

Integrate[$L^{(3n+2)} \text{Exp}[(2n-k)qE_0 L/2/k_B/T]$, { L, θ, L_c }]

$$\text{ConditionalExpression}\left[\left(8^{1+n} k_B^3 L_c^{3n} \left(\frac{E_0 L_c (k-2n) q}{k_B T}\right)^{-3n} T^3 \left(\Gamma[3+3n] - \Gamma\left[3(1+n), \frac{E_0 L_c (k-2n) q}{2 k_B T}\right]\right)\right) / (E_0^3 (k-2n)^3 q^3), \text{Re}[n] > -1\right]$$

$$\text{FullSimplify}\left[\left(8^{1+n} k_B^3 L_c^{3n} \left(\frac{E_0 L_c (k-2n) q}{k_B T}\right)^{-3n} T^3 \left(\Gamma[3+3n] - \Gamma\left[3(1+n), \frac{E_0 L_c (k-2n) q}{2 k_B T}\right]\right)\right) / (E_0^3 (k-2n)^3 q^3), \right.$$

Assumptions $\rightarrow k_B > 0 \ \&\& \ T > 0 \ \&\& \ L_c > 0 \ \&\& \ E_0 > 0 \ \&\& \ q > 0 \ \&\& \ 0 \leq k \leq n/2 \ \&\& \ n > 0 \ \&\& \ n \in \text{Integers}$

$$(-1)^n 8^{1+n} \left(-\frac{E_0 (k-2n) q}{k_B T}\right)^{-3(1+n)} \left(-\Gamma[3+3n] + \Gamma\left[3(1+n), \frac{E_0 L_c (k-2n) q}{2 k_B T}\right]\right)$$

Gamma[9, -10]

54 133 120 e^{10}

Integrate[$P L^{(3n+2)} / k_B / T \text{Exp}[-P L^3 / k_B / T - (n+k)qE_0 L / k_B / T]$, { $L, \theta, \text{Infinity}$ }] // **Together** // **FullSimplify**

$$\text{ConditionalExpression}\left[\frac{1}{6 k_B^2 T^2} \left(\frac{P}{k_B T}\right)^{-1-n} \left(2 k_B P T \Gamma[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E_0^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right] + E_0 (k+n) q \left(\frac{P}{k_B T}\right)^{1/3} \left(-2 k_B \left(\frac{P}{k_B T}\right)^{1/3} T \Gamma\left[\frac{4}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E_0^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right] + E_0 (k+n) q \Gamma\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E_0^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right]\right)\right), \text{Re}[n] > -1 \ \&\& \ \text{Re}\left[\frac{P}{k_B T}\right] > 0 \ \&\& \ \text{Re}\left[\frac{E_0 (k+n) q}{k_B T}\right] > 0\right]$$

$$\begin{aligned}
& \text{Coefficient}\left[\frac{1}{6 k_B^2 T^2} \left(\frac{P}{k_B T}\right)^{-1-n}\right. \\
& \left(2 k_B P T \Gamma[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right] + \right. \\
& E \theta (k+n) q \left(\frac{P}{k_B T}\right)^{1/3} \left(-2 k_B \left(\frac{P}{k_B T}\right)^{1/3} T \Gamma\left[\frac{4}{3}+n\right] \right. \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right] + E \theta (k+n) q \right. \\
& \left. \left. \Gamma\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right]\right)\right), \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right]\right] // \text{FullSimplify} \\
& - \frac{E \theta (k+n) q \left(\frac{P}{k_B T}\right)^{\frac{2}{3}-n} \Gamma\left[\frac{4}{3}+n\right]}{3 P}
\end{aligned}$$

$$\begin{aligned}
& \text{Coefficient}\left[\frac{1}{6 k_B^2 T^2} \left(\frac{P}{k_B T}\right)^{-1-n}\right. \\
& \left(2 k_B P T \Gamma[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right] + \right. \\
& E \theta (k+n) q \left(\frac{P}{k_B T}\right)^{1/3} \left(-2 k_B \left(\frac{P}{k_B T}\right)^{1/3} T \Gamma\left[\frac{4}{3}+n\right] \right. \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right] + E \theta (k+n) q \right. \\
& \left. \left. \Gamma\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right]\right)\right), \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right]\right] // \text{FullSimplify} \\
& - \frac{E \theta^2 (k+n)^2 q^2 \left(\frac{P}{k_B T}\right)^{-\frac{2}{3}-n} \Gamma\left[\frac{5}{3}+n\right]}{6 k_B^2 T^2}
\end{aligned}$$

$$\begin{aligned}
& \text{Coefficient}\left[\frac{1}{6 k_B^2 T^2} \left(\frac{P}{k_B T}\right)^{-1-n}\right. \\
& \left(2 k_B P T \text{Gamma}[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E_0^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right] + \right. \\
& E_0 (k+n) q \left(\frac{P}{k_B T}\right)^{1/3} \left(-2 k_B \left(\frac{P}{k_B T}\right)^{1/3} T \text{Gamma}\left[\frac{4}{3}+n\right] \right. \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E_0^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right] + E_0 (k+n) q \right. \\
& \left. \left. \text{Gamma}\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E_0^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right]\right)\right], \\
& \left. \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E_0^3 (k+n)^3 q^3}{27 k_B^2 P T^2}\right]\right] // \text{FullSimplify} \\
& \frac{1}{3} \left(\frac{P}{k_B T}\right)^{-n} \text{Gamma}[1+n]
\end{aligned}$$

Integrate[

$$P L^{\wedge} (3 n + 2) / k_B / T \text{Exp}[-P L^{\wedge} 3 / k_B / T + (2 n - k) q E_0 L / 2 / k_B / T], \{L, 0, \text{Infinity}\}]$$

$$\begin{aligned}
& \text{ConditionalExpression}\left[\frac{1}{24 k_B P T} \left(\frac{P}{k_B T}\right)^{-n}\right. \\
& \left(8 k_B P T \text{Gamma}[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E_0^3 (k-2 n)^3 q^3}{216 k_B^2 P T^2}\right] + \right. \\
& E_0 (k-2 n) q \left(\frac{P}{k_B T}\right)^{1/3} \left(-4 k_B \left(\frac{P}{k_B T}\right)^{1/3} T \text{Gamma}\left[\frac{4}{3}+n\right] \right. \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E_0^3 (k-2 n)^3 q^3}{216 k_B^2 P T^2}\right] + E_0 (k-2 n) q \right. \\
& \left. \left. \text{Gamma}\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E_0^3 (k-2 n)^3 q^3}{216 k_B^2 P T^2}\right]\right)\right], \\
& \text{Re}[n] > -1 \&\& \text{Re}\left[\frac{P}{k_B T}\right] > 0 \&\& \text{Re}\left[\frac{E_0 (k-2 n) q}{k_B T}\right] > 0]
\end{aligned}$$

Integrate[$P L^{\wedge} (3 n + 2) / k_B / T \text{Exp}[-P L^{\wedge} 3 / k_B / T + (2 n - k) q E_0 L / 2 / k_B / T],$
 $\{L, 0, \text{Infinity}\}, \text{Assumptions} \rightarrow 0 < k < n / 2]$

$$\begin{aligned}
& \text{ConditionalExpression}\left[\frac{1}{24 k_B P T} \left(\frac{P}{k_B T}\right)^{-n}\right. \\
& \left(8 k_B P T \text{Gamma}[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E_0^3 (k-2 n)^3 q^3}{216 k_B^2 P T^2}\right] + \right. \\
& E_0 (k-2 n) q \left(\frac{P}{k_B T}\right)^{1/3} \left(-4 k_B \left(\frac{P}{k_B T}\right)^{1/3} T \text{Gamma}\left[\frac{4}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \right. \\
& \left. \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E_0^3 (k-2 n)^3 q^3}{216 k_B^2 P T^2}\right] + E_0 (k-2 n) q \text{Gamma}\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \right. \\
& \left. \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E_0^3 (k-2 n)^3 q^3}{216 k_B^2 P T^2}\right]\right)\right], \text{Re}\left[\frac{E_0 q}{k_B T}\right] < 0 \&\& \text{Re}\left[\frac{P}{k_B T}\right] > 0]
\end{aligned}$$

Integrate[P L ^ (3 n + 2) / kB / T Exp[-P L ^ 3 / kB / T + (2 n - k) q E0 L / 2 / kB / T],
 {L, 0, Infinity}, Assumptions -> 0 < k < n / 2 && q E0 > 0 && kB > 0 && T > 0 && P > 0]

$$\frac{1}{24} P^{-\frac{2}{3}-n} (kB T)^{-\frac{4}{3}+n} \left(8 P^{2/3} (kB T)^{4/3} \Gamma[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 kB^2 P T^2}\right] + \right. \\ \left. E0 (k-2n) q \left(-4 P^{1/3} (kB T)^{2/3} \Gamma\left[\frac{4}{3}+n\right] \right. \right. \\ \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 kB^2 P T^2}\right] + E0 (k-2n) q \right. \\ \left. \left. \Gamma\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 kB^2 P T^2}\right]\right) \right) \right)$$

Coefficient[

$$\frac{1}{24} P^{-\frac{2}{3}-n} (kB T)^{-\frac{4}{3}+n} \left(8 P^{2/3} (kB T)^{4/3} \Gamma[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, \right. \right. \\ \left. \left. -\frac{E0^3 (k-2n)^3 q^3}{216 kB^2 P T^2}\right] + E0 (k-2n) q \left(-4 P^{1/3} (kB T)^{2/3} \Gamma\left[\frac{4}{3}+n\right] \right. \right. \\ \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 kB^2 P T^2}\right] + E0 (k-2n) q \right. \\ \left. \left. \Gamma\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 kB^2 P T^2}\right]\right) \right) \right), \\ \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 kB^2 P T^2}\right] //$$

FullSimplify

$$\frac{1}{3} P^{-n} (kB T)^n \Gamma[1+n]$$

Coefficient[

$$\begin{aligned} & \frac{1}{24} P^{-\frac{2}{3}-n} (k_B T)^{-\frac{4}{3}+n} \left(8 P^{2/3} (k_B T)^{4/3} \text{Gamma}[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, \right. \right. \\ & \quad \left. \left. - \frac{E0^3 (k-2n)^3 q^3}{216 k_B^2 P T^2} \right] + E0 (k-2n) q \left(-4 P^{1/3} (k_B T)^{2/3} \text{Gamma}\left[\frac{4}{3}+n\right] \right. \right. \\ & \quad \left. \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 k_B^2 P T^2} \right] + E0 (k-2n) q \right. \right. \\ & \quad \left. \left. \text{Gamma}\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 k_B^2 P T^2} \right] \right) \right) \Bigg), \\ & \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 k_B^2 P T^2} \right] \Bigg] // \end{aligned}$$

FullSimplify

$$-\frac{1}{6} E0 (k-2n) P^{-\frac{1}{3}-n} q (k_B T)^{-\frac{2}{3}+n} \text{Gamma}\left[\frac{4}{3}+n\right]$$

Coefficient[

$$\begin{aligned} & \frac{1}{24} P^{-\frac{2}{3}-n} (k_B T)^{-\frac{4}{3}+n} \left(8 P^{2/3} (k_B T)^{4/3} \text{Gamma}[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, \right. \right. \\ & \quad \left. \left. - \frac{E0^3 (k-2n)^3 q^3}{216 k_B^2 P T^2} \right] + E0 (k-2n) q \left(-4 P^{1/3} (k_B T)^{2/3} \text{Gamma}\left[\frac{4}{3}+n\right] \right. \right. \\ & \quad \left. \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 k_B^2 P T^2} \right] + E0 (k-2n) q \right. \right. \\ & \quad \left. \left. \text{Gamma}\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 k_B^2 P T^2} \right] \right) \right) \Bigg), \\ & \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 k_B^2 P T^2} \right] \Bigg] // \end{aligned}$$

FullSimplify

$$\frac{1}{24} E0^2 (k-2n)^2 P^{-\frac{2}{3}-n} q^2 (k_B T)^{-\frac{4}{3}+n} \text{Gamma}\left[\frac{5}{3}+n\right]$$

Integrate[Exp[-p^2/2/m/kB/T], {p, -Infinity, Infinity}]

$$\text{ConditionalExpression}\left[\frac{\sqrt{2\pi}}{\sqrt{\frac{1}{k_B m T}}}, \text{Re}\left[\frac{1}{k_B m T}\right] > 0\right]$$

Integrate[Exp[-q E0 x / kB / T], {x, L/2, L}]

$$\frac{e^{-\frac{E0 L q}{k_B T}} \left(-1 + e^{\frac{E0 L q}{2 k_B T}} \right) k_B T}{E0 q}$$

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Integrate[P L^ (n + 2) / kB / T Exp[-P L^3 / kB / T]
  Cosh[n q E0 L / kB / T] (1 - Exp[-q E0 L / 2 / kB / T]) ^ (n / 2), {L, 0, Infinity}]
```

$$\int_0^{\infty} \frac{e^{-\frac{L^3 P}{kB T}} \left(1 - e^{-\frac{E_0 L q}{2 kB T}}\right)^{n/2} L^{2+n} P \cosh\left[\frac{E_0 L n q}{kB T}\right]}{kB T} dL$$

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Table[Binomial[9, k], {k, 0, 9}]
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{1, 9, 36, 84, 126, 126, 84, 36, 9, 1}
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```
Table[Binomial[9, k], {k, 0, 9}] // Length
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10
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Integrate[P L^ (n + 2) / kB / T Cosh[n q E0 L / kB / T]
  Exp[-P L^3 / kB / T - k q E0 L / 2 / kB / T], {L, 0, Infinity}]
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$$\text{ConditionalExpression}\left[\frac{1}{48 kB P T} \left(\frac{P}{kB T}\right)^{-n/3} \left(8 kB P T \Gamma\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E_0^3 (k - 2 n)^3 q^3}{216 kB^2 P T^2}\right] + \right. \right. \\ \left. 8 kB P T \Gamma\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E_0^3 (k + 2 n)^3 q^3}{216 kB^2 P T^2}\right] + \right. \\ \left. E_0 q \left(\frac{P}{kB T}\right)^{1/3} \left(-4 kB (k - 2 n) \left(\frac{P}{kB T}\right)^{1/3} T \Gamma\left[\frac{4 + n}{3}\right] \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E_0^3 (k - 2 n)^3 q^3}{216 kB^2 P T^2}\right] - 4 kB (k + 2 n) \left(\frac{P}{kB T}\right)^{1/3} T \Gamma\left[\frac{4 + n}{3}\right] \right. \right. \\ \left. \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E_0^3 (k + 2 n)^3 q^3}{216 kB^2 P T^2}\right] + E_0 q \Gamma\left[\frac{5 + n}{3}\right] \right. \right. \\ \left. \left. \left((k - 2 n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E_0^3 (k - 2 n)^3 q^3}{216 kB^2 P T^2}\right] + \right. \right. \right. \\ \left. \left. (k + 2 n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, \right. \right. \right. \\ \left. \left. \left. - \frac{E_0^3 (k + 2 n)^3 q^3}{216 kB^2 P T^2}\right]\right)\right)\right), \text{Re}[n] > -3 \&\& \text{Re}\left[\frac{P}{kB T}\right] > 0]$$

$$\begin{aligned}
& \text{Coefficient}\left[\frac{1}{48 \, k B \, P \, T} \left(\frac{P}{k B \, T}\right)^{-n/3}\right. \\
& \left(8 \, k B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] + \right. \\
& \left. 8 \, k B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] + \right. \\
& E \theta \, q \left(\frac{P}{k B \, T}\right)^{1/3} \left(-4 \, k B (k - 2 n) \left(\frac{P}{k B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4 + n}{3}\right] \text{HypergeometricPFQ}\left[\right. \right. \\
& \left. \left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] - 4 \, k B (k + 2 n) \left(\frac{P}{k B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4 + n}{3}\right] \right. \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] + E \theta \, q \, \text{Gamma}\left[\frac{5 + n}{3}\right] \right. \\
& \left. \left((k - 2 n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] + \right. \\
& \left. (k + 2 n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] \right) \left. \right) \left. \right), \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] \right] // \\
& \text{FullSimplify} \\
& \frac{E \theta^2 (k - 2 n)^2 q^2 \left(\frac{P}{k B \, T}\right)^{-\frac{2}{3} - \frac{n}{3}} \text{Gamma}\left[\frac{5 + n}{3}\right]}{48 \, k B^2 \, T^2}
\end{aligned}$$

$$\begin{aligned}
& \text{Coefficient}\left[\frac{1}{48 \, k_B \, P \, T} \left(\frac{P}{k_B \, T}\right)^{-n/3} \right. \\
& \left(8 \, k_B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& \left. 8 \, k_B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& E \theta \, q \left(\frac{P}{k_B \, T}\right)^{1/3} \left(-4 \, k_B (k - 2 n) \left(\frac{P}{k_B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4+n}{3}\right] \text{HypergeometricPFQ}\left[\right. \\
& \left.\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] - 4 \, k_B (k + 2 n) \left(\frac{P}{k_B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4+n}{3}\right] \right. \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + E \theta \, q \, \text{Gamma}\left[\frac{5+n}{3}\right] \right. \\
& \left. \left((k - 2 n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& \left. (k + 2 n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] \right) \left. \right) \left. \right), \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] \right] // \\
& \text{FullSimplify} \\
& \frac{E \theta^2 (k + 2 n)^2 q^2 \left(\frac{P}{k_B \, T}\right)^{-\frac{2}{3} - \frac{n}{3}} \text{Gamma}\left[\frac{5+n}{3}\right]}{48 \, k_B^2 \, T^2}
\end{aligned}$$

$$\begin{aligned}
& \text{Coefficient}\left[\frac{1}{48 \, k_B \, P \, T} \left(\frac{P}{k_B \, T}\right)^{-n/3} \right. \\
& \left(8 \, k_B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& \left. 8 \, k_B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& E \theta \, q \left(\frac{P}{k_B \, T}\right)^{1/3} \left(-4 \, k_B (k - 2 n) \left(\frac{P}{k_B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4+n}{3}\right] \text{HypergeometricPFQ}\left[\right. \\
& \left.\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] - 4 \, k_B (k + 2 n) \left(\frac{P}{k_B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4+n}{3}\right] \right. \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + E \theta \, q \, \text{Gamma}\left[\frac{5+n}{3}\right] \right. \\
& \left. \left((k - 2 n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& \left. (k + 2 n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] \right) \left. \right) \left. \right), \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] \right] // \\
& \text{FullSimplify} \\
& \frac{E \theta (k - 2 n) \, q \left(\frac{P}{k_B \, T}\right)^{\frac{2}{3} - \frac{n}{3}} \text{Gamma}\left[\frac{4+n}{3}\right]}{12 \, P}
\end{aligned}$$

$$\begin{aligned}
& \text{Coefficient}\left[\frac{1}{48 \, k_B \, P \, T} \left(\frac{P}{k_B \, T}\right)^{-n/3} \right. \\
& \left(8 \, k_B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& \left. 8 \, k_B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& E \theta \, q \left(\frac{P}{k_B \, T}\right)^{1/3} \left(-4 \, k_B (k - 2 n) \left(\frac{P}{k_B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4+n}{3}\right] \text{HypergeometricPFQ}\left[\right. \\
& \left.\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] - 4 \, k_B (k + 2 n) \left(\frac{P}{k_B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4+n}{3}\right] \right. \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + E \theta \, q \, \text{Gamma}\left[\frac{5+n}{3}\right] \right. \\
& \left. \left((k - 2 n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& \left. \left. (k + 2 n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] \right) \right) \right), \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] \right] // \\
& \text{FullSimplify} \\
& \frac{E \theta (k + 2 n) \, q \left(\frac{P}{k_B \, T}\right)^{\frac{2}{3} - \frac{n}{3}} \text{Gamma}\left[\frac{4+n}{3}\right]}{12 \, P}
\end{aligned}$$

$$\text{Coefficient}\left[\frac{1}{48 \, k B \, P \, T} \left(\frac{P}{k B \, T}\right)^{-n/3}\right.$$

$$\begin{aligned} & \left(8 \, k B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \, \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] + \right. \\ & 8 \, k B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \, \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] + \\ & E \theta \, q \left(\frac{P}{k B \, T}\right)^{1/3} \left(-4 \, k B \, (k - 2 n) \left(\frac{P}{k B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4 + n}{3}\right] \, \text{HypergeometricPFQ}\left[\right. \\ & \left.\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] - 4 \, k B \, (k + 2 n) \left(\frac{P}{k B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4 + n}{3}\right] \right. \\ & \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] + E \theta \, q \, \text{Gamma}\left[\frac{5 + n}{3}\right] \right. \\ & \left. \left((k - 2 n)^2 \, \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] + \right. \\ & \left. (k + 2 n)^2 \, \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k + 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] \right) \left. \right) \Bigg], \\ & \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k - 2 n)^3 q^3}{216 \, k B^2 \, P \, T^2}\right] \Bigg] // \end{aligned}$$

FullSimplify

$$\frac{1}{6} \left(\frac{P}{k B \, T}\right)^{-n/3} \text{Gamma}\left[1 + \frac{n}{3}\right]$$

$$\begin{aligned}
& \text{Coefficient}\left[\frac{1}{48 \, k_B \, P \, T} \left(\frac{P}{k_B \, T}\right)^{-n/3} \right. \\
& \left(8 \, k_B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& \left. 8 \, k_B \, P \, T \, \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E0^3 (k+2n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& E0 \, q \left(\frac{P}{k_B \, T}\right)^{1/3} \left(-4 \, k_B (k-2n) \left(\frac{P}{k_B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4+n}{3}\right] \text{HypergeometricPFQ}\left[\right. \right. \\
& \left. \left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] - 4 \, k_B (k+2n) \left(\frac{P}{k_B \, T}\right)^{1/3} T \, \text{Gamma}\left[\frac{4+n}{3}\right] \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E0^3 (k+2n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + E0 \, q \, \text{Gamma}\left[\frac{5+n}{3}\right] \right. \\
& \left. \left((k-2n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E0^3 (k-2n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] + \right. \\
& \left. (k+2n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E0^3 (k+2n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] \right) \left. \right) \left. \right), \\
& \left. \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E0^3 (k+2n)^3 q^3}{216 \, k_B^2 \, P \, T^2}\right] \right] //
\end{aligned}$$

FullSimplify

$$\frac{1}{6} \left(\frac{P}{k_B \, T}\right)^{-n/3} \text{Gamma}\left[1 + \frac{n}{3}\right]$$

Integrate[Exp[-q E0 x / kB / T], {x, 0, L}]

$$\frac{\left(1 - e^{-\frac{E0 \, L \, q}{k_B \, T}}\right) k_B \, T}{E0 \, q}$$

Integrate[Exp[q E0 x / kB / T], {x, 0, L}]

$$\frac{\left(-1 + e^{\frac{E0 \, L \, q}{k_B \, T}}\right) k_B \, T}{E0 \, q}$$