1. (25 mins) 15 points

Two particles move along the x-axis. Table for twice-differentiable function Q(t) is given below. Selected values of Particle Q's position, velocity , and acceleration are provided.

t (minutes)	0	1	2	3	6	7	10
Q(t)	5	7	8	6	5	4	7
$Q'(t) = v_Q(t)$	2	3	0	-2	-1	0	4
$Q''(t) = a_Q(t)$	-1	-2	-3	-1	0	1	2

Particle P's **velocity** is given by the piecewise function P(t)

$$P(t) = \begin{cases} 3 + 2t - t^2 & for \ \ 0 \le t \le 3 \\ 2te^{2-t} & for \ \ 3 < t \le 10 \end{cases}$$

a) *Find the average acceleration of particle Q in the interval* $0 \le t \le 10$

b) For Particle Q, explain the meaning of the definite integral $\int_0^{10} |v(t)| dt$. Approximate the value of $\int_0^{10} |v(t)| dt$ using Trapezoid approximation with 3 subintervals indicated in the table.

c) For Particle Q, evaluate $\int_0^{10} a(t) dt$ and explain the meaning of this value.

d) At t = 1, are the particles P and Q speeding up or slowing down? Show work for each to justify answer.

e) *Find* $\lim\limits_{t \to 3^-} \dfrac{1 - e^{3-t}}{2P(t)}$

f) *Let* $h(t) = \dfrac{Q(t)}{3 - t^2}$ *Find* $h'(1)$

g) Do Particles Q and P both change directions in the interval $0 \le t \le 4$? Show work to justify your answer

2) (15 minutes)   9 points

$Let\ f(x) = e^x - x$

a) Find the critical value(s) of f. Classify each of these values as a relative minimum, relative maximum, or neither. Justify your conclusion

b) Write the equation of the line tangent to the graph of f at the point where x = 1

c) Given $\int_0^a f(x)dx = f'(a)$ $find\ a.$

d) Suppose $y^2 f(x) = y - 4.$ $Find\ \dfrac{dy}{dx}$