Problem 3

In[330]:=
```
Clear["Global`*"]
```

In[331]:=
```
eqs = {
    n == m1 g Cos[θ],
    m1 a == m1 g Sin[θ] - tension,
    tension == 1/2 m2 a};
```

In[332]:=
```
Solve[eqs, {n, a, tension}]
```

Out[332]= $\left\{\left\{n \to g\ m1\ Cos[\theta],\ a \to \frac{2\ g\ m1\ Sin[\theta]}{2\ m1 + m2},\ tension \to \frac{g\ m1\ m2\ Sin[\theta]}{2\ m1 + m2}\right\}\right\}$

Problem 5

In[333]:=
```
Clear["Global`*"]
```

In[334]:=
```
PlanetData[]
```

Out[334]= {Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune}

In[335]:=
```
values = {
   massEarth -> PlanetData["Earth", "Mass"],
   radiusEarth -> UnitConvert[PlanetData["Earth", "Radius"], "SI"],
   gSurface -> UnitConvert[PlanetData["Earth", "Gravity"], "SI"],
   newtonG -> Quantity["G"]
  }
```

Out[335]= $\{massEarth \to 5.97 \times 10^{24}\ kg,$ $radiusEarth \to 6371.009\ km,\ gSurface \to 9.80\ m/s^2,\ newtonG \to 1\ G\}$

In[336]:=
```
eq1 = m1 g == (newtonG massEarth m1)/r^2;
solg = Solve[eq1, g][[1]]
```

Out[337]= $\left\{g \to \frac{massEarth\ newtonG}{r^2}\right\}$

In[338]:=
```
grav[r_] = g /. solg /. values
```

Out[338]= $\frac{5.97 \times 10^{24}\ kg\ G}{r^2}$

Compute from surface of Earth

In[339]:=
```
radiusEarth /. values
```
Out[339]= 6371.009 km

In[340]:=
```
earthG = grav[radiusEarth] /. values // UnitConvert
```
Out[340]= $9.82\ \text{m/s}^2$

Compute from surface of Earth + 100 Miles

In[341]:=
```
grav[radiusEarth + Quantity[100 , "Miles"]] /. values // UnitConvert
```
Out[341]= $9.34\ \text{m/s}^2$

In[342]:=
```
% / earthG
```
Out[342]= 0.951

Compute from moon

In[343]:=
```
PlanetaryMoonData ["Moon", "AverageOrbitDistance "]
```
Out[343]= 0.002573 au

In[344]:=
```
radius = PlanetaryMoonData ["Moon", "AverageOrbitDistance "];
grav[radius /. values ] // UnitConvert
```
Out[345]= $0.00269\ \text{m/s}^2$

In[346]:=
```
% / earthG
```
Out[346]= 0.000274

Assume g=9.8, compute time to fall from moon:

In[347]:= solT = Solve$\left[x == \frac{1}{2} a\, t^2, t\right]$[[2]]

Out[347]= $\left\{t \to \frac{\sqrt{2}\ \sqrt{x}}{\sqrt{a}}\right\}$

In[348]:=
```
time1 =
  t /. solT /. {x -> PlanetaryMoonData ["Moon", "AverageOrbitDistance "], a → earthG}
```
Out[348]= 8.85×10^3 s

In[349]:=
```
UnitConvert[time1, "Hours"]
```
Out[349]= 2.460 h

In[350]:=
```
UnitConvert[time1, "Days"]
```
Out[350]= 0.1025 days

Assume g= $\frac{\text{massEarth newtonG}}{r^2}$, compute time to fall from moon:

In[351]:=
```
eq1 = m1 g - m1 r''[t] /. {g → massEarth newtonG / r[t]^2}
```
Out[351]= $\frac{\text{m1 massEarth newtonG}}{r[t]^2} - \text{m1}\, r''[t]$

In[352]:=
```
eq2 = eq1/m1 r[t]^2 // Simplify
```
Out[352]= $\text{massEarth newtonG} - r[t]^2\, r''[t]$

In[353]:=
```
eq2[[1]]
```
Out[353]= massEarth newtonG

In[354]:=
```
eq2[[2]]
```
Out[354]= $-r[t]^2\, r''[t]$

In[355]:=
```
rhs = Integrate[-r[t], {r[t], 0, r0}, {r[t], r0, 0}]
```
Out[355]= $\frac{r0^3}{2}$

In[356]:=
```
lhs = Integrate[eq2[[1]], {t, 0, t}, {t, 0, t}]
```
Out[356]= $\frac{1}{2}\,\text{massEarth newtonG}\, t^2$

In[357]:=
```
solt = Solve[lhs == rhs, t][[2]]
```
Out[357]= $\left\{t \to \frac{r0^{3/2}}{\sqrt{\text{massEarth}}\,\sqrt{\text{newtonG}}}\right\}$

In[358]:=
```
moonRadius = PlanetaryMoonData["Moon", "AverageOrbitDistance "]
```
Out[358]= 0.002573 au

In[359]:=
```
time2 = t /. solt /. r0 → moonRadius /. values // UnitConvert
```
Out[359]= 3.78×10^5 s

In[360]:=
```
UnitConvert[time2, "Hours"]
```
Out[360]=
```
105.1 h
```

In[361]:=
```
UnitConvert[time2, "Days"]
```
Out[361]=
```
4.38 days
```