1. \( \Delta N = \int_0^3 f(t) \, dt \)

After \( t = \sqrt{3} \), \( f(t) \) is negative, so the shaded area is decreasing. Thus \( N(2.1) < N(1.9) \)

2. \( F \) increases with fixed \( I \) and increasing \( A \): \( \frac{\partial F}{\partial A} > 0 \)

\( F \) increases with fixed \( A \) and increasing \( I \): \( \frac{\partial F}{\partial I} > 0 \)

3. \[ \text{Confusing Language:} \]

\[ \text{Should call it } 0.1 \text{, not } 1/0.1 \text{, which suggests } 0.1 \cdot B \]

Have \( \frac{1}{B} \frac{dB}{dt} = 0.1 \), so \( B'@ (t, B) = (1, 5) \) is \( 0.1 \cdot B @ (1, 5) \)

\( B' = (0.1)(5) = 0.5 \).

Now \( \Delta B \approx B' \Delta t \), so \( B(1.1) - B(1) \approx (0.5)(1.1 - 1) \)

\( \text{or } B(1.1) \approx 5 + 0.05 = 5.05 \)

4. \( a \) \( w = 2x \) \( dw = 2 \, dx \) \( \Rightarrow \int \sin(w) \, dw = \frac{-1}{2} \cos(w) = \frac{-1}{2} \cos(2x) + C \)

\( b \) \( u = x \) \( dv = \sin(2x) \, dx \)

\( du = dx \) \( v = \frac{-1}{2} \cos(2x) \)

\( \int uv - \int v \, du = -\frac{x}{2} \cos(2x) - \int \frac{-1}{2} \cos(2x) \, dx = -\frac{x}{2} \cos(2x) + \frac{1}{4} \sin(2x) + C \)

\( b \) \( w = \sin(x^2 + 4x) \) \( dw = \cos(x^2 + 4x) \cdot (2x + 4) \, dx \)

\( \Rightarrow \int_0^3 w \, dw \)

\( \Rightarrow \frac{1}{11} w^{11} \bigg|_0^3 = \frac{1}{11} \sin(32) - \frac{1}{11} \sin(2) \)
5. a) 
\[ F = \text{probability that you've died by year } x \]
\[ = \text{cdf for the prob. density for death at year } x \] 
\[ 1 - \text{prob. that you have died } \beta = \text{prob. that you are alive} \]

b) \( S \) must be a decreasing function: prob. that you are alive at age 90 is smaller than prob. that you are alive at age 80.

Thus \( \frac{dS}{dt} < 0 \). Thus \( \Theta(x) = (-)(+)(-) \) is always nonnegative.

\[ -\frac{1}{S} \cdot \frac{dS}{dt} \]

\( c \) Note that \( S(0) = 1 \), from interpretation in a).

We have \( -\frac{1}{S} \frac{dS}{dt} = 2 \) or \( \frac{dS}{dt} = -2S \) or \( S(t) = A e^{-2t} \).

Also \( S(0) = 1 = A e^{-2(0)} \Rightarrow A = 1. \)

Finally, we want \( S(10) = 1 - e^{-2(10)} \approx 2.06 \times 10^{-9} \) (≈ 0)

6. 95% is two standard deviations (64% is one std. dev.),

so 95% of the population lies within

\[ (14.5, 22.9) \]

\[ \uparrow \uparrow \]

\[ 18.7 - 2 \sigma \quad 18.7 + 2 \sigma \]
7. I - looks like predator/prey model (P = prey; K = predator)
   - so match with D.

II - looks like disease model (P = infected; K = susceptible)
   - so match with C (note that ordinary we plot I vs. S, but they have plotted S vs. I)

III - looks like two populations competing for same resource
   - so shouldn't be able to have large P+K population at same time
   - so don't match with A. Instead, match with B

8. (a) \( \frac{dQ}{dt} = -kQ \) for some \( k > 0 \). (to be determined below)

(b) \( Q(t) = A e^{-kt} \)

\[ \begin{align*}
\text{let } A &= Q(0) = 9 \quad \text{(given)} \\
\text{let } \frac{1}{2} A &= Q(3.8) = 4.5 \quad \text{(given)} \\
\Rightarrow \ln(\frac{1}{2}) &= -k(3.8) \quad \text{or} \quad k = 0.182
\end{align*} \]

\( k = 0.182 \)

Know that \( A = Q(0) = 9 \), so we get \( Q(t) = 9 e^{-0.182 t} \)

(c) \( Q(12) = 9 e^{-0.182 \times 12} = 1.01 \text{ mg} \)
9. Choose level curves $f=1$, $f=3$, $f=-2$ to graph.

\[
\frac{6-y}{x} = 1 \implies y = 6-x \\
\frac{6-y}{x} = 3 \implies y = 6-3x \\
\frac{6-y}{x} = -2 \implies y = 6+2x
\]

10. (a) \[
\mu = \int_0^\infty x \left( \frac{2^4 x^3}{6} \cdot e^{-2x} \right) dx
\]

median = the $T$ satisfying: \[
\frac{1}{2} = \int_0^T \left( \frac{2^4 x^3}{6} \cdot e^{-2x} \right) dx
\]

(b) \[
\begin{array}{c|c|c|c}
\mu/\text{Int} & 10 & 1000 & 10000 \\
\hline
\text{fn Int} & 1.999 & 2 & \\
\end{array}
\]

up to precision of the calculator. \text{ Ans: } 2

median \[
\begin{array}{c|c|c|c|c|c|c}
T & 1 & 2 & 1.5 & 1.8 & 1.85 \\
\hline
\text{fn Int} & .143 & .567 & .353 & .485 & .506 \\
\end{array}
\]

\text{ Ans: } 1.85 \text{ good enough.}

11. Need $\frac{dy}{dx} = 0$ for all $x$. \text{ Ans: } y=0 or $y=4$ or $y=-2$
12. \( C = f(x,y) = 1 \cdot x + 3 \cdot y \)

\[ S = g(x,y) = 6xy^2 = 18 \]

From (1):
\[ \lambda = \frac{1}{6y^2} \]

From (1) and (2):
\[ 3 = \left( \frac{1}{6y^2} \right) 12xy \]

\[ 18y^2 = 12xy \]

\[ \frac{3}{2} y = x \]

From (1), (2), and (3):
\[ 6\left( \frac{3}{2} y \right)^2 = 18 \Rightarrow y^3 = \frac{18}{9} = 2 \Rightarrow y = \sqrt[3]{2} \approx 1.26 \]

From (2):
\[ \frac{3}{2} (1.26) = x = 1.89 \]

To minimize cost:
\[ (x,y) = (1.89, 1.26) \]

\[ \Delta C \approx \lambda \Delta S \] so increasing salt concentration by 1

causes an increase of \( (0.6467)(1) \approx 5 \)
13. Divide into 3 subintervals.

left Riemann gives $1 + 1 + 1 = 3$
right Riemann gives $1 + 1 + 2 = 4$

T started at $v = 0$ and averaged 65 mph => went faster than 65 at some point.

$FV = \int_0^2 200 e^{.03(2-t)} \, dt \approx 412$. [Could have guessed. Even w/o interest, you have$400.]

$Fw = 10(q+3)^9 \, dq$, which appears nowhere in $\int (q+3)^{10} \, dq$.

$F x = x - 5 \quad y = y - 0.1 \quad g(x, y) = 2(x + 5) - (y + 0.1) = 2x + 10 - y - 0.1$

In this case $D = 0$, which is the inconclusive case.

$F f_x = 6x e^{2y} \quad f_y = 6x^2 e^{2y} \quad f_x(1, 0) = 6y \quad f_y(1, 0)

$T x^2 + y^2 = r^2 \quad y = \sqrt{r^2 - x^2} \quad y' = \frac{-x}{\sqrt{r^2 - x^2}} = \frac{-y}{x}

$T dy \approx y' \Delta x. \quad y' @ (x, y) = \boxed{(2, -1)} \quad IS (2)(-1) = -2.

So $y(2.1) \approx y(2) + (2)(.1) = -1 + .2 = -0.8

$F \frac{dy}{dx} @ (6, 1) = -(6)/(1+1) = -3

$T [Poorly Worded: should read "over short time intervals"]$

$\frac{dx}{dt} @ (1, 2) = -3(1) + 1(2) = -1 (x$ decreases $)$

$\frac{dy}{dt} @ (1, 2) = 2(2) - 5(1)(2) = -6 (y$ decreases $)$