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Integrate[L^(3 n + 2) Exp[(2 n - k) q E0 L / 2 / kB / T], {L, 0, Lc}]
ConditionalExpression[
$$\left(8^{1+n} kB^3 Lc^{3n} \left(\frac{E0 Lc (k - 2n) q}{kB T}\right)^{-3n} T^3 \left(\text{Gamma}[3 + 3n] - \text{Gamma}\left[3 (1 + n), \frac{E0 Lc (k - 2n) q}{2 kB T}\right]\right)\right) / (E0^3 (k - 2n)^3 q^3), \text{Re}[n] > -1]$$


FullSimplify[
$$\left(8^{1+n} kB^3 Lc^{3n} \left(\frac{E0 Lc (k - 2n) q}{kB T}\right)^{-3n} T^3 \left(\text{Gamma}[3 + 3n] - \text{Gamma}\left[3 (1 + n), \frac{E0 Lc (k - 2n) q}{2 kB T}\right]\right)\right) / (E0^3 (k - 2n)^3 q^3),$$


Assumptions → kB > 0 && T > 0 && Lc > 0 && E0 > 0 && q > 0 &&
0 ≤ k ≤ n / 2 && n > 0 && n ∈ Integers]


$$(-1)^n 8^{1+n} \left(-\frac{E0 (k - 2n) q}{kB T}\right)^{-3(1+n)} \left(-\text{Gamma}[3 + 3n] + \text{Gamma}\left[3 (1 + n), \frac{E0 Lc (k - 2n) q}{2 kB T}\right]\right)$$


Gamma[9, -10]
54 133 120 e10

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

ConditionalExpression[
$$\frac{1}{6 kB^2 T^2} \left(\frac{P}{kB T}\right)^{-1-n}$$


$$\left(2 kB P T \text{Gamma}[1 + n] \text{HypergeometricPFQ}\left[\{1 + n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E0^3 (k + n)^3 q^3}{27 kB^2 P T^2}\right] + E0 (k + n) q \left(\frac{P}{kB T}\right)^{1/3} \left(-2 kB \left(\frac{P}{kB T}\right)^{1/3} T \text{Gamma}\left[\frac{4}{3} + n\right] \text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E0^3 (k + n)^3 q^3}{27 kB^2 P T^2}\right] + E0 (k + n) q \text{Gamma}\left[\frac{5}{3} + n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E0^3 (k + n)^3 q^3}{27 kB^2 P T^2}\right]\right)\right),$$


$$\text{Re}[n] > -1 \&& \text{Re}\left[\frac{P}{kB T}\right] > 0 \&& \text{Re}\left[\frac{E0 (k + n) q}{kB T}\right] > 0$$


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$$\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. \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), \\
& \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} \\
& \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. \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), \\
& \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)^{-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. \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), \\
& \left. \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] // \text{FullSimplify} \\
& \frac{1}{3} \left( \frac{P}{k B T} \right)^{-n} \Gamma[1+n] \\
\\
& \text{Integrate}[ \\
& P L^{(3 n+2)} / k B / T \text{Exp}[-P L^3 / k B / T + (2 n - k) q E \theta L / 2 / k B / T], \{L, 0, \text{Infinity}\}] \\
& \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 \Gamma[1+n] \text{HypergeometricPFQ} \left[ \{1+n\}, \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 (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 \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-2 n)^3 q^3}{216 k B^2 P T^2} \right] + E \theta (k-2 n) q \right. \\
& \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-2 n)^3 q^3}{216 k B^2 P T^2} \right] \right), \\
& \left. \text{Re}[n] > -1 \&& \text{Re} \left[ \frac{P}{k B T} \right] > 0 \&& \text{Re} \left[ \frac{E \theta (k-2 n) q}{k B T} \right] > 0 \right] \\
\\
& \text{Integrate}[P L^{(3 n+2)} / k B / T \text{Exp}[-P L^3 / k B / T + (2 n - k) q E \theta L / 2 / k B / T], \\
& \{L, 0, \text{Infinity}\}, \text{Assumptions} \rightarrow 0 < k < n / 2] \\
& \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 \Gamma[1+n] \text{HypergeometricPFQ} \left[ \{1+n\}, \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 (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 \Gamma \left[ \frac{4}{3} + n \right] \text{HypergeometricPFQ} \left[ \left\{ \frac{4}{3} + n \right\}, \right. \right. \\
& \left. \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 (k-2 n) q \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 \theta^3 (k-2 n)^3 q^3}{216 k B^2 P T^2} \right] \right), \text{Re} \left[ \frac{E \theta q}{k B T} \right] < 0 \&& \text{Re} \left[ \frac{P}{k B T} \right] > 0
\end{aligned}$$

$$\begin{aligned}
& \text{Integrate}[P L^{(3 n + 2) / k B / T} \text{Exp}[-P L^3 / k B / T + (2 n - k) q E \theta L / 2 / k B / T], \\
& \quad \{L, 0, \text{Infinity}\}, \text{Assumptions} \rightarrow 0 < k < n / 2 \&& q E \theta > 0 \&& k B > 0 \&& T > 0 \&& P > 0] \\
& \frac{1}{24} P^{-\frac{2}{3}-n} (k B T)^{-\frac{4}{3}+n} \\
& \left( 8 P^{2/3} (k B T)^{4/3} \text{Gamma}[1+n] \text{HypergeometricPFQ}\left[\{1+n\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E \theta^3 (k-2 n)^3 q^3}{216 k B^2 P T^2}\right] + \right. \\
& E \theta (k-2 n) q \left( -4 P^{1/3} (k B T)^{2/3} \text{Gamma}\left[\frac{4}{3}+n\right] \right. \\
& \left. \text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E \theta^3 (k-2 n)^3 q^3}{216 k B^2 P T^2}\right] + E \theta (k-2 n) q \right. \\
& \left. \left. \text{Gamma}\left[\frac{5}{3}+n\right] \text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E \theta^3 (k-2 n)^3 q^3}{216 k B^2 P T^2}\right] \right) \right)
\end{aligned}$$

**Coefficient[**

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

**FullSimplify**

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

**Coefficient[**

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

$$\text{HypergeometricPFQ}\left[\left\{\frac{4}{3}+n\right\}, \left\{\frac{2}{3}, \frac{4}{3}\right\}, -\frac{E\theta^3 (k-2n)^3 q^3}{216 kB^2 P T^2}\right] //$$

**FullSimplify**

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

**Coefficient[**

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

$$\text{HypergeometricPFQ}\left[\left\{\frac{5}{3}+n\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E\theta^3 (k-2n)^3 q^3}{216 kB^2 P T^2}\right] //$$

**FullSimplify**

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

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

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

**Integrate[Exp[-q E\theta x/kB/T], {x, L/2, L}]**

$$\frac{e^{-\frac{E\theta L q}{kB T}} \left(-1 + e^{\frac{E\theta L q}{kB T}}\right) kB T}{E\theta q}$$

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


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


Table[Binomial[9, k], {k, 0, 9}]
{1, 9, 36, 84, 126, 126, 84, 36, 9, 1}

Table[Binomial[9, k], {k, 0, 9}] // Length
10

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

ConditionalExpression[ $\frac{1}{48 kB P T} \left(\frac{P}{kB T}\right)^{-n/3}$ 

$$\left(8 kB P T \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E\theta^3 (k - 2n)^3 q^3}{216 kB^2 P T^2}\right] +$$


$$8 kB P T \text{Gamma}\left[1 + \frac{n}{3}\right] \text{HypergeometricPFQ}\left[\left\{1 + \frac{n}{3}\right\}, \left\{\frac{1}{3}, \frac{2}{3}\right\}, -\frac{E\theta^3 (k + 2n)^3 q^3}{216 kB^2 P T^2}\right] +$$


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


$$\text{HypergeometricPFQ}\left[\left\{\frac{4}{3} + \frac{n}{3}, \frac{2}{3}, \frac{4}{3}\right\}, -\frac{E\theta^3 (k + 2n)^3 q^3}{216 kB^2 P T^2}\right] + E\theta q \text{Gamma}\left[\frac{5+n}{3}\right]$$


$$\left((k - 2n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E\theta^3 (k - 2n)^3 q^3}{216 kB^2 P T^2}\right] +$$


$$(k + 2n)^2 \text{HypergeometricPFQ}\left[\left\{\frac{5}{3} + \frac{n}{3}\right\}, \left\{\frac{4}{3}, \frac{5}{3}\right\}, -\frac{E\theta^3 (k + 2n)^3 q^3}{216 kB^2 P T^2}\right]\right)\right), \text{Re}[n] > -3 \& \& \text{Re}\left[\frac{P}{kB T}\right] > 0]$$


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

$$\frac{E \theta^2 (k - 2n)^2 q^2 \left( \frac{P}{k B T} \right)^{-\frac{2}{3}-\frac{n}{3}} \text{Gamma} \left[ \frac{5+n}{3} \right]}{48 k B^2 T^2}$$

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

**FullSimplify**

$$\frac{E \theta^2 (k + 2n)^2 q^2 \left( \frac{P}{k B T} \right)^{-\frac{2}{3}-\frac{n}{3}} \text{Gamma} \left[ \frac{5+n}{3} \right]}{48 k B^2 T^2}$$

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

$$\frac{E \theta (k - 2n) q \left( \frac{P}{k B T} \right)^{\frac{2}{3} - \frac{n}{3}} \text{Gamma} \left[ \frac{4+n}{3} \right]}{12 P}$$

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

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

$$\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{E \theta^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{E \theta^3 (k + 2n)^3 q^3}{216 k B^2 P T^2} \right] + \right. \\
& \left. E \theta 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[ \left\{ \frac{4}{3} + \frac{n}{3} \right\}, \left\{ \frac{2}{3}, \frac{4}{3} \right\}, -\frac{E \theta^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] \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 \theta^3 (k + 2n)^3 q^3}{216 k B^2 P T^2} \right] + E \theta q \text{Gamma} \left[ \frac{5+n}{3} \right] \right. \right. \\
& \left. \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{E \theta^3 (k - 2n)^3 q^3}{216 k B^2 P T^2} \right] + \right. \right. \right. \\
& \left. \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{E \theta^3 (k + 2n)^3 q^3}{216 k B^2 P T^2} \right] \right) \right) \right), \\
& \left. \text{HypergeometricPFQ} \left[ \left\{ 1 + \frac{n}{3} \right\}, \left\{ \frac{1}{3}, \frac{2}{3} \right\}, -\frac{E \theta^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**[ $\text{Exp}[-q E \theta x / k B / T]$ , { $x$ , 0, L}]

$$\frac{\left( 1 - e^{-\frac{E \theta L q}{k B T}} \right) k B T}{E \theta q}$$

**Integrate**[ $\text{Exp}[q E \theta x / k B / T]$ , { $x$ , 0, L}]

$$\frac{\left( -1 + e^{\frac{E \theta L q}{k B T}} \right) k B T}{E \theta q}$$