllllllll</b> (?)	195 <b>Uuqlllllllllllllllll</b> (?)	196 <b>Uuqlllllllllllllllll</b> (?)	197 <b>Uuqlllllllllllllllll</b> (?)	198 <b>Uuqlllllllllllllllll</b> (?)	199 <b>Uuqlllllllllllllllll</b> (?)	200 <b>Uuqlllllllllllllllll</b> (?)	201 <b>Uuqlllllllllllllllll</b> (?)	202 <b>Uuqlllllllllllllllll</b> (?)	203 <b>Uuqlllllllllllllllll</b> (?)	204 <b>Uuqlllllllllllllllll</b> (?)	205 <b>Uuqlllllllllllllllll</b> (?)	206 <b>Uuqlllllllllllllllll</b> (?)	207 <b>Uuqlllllllllllllllll</b> (?)	208 <b>Uuqlllllllllllllllll</b> (?)	209 <b>Uuqlllllllllllllllll</b> (?)	210 <b>Uuqlllllllllllllllll</b> (?)	211 <b>Uuqlllllllllllllllll</b> (?)	212 <b>Uuqlllllllllllllllll</b> (?)	213 <b>Uuqlllllllllllllllll</b> (?)	214 <b>Uuqlllllllllllllllll</b> (?)	215 <b>Uuqlllllllllllllllll</b> (?)	216 <b>Uuqlllllllllllllllll</b> (?)	217 <b>Uuqlllllllllllllllll</b> (?)	218 <b>Uuqlllllllllllllllll</b> (?)	219 <b>Uuqlllllllllllllllll</b> (?)	220 <b>Uuqlllllllllllllllll</b> (?)	221 <b>Uuqlllllllllllllllll</b> (?)	222 <b>Uuqlllllllllllllllll</b> (?)	223 <b>Uuqlllllllllllllllll</b> (?)	224 <b>Uuqlllllllllllllllll</b> (?)	225 <b>Uuqlllllllllllllllll</b> (?)	226 <b>Uuqlllllllllllllllll</b> (?)	227 <b>Uuqlllllllllllllllll</b> (?)	228 <b>Uuqlllllllllllllllll</b> (?)	229 <b>Uuqlllllllllllllllll</b> (?)	230 <b>Uuqlllllllllllllllll</b> (?)	231 <b>Uuqlllllllllllllllll</b> (?)	232 <b>Uuqlllllllllllllllll</b> (?)	233 <b>Uuqlllllllllllllllll</b> (?)	234 <b>Uuqlllllllllllllllll</b> (?)	235 <b>Uuqlllllllllllllllll</b> (?)	236 <b>Uuqlllllllllllllllll</b> (?)	237 <b>Uuqlllllllllllllllll</b> (?)	238 <b>Uuqlllllllllllllllll</b> (?)	239 <b>Uuqlllllllllllllllll</b> (?)	240 <b>Uuqlllllllllllllllll</b> (?)	241 <b>Uuqlllllllllllllllll</b> (?)	242 <b>Uuqlllllllllllllllll</b> (?)	243 <b>Uuqlllllllllllllllll</b> (?)	244 <b>Uuqlllllllllllllllll</b> (?)	245 <b>Uuqlllllllllllllllll</b> (?)	246 <b>Uuqlllllllllllllllll</b> (?)	247 <b>Uuqlllllllllllllllll</b> (?)	248 <b>Uuqlllllllllllllllll</b> (?)	249 <b>Uuqlllllllllllllllll</b> (?)	250 <b>Uuqlllllllllllllllll</b> (?)	251 <b>Uuqlllllllllllllllll</b> (?)	252 <b>Uuqlllllllllllllllll</b> (?)	253 <b>Uuqlllllllllllllllll</b> (?)	254 <b>Uuqlllllllllllllllll</b> (?)	255 <b>Uuqlllllllllllllllll</b> (?)	256 <b>Uuqlllllllllllllllll</b> (?)	257 <b>Uuqlllllllllllllllll</b> (?)	258 <b>Uuqlllllllllllllllll</b> (?)	259 <b>Uuqlllllllllllllllll</b> (?)	260 <b>Uuqlllllllllllllllll</b> (?)	261 <b>Uuqlllllllllllllllll</b> (?)	262 <b>Uuqlllllllllllllllll</b> (?)	263 <b>Uuqlllllllllllllllll</b> (?)	264 <b>Uuqlllllllllllllllll</b> (?)	265 <b>Uuqlllllllllllllllll</b> (?)	266 <b>Uuqlllllllllllllllll</b> (?)	267 <b>Uuqlllllllllllllllll</b> (?)	268 <b>Uuqlllllllllllllllll</b> (?)	269 <b>Uuqlllllllllllllllll</b> (?)	270 <b>Uuqlllllllllllllllll</b> (?)	271 <b>Uuqlllllllllllllllll</b> (?)	272 <b>Uuqlllllllllllllllll</b> (?)	273 <b>Uuqlllllllllllllllll</b> (?)	274 <b>Uuqlllllllllllllllll</b> (?)	275 <b>Uuqlllllllllllllllll</b> (?)	276 <b>Uuqlllllllllllllllll</b> (?)	277 <b>Uuqlllllllllllllllll</b> (?)	278 <b>Uuqlllllllllllllllll</b> (?)	279 <b>Uuqlllllllllllllllll</b> (?)	280 <b>Uuqlllllllllllllllll</b> (?)	281 <b>Uuqlllllllllllllllll</b> (?)	282 <b>Uuqlllllllllllllllll</b> (?)	283 <b>Uuqlllllllllllllllll</b> (?)	284 <b>Uuqlllllllllllllllll</b> (?)	285 <b>Uuqlllllllllllllllll</b> (?)	286 <b>Uuqlllllllllllllllll</b> (?)	287 <b>Uuqlllllllllllllllll</b> (?)	288 <b>Uuqlllllllllllllllll</b> (?)	289 <b>Uuqlllllllllllllllll</b> (?)	290 <b>Uuqlllllllllllllllll</b> (?)	291 <b>Uuqlllllllllllllllll</b> (?)	292 <b>Uuqlllllllllllllllll</b> (?)	293 <b>Uuqlllllllllllllllll</b> (?)	294 <b>Uuqlllllllllllllllll</b> (?)	295 <b>Uuqlllllllllllllllll</b> (?)	296 <b>Uuqlllllllllllllllll</b> (?)	297 <b>Uuqlllllllllllllllll</b> (?)	298 <b>Uuqlllllllllllllllll</b> (?)	299 <b>Uuqlllllllllllllllll</b> (?)	300 <b>Uuqlllllllllllllllll</b> (?)	301 <b>Uuqlllllllllllllllll</b> (?)	302 <b>Uuqlllllllllllllllll</b> (?)	303 <b>Uuqlllllllllllllllll</b> (?)	304 <b>Uuqlllllllllllllllll</b> (?)	305 <b>Uuqlllllllllllllllll</b> (?)	306 <b>Uuqlllllllllllllllll</b> (?)	307 <b>Uuqlllllllllllllllll</b> (?)	308 <b>Uuqlllllllllllllllll</b> (?)	309 <b>Uuqlllllllllllllllll</b> (?)	310 <b>Uuqlllllllllllllllll</b> (?)	311 <b>Uuqlllllllllllllllll</b> (?)	312 <b>Uuqlllllllllllllllll</b> (?)	313 <b>Uuqlllllllllllllllll</b> (?)	314 <b>Uuqlllllllllllllllll</b> (?)	315 <b>Uuqlllllllllllllllll</b> (?)	316 <b>Uuqlllllllllllllllll</b> (?)	317 <b>Uuqlllllllllllllllll</b> (?)	318 <b>Uuqlllllllllllllllll</b> (?)	319 <b>Uuqlllllllllllllllll</b> (?)	320 <b>Uuqlllllllllllllllll</b> (?)	321 <b>Uuqlllllllllllllllll</b> (?)	322 <b>Uuqlllllllllllllllll</b> (?)	323 <b>Uuqlllllllllllllllll</b> (?)	324 <b>Uuqlllllllllllllllll</b> (?)	325 <b>Uuqlllllllllllllllll</b> (?)	326 <b>Uuqlllllllllllllllll</b> (?)	327 <b>Uuqlllllllllllllllll</b> (?)	328 <b>Uuqlllllllllllllllll</b> (?)	329 <b>Uuqlllllllllllllllll</b> (?)	330 <b>Uuqlllllllllllllllll</b> (?)	331 <b>Uuqlllllllllllllllll</b> (?)	332 <b>Uuqlllllllllllllllll</b> (?)	333 <b>Uuqlllllllllllllllll</b> (?)	334 <b>Uuqlllllllllllllllll</b> (?)	335 <b>Uuqlllllllllllllllll</b> (?)	336 <b>Uuqlllllllllllllllll</b> (?)	337 <b>Uuqlllllllllllllllll</b> (?)	338 <b>Uuqlllllllllllllllll</b> (?)	339 <b>Uuqlllllllllllllllll</b> (?)	340 <b>Uuqlllllllllllllllll</b> (?)	341 <b>Uuqlllllllllllllllll</b> (?)	342 <b>Uuqlllllllllllllllll</b> (?)	343 <b>Uuqlllllllllllllllll</b> (?)	344 <b>Uuqlllllllllllllllll</b> (?)	345 <b>Uuqlllllllllllllllll</b> (?)	346 <b>Uuqlllllllllllllllll</b> (?)	347 <b>Uuqlllllllllllllllll</b> (?)	348 <b>Uuqlllllllllllllllll</b> (?)	349 <b>Uuqlllllllllllllllll</b> (?)	350 <b>Uuqlllllllllllllllll</b> (?)	351 <b>Uuqlllllllllllllllll</b> (?)	352 <b>Uuqlllllllllllllllll</b> (?)	353 <b>Uuqlllllllllllllllll</b> (?)	354 <b>Uuqlllllllllllllllll</b> (?)	355 <b>Uuqlllllllllllllllll</b> (?)	356 <b>Uuqlllllllllllllllll</b> (?)	357 <b>Uuqlllllllllllllllll</b> (?)	358 <b>Uuqlllllllllllllllll</b> (?)	359 <b>Uuqlllllllllllllllll</b> (?)	360 <b>Uuqlllllllllllllllll</b> (?)	361 <b>Uuqlllllllllllllllll</b> (?)	362 <b>Uuqlllllllllllllllll</b> (?)	363 <b>Uuqlllllllllllllllll</b> (?)	364 <b>Uuqlllllllllllllllll</b> (?)	365 <b>Uuqlllllllllllllllll</b> (?)	366 <b>Uuqlllllllllllllllll</b> (?)	367 <b>Uuqlllllllllllllllll</b> (?)	368 <b>Uuqlllllllllllllllll</b> (?)	369 <b>Uuqlllllllllllllllll</b> (?)	370 <b>Uuqlllllllllllllllll</b> (?)	371 <b>Uuqlllllllllllllllll</b> (?)	372 <b>Uuqlllllllllllllllll</b> (?)	373 <b>Uuqlllllllllllllllll</b> (?)	374 <b>Uuqlllllllllllllllll</b> (?)	375 <b>Uuqlllllllllllllllll</b> (?)	376 <b>Uuqlllllllllllllllll</b> (?)	377 <b>Uuqlllllllllllllllll</b> (?)	378 <b>Uuqlllllllllllllllll</b> (?)	379 <b>Uuqlllllllllllllllll</b> (?)	380 <b>Uuqlllllllllllllllll</b> (?)	381 <b>Uuqlllllllllllllllll</b> (?)	382 <b>Uuqlllllllllllllllll</b> (?)	383 <b>Uuqlllllllllllllllll</b> (?)	384 <b>Uuqlllllllllllllllll</b> (?)	385 <b>Uuqlllllllllllllllll</b> (?)	386 <b>Uuqlllllllllllllllll</b> (?)	387 <b>Uuqlllllllllllllllll</b> (?)	388 <b>Uuqlllllllllllllllll</b> (?)	389 <b>Uuqlllllllllllllllll</b> (?)	390 <b>Uuqlllllllllllllllll</b> (?)	391 <b>Uuqlllllllllllllllll</b> (?)	392 <b>Uuqlllllllllllllllll</b> (?)	393 <b>Uuqlllllllllllllllll</b> (?)	394 <b>Uuqlllllllllllllllll</b> (?)	395 <b>Uuqlllllllllllllllll</b> (?)	396 <b>Uuqlllllllllllllllll</b> (?)	397 <b>Uuqlllllllllllllllll</b> (?)	398 <b>Uuqlllllllllllllllll</b> (?)	399 <b>Uuqlllllllllllllllll</b> (?)	400 <b>Uuqlllllllllllllllll</b> (?)	401 <b>Uuqlllllllllllllllll</b> (?)	402 <b>Uuqlllllllllllllllll</b> (?)	403 <b>Uuqlllllllllllllllll</b> (?)	404 <b>Uuqlllllllllllllllll</b> (?)	405 <b>Uuqlllllllllllllllll</b> (?)	406 <b>Uuqlllllllllllllllll</b> (?)	407 <b>Uuqlllllllllllllllll</b> (?)	408 <b>Uuqlllllllllllllllll</b> (?)	409 <b>Uuqlllllllllllllllll</b> (?)	410 <b>Uuqlllllllllllllllll</b> (?)	411 <b>Uuqlllllllllllllllll</b> (?)	412 <b>Uuqlllllllllllllllll</b> (?)	413 <b>Uuqlllllllllllllllll</b> (?)	414 <b>Uuqlllllllllllllllll</b> (?)	415 <b>Uuqlllllllllllllllll</b> (?)	416 <b>Uuqlllllllllllllllll</b> (?)	417 <b>Uuqlllllllllllllllll</b> (?)	418 <b>Uuqlllllllllllllllll</b> (?)	419 <b>Uuqlllllllllllllllll</b> (?)	420 <b>Uuqlllllllllllllllll</b> (?)	421 <b>Uuqlllllllllllllllll</b> (?)	422 <b>Uuqlllllllllllllllll</b> (?)	423 <b>Uuqlllllllllllllllll</b> (?)	424 <b>Uuqlllllllllllllllll</b> (?)	425 <b>Uuqlllllllllllllllll</b> (?)	426 <b>Uuqlllllllllllllllll</b> (?)	427 <b>Uuqlllllllllllllllll</b> (?)	428 <b>Uuqlllllllllllllllll</b> (?)	429 <b>Uuqlllllllllllllllll</b> (?)	430 <b>Uuqlllllllllllllllll</b> (?)	431 <b>Uuqlllllllllllllllll</b> (?)	432 <b>Uuqlllllllllllllllll</b> (?)	433 <b>Uuqlllllllllllllllll</b> (?)	434 <b>Uuqlllllllllllllllll</b> (?)	435 <b>Uuqlllllllllllllllll</b> (?)	436 <b>Uuqlllllllllllllllll</b> (?)	437 <b>Uuqlllllllllllllllll</b> (?)	438 <b>Uuqllllllllll</b>