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

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

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

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

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

- mass is 3x greater
- radius is the same

g ON B IS 3× GREATER

b) Planet X vs. Planet Y

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

- mass is the same
- radius is 4x greater

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

c) Planet M vs. Planet N

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

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

- mass is half as great
- radius is 2x greater

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

d) Planet α vs. Planet β

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

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

- mass is 1/3 as great
- radius is half as great

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:

$$F_{g_0} = G\frac{Mm}{r_E^2}$$

ABOVE EARTH, AT HALF WEIGHT:

$$\frac{1}{2}F_{g_0} = G\frac{Mm}{r^2}$$

$$\frac{1}{2}\cancel{G}\frac{\cancel{M}\cancel{m}}{r_E^2} = \cancel{G}\frac{\cancel{M}\cancel{m}}{r^2}$$

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

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

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

$$h = r - r_E$$
$$= \sqrt{2}\, r_E - r_E$$
$$= (\sqrt{2} - 1)\, r_E$$
$$= \boxed{2.64 \times 10^6 \text{ m}}$$

ALTERNATIVE METHOD:

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

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

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

$$h = r - r_E$$
$$= \sqrt{2}\, r_E - r_E$$
$$= (\sqrt{2} - 1)\, r_E$$
$$= \boxed{2.64 \times 10^6 \text{ m}}$$