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

Name: _____

Instructors name: _____

1. Evaluate these expressions

   (a) [2]

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

   (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 $[\mathrm{A}]_0$ [2]

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

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

   $$\mathrm{A} + \mathrm{B} \longrightarrow \mathrm{C}$$

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

   $$\mathrm{A} + \mathrm{B} \longrightarrow 2\,\mathrm{C}$$

5. For the following chain reaction, write a differential equation for [6]
   (a) [Br]
   (b) [H]

   $$\begin{aligned}
   \mathrm{Br_2} &\xrightarrow{k1} 2\,\mathrm{Br} \\
   \mathrm{Br} + \mathrm{H_2} &\xrightarrow{k2} \mathrm{HBr} + \mathrm{H} \\
   \mathrm{H} + \mathrm{Br} &\xrightarrow{k3} \mathrm{HBr} + \mathrm{Br} \\
   \mathrm{H} + \mathrm{HBr} &\xrightarrow{k4} \mathrm{H_2} + \mathrm{Br} \\
   \mathrm{Br} + \mathrm{Br} &\xrightarrow{k5} \mathrm{Br_2}
   \end{aligned}$$

6. Use steady state and the chain reaction from the previous question to find an expression for $\frac{d[\mathrm{HBr}]}{ddt}$. Your answer should have the quantities $[H_2]$, $[Br_2]$, [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

Name: _____
Instructors name: _____

$$\begin{aligned}
CH_3CHO &\xrightarrow{k_1} {}^{\bullet}CH_3 + {}^{\bullet}CHO \\
CH_3CO^{\bullet} &\xrightarrow{k_2} {}^{\bullet}CH_3 + CO \\
{}^{\bullet}CH_3 + {}^{\bullet}CH_3 &\xrightarrow{k_3} CH_3CH_3 \\
CH_3CHO + {}^{\bullet}CH_3 &\xrightarrow{k_4} CH_3CO^{\bullet} + CH_4
\end{aligned}$$

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]

$$\begin{aligned}
[CH_3CHO] &= 1 \\
[{}^{\bullet}CH_3] &= 0 \\
[CH_3CO^{\bullet}] &= 0 \\
[CO] &= 0 \\
[CH_3CH_3] &= 0 \\
[CH_4] &= 0 \\
[{}^{\bullet}CHO] &= 0 \\
k_1 &= 1 \\
k_2 &= 20 \\
k_3 &= 20 \\
k_4 &= 10
\end{aligned}$$

   (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]