Evaluate the integral.

1) $\int x e^{9x} dx$

Use Integration by Parts

$u = x$ $\qquad v = \frac{e^{9x}}{9}$

$du = 1dx$ $\qquad dv = e^{9x} dx$

$$\int u\,dv = uv - \int v\,du$$

$$= x \cdot \frac{e^{9x}}{9} - \int \frac{e^{9x}}{9} dx$$

$$-\frac{1}{9}\int e^{9x} dx$$

$$-\frac{1}{9}\frac{e^{9x}}{9}$$

$$\frac{1}{9} x e^{9x} - \frac{1}{81} e^{9x} + C$$

$$e^{9x}\left(\frac{1}{9}x - \frac{1}{81}\right) + C$$

$$\frac{1}{9} e^{9x}\left(x - \frac{1}{9}\right) + C$$

Use tabular integration to find the antiderivative.

2) $\int (x^2 - 5x)\, e^x \, dx$

A) $\frac{1}{3}x^3e^x - \frac{5}{2}x^2e^x + C$

B) $e^x[x^2 - 7x - 7] + C$

C) $e^x[x^2 - 7x + 7] + C$

D) $e^x[x^2 - 5x + 5] + C$

deriv		anti
x^2-5x	$+$	e^x
$2x-5$	$-$	e^x
2	$+$	e^x
0		e^x

$$e^x(x^2-5x) - e^x(2x-5) + e^x(2) + C$$

$$-(2x-5)$$

$$e^x(x^2-5x-2x+5+2)+c$$

$$e^x(x^2-7x+7)+c$$

Use separation of variables to solve the initial value problem.

3) $y' = 8xy$ and $y = 3$ when $x = 0$

$$dx \cdot \frac{1}{y} \frac{dy}{dx} = 8xy \cdot \frac{1}{y} dx$$

$$\frac{1}{y} dy = 8x\,dx$$

$$\frac{8x^2}{2}$$

$$\ln y = 4x^2 + C \qquad (0,3)$$

$$\ln 3 = 0 + C$$

$$C = \ln 3$$

$$\ln y = 4x^2 + \ln 3$$

$$\log_e y = 4x^2 + \ln 3$$

$$e^{4x^2 + \ln 3} = y$$

$$y = e^{4x^2} \cdot \underbrace{e^{\ln 3}}_{e^{\log_e 3}}$$

$$\boxed{y = 3e^{4x^2}}$$

Find the solution of the differential equation dy/dt = ky, k a constant, that satisfies the given conditions.

4) $y(0) = 1710$, $k = -2.5$ 4)

initial value

$A = Pe^{rt}$

$(0, 1710)$

$y = y_0 e^{kt}$

$k = -2.5$

$$\boxed{y = 1710e^{-2.5t}}$$

$\frac{dy}{dt} = ky$

$\frac{1}{y}\,dy = k\,dt$

Solve the problem.

5) Find the amount of time required for a $19,000 investment to double if the annual interest rate r is 5.2% and interest is compounded continuously. Round your answer to the nearest hundredth of a year.

A) 189.47 years B) 13.33 years C) 202.80 years D) 1.89 years

$A = Pe^{rt}$

$$\frac{38000}{19000} = \frac{19000e^{.052t}}{19000}$$

$2 = e^{.052t}$

$\log_e 2 = .052t$

$$\frac{\ln(2)}{.052} = \frac{.052t}{.052}$$

$t = 13.33$ yrs.

6) A bacterial culture has an initial population of 10,000. If its population declines to 6000 in 6 hours, what will it be at the end of 8 hours? Assume that the population decreases according to the exponential model.

$P = 10000$ $(6, 6000)$ t A

$A = Pe^{rt}$

$\frac{6000}{10000} = \frac{10000e^{r(6)}}{10000}$

$.6 = e^{6r}$

$\frac{\ln(.6)}{6} = \frac{6r}{6}$

$r = -.08513\ldots$

$t = 8$ hrs

$A = Pe^{rt}$

$A = 10000e^{-.085\ldots(8)}$

$A = 5060.59592$

$\boxed{5061 \text{ bact}}$

7) How long will it take a sample of radioactive substance to decay to half of its original amount, if it decays according to the function $A(t) = 350e^{-.102t}$, where t is the time in years? Round your answer to the nearest hundredth year.

$$\frac{175}{350} = \frac{350e^{-.102t}}{350}$$

$$\frac{1}{2} = e^{-.102t}$$

$$\frac{-\ln\frac{1}{2}}{-.102} = \frac{-.102t}{-.102}$$

$t =$

$$t = \frac{\ln 2}{k}$$

$$t = \frac{\ln 2}{.102}$$

$t = 6.7955$

$\boxed{t = 6.80 \text{ yrs}}$

Use Newton's Law of Cooling to solve the problem.

8) A dish of lasagna baked at 350°F is taken out of the oven into a kitchen that is 69°F. After 5 minutes, the temperature of the lasagna is 304.9°F. What will its temperature be 15 minutes after it was taken out of the oven? Round your answer to the nearest degree.