## 1. Detail of Unit Revision

| | |
|---|---|
| Subject Name | Physics |
| Course Name | Physics 01 (Physics Part-1, Class XI) |
| Module Name/Title | Unit 3: Laws of Motion_Revision |
| Objectives | After going through this lesson, the learners will be able to understand<br>• How to plan for study<br>• How to consolidate the unit |
| Keywords | Force, inertia, newton's law of motion, momentum, impulse, friction, centripetal force, circular motion |

## 2. Development team

| Role | Name | Affiliation |
|---|---|---|
| National MOOC Coordinator (NMC) | Prof. Amarendra P. Behera | Central Institute of Educational Technology, NCERT, New Delhi |
| Programme Coordinator | Dr. Mohd Mamur Ali | Central Institute of Educational Technology, NCERT, New Delhi |
| Course Coordinator / PI | Anuradha Mathur | Central Institute of Educational Technology, NCERT, New Delhi |
| Teaching Assistants | Chinty Chhawari | Central Institute of Educational Technology, NCERT, New Delhi |
| | Shivam Dixit | Central Institute of Educational Technology, NCERT, New Delhi |

## STUDY GUIDE UNIT 3

## LAWS OF MOTION

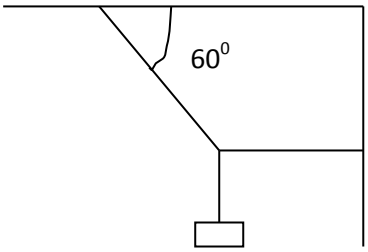
### Chapter–5: Laws of Motion

Intuitive concept of force, Inertia, Newton's first law of motion; momentum and Newton's second law of motion; impulse; Newton's third law of motion. Law of conservation of linear momentum and its applications. Equilibrium of concurrent forces, Static and kinetic friction, laws of friction, rolling friction, lubrication. Dynamics of uniform circular motion: Centripetal force, examples of circular motion (vehicle on a level circular road, vehicle on a banked road).

1. **After going through the unit, Study the syllabus**
2. **Make a list of concepts to be learnt**
    - Intuitive concept of force
    - Inertia
    - Newton's first law of motion
    - momentum and Newton's second law of motion
    - impulse
    - Newton's third law of motion
    - Law of conservation of linear momentum and its applications
    - Equilibrium of concurrent forces
    - Static and kinetic friction
    - laws of friction
    - rolling friction
    - lubrication
    - Dynamics of uniform circular motion
    - Centripetal force
    - Examples of circular motion (vehicle on a level circular road, vehicle on a banked road)
3. **Explain each concept to yourself**
4. **Find examples from real life around you**
5. **Think of forces acting on stable stationary objects around you**
6. **Think of net force that may cause motion of any object around you, including yourself.**
7. **Study the videos for constant and variable forces, free body diagram, banking of roads**
8. **Use equations of motion and the second law, third law for problem solving.**
9. **Make your own notes, read from NCERT book**
10. **Solve problems**

## QUESTIONS FOR PRACTICE

1. State Newton's Second law of motion.
2. Give two important conditions under which the tension in a string to be constant.
3. A book rests on a table. What are the forces acting on the book?
4. Two bodies of different masses have the same momentum. Which one has a larger kinetic energy?
5. State the condition for equilibrium of a body under concurrent forces.
6. A 2.5 kg brick is supported by two ropes as shown in the figure. Find the tension in each rope




7. Why does a gun recoil? Derive the recoil velocity of a gun.
8. Why is the force of friction not constant between two masses while coefficient of friction is? How does the use of ball bearing reduce friction in a wheel?
9. A bird is sitting on the floor of a cage and the cage is in the hands of a boy. The bird starts flying in the cage. Will the boy experience any change in the weight of the cage?
10. i. What is meant by banking of roads?
    ii. Why is banking necessary for automobiles? Draw suitable diagram to support your answer.

    iii. A curved road of diameter 1.8 km is banked, so that no friction is required at the speed of 30 m/s. What is the banking angle?

**11. Give reasons**

i. If you shake the braches of a tree the fruits will fall

ii. If you place a brick on a smooth floor, you can move it easily by pushing it with your foot, yet if you kick it could be a disaster.

iii. In a game of tug o-war the team that pushes the ground harder wins

iv. Sparks from a grinding stone are tangential to the rotating wheel

v. Athletes run a distance before taking a long jump

vi. It is advisable to hold a gun to one's shoulder when it is being fired

vii. It is easier to pull than to push

viii. Shockers are used in cars scooters and mobikes

ix. Wicket keepers pull in their hands after catching the ball

x. A man stranded in the middle of a frozen pond can rescue himself by throwing off his clothing.

12. A board is suspended by ropes making angles 30 and 45 with the horizontal. Find the tension in the string.

13. A sack of potatoes of mass10 kg is suspended by a rope of length from a ceiling. A force of 50N in the horizontal direction is applied at the midpoint of the rope. What is the angle the rope makes with the vertical when in equilibrium

14. Find the horizontal force required to displace a mass of 0.5 Kg suspended by a string until the string makes an angle of $30^0$ to the vertical.

15. A constant force of 50N is applied to a body of mass 20 kg moving initially with a speed of 15 m/s .How long does the body take to stop?

[5s]

16. A truck and a car moving with the same kinetic energy are stopped by applying the same retarding force by means of brakes. Which one will stop at a shorter distance?

17. Why does a gun recoil when fired? Derive the recoil velocity of a gun.

OR

A 3 kg object is subjected to two forces $\overrightarrow{F} = (6i - 2j + 4k)$ $and$ $\overrightarrow{G} = (2i + 4k - 5k)$ Calculate the angle between the vectors and the acceleration they would produce in the object.

18. Find the acceleration with which a mass slides down an inclined plane. If the angle of inclination with the horizontal is θ and coefficient of friction between the mass and inclined plane is μ.

19. a. What is meant by banking of roads?
    b. Why is banking necessary for automobiles? Draw suitable diagram to support your answer.
    c. A curved road of diameter 1.8 km is banked, so that no friction is required at the speed of 30 m/s. What is the banking angle?

20. a. Why is the final kinetic energy always less than the initial kinetic energy of the system in inelastic collision?
    b. A bob of mass m is suspended by a light string of length L. It is imparted a horizontal velocity v at the lower most point A such that it completes a semicircular trajectory in the vertical plane with the string becoming slack only at the highest

point B obtain an expression for v and the velocity at point B .

21. A cricket ball of mass 200g moving with a velocity of 15 m/s is brought to rest in 0.05 s. What are the impulse and the average force applied by the player?
[3Ns, 60N]

22. A driver of a three wheeler moving with a speed of 36km/h sees a cow standing in the middle of the road and brings his vehicle to rest in 4s just in time to save the holy animal! What is the average force he applies? mass of the auto = 400kg, mass of the driver = 65kg

[1162.5N]

23. A bats man deflects the ball by an angle of 45° without changing its initial speed which is equal to 54 km/h. What is the impulse imparted to the ball? Mass= 0.15 kg
4.16 kg m/s

24. The force on a particle of mass 50g is $(10\hat{\imath} + 5\hat{k})$. If it starts from rest what will be its position in time t = 5s , a = 200m/s$^2$

[2500 $\hat{\imath}$ +1000 $\hat{k}$]

25. A constant force acts for 3 s on a mass of 16 kg and then ceases to act. During the next three seconds the body moves 81 m. Find the magnitude of force ( assume that the body started from rest) [144 N]

26. Two blocks of masses 3 kg and 2 kg are placed in contact with each other on a smooth table. Find the force on the common cross-sectional area of contact if a force of 5 N is applied on the i) bigger block ii) smaller block

[2 N, 3 N]

27. Three blocks A, B and C of masses 1 kg, 2 kg and 3 kg are connected to each other by ropes in between forming a train. The system is pulled on the table with a force of 6 N applied on the 3 kg. Find the tension in the string. [3 N , 1 N]

28. A block of mass 2 kg rests on a plane inclined at an angle of $30^0$ with the horizontal. The coefficient of friction between the block and the surface is 0.7, what will be the frictional force acting on the block? Will the block move?

29. Two masses 5 kg and 10 kg are connected at the two ends of a light inextensible cord passing over a frictionless pulley. Find the acceleration and tension when the masses are released.

30. A 75 kg man stands in a lift. What force does the floor exert on him when the elevator
    a. accelerates upwards at 2 $ms^{-2}$
    b. accelerates downwards at 2 $ms^{-2}$
    c. falls with an acceleration of g

31. The rear of a truck is open and a box of 40 kg mass is placed 5 m from the open end.

    Coefficient of friction between the box and the surface is 0.15. On a straight road, the truck starts from rest and accelerates with 2 $ms^{-2}$. At what distance from the starting point does the box fall off. [20 m]

32. A body of mass ‘m ‘ placed on a frictionless inclined plane making an angle of θ with the horizontal is connected to a string passing over a free pulley and has a block of mass M hanging from the other end. Calculate the acceleration of either body or the tension in the string.

33. A 10 kg block slides, without acceleration, down a rough inclined plane making an angle of $20^0$ with the horizontal. Find the acceleration when the angle of inclination is increased to $30^0$.

    [1.81 $ms^{-2}$]

34. State the laws of static friction. Draw a diagram for the experimental set up to find the coefficient of friction in the laboratory. Use the data given below to plot a graph between F (force of friction) and N (normal force), calculate the coefficient of friction from the graph.
    Weight of wooden block= 225g
    Weight of pan=25g

| S.No | Load on the block | Total weight of block and load | Load on pan | Total weight of pan and load |
|---|---|---|---|---|
| 1 | 0 | 225 | 10 | 35 |
| 2 | 20 | 245 | 20 | 45 |
| 3 | 40 | 265 | 40 | 65 |
| 4 | 80 | 305 | 60 | 85 |
| 5 | 120 | 345 | 80 | 105 |

35. What will be the dimensions of $\alpha$ *if* $Force = \frac{\alpha}{density + \beta^2}$ ?