```
(%i1)  kill(all);
(%o0)  done
```

1 Eq. (19)

```
(%i1)  E1: diff(W(x),x)=sqrt(2*m*alpha_x);
```

$$(\%o1)\quad \frac{\mathrm{d}}{\mathrm{d}\,x}\,W(x)=\sqrt{2}\,\sqrt{\alpha_x\,m}$$

```
(%i2)  ode2(E1,W(x),x);
```

$$(\%o2)\quad W(x)=\sqrt{2}\,\sqrt{\alpha_x\,m}\,x+\%c$$

```
(%i3)  E2: diff(W(x),x)=-sqrt(2*m*alpha_x);
```

$$(\%o3)\quad \frac{\mathrm{d}}{\mathrm{d}\,x}\,W(x)=-\sqrt{2}\,\sqrt{\alpha_x\,m}$$

```
(%i4)  E3: ode2(E1,W(x),x);
```

$$(\%o4)\quad W(x)=\sqrt{2}\,\sqrt{\alpha_x\,m}\,x+\%c$$

2 Eq. (20)

```
(%i5)  E4: 1/(2*m)*diff(W(z),z)^2+m*g*z=alpha_z;
```

$$(\%o5)\quad \frac{\left(\frac{\mathrm{d}}{\mathrm{d}\,z}\,W(z)\right)^2}{2\,m}+g\,m\,z=\alpha_z$$

```
(%i6)  ode2(E4,W(z),z);
```

$$(\%t6)\quad \frac{\left(\frac{\mathrm{d}}{\mathrm{d}\,z}\,W(z)\right)^2}{2\,m}+g\,m\,z=\alpha_z$$

```
first order equation not linear in y'
(%o6)  false
```

```
(%i7)  E5: 1/(2*m)*diff(W(z),z)^2+m*g*z = alpha_z;
```

$$(\%o7)\quad \frac{\left(\frac{\mathrm{d}}{\mathrm{d}\,z}\,W(z)\right)^2}{2\,m}+g\,m\,z=\alpha_z$$

```
(%i8)  E6: solve(E5, diff(W(z),z));
```

$$(\%o8)\quad \left[\frac{d}{dz}W(z)=-\sqrt{2}\sqrt{\alpha_z m-g m^2 z},\ \frac{d}{dz}W(z)=\sqrt{2}\sqrt{\alpha_z m-g m^2 z}\right]$$

```
(%i9)  E7: diff(W(z),z)=sqrt(2*m*(-m*g*z+alpha_z));
```

$$(\%o9)\quad \frac{d}{dz}W(z)=\sqrt{2}\sqrt{m\left(\alpha_z-g m z\right)}$$

```
(%i10)  E8: ode2(E7,W(z),z);
```

$$(\%o10)\quad W(z)=\%c-\frac{2^{3/2}\left(\alpha_z m-g m^2 z\right)^{3/2}}{3 g m^2}$$

```
(%i11)  E9: diff(W(z),z)=-sqrt(2*m*(-m*g*z+alpha_z));
```

$$(\%o11)\quad \frac{d}{dz}W(z)=-\sqrt{2}\sqrt{m\left(\alpha_z-g m z\right)}$$

```
(%i12)  E10: ode2(E9,W(z),z);
```

$$(\%o12)\quad W(z)=\frac{2^{3/2}\left(\alpha_z m-g m^2 z\right)^{3/2}}{3 g m^2}+\%c$$

3 Eqs.(21,22)

```
(%i13)  S: W(x)+W(z)-E*t;
```

$$(\%o13)\quad W(z)+W(x)-E t$$

Insert solutions

```
(%i14)  S: rhs(E3)+rhs(E10) -2*%c - E*t;
```

$$(\%o14)\quad \frac{2^{3/2}\left(\alpha_z m-g m^2 z\right)^{3/2}}{3 g m^2}+\sqrt{2}\sqrt{\alpha_x m}\,x-E t$$

```
(%i15)  E11: beta_x = diff(S,alpha_x)+diff(S,E);
```

$$(\%o15)\quad beta_x=\frac{m x}{\sqrt{2}\sqrt{\alpha_x m}}-t$$

(%i16) `E12: beta_z = diff(S,alpha_z)+diff(S,E);`

(%o16) $$beta_z = \frac{\sqrt{2}\,\sqrt{\alpha_z\, m - g\, m^2\, z}}{g\, m} - t$$

4 Eq.(23,24)

(%i23) `expand(solve(E11, x));`

(%o23) $$[x = \frac{\sqrt{2}\,\sqrt{\alpha_x\, m}\, t}{m} + \frac{\sqrt{2}\, beta_x\, \sqrt{\alpha_x\, m}}{m}]$$

(%i22) `expand(solve(E12, z));`

Is $g\, m \left(t + beta_z\right)$ positive, negative or zero? `p;`

(%o22) $$[z = -\frac{g\, t^2}{2} - beta_z\, g\, t + \frac{\alpha_z}{g\, m} - \frac{beta_z^2\, g}{2}]$$