

# Physics

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(Chapter 7) (Gravitation) (Exercises)  
(Class 11)

## Question 7.16:

Assuming the earth to be a sphere of uniform mass density, how much would a body weigh half way down to the centre of the earth if it weighed 250 N on the surface?

### Answer 7.16:

Weight of a body of mass  $m$  at the Earth's surface,  $W = mg = 250 \text{ N}$

Body of mass  $m$  is located at depth,  $d = \frac{1}{2} R_e$

Where,  $R_e$  = Radius of the Earth

Acceleration due to gravity at depth  $g$  ( $d$ ) is given by the relation:  $g' = \left(1 - \frac{d}{R_e}\right)g = \left(1 - \frac{R_e}{2 \times R_e}\right)g = \frac{1}{2}g$

Weight of the body at depth  $d$ ,

$$W' = mg' = m \times \frac{1}{2}g = \frac{1}{2}mg = \frac{1}{2}W = \frac{1}{2} \times 250 = 125 \text{ N}$$

## Question 7.17:

A rocket is fired vertically with a speed of  $5 \text{ km s}^{-1}$  from the earth's surface. How far from the earth does the rocket go before returning to the earth? Mass of the earth =  $6.0 \times 10^{24} \text{ kg}$ ; mean radius of the earth =  $6.4 \times 10^6 \text{ m}$ ;  $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ .

### Answer 7.17:

Velocity of the rocket,  $v = 5 \text{ km/s} = 5 \times 10^3 \text{ m/s}$

Mass of the Earth,  $M_e = 6.0 \times 10^{24} \text{ kg}$  and radius of the Earth,  $R_e = 6.4 \times 10^6 \text{ m}$

Height reached by rocket mass,  $m = h$

At the surface of the Earth,

$$\text{Total energy of the rocket} = \text{Kinetic energy} + \text{Potential energy} = \frac{1}{2}mv^2 + \left(\frac{-GM_e m}{R_e}\right)$$

$$\text{At highest point } h, v = 0 \text{ and, Potential energy} = -\frac{GM_e m}{R_e + h}$$

$$\text{Total energy of the rocket} = 0 + \left(\frac{-GM_e m}{R_e + h}\right) = \frac{-GM_e m}{R_e + h}$$

From the law of conservation of energy, we have,

Total energy of the rocket at the Earth's surface = Total energy at height  $h$

$$\frac{1}{2}mv^2 + \left(\frac{-GM_e m}{R_e}\right) = \frac{-GM_e m}{R_e + h} \Rightarrow \frac{1}{2}v^2 = GM_e \left(\frac{1}{R_e} - \frac{1}{R_e + h}\right)$$
$$= GM_e \left(\frac{R_e + h - R_e}{R_e(R_e + h)}\right) \Rightarrow \frac{1}{2}v^2 = \frac{GM_e h}{R_e(R_e + h)} \times \frac{R_e}{R_e} \Rightarrow \frac{1}{2}v^2 = \frac{gR_e h}{R_e + h}$$

Where  $g = \frac{GM_e}{R_e^2} = 9.8 \text{ m/s}^2$  (Acceleration due to gravity on the Earth's surface)

$$\therefore v^2(R_e + h) = 2gR_e h \Rightarrow v^2 R_e = h(2gR_e - v^2)$$

$$h = \frac{R_e v^2}{2gR_e - v^2} = \frac{6.4 \times 10^6 \times (5 \times 10^3)^2}{2 \times 9.8 \times 6.4 \times 10^6 - (5 \times 10^3)^2} = \frac{6.4 \times 25 \times 10^{12}}{100.44 \times 10^6} = 1.6 \times 10^6 \text{ m}$$

Height achieved by the rocket with respect to the centre of the Earth

$$= R_e + h = 6.4 \times 10^6 + 1.6 \times 10^6 = 8.0 \times 10^6 \text{ m}$$

# Chapter 7 Physics Answers

**Oxford University Press**



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Sherwood, Aaron P. Titus, Stephen J. Spicklemire, 2025-01-10 Matter Interactions is a calculus based introductory physics text that reflects a modernized view of physics It stresses reasoning from powerful physics principles and integrates contemporary insights such as the atomic nature of matter quantized energy and relativistic dynamics throughout the curriculum Students engage in the full process of creating and refining physical models Computational modeling is integrated to allow students to apply fundamental principles to more complex realistic systems and to explore the possible ranges of behavior of physical models Joining Ruth Chabay and Bruce Sherwood for this edition as authors are longtime collaborators Aaron Titus North Carolina State University and Stephen Spicklemire University of Indianapolis who have made great impacts on the new video series interactive figures and simulations The new edition is thoughtfully updated with extensive content revisions including chapter and section level learning objectives clarified and simplified initial presentation of key concepts and techniques and the introduction of angular momentum earlier before collisions *MCAT*

*Comprehensive Review 1999*, 1998-11 Complete Review of ALL the science you need to know Full Length Practice Test with complete explanations for each question 2 Full Length Verbal Reasoning Tests with detailed explanations and strategies

**General Catalogue** Oxford University Press, 1916 Modern Probability Theory and Its Applications Emanuel Parzen, 1960 **The House of Science** Philip R. Holzinger, 1990-01-16 Grade level 4 5 6 7 e i *The American Journal of Science*, 1923 **Barron's How to Prepare for the ACT, American College Testing Program** Murray Shapiro, 1985

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