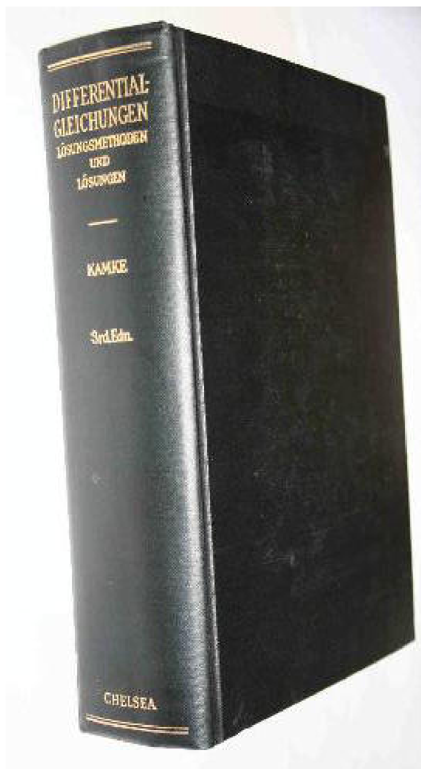
A Solution Manual For

Differential Gleichungen, Kamke, 3rd ed, Abel ODEs



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Contents

1 Abel ODE's with constant invariant

1.1 problem problem 38

Internal problem ID [4675]

Book: Differential Gleichungen, Kamke, 3rd ed, Abel ODEs
Section: Abel ODE's with constant invariant
Problem number: problem 38.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _rational, _Abel]`

$$\boxed{-a y^{3}+y^{\prime}=\frac{b}{x^{\frac{3}{2}}}}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 34

```
dsolve(-a*y(x)^3-b/(x^(3/2))+diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x)=\frac{\operatorname{RootOf}\left(-\ln (x)+c_{1}+2\left(\int^{\_Z} \frac{1}{2 a\_a^{3}+\_a+2 b} d\_a\right)\right)}{\sqrt{x}}$$

✓ Solution by Mathematica

Time used: 0.332 (sec). Leaf size: 320

```
DSolve[-a*y[x]^3-b/(x^(3/2))+y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[\frac{2}{3}ab^2\text{RootSum}\left[8\#1^9ab^2+24\#1^6ab^2+24\#1^3ab^2+\#1^3\right.\right.$$

$$+8ab^2\&,\frac{4\#1^6\log\left(y(x)\sqrt[3]{\frac{ax^{3/2}}{b}}-\#1\right)+2\#1^4\sqrt[3]{-\frac{1}{ab^2}}\log\left(y(x)\sqrt[3]{\frac{ax^{3/2}}{b}}-\#1\right)+8\#1^3\log\left(y(x)\sqrt[3]{\frac{a}{}}\right.}{24\#1^8}$$

$$\left.+c_1,y(x)\right]$$

1.2 problem problem 41

Internal problem ID [4676]

Book: Differential Gleichungen, Kamke, 3rd ed, Abel ODEs
Section: Abel ODE's with constant invariant
Problem number: problem 41.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _Abel]`

$$\boxed{axy^3 + by^2 + y' = 0}$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 103

```
dsolve(a*x*y(x)^3+b*y(x)^2+diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{e^{\operatorname{RootOf}\left(2\sqrt{b^2+4a}\, b \operatorname{arctanh}\left(\frac{2a\,e^{\_Z}+b}{\sqrt{b^2+4a}}\right) - \ln\left(x^2\left(a\,e^{2\_Z}+b\,e^{\_Z}-1\right)\right)b^2+2c_1b^2+2\_Zb^2-4\ln\left(x^2\left(a\,e^{2\_Z}+b\,e^{\_Z}-1\right)\right)a+8c_1a+8\_Za\right)}}{x}$$

✓ Solution by Mathematica

Time used: 0.192 (sec). Leaf size: 103

```
DSolve[a*x*y[x]^3+b*y[x]^2+y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[-\frac{b^2\left(\frac{2\arctan\left(\frac{-2axy(x)-b}{b\sqrt{-\frac{4a}{b^2}-1}}\right)}{\sqrt{-\frac{4a}{b^2}-1}} - \log\left(\frac{a(-x)y(x)(-axy(x)-b)-a}{a^2x^2y(x)^2}\right)\right)}{2a} = -\frac{b^2\log(x)}{a}+c_1, y(x)\right]$$

1.3 problem problem 46

Internal problem ID [4677]

Book: Differential Gleichungen, Kamke, 3rd ed, Abel ODEs
Section: Abel ODE's with constant invariant
Problem number: problem 46.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_Abel]`

$$y' - x^a y^3 + 3y^2 - x^{-a} y = x^{-2a} - a\, x^{-a-1}$$

✓ Solution by Maple
Time used: 0.015 (sec). Leaf size: 2084

```
dsolve(diff(y(x),x)-x^a*y(x)^3+3*y(x)^2-x^(-a)*y(x)-x^(-2*a)+a*x^(-a-1) = 0,y(x), singsol=al
```

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Expression too large to display

✓ Solution by Mathematica
Time used: 13.424 (sec). Leaf size: 231

```
DSolve[y'[x]-x^a*y[x]^3+3*y[x]^2-x^(-a)*y[x]-x^(-2*a)+a*x^(-a-1) == 0,y[x],x,IncludeSingular
```

$$y(x) \to x^{-a} - \frac{e^{\frac{2x^{1-a}}{a-1}}}{\sqrt{-\frac{2^{\frac{3a+1}{a-1}} x^{a+1} \left(\frac{x^{1-a}}{1-a}\right)^{\frac{a+1}{a-1}} \Gamma\left(\frac{a+1}{1-a}, -\frac{4x^{1-a}}{a-1}\right)}{a-1} + c_1}}$$
$$y(x) \to x^{-a} + \frac{e^{\frac{2x^{1-a}}{a-1}}}{\sqrt{-\frac{2^{\frac{3a+1}{a-1}} x^{a+1} \left(\frac{x^{1-a}}{1-a}\right)^{\frac{a+1}{a-1}} \Gamma\left(\frac{a+1}{1-a}, -\frac{4x^{1-a}}{a-1}\right)}{a-1} + c_1}}$$
$$y(x) \to x^{-a}$$

1.4 problem problem 51

Internal problem ID [4678]

Book: Differential Gleichungen, Kamke, 3rd ed, Abel ODEs
Section: Abel ODE's with constant invariant
Problem number: problem 51.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_Abel]`

$$y' - (y - f(x))\,(y - g(x))\left(y - \frac{f(x)\,a + bg(x)}{a+b}\right)h(x) - \frac{f'(x)\,(y - g(x))}{f\,(x) - g\,(x)} - \frac{g'(x)\,(y - f(x))}{g\,(x) - f\,(x)} = 0$$

✓ Solution by Maple

Time used: 0.156 (sec). Leaf size: 648

```
dsolve(diff(y(x),x)-(y(x)-f(x))*(y(x)-g(x))*(y(x)-(a*f(x)+b*g(x))/(a+b))*h(x)-diff(f(x),x)*(
```

$$y(x) = \frac{(f(x) - g(x))\,(a + 2b)\,\mathrm{e}^{\mathrm{RootOf}\left(-\_Z a^4 - b^4 \ln\left(\frac{9a^3+18a^2b+18a\,b^2+9b^3+a\,\mathrm{e}^{-\_Z}+2b\,\mathrm{e}^{-\_Z}}{2a+b}\right) + \ln\left(\frac{9a^2b+9a\,b^2+9b^3+a\,\mathrm{e}^{-\_Z}+2b\,\mathrm{e}^{-\_Z}}{a-b}\right)a^4 + \ln\left(\right.}}{}$$

✓ Solution by Mathematica

Time used: 1.124 (sec). Leaf size: 355

```
DSolve[y'[x]-(y[x]-f[x])*(y[x]-g[x])*(y[x]-(a*f[x]+b*g[x])/(a+b))*h[x]-f'[x]*(y[x]-g[x])/(f[
```

$$\text{Solve}\left[-\frac{1}{3}(a\right.$$

$$-b)^{2/3}(2a+b)^{2/3}(a+2b)^{2/3}\text{RootSum}\left[\#1^3(a-b)^{2/3}(2a+b)^{2/3}(a+2b)^{2/3}-3\#1a^2-3\#1ab-3\#1b^2+(a-b)^{2/\right.$$

1.5 problem problem 146

Internal problem ID [4679]

Book: Differential Gleichungen, Kamke, 3rd ed, Abel ODEs
Section: Abel ODE's with constant invariant
Problem number: problem 146.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational, _Abel]`

$$\boxed{x^2 y' + y^3 x + y^2 a = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 65

```
dsolve(x^2*diff(y(x),x)+x*y(x)^3+a*y(x)^2 = 0,y(x), singsol=all)
```

$$c_1 + \mathrm{e}^{-\frac{((a+x)y(x)+x)((a-x)y(x)+x)}{2y(x)^2 x^2}} x + \frac{\operatorname{erf}\left(\frac{\sqrt{2}\,(ay(x)+x)}{2y(x)x}\right)\sqrt{2}\,\sqrt{\pi}\,a\,\mathrm{e}^{\frac{1}{2}}}{2} = 0$$

✓ Solution by Mathematica

Time used: 0.61 (sec). Leaf size: 78

```
DSolve[x^2*y'[x]+x*y[x]^3+a*y[x]^2 == 0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[-\frac{ia}{x} = \frac{2e^{\frac{1}{2}\left(-\frac{ia}{x}-\frac{i}{y(x)}\right)^2}}{\sqrt{2\pi}\text{erfi}\left(\frac{-\frac{ia}{x}-\frac{i}{y(x)}}{\sqrt{2}}\right)+2c_1}, y(x)\right]$$

1.6 problem problem 169

Internal problem ID [4680]

Book: Differential Gleichungen, Kamke, 3rd ed, Abel ODEs
Section: Abel ODE's with constant invariant
Problem number: problem 169.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational, _Abel]`

$$(ax+b)^2 y' + (ax+b) y^3 + cy^2 = 0$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 126

```
dsolve((a*x+b)^2*diff(y(x),x)+(a*x+b)*y(x)^3+c*y(x)^2 = 0,y(x), singsol=all)
```

$$\frac{\left(\sqrt{a}\,b+a^{\frac{3}{2}}x\right)\mathrm{e}^{-\frac{((ax+b+c)y(x)+a(ax+b))((-ax-b+c)y(x)+a(ax+b))}{2y(x)^2(ax+b)^2a}}+\frac{c\sqrt{2}\,\sqrt{\pi}\,\mathrm{e}^{\frac{1}{2a}}\,\mathrm{erf}\left(\frac{(cy(x)+a(ax+b))\sqrt{2}}{2\sqrt{a}\,y(x)(ax+b)}\right)}{2}+c_1a^{\frac{3}{2}}}{a^{\frac{3}{2}}}$$
$$= 0$$

✓ Solution by Mathematica

Time used: 1.43 (sec). Leaf size: 149

```
DSolve[(a*x+b)^2*y'[x]+(a*x+b)*y[x]^3+c*y[x]^2 == 0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[-\frac{c}{\sqrt{-a(ax+b)^2}}=\frac{2\exp\left(\frac{1}{2}\left(-\frac{c}{\sqrt{-a(ax+b)^2}}-\frac{\left(-a(ax+b)^2\right)^{3/2}}{ay(x)(ax+b)^3}\right)^2\right)}{\sqrt{2\pi}\text{erfi}\left(\frac{-\frac{c}{\sqrt{-a(ax+b)^2}}-\frac{\left(-a(ax+b)^2\right)^{3/2}}{ay(x)(ax+b)^3}}{\sqrt{2}}\right)+2c_1},y(x)\right]$$