Module 3

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Question 1.

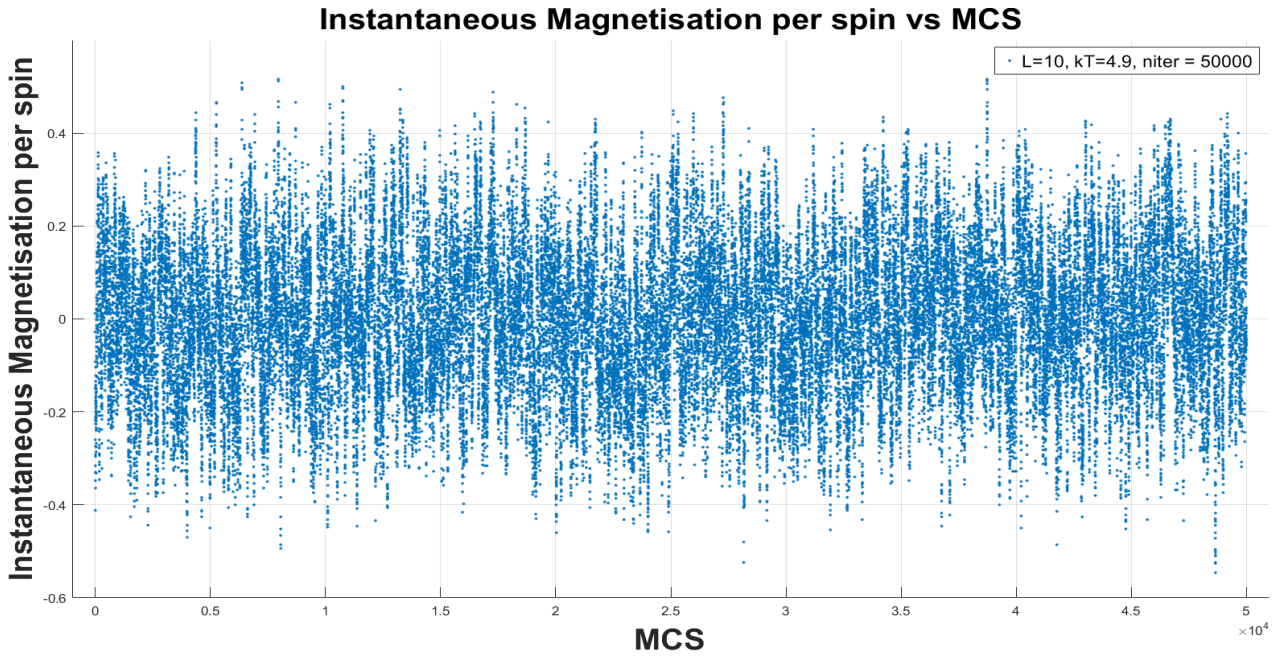
```
PS E:\computational_physics> cd "e:\computation
al_physics\Module_3\" ; if ($?) { gfortran 3d_i
sing.f90 -o 3d_ising } ; if ($?) { .\3d_ising }


 Total magnetic moment (L = 20) when all spins
are -1 =   -8000.00000

 Total energy of the lattice (L = 20) when all
spins are -1 =   -24000.0000
```

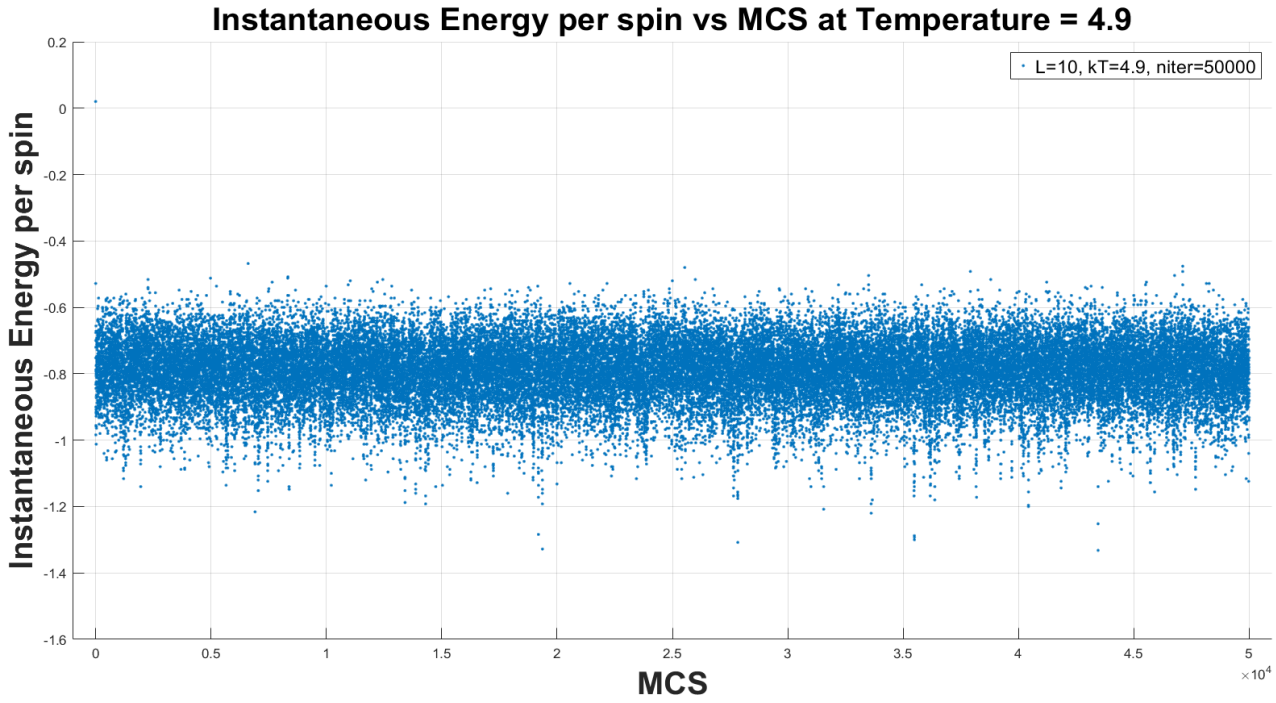
Question 2.

```
PS E:\computational_physics\Module_3> cd "e:\co
mputational_physics\Module_3\" ; if ($?) { gfor
tran 3d_ising.f90 -o 3d_ising } ; if ($?) { .\3
d_ising }

 Total magnetic moment (L = 10) when all spins
are +1 =    1000.00000

 Total energy of the lattice (L = 10) when all
spins are +1 =   -3000.00000
```

Question 3.

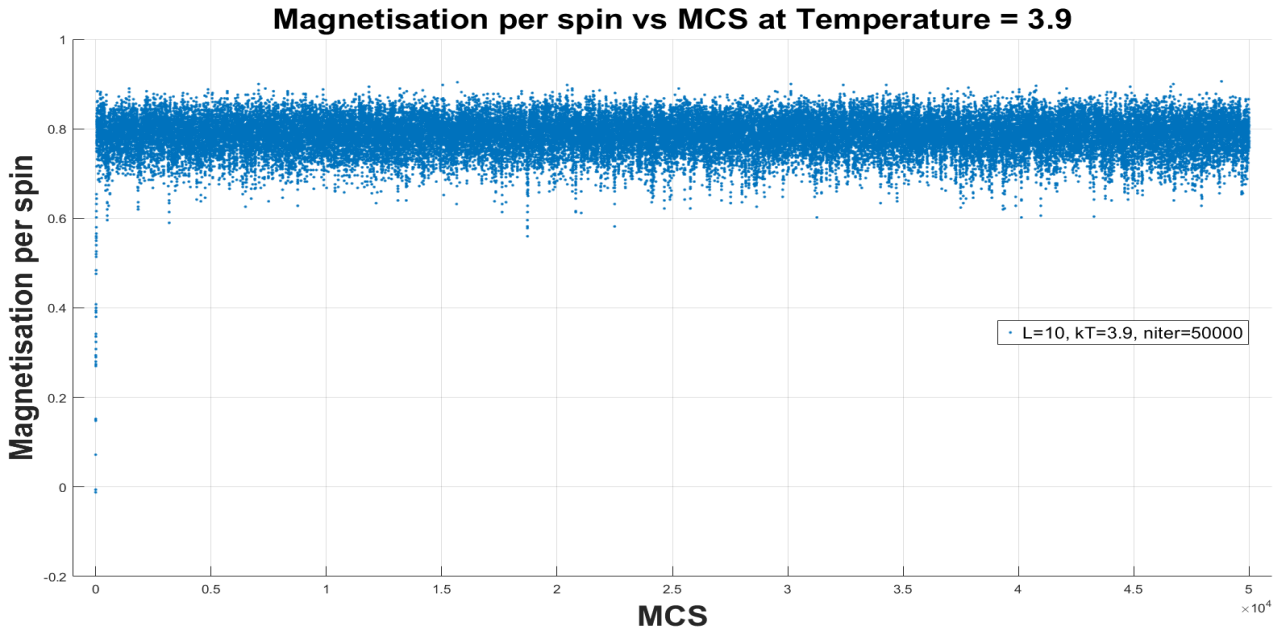
```
PS E:\computational_physics> cd "e:\computational_phy
sics\Module_3\" ; if ($?) { gfortran question_3.f90 -
o question_3 } ; if ($?) { .\question_3 }

 The instantaneous magnetisation per spin fluctuates
around the value:    2.36583152E-03

 The instantaneous magnetisation (abs value) per spin
 fluctuates around the value:   0.127448484

 The instantaneous energy per spin fluctuates around
the value: -0.794960916
```

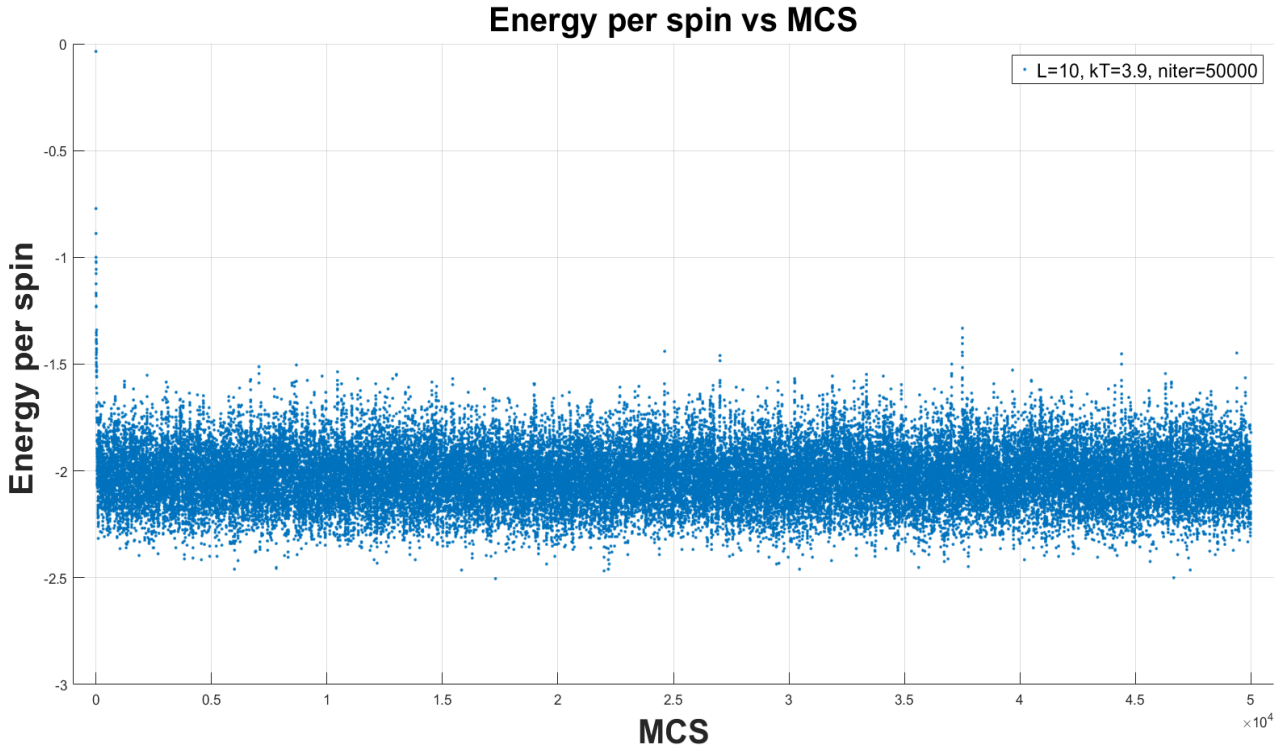




Question 4.

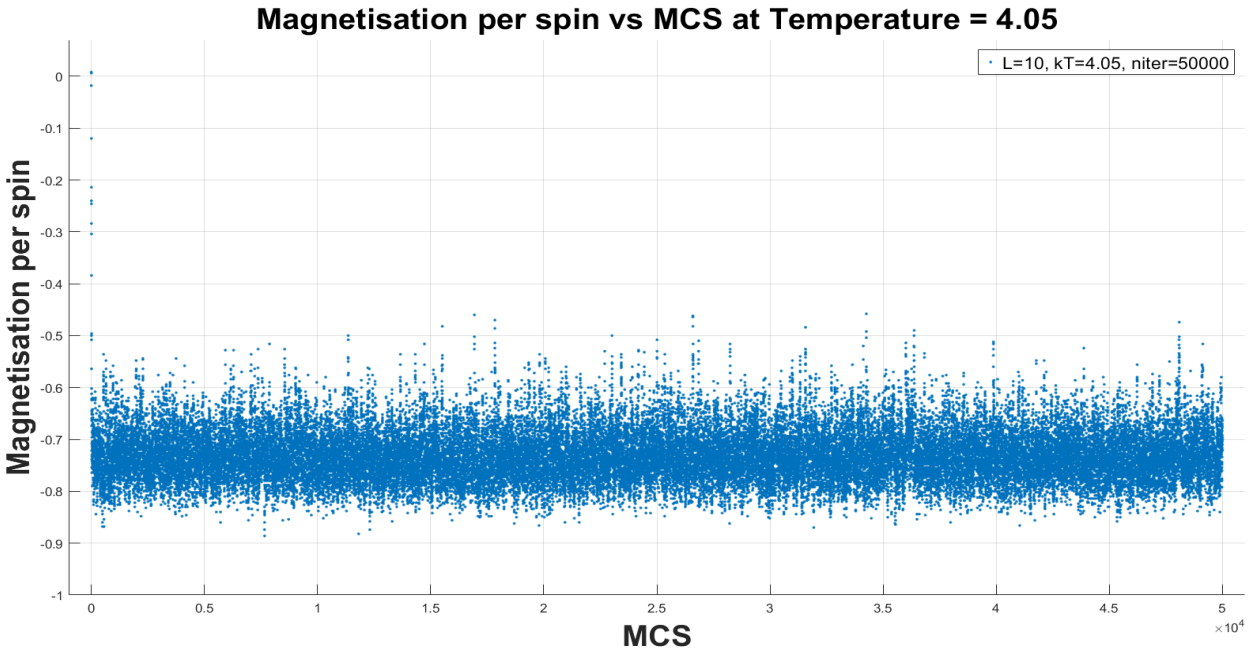
```
PS E:\computational_physics\Module_3> cd "e:\computat
ional_physics\Module_3\" ; if ($?) { gfortran questio
n_4.f90 -o question_4 } ; if ($?) { .\question_4 }

 The instantaneous magnetisation per spin fluctuates
around the value: -0.784768045

 The instantaneous magnetisation (abs value) per spin
 fluctuates around the value:  0.784768045

 The instantaneous energy per spin fluctuates around
the value:  -2.02331972
```

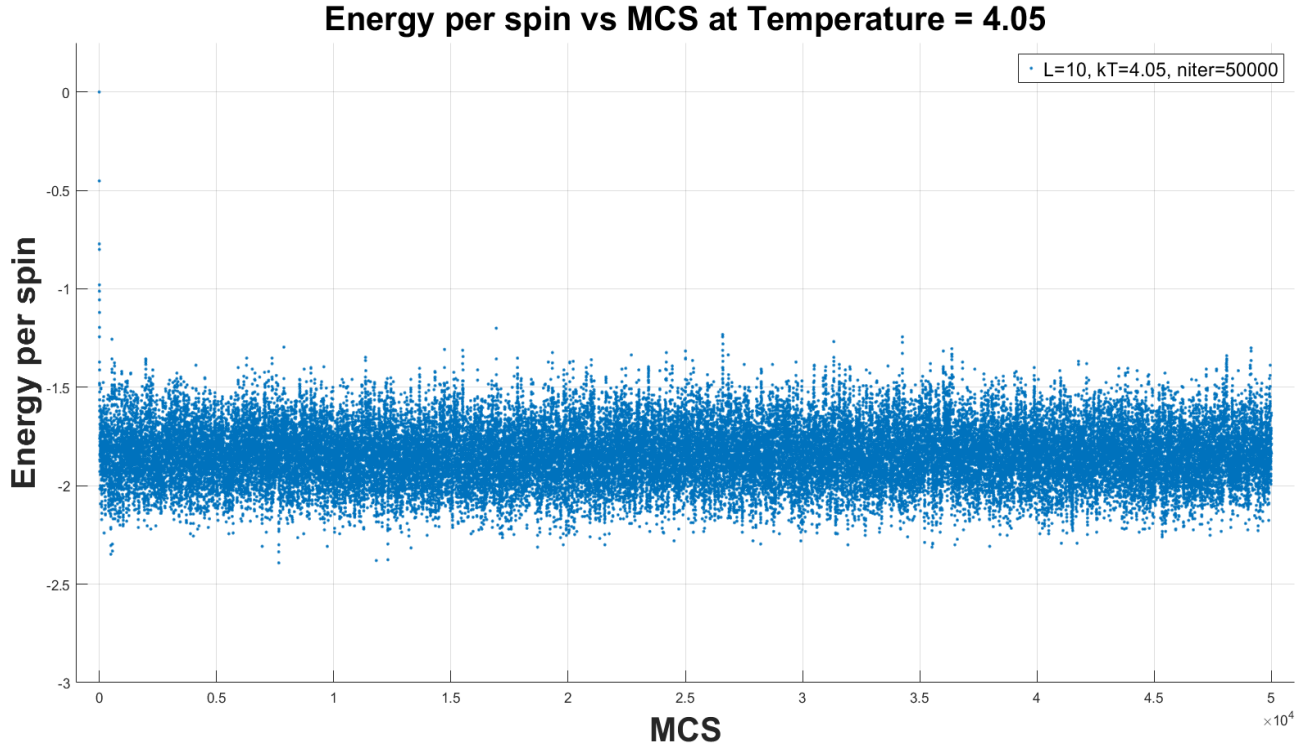




Question 5.

```
PS E:\computational_physics\Module_3> cd "e:\computat
ional_physics\Module_3\" ; if ($?) { gfortran questio
n_5.f90 -o question_5 } ; if ($?) { .\question_5 }

 The instantaneous magnetisation per spin fluctuates
around the value:  0.731482983

 The instantaneous magnetisation (abs value) per spin
 fluctuates around the value:  0.731482983

 The instantaneous energy per spin fluctuates around
the value:  -1.84677601
```



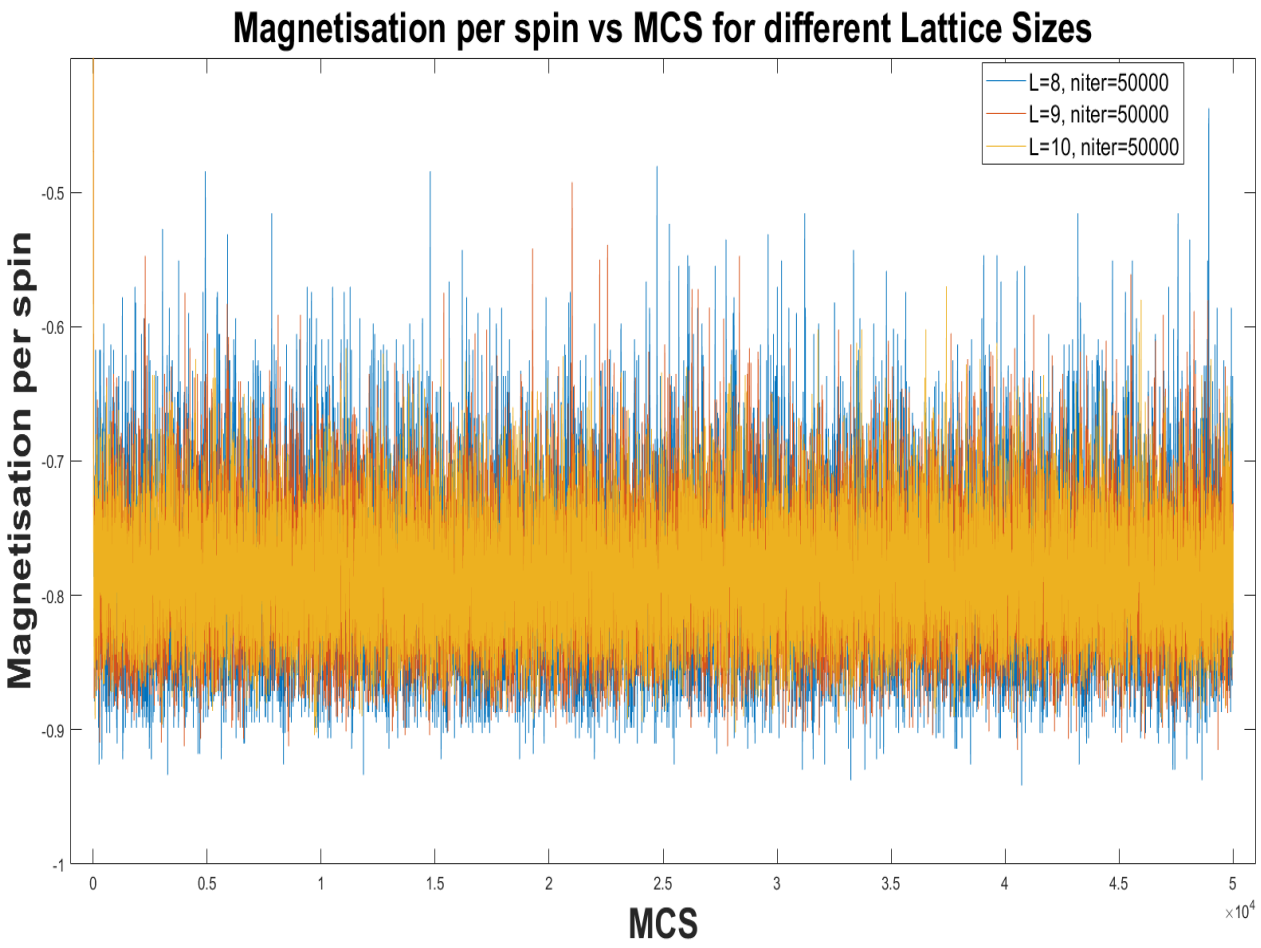


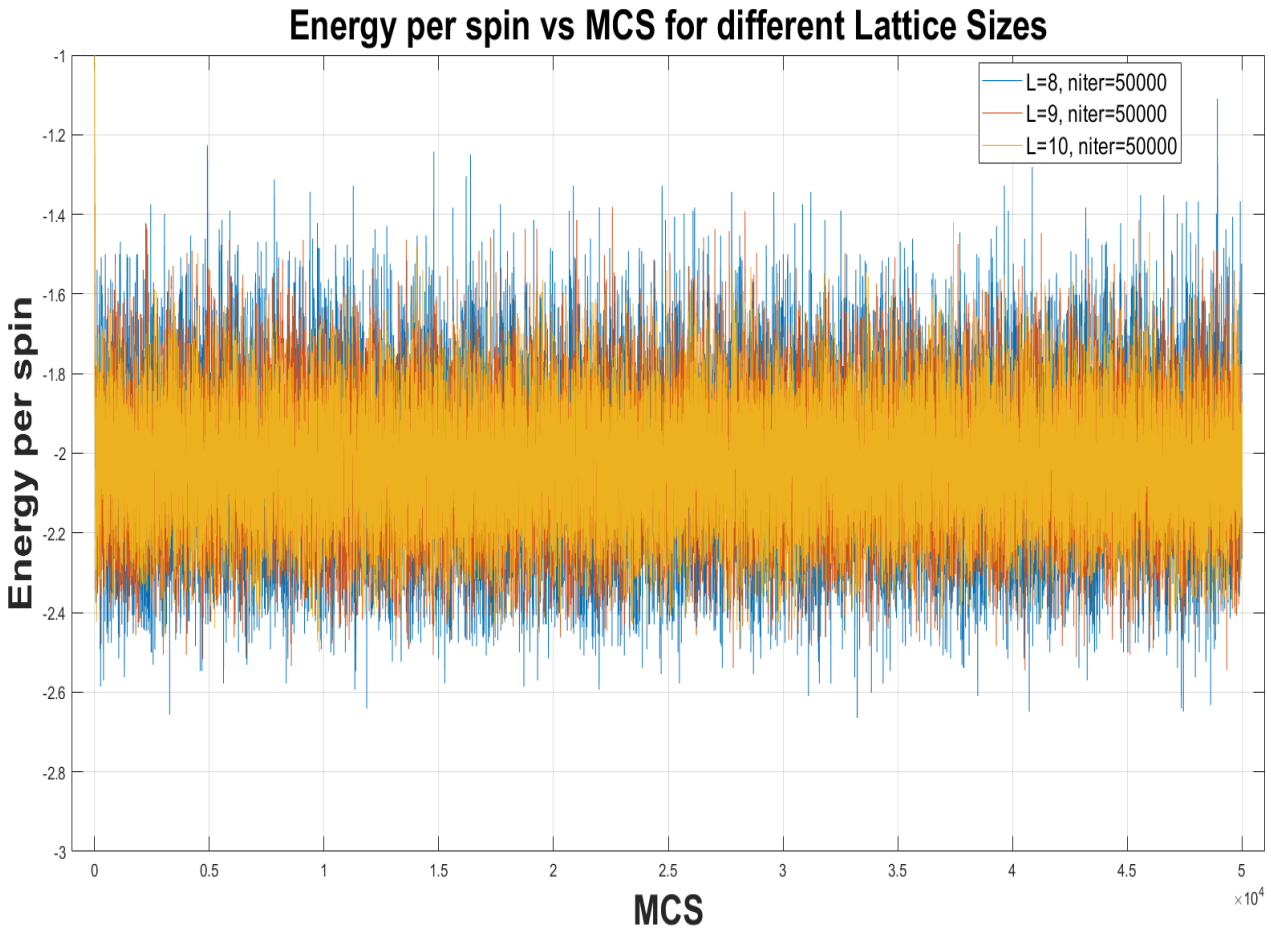
Question 6.

```
PS E:\computational_physics\Module_3> cd "e:\computat
ional_physics\Module_3\" ; if ($?) { gfortran questio
n_6b.f90 -o question_6b } ; if ($?) { .\question_6b }

 For L = 9
 The instantaneous magnetisation per spin fluctuates
around the value: -0.785614252
 The instantaneous magnetisation (abs value) per spin
 fluctuates around the value:  0.785614252
 The instantaneous energy per spin fluctuates around
the value:  -2.02714849
```

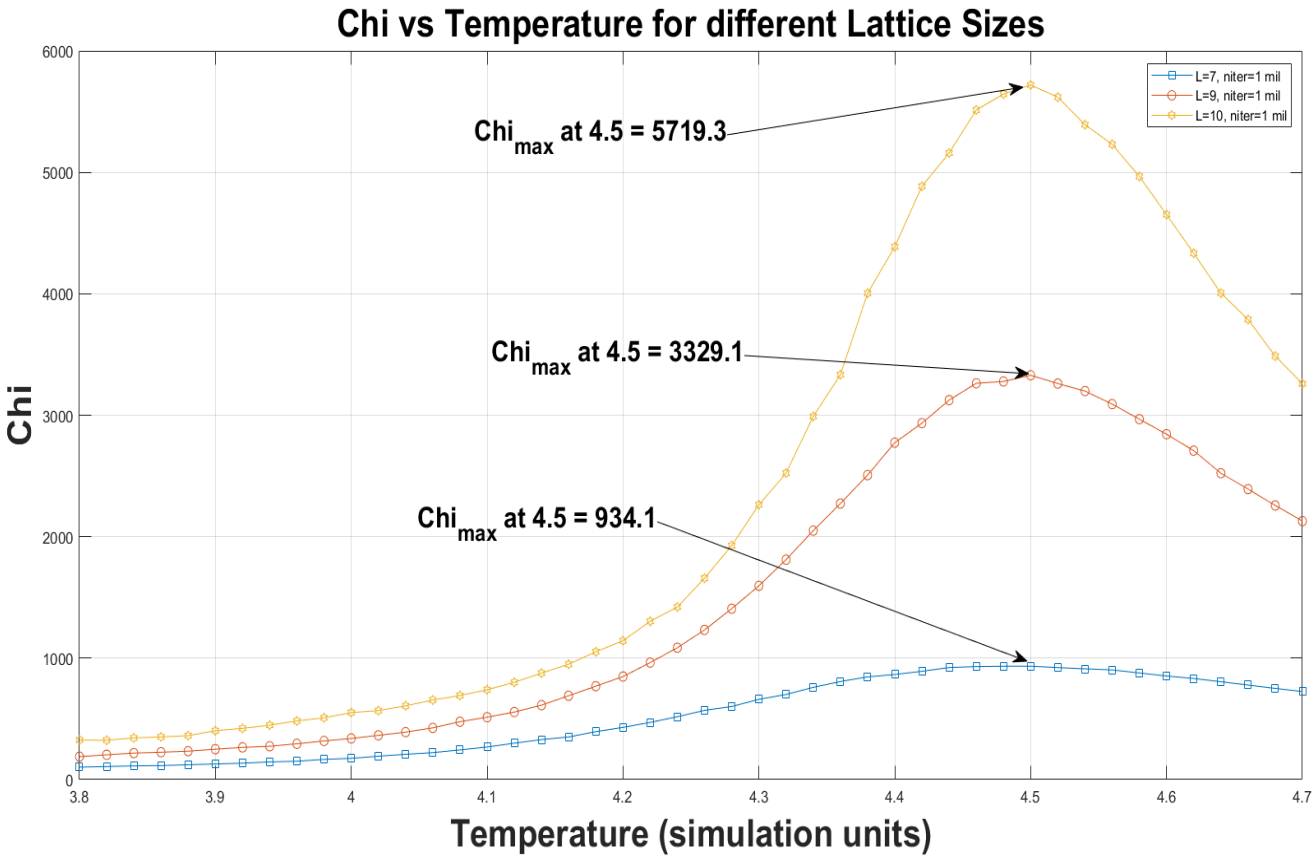
```
PS E:\computational_physics\Module_3> cd "e:\computat
ional_physics\Module_3\" ; if ($?) { gfortran questio
n_6c.f90 -o question_6c } ; if ($?) { .\question_6c }

 For L = 10
 The instantaneous magnetisation per spin fluctuates
around the value: -0.786130309
 The instantaneous magnetisation (abs value) per spin
 fluctuates around the value:  0.786130309
 The instantaneous energy per spin fluctuates around
the value:  -2.02698302
```

```
PS E:\computational_physics\Module_3> cd "e:\computat
ional_physics\Module_3\" ; if ($?) { gfortran questio
n_6a.f90 -o question_6a } ; if ($?) { .\question_6a }

 For L = 8
 The instantaneous magnetisation per spin fluctuates
around the value: -0.785530627
 The instantaneous magnetisation (abs value) per spin
 fluctuates around the value:  0.785530627
 The instantaneous energy per spin fluctuates around
the value:  -2.02623844
```

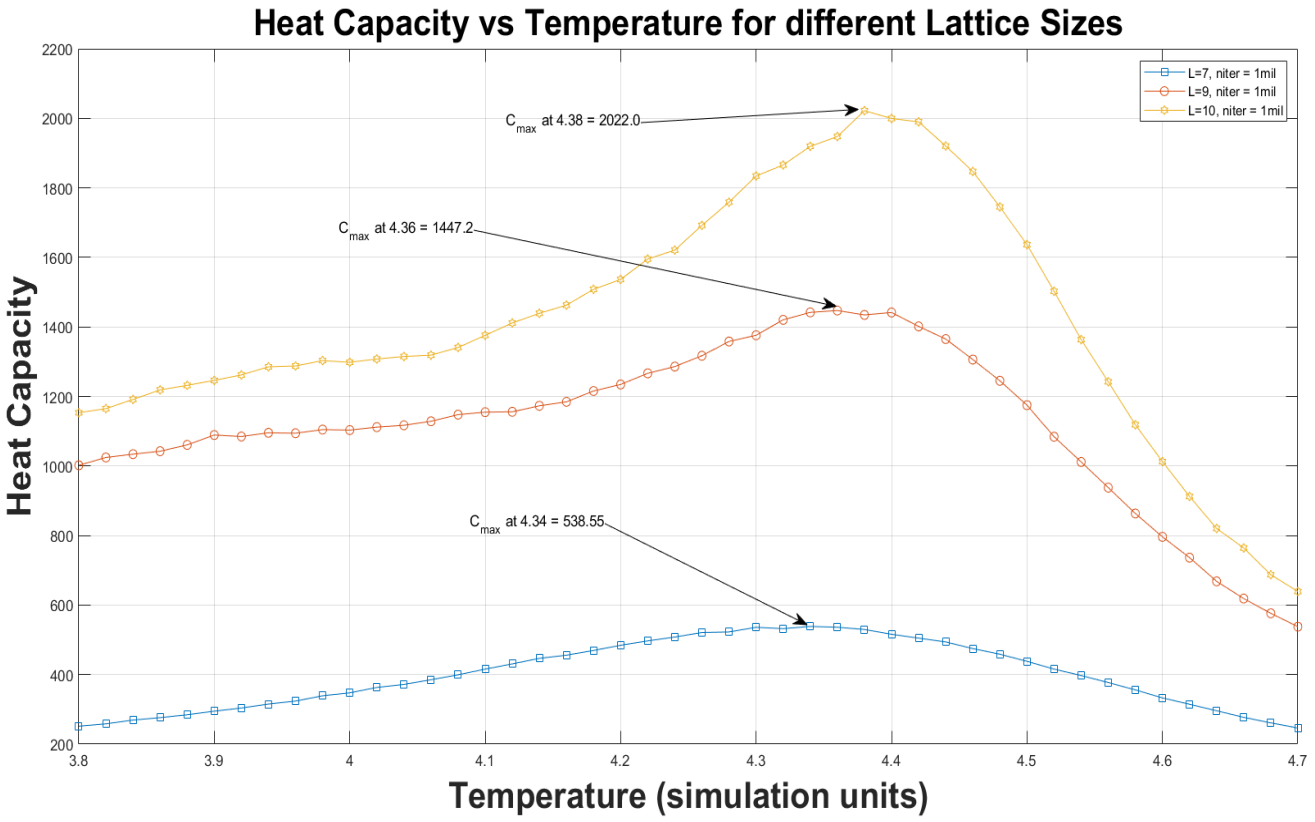

Magnetisation per spin vs MCS for different Lattice Sizes
L=8, niter=50000
L=9, niter=50000
L=10, niter=50000
Magnetisation per spin
-0.5
-0.6
-0.7
-0.8
-0.9
-1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
×10^4
MCS


Energy per spin vs MCS for different Lattice Sizes
L=8, niter=50000
L=9, niter=50000
L=10, niter=50000
Energy per spin
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
-2.6
-2.8
-3
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
×10^4
MCS

Question 7.

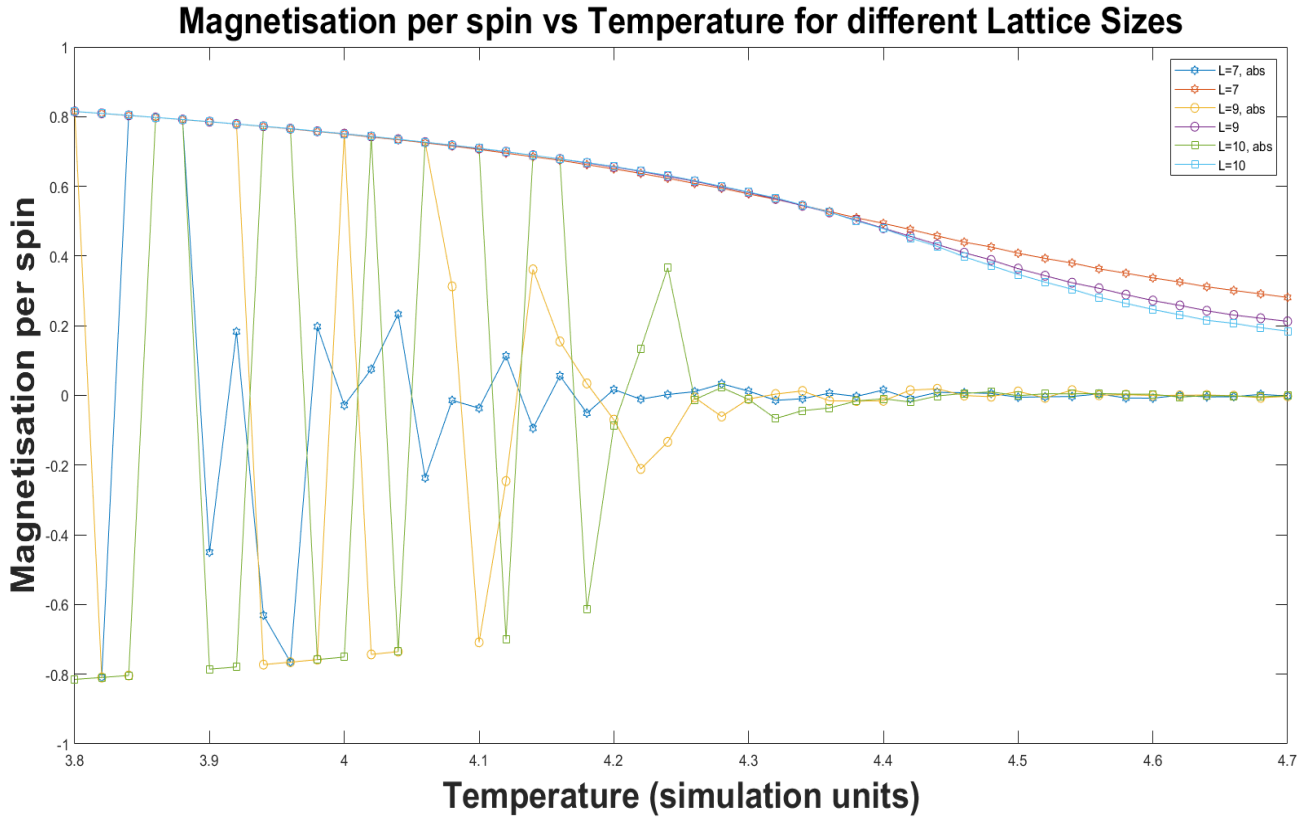


Question 8. and Question 9.

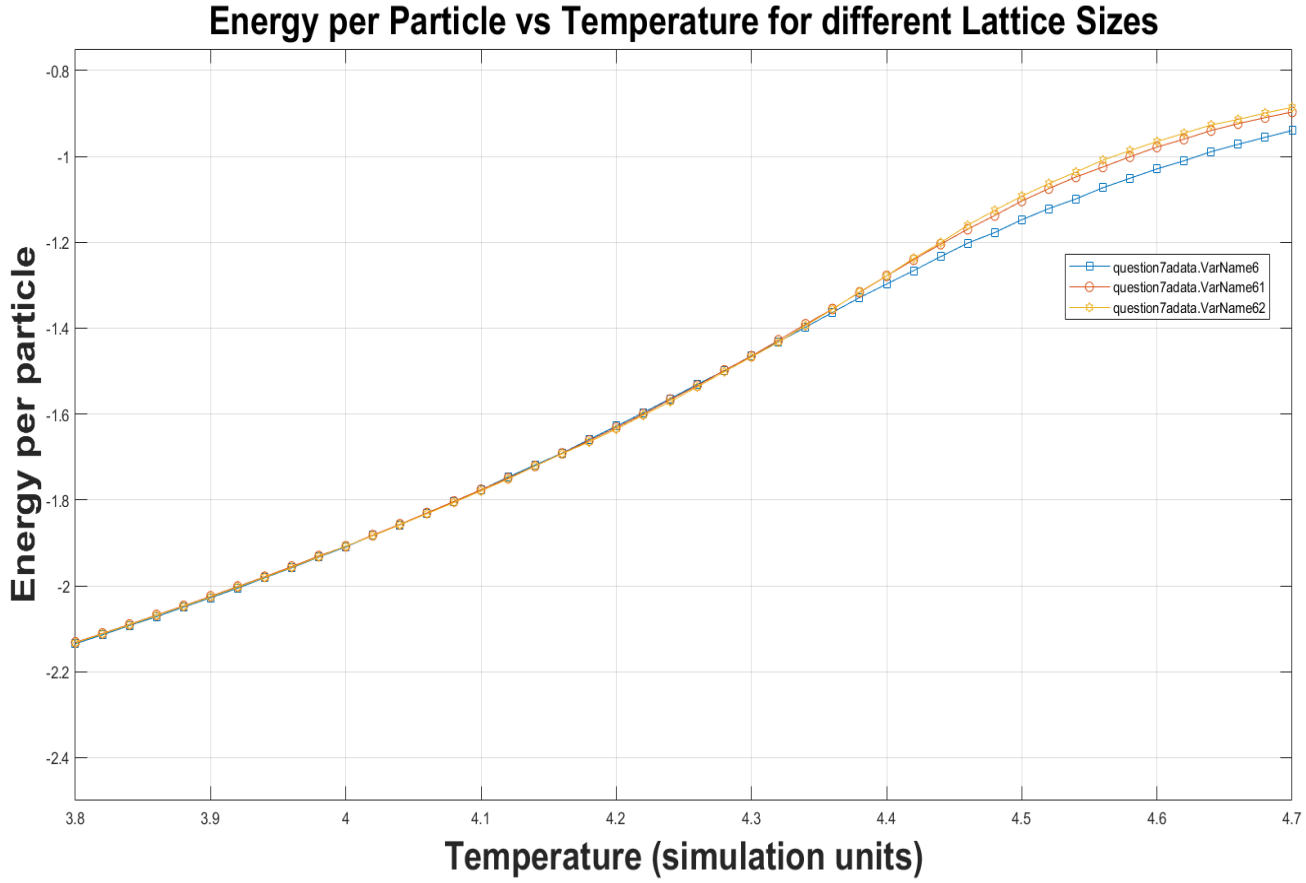


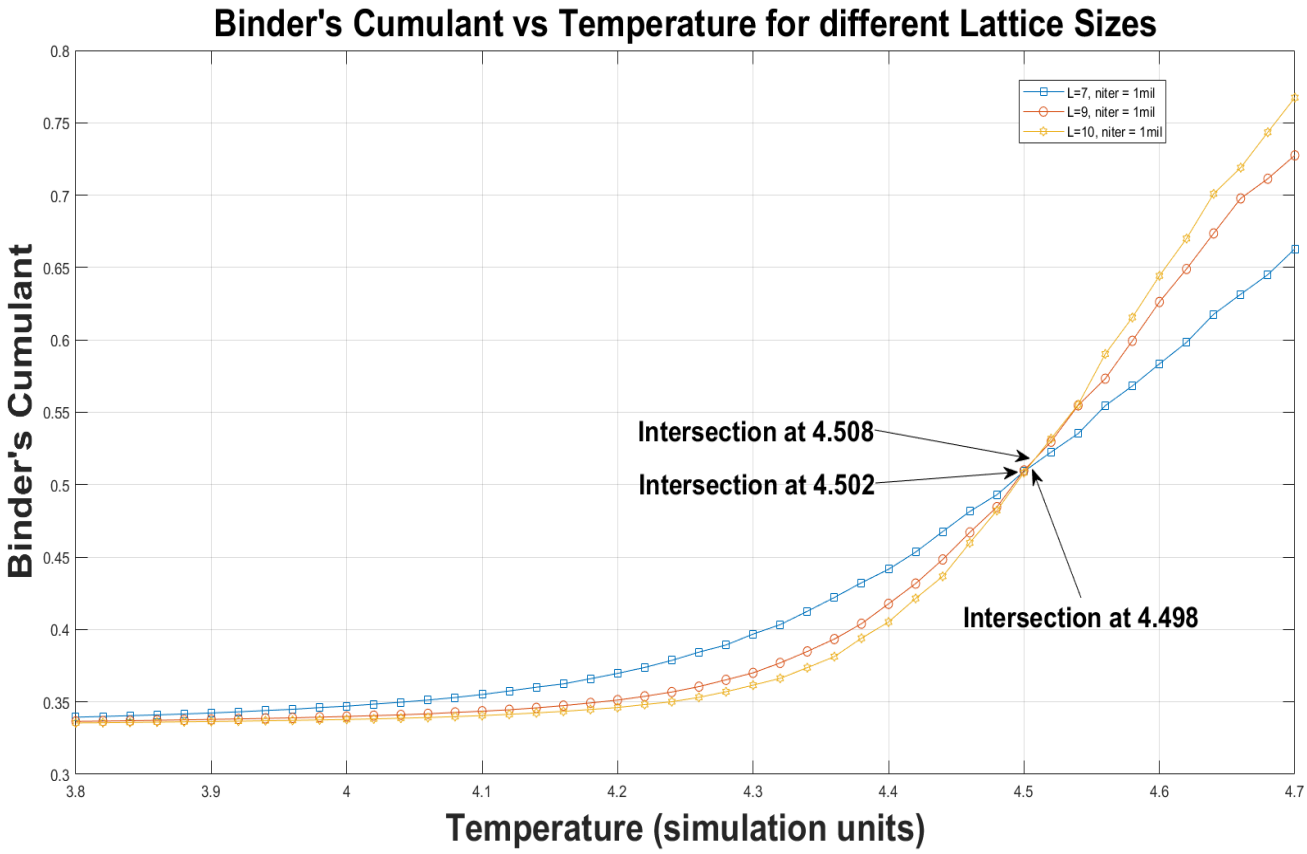
Question 10.

The value of Magnetisation per spin for L = 7 at temperature 3.8 is **0.8148**



Extra Plots.





We see that the **Critical Temperature is 4.503** (in simulation units).

Question 11.

At equilibrium, we expect no net current in the system, i.e. no net transfer of particles from one state to another. Therefore, if 10 particles/sec are jumping from E_5 to $E_{10;}$ then to make sure that no net current is there in the system, we need to have 10 particles/sec jumping from E_{10} to E_5.

Comparisons Between Model with upto 1st, 2nd and 3rd Nearest Neighbours