

In[1]:=

```
Print["\nFunctions dmp[] and prt0[]are equivalent Print[] statements"];
```

Functions dmp[] and prt0[]are equivalent Print[] statements

In[2]:= **R1 = 0.795 * 10⁻³; (* 1 is sphere *)**

```
R2 = Infinity; (* 2 is flat *)
```

In[4]:= **R = radius = (1/R1 + 1/R2)⁻¹; (* Equivalent radius *)**

```
dmp[{R1, R2, R}];
```

```
-----: R1 = 0.000795
```

```
-----: R2 = ∞
```

```
-----: R = 0.000795
```

In[6]:=

```

nu1 = 0.22; C1 = 1.295 * Exp[0.736 * nu1]; (* WC indenter - ball *)
nu2 = 0.30; C2 = 1.295 * Exp[0.736 * nu2]; (* Pure nickel - flat *)

E1 = 475 * 10^9;
E2 = 160 * 10^9;

EE = ((1 - nu1^2) / E1 + (1 - nu2^2) / E2)^(-1); (* equivalent E *)
dmp[EE];

Print["\nHardness is NEVER used in the JG model!\n"];
Sy1 = 1. * 10^20; (* WC is a ceramic ;
make Sy1 huge so it won't be in effect/used anyway *)
Sy2 = 159. * 10^6; (* pure nickel in paper by Dr. *)

dmp[{nu1, nu2, C1, C2, Sy1, Sy2, C1 * Sy1, C2 * Sy2}];
CSy = Min[C1 * Sy1, C2 * Sy2]; dmp[CSy];
If[C1 * Sy1 < C2 * Sy2, CC = C1; Sy = Sy1, CC = C2; Sy = Sy2];
dmp[{CC, Sy, CC * Sy}];

(* JG model *)
omegac = wc = (Pi * CSy / (2 * EE))^2 * R;
Pc = (4 / 3) * (R / EE)^2 * (Pi * CSy / 2)^3;
dmp[wcjg = omegac];
dmp[Pcjg = Pc];

```

```
-----: EE =  $1.30024 \times 10^{11}$ 
```

Hardness is NEVER used in the JG model!

```
-----: nu1 = 0.22
```

```
-----: nu2 = 0.3
```

```
-----: C1 = 1.52262
```

```
-----: C2 = 1.61496
```

```
-----: Sy1 =  $1. \times 10^{20}$ 
```

```
-----: Sy2 =  $1.59 \times 10^8$ 
```

```
-----: C1*Sy1 =  $1.52262 \times 10^{20}$ 
```

```
-----: C2*Sy2 =  $2.56779 \times 10^8$ 
```

```
-----: CSy =  $2.56779 \times 10^8$ 
```

```
-----: CC = 1.61496
```

```
-----: Sy =  $1.59 \times 10^8$ 
```

```
-----: CC*Sy =  $2.56779 \times 10^8$ 
```

```
-----: wcjg = omegac =  $7.65025 \times 10^{-9}$ 
```

```
-----: Pcjg = Pc = 0.00327085
```

In[23]:=

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In[24]:= (*JG model - force vs. disp. *)
wstar = w / wcjg;
PF1jg = wstar^(3/2);
dmp[PF1jg]; (* Hertzian solution - it stretches accurately to wstar=1.9 *)

ey = Sy / EE;
B = 0.14 * Exp[23 * ey]; dmp[B];
aoR = 0.5 * Pi * CC * ey * Sqrt[wstar * (wstar / 1.9)^B]; dmp[aoR];

HGSyorg = 2.84 * (1 - Exp[-0.82 * aoR^(-0.7)]);
dmp[HGSyorg]; (* original paper by JG *)
HGSy = 2.84 - 0.92 * (1 - Cos[Pi * aoR]); dmp[HGSy]; (* newer expression,
from COR paper to handle extreme deformation and palstcity *)

orgHGSy = 0 * 1; (* use 0 to apply newer value;
use 1 to apply the original orger expression;
BOTH are very close anyways in up to moderate wstar*)
If[orgHGSy == 1, HGSy = HGSyorg];

wmax = N[25 * 10^(-6) * 1]; dmp[wmax]; (* maximum wstar *)

Print["\nHG/Sy"]
Plot[{HGSy, HGSyorg}, {w, 0, wmax}, GridLines -> Automatic,
PlotLegends -> {"HG/Sy newer", "HG/Sy original "}]

PF2jg = Exp[-0.25 * wstar^(5/12)] * wstar^(3/2) +
(4 * HGSy / CC) * (1 - Exp[-wstar^(5/9) / 25]) * wstar; dmp[PF2jg];

pfjg = Pcjg * Which[w < 1.9 * wcjg, PF1jg,
w >= 1.9 * wcjg, PF2jg];

dmp[pfjg];
dmp[Pcjg * PF1jg /. w -> wcjg]
dmp[Pcjg * PF2jg /. w -> wmax]

ww = Table[w, {w, 0, wmax, wmax/100}] * 1. * 10^6;
ffjg = Table[pfjg, {w, 0, wmax, wmax/100}];
dmp[{Min[ww], Max[ww], Min[ffjg], Max[ffjg]}];

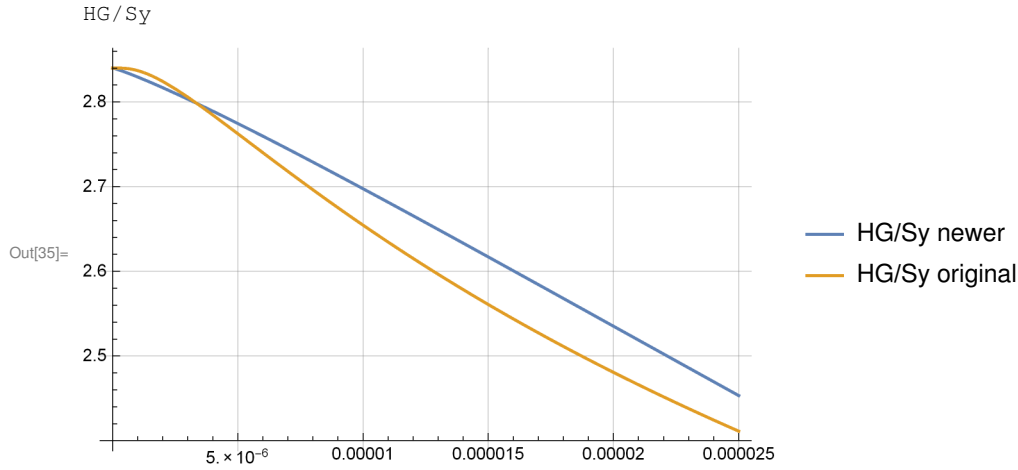
dmp[wmax / wcjg]

Print["\na/R"]
Plot[aoR, {w, 0, wmax}, GridLines -> Automatic]

```

```

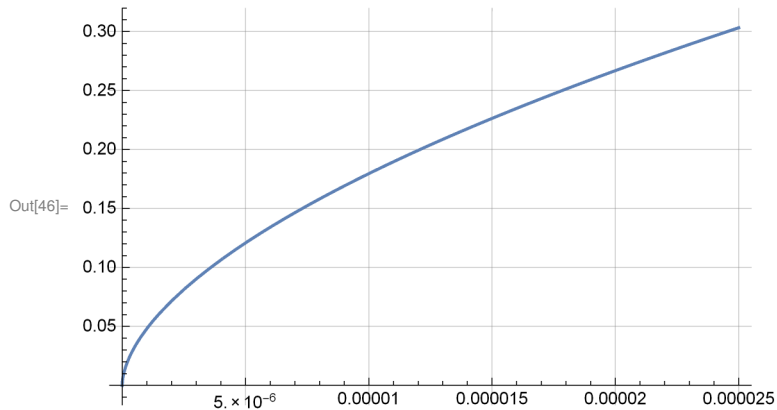
-----: PF1jg = 1.49447 × 1012 w3/2
-----: B = 0.143993
-----: aoR = 130.046 √w1.14399
-----: HGSyorg = 2.84 (1 - e- $\frac{0.0271611}{(w^{1.14399})^{0.35}}$ )
-----: HGSy = 2.84 - 0.92 (1 - Cos[408.551 √w1.14399])
-----: wmax = 0.000025
    
```



```

-----: PF2jg = 1.49447 × 1012 e-602.201 w5/12 w3/2 +
      3.23759 × 108 (1 - e-1291.6 w5/9) w (2.84 - 0.92 (1 - Cos[408.551 √w1.14399]))
-----: pfjg = 0.00327085 Which[w < 1.45355 × 10-8, PF1jg, w ≥ 1.9 wcjg, PF2jg]
-----: Pcjg*PF1jg /. w -> wcjg = 0.00327085
-----: Pcjg*PF2jg /. w -> wmax = 63.5659
-----: Min[ww] = 0.
-----: Max[ww] = 25.
-----: Min[ffjg] = 0.
-----: Max[ffjg] = 63.5659
-----: wmax/wcjg = 3267.87
    
```

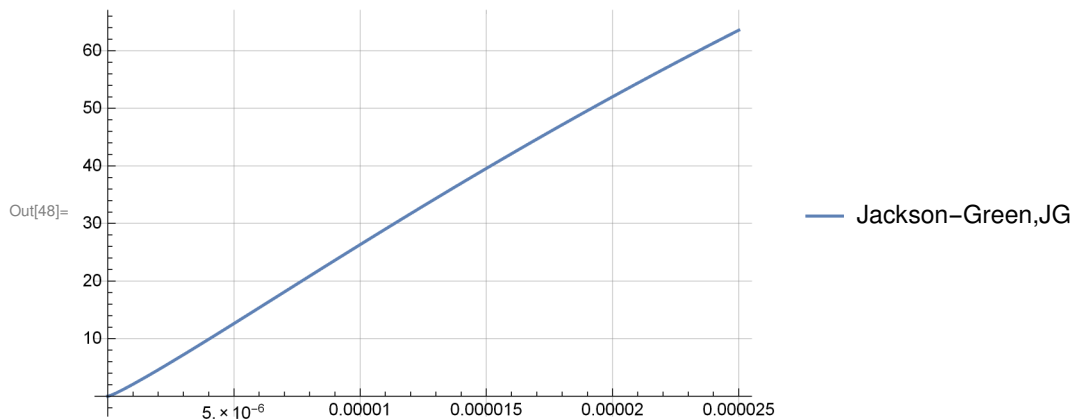
a/R



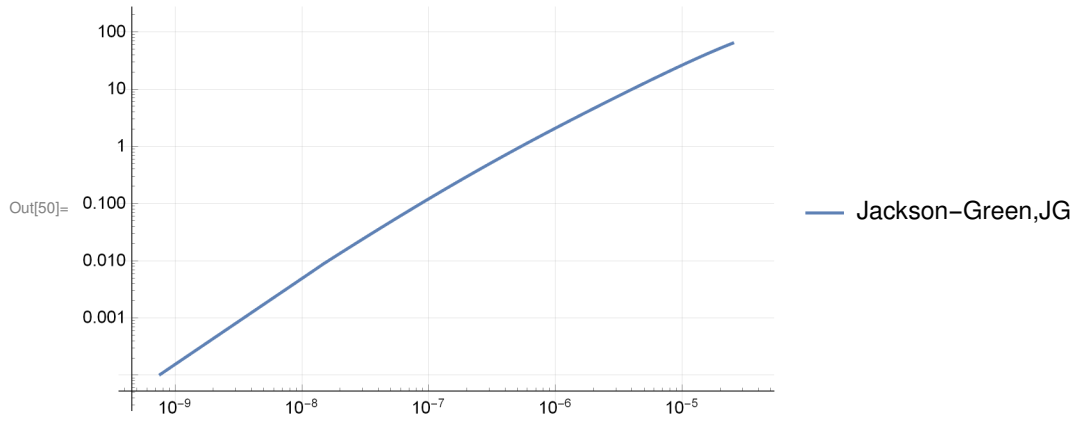
In[47]:=

```
Print["\nForce vs. disp.: Linear-Linear"]
Plot[{pfjg}, {w, 0, wmax},
  GridLines -> Automatic, PlotLegends -> {"Jackson-Green,JG"}]
Print["\nForce vs. disp.: Log-Log"]
LogLogPlot[{pfjg}, {w, wcjg/10.0, wmax},
  GridLines -> Automatic, PlotLegends -> {"Jackson-Green,JG"}]
Print["\nForce vs. disp.: Linear-Log"]
LogPlot[{pfjg}, {w, 0, wmax},
  GridLines -> Automatic, PlotLegends -> {"Jackson-Green,JG"}]
Print["\nForce vs. disp.: Log-Linear"]
LogLinearPlot[{pfjg}, {w, wcjg/10.0, wmax},
  GridLines -> Automatic, PlotLegends -> {"Jackson-Green,JG"}]
```

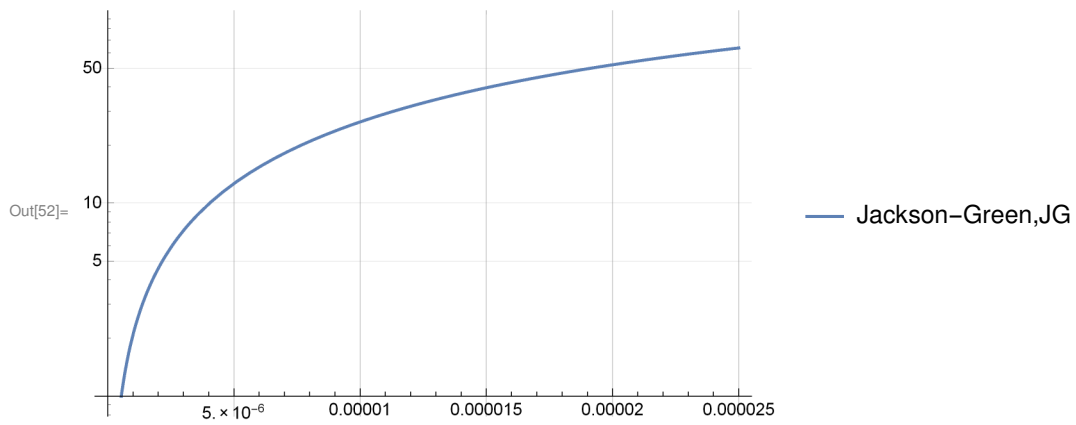
Force vs. disp.: Linear-Linear



Force vs. disp.: Log-Log



Force vs. disp.: Linear-Log



Force vs. disp.: Log-Linear

