Compare the gravitational field strength on the surface of the following planets.

a) Planet A vs. Planet B
- mass is 3× greater
- radius is the same

b) Planet X vs. Planet Y
- mass is the same
- radius is 4× greater

c) Planet M vs. Planet N
- mass is half as great
- radius is 2× greater

d) Planet α vs. Planet β
- mass is 1/3 as great
- radius is half as great

How far above the surface of Earth do you have to travel in order to be half your weight on Earth?

Compare the gravitational field strength on the surface of the following planets.

a) Planet A vs. Planet B
- mass is 3× greater
- radius is the same

$g \propto M$ IF $M \uparrow 3$, $g \uparrow 3$

g ON B IS 3× GREATER

b) Planet X vs. Planet Y
- mass is the same
- radius is 4× greater

$g \propto \frac{1}{r^2}$ IF $r \uparrow 4$, $g \downarrow 16$

g ON Y IS $\frac{1}{16}$ AS GREAT

c) Planet M vs. Planet N
- mass is half as great
- radius is 2× greater

$g \propto M$ IF $M \downarrow 2$, $g \downarrow 2$

$g \propto \frac{1}{r^2}$ IF $r \uparrow 2$, $g \downarrow 4$

g ON N IS $\frac{1}{8}$ AS GREAT

d) Planet α vs. Planet β
- mass is 1/3 as great
- radius is half as great

$g \propto M$ IF $M \downarrow 3$, $g \downarrow 3$

$g \propto \frac{1}{r^2}$ IF $r \downarrow 2$, $g \uparrow 4$

g ON β IS $\frac{4}{3}$× GREATER

How far above the surface of Earth do you have to travel in order to be half your weight on Earth?

ON EARTH:

$$F_{g0} = G\frac{Mm}{r_E^2}$$

ABOVE EARTH, AT HALF WEIGHT:

$$\frac{1}{2}F_{g0} = G\frac{Mm}{r^2}$$

$$\frac{1}{2}G\frac{Mm}{r_E^2} = G\frac{Mm}{r^2}$$

$$\frac{1}{2r_E^2} = \frac{1}{r^2}$$

$$2r_E^2 = r^2$$

$$r = \sqrt{2}\,r_E$$

$$h = r - r_E$$
$$= \sqrt{2}\,r_E - r_E$$
$$= (\sqrt{2}-1)\,r_E$$
$$= \boxed{2.64\times10^6\ \text{m}}$$

ALTERNATIVE METHOD:

$$F_g \propto \frac{1}{r^2} \rightarrow r \propto \frac{1}{\sqrt{F_g}}$$

IF $F_g \downarrow 2$, $r \uparrow \sqrt{2}$

$$r = \sqrt{2}\,r_E$$

$$h = r - r_E$$
$$= \sqrt{2}\,r_E - r_E$$
$$= (\sqrt{2}-1)\,r_E$$
$$= \boxed{2.64\times10^6\ \text{m}}$$