Adam B., Will R., Thomas S.
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#1. $\frac{dy}{dx} = \frac{y}{x}$

$\int \frac{dy}{y} = \int \frac{dx}{x}$

$\ln|y| = \ln|x| + C$

$y = \pm e^{\ln|x| + C}$

$y = \pm e^{\ln|x|} e^{C}$

$y = \pm x e^{C}$

#3 $(x^2+1)y' = xy$

$(x^2+1)\frac{dy}{dx} = xy$

$\int \frac{dy}{y} = \int \frac{x\,dx}{(x^2+1)}$ $\quad u = x^2+1 \quad du = 2x\,dx$

$\frac{du}{2} = x\,dx$

$\ln|y| = \frac{1}{2}\int \frac{du}{u}$

$\ln|y| = \frac{1}{2}\ln|u|$

$\ln|y| = \frac{1}{2}\ln|x^2+1| + C$

$y = \pm e^{\frac{1}{2}\ln|x^2+1| + C}$

$y = \pm e^{C} e^{\frac{1}{2}\ln|x^2+1|}$

$y = \pm e^{C}\sqrt{x^2+1}$

#11. $\frac{dy}{dx} = y^2 + 1, \quad y(1) = 0$

$\int \frac{dy}{(y^2+1)} = \int dx$

$\tan^{-1} y = x + C$

$\tan^{-1}(0) = 1 + C$

$0 = 1 + C$

$C = -1$

$\tan^{-1} y = x - 1$

$y = \tan(x - 1)$

#13. $x\cos x = (2y + e^{3y})y', \quad y(0) = 0$

$x\cos x = (2y + e^{3x})\frac{dy}{dx}$

$\int x\cos x\, dx = \int (2y + e^{3y})\, dy$

$u = x \qquad v = \sin x$

$du = 1\, dx \qquad dv = \cos x\, dx$

$\int x\cos x\, dx = x\sin x - \int \sin x\, dx$

$= x\sin x + \cos x$

$x\sin x + \cos x = y^2 + \frac{1}{3}e^{3y} + C$

$0\sin(0) + \cos(0) = 0^2 + \frac{1}{3}e^0 + C$

$1 = \frac{1}{3} + C$

$C = \frac{2}{3}$

$x\sin x + \cos x - \frac{2}{3} = y^2 + \frac{1}{3}e^{3y}$

Group Work 2-17

Separation of Variables

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(1) $\frac{dy}{dx} = \frac{y}{x}$

$\frac{dy}{y} = \frac{dx}{x}$

$\int \frac{dy}{y} = \int \frac{dx}{x}$

$\ln|y| = \ln|x| + c$

$e^{\ln|y|} = \pm e^{\ln|x|+c}$

$y = x \cdot e^{c}$

$y = kx$

(3) $(x^2+1)\frac{dy}{dx} = xy$

$\frac{dy}{y} = \frac{x}{x^2+1}\,dx$

$\int \frac{dy}{y} = \int \frac{x}{x^2+1}\,dx$

$u = x^2+1$

$du = 2x\,dx$

$\ln|y| = \frac{1}{2}\int \frac{du}{u}$

$\ln|y| = \frac{1}{2}\ln|u| + c$

$\ln|y| = \frac{1}{2}\ln|x^2+1| + c$

$y = k\sqrt{x^2+1}$

(11) $\frac{dy}{dx} = y^2+1, \quad y(1)=0$

$\frac{dy}{y^2+1} = dx$

$\int \frac{dy}{y^2+1} = \int dx$

$\tan^{-1} y = x + c \qquad y = \tan(x+c)$

$\tan^{-1} 0 = 1 + c$

$0 = 1 + c$

$c = -1$

$\boxed{y = \tan(x-1)}$

(13) $x \cos x = (2y + e^{3y}) \frac{dy}{dx}, \quad y(0)=0$