M. Prakash Academy **Weekly Workout**

Science Set - III (Part II) 29 April - 5 May

Dear Students,

This set on motion and Newton's laws contains more than two third problems which are very easy and the rest may need a little bit of appropriate effort. So you should be able to solve at least half the problems mentally. While answering the questions, mind the signs of numerical answers.

P1. A box of mass 50 kg is kept on the ground. Two horizontal forces of 35 N and 45 N are applied on the box respectively from the right and the left. However the box remains stationary. Find the frictional force acting on the box.

P2. A force produces an acceleration of 0.5 cm/s^2 when it acts on a body of mass 4 gm. Compute the force in (i) Newton (ii) Dyne.

P3. A force acts on a body of mass 2000 gm. The velocity of the body changes from 15 m/s to 30 m/s in 5 second. Assuming that the force is constant, find its magnitude in (i) Newton (ii) Dyne.

P4. A bullet of mass 40 gm moving with 180 m/s penetrates into a thick wall. It takes 30 mili second to stop after hitting the surface of the wall. Find (i)the acceleration of the bullet in the wall. (ii) the force exerted by the bullet on the wall (iii) the force exerted by the wall on the bullet and (iv) the distance covered by the bullet inside the wall.

P5. A vehicle of mass 1200 kg is moving on an expressway with 108 km/hr. It comes to rest after 6 second of application of the brakes. Assuming that the acceleration produced is constant, what is the force applied on the vehicle during this period?

P6. A box of mass 80 kg is lying on a horizontal floor. When pushed by a horizontal force F_h it moves with a constant velocity. If it is pushed by a horizontal force of $2F_h$ it moves with an acceleration of 0.2 m/s^2. Find the value of F_h.

P7. Two carts C_1 and C_2 of mass 20 kg each are tied to each other with a light but strong wire. Card C_1 is towards the right of cart C_2. A girl holds C_1 and pulls it with a horizontal force of 100 N towards the right. Total force of friction acting on each of the carts is $22\frac{1}{2}$ N and it acts towards the left. Find (i) acceleration of the carts. (ii) force exerted by the wire on cart C_2.

P8. An object having half a kilogram mass is at rest. A force of 8 N acts on it for 8 s. Find the distance travelled by the particle in these 8 second and the next 8 second.

P9. Two magnets of masses 24 gm and 16 gm are held on smooth, frictionless table. They are kept in each other's vicinity with North of one pointing towards the south of the other. The magnets start moving towards each other when left on their own. At some point during the motion, the velocity of the heavier magnet is 2.4 m/s. Find the velocity of the lighter magnet at that instant.

P10. An object of mass 75 gm is moving. Its velocity-time graph plotted for 8 second of the motion turns out to be a line bisecting angle between the positive velocity axis and positive time axis. Compute the force acting on the object. **Given Scale:** On the velocity-axis 1 cm = 2 m/s and on the time-axis 1 cm = 1 s.
Motion of another object plotted on the same graph turns out to be a line intersecting the first line at time $t = 8s$ and the velocity-axis at 1 m/s. If the force acting on this object is same as that on the first object, compute its mass.

P11. A boat is travelling upstream at 14 km/hr with respect to (w.r.t.) water of the river and the water is flowing at 9 km/hr w.r.t. the ground.
(i) What is the velocity of the boat w.r.t. the ground?
(ii) A child on the boat walks from the front to the rear of the boat at 6 km/hr w.r.t the boat. What is her velocity w.r.t. the ground?

P12. A person walks up a stalled (stopped) 15 meter long escalator in $1\frac{1}{2}$ minute. It the escalator were moving, the person would be carried up in 1 minute. How much time would it take for the person to walk up a moving escalator?

P13. You may have heard about people pulling cars and trucks with their teeth or tied to their hair, etc. In one such event, the famous teeth-acrobat John Massis (1940-1988) pulled (with his teeth) on his end of the rope tied to railroad cars with a force $2\frac{1}{2}$ times his body weight. The force was applied at 30^0 angle from the horizontal. The weight of the cars was 700 kilo Newton and he moved them 1 meter along the rails. Assuming that the rolling wheels experienced no retarding force from the rails, compute the speed of the cars at the end of this pull. Massis had a body mass of 80 kg.
(**Note:** URL - http://www.youtube.com/watch?v=C6d4AL3-px0 will offer you a chance of watching John Massis' performance.)

P14. A block B_1 of mass 3.3 kg is placed on a smooth, frictionless and horizontal table. It is connected to B_2 of mass 2.1 kg with a 'massless' string. The string passes over a pulley which is fixed to the rightmost corner of the table. The situation is such that B_1 is on the table (towards the left of the pulley) and B_2 is hanging (towards the south of the pulley). Pulley too has negligible mass compared to that of the blocks. The hanging block B_2 starts falling as the sliding block B_1 starts accelerating towards the right (towards pulley). Find (i) the acceleration of B_1. (ii)the acceleration of B_2. (iii) tension in the string.

P15. A smooth, frictionless platform (incline) is kept in such a way that its one end rests on ground and the other end rests along a vertical wall making an angle of 30^0 with the ground. A 'massless' string, tied to a hook in the wall, holds an object of mass 15 kg on the incline.
(i) Compute magnitudes of (a) force on the block by the string and (b) normal force exerted on the block by the incline.
(ii) Suppose we cut the string, the block will slide down the incline. Does the block accelerate? If so, what is its acceleration?

P16. Note: In the following problems, you are required to answer questions conceptually, no numerical calculations are needed. But you must justify your answer.

CP1. Under what conditions does a spring exert forces on objects attached to its ends?

CP2. A ball is moving on a frictionless horizontal surface and no forces are applied on it. Will its speed increase, decrease or remain constant?

CP3. Suppose two friends are standing besides each other and one of them suddenly pushes the other and the other falls. According to Newton's third law the (falling) friend has exerted equal force on the (pushing) friend. Why doesn't the first friend fall down?

CP4. When you jump on concrete floor, your feet hurt more than when you jump on sand. Explain.

CP5. Make a list of situations where two opposite and equal forces do not form an action-reaction pair.

Documentary of the week:

As we are discussing motion and Newton's laws, lets watch a documentary presenting life and work of $SirIssacNewton$. Like any other source of history, this documentary should also be watched as one of the versions of Newton's life. Visit the following URL to access **Isaac Newton: His life and Work** - by **Simon Schaffer**. **Note:** Parental guidance required i.e. watch the documentary with your parents.

https://www.youtube.com/watch?v=GvW$_Y$9$sw6hk$