

Answer the questions on your own paper and hand that it.

Name: \_\_\_\_\_

Instructors name: \_\_\_\_\_

1. Evaluate these expressions

(a) [2]

$$\frac{d}{dx} ((\arctan (x) (x^2 + 1)))$$

(b) [2]

$$\int_0^1 \frac{a}{\sqrt{x^3}} dx$$

(c) [4]

$$\int \frac{x - 1}{x^2 + x} dx$$

2. Find the rate law for this differential rate equation, with initial concentration of  $[A]_0$  [2]

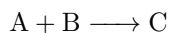
$$\frac{d[A]}{dt} = -k\sqrt{[A]}$$

3. For the following equation find the rate law assuming that it is elementary with initial concentrations of [6]

(a)  $[A] = 1, [B] = 1, [C] = 0$

(b)  $[A] = 2, [B] = 1, [C] = 0$

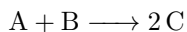
(c)  $[A] = 2, [B] = 3, [C] = 1$



4. For the following equation find the rate law assuming that it is elementary with initial concentrations of [6]

(a)  $[A] = 2, [B] = 3, [C] = 0$

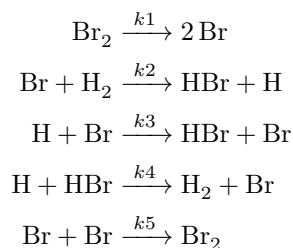
(b)  $[A] = 2, [B] = 2, [C] = 1$



5. For the following chain reaction, write a differential equation for [6]

(a)  $[Br]$

(b)  $[H]$

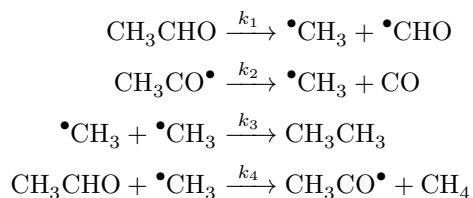


6. Use steady state and the chain reaction from the previous question to find an expression for  $\frac{d[\text{HBr}]}{dt}$ . Your answer should have the quantities  $[\text{H}_2]$ ,  $[\text{Br}_2]$ ,  $[\text{HBr}]$  [6]
7. Prove that  $\cos(t) + \sin(t) + e^{-t}$  is a solution of  $\frac{dy}{dt} + y = 2\cos(t)$  [2]
8. What are the classifications of these ODEs [6]
- (a)  $y' + y = 2$
  - (b)  $y' + -4 = 0$
  - (c)  $y' + y^2 = 0$
  - (d)  $y'' + y = 0$
  - (e)  $y'' + (y')^2 = 2$
  - (f)  $y' = 0$
9. Write the set of ODEs from question 5 in vector notation [3]
10. Reduce this higher order ODE to many first order ODEs [3]
- $$3x''' + 2x' + 4x = t$$
11. Solve the ODE  $\frac{dx}{dt} = x^2/3$ , at  $x(0) = 1$  [2]
12. Use Euler's approximation to calculate the ODE  $\frac{dx}{dt} = x^2/3$ , at  $x(0) = 1$  at the point  $x(2)$  using  $h$  values of [6]
- (a)  $h = 1$
  - (b)  $h = 0.5$
13. Based on the results from the previous two questions what is the error from  $h = 1$  and  $h = \frac{1}{2}$  [2]

# 1 Homework Questions

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1. For the following above chain reaction

- (a) Work out a differential rate expression for each quantity [4]
- (b) Using Euler's approximation plot each quantity over time (on the same graph) with the following initial conditions ( $h = 0.5$ , over a range of 0 to 10) [6]

$$\begin{aligned}[\text{CH}_3\text{CHO}] &= 1 \\ [\bullet\text{CH}_3] &= 0 \\ [\text{CH}_3\text{CO}\bullet] &= 0 \\ [\text{CO}] &= 0 \\ [\text{CH}_3\text{CH}_3] &= 0 \\ [\text{CH}_4] &= 0 \\ [\bullet\text{CHO}] &= 0 \\ k_1 &= 1 \\ k_2 &= 20 \\ k_3 &= 20 \\ k_4 &= 10\end{aligned}$$

- (c) Use online ODE solvers to plot the same graph as the previous question with the same initial conditions [4]
- (d) Use online ODE solvers to plot the same graph as the previous question with initial conditions of your choice [4]