HW 4

Questions 7.2, 7.3, 7.5, 8.4

Question 7.2

In [29]:
```
import scipy.integrate as integrate
import numpy as np
import math
```

In [4]:
```
mass = 4 # amu
m = mass / 6.022e+26 # convert from amu to kg
kb = 1.38e-23 # J/K
temp = 298.15 # K
pi = np.pi

def f(c):
    first = 4 * pi * c**2
    second = (m / 2 / pi / kb / temp)**1.5
    third = np.exp(-m * c**2 / 2 / kb / temp)
    return first * second * third

def xf(c):
    first = 4 * pi * c**2
    second = (m / 2 / pi / kb / temp)**1.5
    third = np.exp(-m * c**2 / 2 / kb / temp)
    return c * first * second * third

average, error = integrate.quad(xf, 0, np.inf)
```

In [5]:
```
print("Average speed:",average,"m/s")
print("Error:",error)
```

```
Average speed: 1255.9356469933211 m/s
Error: 1.3257951487490385e-05
```

In [6]:
```
def varf(c):
    first = 4 * pi * c**2
    second = (m / 2 / pi / kb / temp)**1.5
    third = np.exp(-m * c**2 / 2 / kb / temp)
    return (c-average)**2 * first * second * third

variance, error1 = integrate.quad(varf, 0, np.inf)
stdev = np.sqrt(variance)
```

In [8]:
```
print("Variance:",variance)
print("Standard Deviation:",stdev,"m/s")
```

```
Variance: 280926.0261114654
Standard Deviation: 530.0245523666479 m/s
```

In [39]:
```
def xft(c):
    first = 4 * pi * c**2
```

```
    second = (m / 2 / pi / kb / temp)**1.5
    third = np.exp(-m * c**2 / 2 / kb / temp)
    return c * first * second * third

def varft(c):
    first = 4 * pi * c**2
    second = (m / 2 / pi / kb / temp)**1.5
    third = np.exp(-m * c**2 / 2 / kb / temp)
    return (c-average)**2 * first * second * third

templist = [100, 200, 300, 400, 500]
averagelist = []
stdevlist = []
for x in templist:
    temp = x
    average, error0 = integrate.quad(xft, 0, np.inf)
    variance, error0 = integrate.quad(varft, 0, np.inf)
    stdev = math.sqrt(variance)
    averagelist.append(average)
    stdevlist.append(stdev)


print("Average:\n",averagelist,"m/s")
print("Standard Deviation:\n",stdevlist,"m/s")
```

```
Average:
 [727.3609483257026, 1028.6437178627639, 1259.8261179415967, 1454.7218966514054, 162
6.4285246349828] m/s
Standard Deviation:
 [306.95773463252993, 434.10379139264535, 531.6663921597867, 613.9154692650599, 686.3
783608576783] m/s
```

Both the average and the standard deviation increase.