A man weighs 750 N on the surface of the Earth. What would be his weight when standing on the Moon? The masses of the earth and the moon are respectively, 5.98×10^{24} kg and 7.36×10^{22} kg. Their radii are respectively 6.37×10^{3} km and 1.74×10^{3} km.

200.5 N
123.7 N
550.4 N
1000.0 N

Solution.

With an application of the universal gravitation law, for a man on the Earth surface one have:

$$F_E = G\frac{m M_E}{R_E^2},$$

and, similarly, in case of Moon:

$$F_M = G\frac{m M_M}{R_M^2},$$

where *G* is the is the gravitational constant, m is the mass of a man, *R* and M are the radii and masses of the Earth and the Moon. To evaluate weight on the Moon surface, we will find a proportionality coefficient between forces F_E and F_M. Combining previous two equations, we find

$$F_M = F_E\frac{M_M R_E^2}{M_E R_M^2} = \alpha F_E$$

Than we calculate dimensionless coefficient α numerically:

$$\alpha = \frac{7.36\times10^{22}\,kg\left(6.37\times10^{3}\,km\right)^2}{5.98\times10^{24}\,kg\left(1.74\times10^{3}\,km\right)^2} = 0.165,$$

what means that weight on the Moon surface reaches only 16.5% of the weight on the Earth. Now we find corresponding weights of different objects multiplying their weights F_E to α.

Answer.

$750.0\,N\times0.165 = 123.8\,N$

$200.5\,N\times0.165 = 33.1\,N$

$123.7\,N\times0.165 = 20.4\,N$

$550.4\,N\times0.165 = 90.8\,N$

$1000.0\,N\times0.165 = 165\,N$