6.10 (c) $t^{3/2}$

6.11 12 J

6.12 The electron is faster, $\upsilon_e / \upsilon_p = 13.5$

6.13 0.082 J in each half ; – 0.163 J

6.14 Yes, momentum of the molecule + wall system is conserved. The wall has a recoil momentum such that the momentum of the wall + momentum of the outgoing molecule equals momentum of the incoming molecule, assuming the wall to be stationary initially. However, the recoil momentum produces negligible velocity because of the large mass of the wall. Since kinetic energy is also conserved, the collision is elastic.

6.15 43.6 kW

6.16 (b)

6.17 It transfers its entire momentum to the ball on the table, and does not rise at all.

6.18 5.3 m s^{-1}

6.19 27 km h^{-1} (no change in speed)

6.20 50 J

6.21 (a) $m = \rho A\upsilon t$ (b) $K = \rho A\upsilon^3 t/2$ (c) $P = 4.5$ kW

6.22 (a) 49,000 J (b) 6.45 10^{-3} kg

6.23 (a) 200 m^2(b) comparable to the roof of a large house of dimension 14m × 14m.

6.24 21.2 cm, 28.5 J

6.25 No, the stone on the steep plane reaches the bottom earlier; yes, they reach with the same speed υ, [since $mgh = (1/2)\, m\upsilon^2$]

$\upsilon_B = \upsilon_C = 14.1$ m s^{-1} , $t_B = 2\sqrt{2}$ s , $t_C = 2\sqrt{2}$ s

6.26 0.125

6.27 8.82 J for both cases.

6.28 The child gives an impulse to the trolley at the start and then runs with a constant relative velocity of 4 m s^{-1} with respect to the trolley's new velocity. Apply momentum conservation for an observer outside. 10.36 m s^{-1}, 25.9 m.

6.29 All except (V) are impossible.

Chapter 7

7.1 The geometrical centre of each. No, the CM may lie outside the body, as in case of a ring, a hollow sphere, a hollow cylinder, a hollow cube etc.

7.2 Located on the line joining H and C1 nuclei at a distance of 1.24 Å from the H end.

7.3 The speed of the CM of the (trolley + child) system remains unchanged (equal to υ) because no external force acts on the system. The forces involved in running on the trolley are internal to this system.

7.6 $l_z = xp_y - yp_x$, $l_x = yp_z - zp_y$, $l_y = zp_x - xp_z$

7.8 72 cm

7.9 3675 N on each front wheel, 5145 N on each back wheel.

7.10 (a) 7/5 MR^2 (b) 3/2 MR^2

7.11 Sphere

7.12 Kinetic Energy = 3125 J; Angular Momentum = 62.5 J s

7.13 (a) 100 rev/min (use angular momentum conservation).

(b) The new kinetic energy is 2.5 times the initial kinetic energy of rotation. The child uses his internal energy to increase his rotational kinetic energy.

7.14 $25\ s^{-2}$; $10\ m\ s^{-2}$

7.15 36 kW

7.16 at R/6 from the center of original disc opposite to the center of cut portion.

7.17 66.0 g

7.18 (a) Yes; (b) Yes, (c) the plane with smaller inclination ($\because a \propto \sin\theta$)

7.19 4J

7.20 $6.75\times10^{12}\ rad\ s^{-1}$

7.21 (a) 3.8 m (b) 3.0 s

7.22 Tension = 98 N, N_B = 245 N, N_C = 147 N.

7.23 (a) 59 rev/min, (b) No, the K.E. is increased and it comes from work done by man in the process.

7.24 $0.625\ rad\ s^{-1}$

7.27 (a) By angular momentum conservation, the common angular speed

$\omega = (I_1\, \omega_1 + I_2\, \omega_2) / (I_1 + I_2)$

(b) The loss is due to energy dissipation in frictional contact which brings the two discs to a common angular speed ω. However, since frictional torques are internal to the system, angular momentum is unaltered.

7.28 Velocity of A $= \omega_o R$ in the same direction as the arrow; velocity of B = $\omega_o R$ in the opposite direction to the arrow; velocity of C = $\omega_o R/2$ in the same direction as the arrow. The disc will not roll on a frictionless plane.

7.29 (a) Frictional force at B opposes velocity of B. Therefore, frictional force is in the same direction as the arrow. The sense of frictional torque is such as to oppose angular motion. $\boldsymbol{\omega_o}$ and $\boldsymbol{\tau}$ are both normal to the paper, the first into the paper, and the second coming out of the paper.

(b) Frictional force decreases the velocity of the point of contact B. Perfect rolling ensues when this velocity is zero. Once this is so, the force of friction is zero.

7.30 Frictional force causes the CM to accelerate from its initial zero velocity. Frictional torque causes retardation in the initial angular speed ω_o. The equations of motion are : $\mu_k\, m g = m a$ and $\mu_k\, m g R = -I\alpha$, which yield $v = \mu_k\, g\, t$, $\omega = \omega_o - \mu_k\, m g R t / I$. Rolling begins when $v = R\,\omega$. For a ring, $I = m R^2$, and rolling begins at $t = \omega_o\ R/2\, \mu_k g$. For a disc, $I = ½\, m R^2$ and rolling starts at break line $t = R\omega_o/3\, \mu_k\, g$. Thus, the disc begins to roll earlier than the ring, for the same R and ω_o. The actual times can be obtained for R = 10 cm, $\omega_o = 10\,\pi\ rad\ s^{-1}$, $\mu_k = 0.2$

7.31 (a) 16.4 N

(b) Zero

(c) 37° approx.

Chapter 8

8.1 (a) No.

(b) Yes, if the size of the space ship is large enough for him to detect the variation in g.

(c) Tidal effect depends inversely on the cube of the distance unlike force, which depends inversely on the square of the distance.

8.2 (a) decreases; (b) decreases; (c) mass of the body; (d) more.

8.3 Smaller by a factor of 0.63.

8.5 3.54×10^8 years.

8.6 (a) Kinetic energy, (b) less,

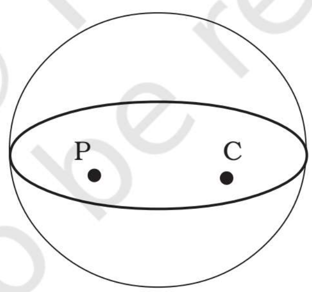
8.7 (a) No, (b) No, (c) No, (d) Yes

[The escape velocity is independent of mass of the body and the direction of projection. It depends upon the gravitational potential at the point from where the body is launched. Since this potential depends (slightly) on the latitude and height of the point, the escape velocity (speed) depends (slightly) on these factors.]

8.8 All quantities vary over an orbit except angular momentum and total energy.

8.9 (b), (c) and (d)

8.10 and **8.11** For these two problems, complete the hemisphere to sphere. At both P, and C, potential is constant and hence intensity = 0. Therefore, for the hemisphere, (c) and (e) are correct.



8.12 2.6×10^8 m

8.13 2.0×10^{30} kg

8.14 1.43×10^{12} m

8.15 28 N

8.16 125 N

8.17 8.0×10^6 m from the earth's centre

8.18 31.7 km/s

8.19 5.9×10^9 J