Q1:

Knowledge base:

$\mathrm{p} \Rightarrow (q \Rightarrow \mathrm{r})$

$\mathrm{p} \Rightarrow (\neg q \vee \mathrm{r})$

$\neg \mathrm{p} \vee (\neg q \vee \mathrm{r})$

$\neg \mathrm{p} \vee \neg q \vee \mathrm{r}$

Query:

$(p \Rightarrow \mathrm{q}) \Rightarrow (p \Rightarrow \mathrm{r})$

$(\neg p \vee \mathrm{q}) \Rightarrow (p \Rightarrow \mathrm{r})$

$(\neg p \vee \mathrm{q}) \Rightarrow (\neg p \vee \mathrm{r})$

$\neg(\neg p \vee \mathrm{q}) \vee (\neg p \vee \mathrm{r})$

$(p \vee \neg \mathrm{q}) \vee (\neg p \vee \mathrm{r})$

$p \vee \neg \mathrm{q} \vee \neg p \vee \mathrm{r}$

$\neg \mathrm{q} \vee \mathrm{r}$

Because in the knowledge base $\neg \mathrm{p}$ or $(\neg q \vee \mathrm{r})$ is true, therefore this query is true

Q2:

Part1:

1. All things can jump jumps higher than a building
2. x: for all things exist;
3. canJump(x): x can jump;
   jumpHigher(x): x can jump higher than a building
4. $\forall x\ canJump(x) \Rightarrow jumpHihger(x)$

Part2:

1. For any of the 100 politicians, they can only be honest or lying. For any of the two politicians in the party, one or both of them are lying.
2. x: 100 politicians in the party
3. honest(x): x is honest;
   individual(x): x is an individual in the party
   grab2(x): x is two random individuals in the part
   lying(x): x is lying;
4. $\forall x\ individual(x) \Rightarrow honest(x) \wedge lying(x)$
   $\exists x\ individual(x) \Rightarrow honest(x)$
   $\forall x\ grab2(x) \Rightarrow \exists x\ lying(x)$

Q3:

For simplicity, here I write the name of the cities in short forms defined by the following:

M = Madison; S = Seattle; B = Boston; V = Vancouver; W = Winnipeg; MT = Montreal

The initial table:

	M	S	B	V	W	MT
M	0	1617	931	1654	597	800
S		0	2486	121	1153	2283
B			0	2501	1344	250
V				0	1159	2291
W					0	1132
MT						0

Here I only show the upper half of the table because the other part would just be the reflection of this part of the table.

From the table we can see the shortest distance in the table is from Seattle to Vancouver, which is 121 miles so we put them in one cluster. Because it is complete clustering we take the largest distance from other cities to these cities.

	M	S-V	B	W	MT
M	0	1654	931	597	800
S-V		0	2501	1159	2291
B			0	1344	250
W				0	1132
MT					0

Next step we put Boston and Montreal into one cluster, 250 miles

	M	S-V	B-MT	W
M	0	1654	931	597
S-V		0	2501	1159
B-MT			0	1344
W				0

Next step Winnipeg and Madison, 597 miles

	S-V	B-MT	W-M
S-V	0	2501	1654
B-MT		0	1344
W-M			0

Next step W-M and B-MT, 1344 miles

	S-V	W-M-B-MT
S-V	0	2501
W-M-B-MT		0

Now we are left with these two clusters

Q4:

1. Iteration 1: k1 = { 0 , 2 , 4 }
   k2 = { 6 , 7 , 8 }
   c1 = (0+2+4)/3 = 2
   c2 = (6+7+8)/3 = 7
   E1 = 4+0+4 =8
   E2 = 1+0+1 =2
   E(total) = 10
2. Iteration 1: k1 = { 0 , 2 , 4 }
   k2 = { 6 , 7 , 8 }
   c1 = 1
   c2 = 10
   E1 = 1 + 1 + 9 = 11
   E2 = 16 + 9 + 4 = 29
   E(total) = 40
3. The first method is a better K means solution. Its total energy over the two clusters are lower.