homework 4 question q1

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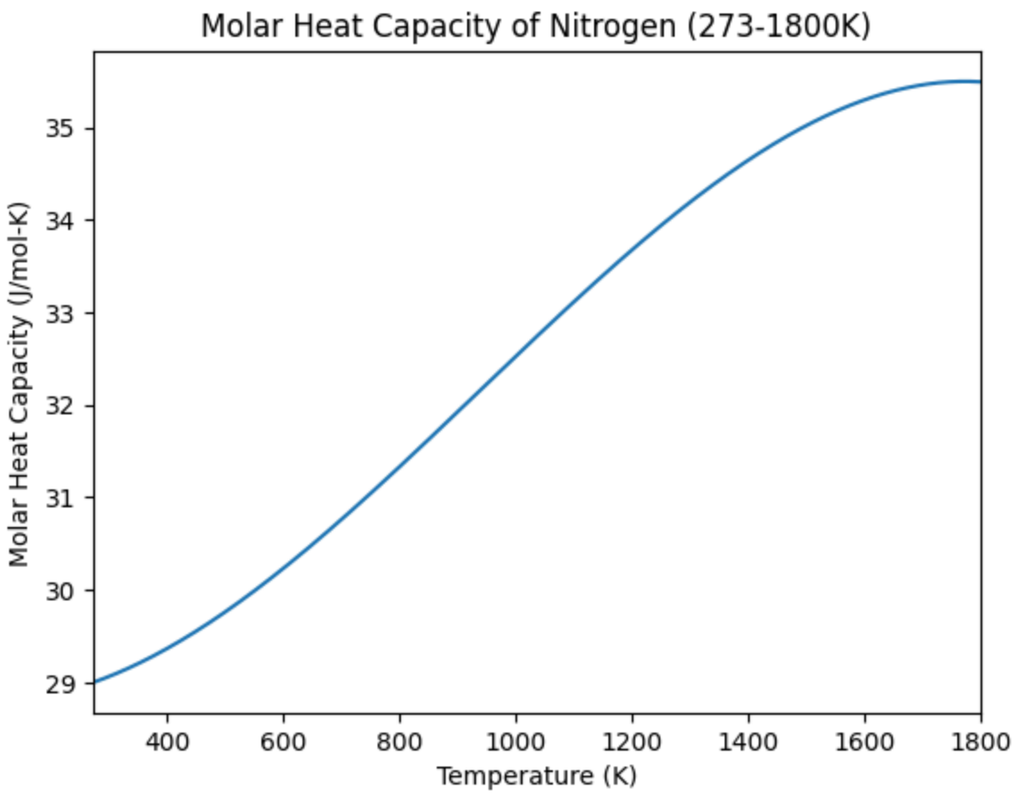
In [6]:
```
import numpy as np
import matplotlib.pyplot as plt

def nitrogen_cp(T):
    return 28.883 - (0.157e-2 * T) + (0.808e-5 * T**2) - (2.871e-9 * T**3)

temps = np.arange(273, 1800, 1)
cps_n2 = nitrogen_cp(temps)

plt.plot(temps, cps_n2)
plt.xlim(273, 1800)
plt.xlabel('Temperature (K)')
plt.ylabel('Molar Heat Capacity (J/mol-K)')
plt.title('Molar Heat Capacity of Nitrogen (273-1800K)')
```

Out[6]:
```
Text(0.5, 1.0, 'Molar Heat Capacity of Nitrogen (273-1800K)')
```



Explain the trend in this plot.

- as temperature increases so does the molar heat capacity. when the temperature gets to 1200-1800K the higher order terms start to affect the heat capacity more making it start to level off.

Compare the values you calculate to the expected constant pressure molar heat capacity of a diatomic ideal gas

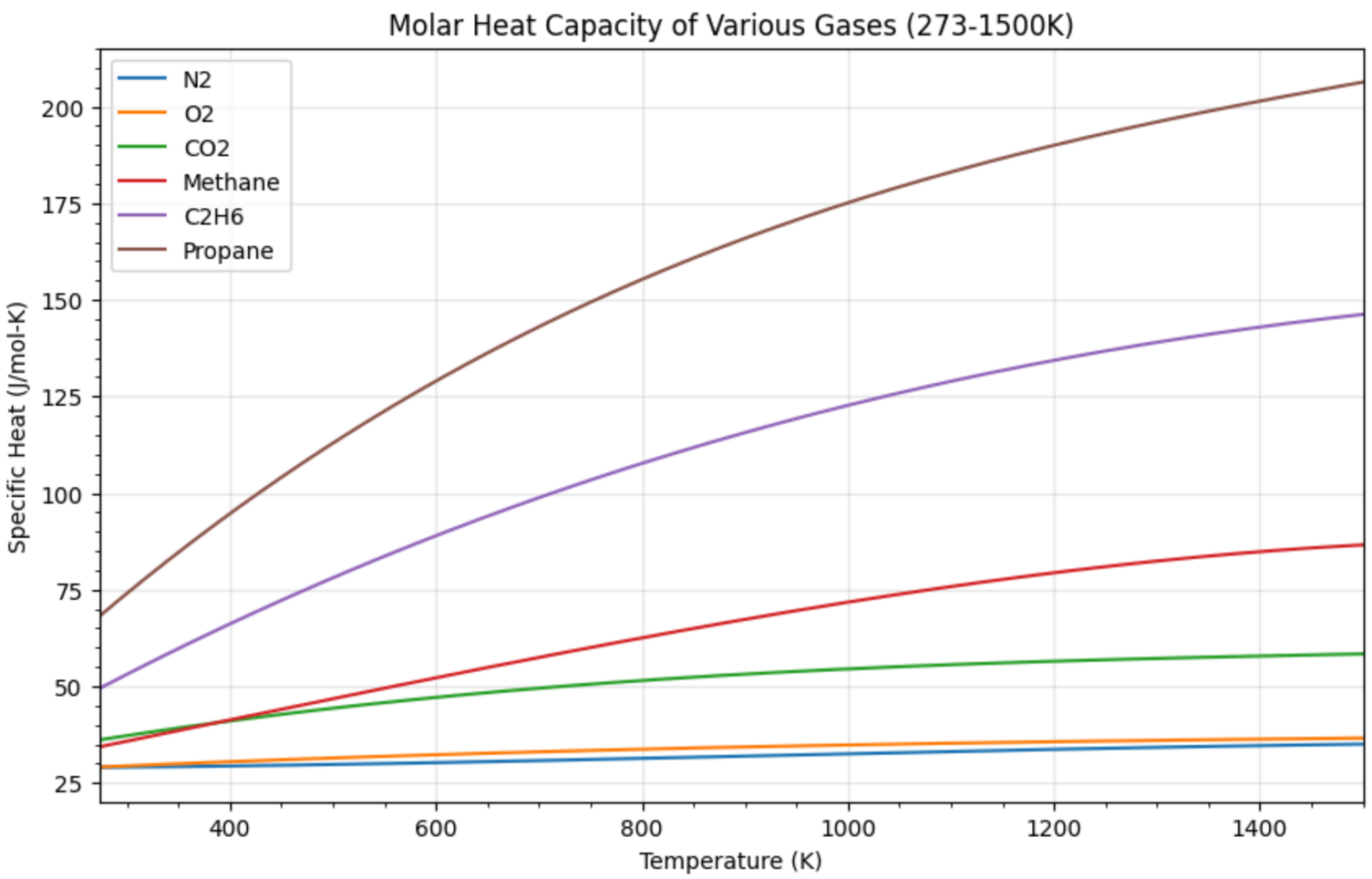
- the expected heat capacity for a diatomic ideal gas is $\frac{7}{2}R \approx 29.1$, which is very close to the molar heat capacity at 273° K. However, the diatomic ideal gas heat capacity is not a function of temperature whereas the real N_2 molar heat capacity is a function of temperature.

Plot the constant pressure molar heat capacities of nitrogen, oxygen, carbon dioxide, methane, ethane, and propane in a single figure for the range of temperatures 273–1500 K

In [7]:
```
def oxygen_cp(T):
    return 25.460 + (1.519e-2 * T) - (0.715e-5 * T**2) + (1.311e-9 * T**3)

def co2_cp(T):
    return 22.243 + (5.977e-2 * T) - (3.499e-5 * T**2) + (7.464e-9 * T**3)

def methane_cp(T):
    return 19.875 + (5.021e-2 * T) + (1.268e-5 * T**2) + (-11.004e-9 * T**3)

def ethane_cp(T):
```

```
    return 6.895 + (17.255e-2 * T) - (6.402e-5 * T**2) + (7.280e-9 * T**3)

def propane_cp(T):
    return -4.042 + (30.456e-2 * T) + (-15.711e-5 * T**2) + (31.716e-9 * T**3)


temps = np.arange(273, 1500, 1)
cps_n2 = nitrogen_cp(temps)
cps_o2 = oxygen_cp(temps)
cps_co2 = co2_cp(temps)
cps_ch4 = methane_cp(temps)
cps_c2h6 = ethane_cp(temps)
cps_propane = propane_cp(temps)

fig, ax = plt.subplots(figsize=(10, 6), dpi=100)

ax.plot(temps, cps_n2, label='N2')
ax.plot(temps, cps_o2, label='O2')
ax.plot(temps, cps_co2, label='CO2')
ax.plot(temps, cps_ch4, label='Methane')
ax.plot(temps, cps_c2h6, label='C2H6')
ax.plot(temps, cps_propane, label='Propane')
ax.set_xlim(273, 1500)
ax.grid(True, alpha=0.3)

#major minor tick
ax.minorticks_on()

ax.legend()
ax.set_xlabel('Temperature (K)')
ax.set_ylabel('Specific Heat (J/mol-K)')
ax.set_title('Molar Heat Capacity of Various Gases (273-1500K)')
```

Out[7]: `Text(0.5, 1.0, 'Molar Heat Capacity of Various Gases (273-1500K)')`



In [ ]: