Exam 3

Problem 1

In[18]:=
```
h = 6.626*^-34;
c = 3*^8;
T = 5800;
k = 1.381*^-23;
I1 = NIntegrate[1/(λ^5 (e^(h c/(λ k T)) - 1)), {λ, 400 × 10^-9, 500 × 10^-9}];
I2 = NIntegrate[1/(λ^5 (e^(h c/(λ k T)) - 1)), {λ, 600 × 10^-9, 700 × 10^-9}];
I2/I1
```

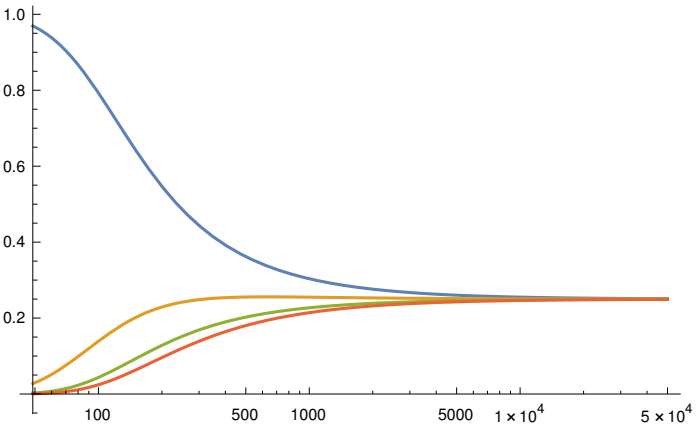
Out[24]=
```
0.892997
```

Problem 2

Part a.

In[199]:=
```
k = 8.617*^-5;
z[T_] := 1 + e^(-15*^-3/(k T)) + e^(-25*^-3/(k T)) + e^(-3*^-2/(k T))
P[e_, T_] := 1/z[T] e^(-e/(k T))
LogLinearPlot[{P[0, T], P[.015, T], P[.025, T], P[.03, T]}, {T, 0, 5*^4}, PlotRange → All]
```

Out[202]=



Part b.

In[203]:=
```
T = 0.01/(k Log[3])
P[0, T]
P[0.03, T]
```

Out[203]= 105.633

Out[204]= 0.773014

Out[205]= 0.0286302

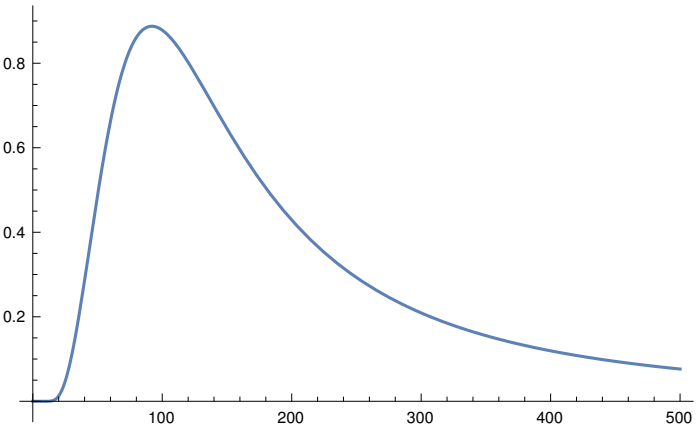
Part c.

In[343]:=
```
Clear[T]

heatCap[T_] = 1/k D[(.015 e^(-.015/kT) + .025 e^(-.025/kT) + .03 e^(-.03/kT))/(1 + e^(-.015/kT) + e^(-.025/kT) + e^(-.03/kT)), T];

Plot[heatCap[T], {T, 0, 500}]
max = FindMaximum[heatCap[T], {T, 100}]
FindRoot[heatCap[T] - max[[1]]/2, {T, 200}]
FindRoot[heatCap[T] - max[[1]]/2, {T, 42}]
```

Out[345]=



Out[346]= {0.887507, {T → 91.9626}}

Out[347]= {T → 195.775}

Out[348]= {T → 47.8131}

Problem 3

In[351]:=
```
Integrate[x^4 e^x/(e^x - 1)^2, {x, 0, Infinity}]
```

Out[351]= $\frac{4\pi^4}{15}$

Problem 4

In[357]:=
$$\text{Integrate}\left[\frac{2}{\sqrt{\pi}}\sqrt{x}\, e^{-x}, \{x, 0, \text{Infinity}\}\right] - \text{Integrate}\left[\frac{2}{\sqrt{\pi}}\sqrt{x}\, e^{-x}, \{x, 0, 4\}\right] // N$$

Out[357]= 0.0460117

Problem 5

In[480]:=
```
Clear[T, c]
k = 1.381*^-23;
integral = Integrate[1/(e^x + 1), x];
Solve[(integral /. x → 0) - (integral /. x → μ/(k T)) == 1/(2 c), T]
Solve[e^((1/c + μ)/k) - 2 e^(μ/k) == 2^T, T]
1 / k
```

Solve: Inverse functions are being used by Solve, so some solutions may not be found; use Reduce for complete solution information.

Out[483]=
$$\left\{\left\{T \to -\frac{7.24113 \times 10^{22}\, \mu}{\text{Log}[-1. + 2.\, e^{0.5/c}]}\right\}\right\}$$

Solve: Inverse functions are being used by Solve, so some solutions may not be found; use Reduce for complete solution information.

Out[484]=
$$\left\{\left\{T \to 1.4427\, \text{Log}\left[-2.\, e^{-7.24113\times 10^{22}\,\mu} + e^{7.24113\times 10^{22}\left(\frac{0.5}{c}+\mu\right)}\right]\right\}\right\}$$

Out[485]= 7.24113×10^{22}

Problem 6

In[567]:=
```
c = 3*^8;
xval[T_, λ_] := h c/(λ k T)
integral = -15/π^4 NIntegrate[x^3/(e^x - 1), {x, xval[17 394.35, 400*^-9], xval[17 394.35, 750*^-9]}]
```

Out[569]= 0.15

Problem 7

In[771]:=
```
h = 6.626*^-34;
T = √10 ;
c = 5*^-3 * T;
n = 6.022*^23;
m = 196.97 / (6.022*^26);
k = 1.381*^-23;
nOvV = 19.3 / (196.97*^-6);
ef = h^2/(8 m) (3 nOvV/π)^(2/3) ;
γ = π^2 n k^2/(2 ef);
Td = CubeRoot[12 k π^4 n T^3/(5 (c - γ T))]
```

$$\frac{2\,k\,Td}{h}$$

Out[780]= −0.0000228067

Out[781]= −950 680.