

CHEM1047 - Week 10 - Workshop problem set

1. Using the suggested substitutions, evaluate the integrals:

$$(a) \int (3x+1)^5 dx, \quad u = 3x+1 \qquad (b) \int (3y^2 + 2)e^{-(y^3+2y)} dy, \quad u = y^3 + 2y$$

2. Find an appropriate substitution and evaluate the following integrals:

$$(a) \int \sqrt{2x-1} dx \qquad (b) \int (1-\alpha)e^{4\alpha-2\alpha^2} d\alpha \qquad (c) \int \cos(\varphi)e^{2\sin(\varphi)} d\varphi$$

3. The rotational partition function of an ensemble of linear molecules with rotational temperature θ_R

$$Q = \sum_{J=0}^{\infty} (2J+1) e^{-\frac{J(J+1)\theta_R}{T}}$$

may be approximated by replacing the sum (for which no convenient expression exists) with an integral, which is quite easy to take:

$$Q \approx \int_0^{\infty} (2J+1) e^{-\frac{J(J+1)\theta_R}{T}} dJ$$

Take this integral.

4. Evaluate the following integrals using substitutions:

$$(a) \int_1^2 \frac{xdx}{3x^2-2} \qquad (b) \int_0^{\pi^2} \left[\sin(\sqrt{x} + \pi) / \sqrt{x} \right] dx \qquad (c) \int_0^{\pi/2} \sqrt{\sin(\theta)} \cos(\theta) d\theta$$
$$(d) \int_0^1 \frac{dx}{\sqrt{2-x^2}} \qquad (e) \int_0^{\infty} xe^{-x^2} dx$$

5. Evaluate the following integrals using integration by parts:

$$(a) \int x \sin(x) dx \qquad (b) \int x^3 \sin(x) dx \qquad (c) \int (x+1)^2 \cos(2x) dx \qquad (d) \int x^2 e^{2x} dx$$
$$(e) \int_0^1 xe^x dx \qquad (f) \int_0^{\infty} x^2 e^{-2x} dx \qquad (g) \int x \ln(x) dx \qquad (h) \int \frac{\ln x}{x^2} dx$$

6. Good luck trying to evaluate $\int \frac{dx}{\cos x}$.