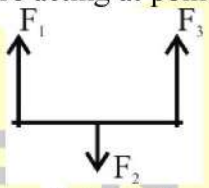
UNIT 4
TURNING EFFECT OF FORCE

SHORT QUESTIONS

Q.1 What is meant by parallel forces?

Ans: In a plane, if number of forces act on a body such that their points of action are different but lines of action are parallel to each other, then these forces are called parallel forces. In the given figure, the forces $\mathbf{F_1}$, $\mathbf{F_2}$, $\mathbf{F_3}$ are acting at points A, B, C are parallel forces.



Q.2 What is meant by like parallel forces? Also give examples. **(LHR 2011, 2014, 2015, GRW 2013)**

Ans:

Like parallel forces are the forces that are parallel to each other and have the same direction.

Examples

In the second figure, the direction of the parallel forces $\mathbf{F_1}$ and $\mathbf{F_3}$ is the same, so these are like parallel forces.

Q.3 What are unlike parallel forces? **(LHR 2011, 2014, 2015 GRW 2013)**

Unlike parallel forces are the forces that are parallel but have direction opposite to each other.

Example

In the second figure, the parallel forces $\mathbf{F_1}$, $\mathbf{F_2}$ and $\mathbf{F_2}$, $\mathbf{F_3}$ are acting in opposite direction, so these are unlike parallel forces.

Q.4 Define head to tail rule. **(GRW 2015)**

Draw the representative lines of all the vector to be added in such a way that head of first vector coincides with the tail of second vector, head of second vector coincides with the tail of third vector and so on. The line obtained by joining the tail of first vector with the head of last vector represent resultant vector.

Q.5 Resultant Force **(LHR 2011, 2013, GRW 2013)**

A resultant force is a single force that has the same effect as the combined effect of the all the forces to be added. And resultant vector is drawn in such a way that tail of first vector is joined with the head of the last vector.

Q.6 Define resolution of vectors. **(LHR 2012, GRW 2014, 2015)**

Ans: The decomposition or division of a vector into its rectangular components is called resolution of a vector. **OR**

The splitting of a single force into two mutually perpendicular components is called the resolution of that force.

Q.7 Define torque or moment of force. **(GRW 2012, LHR 2012, 2013)**

Ans: "The rotational effect of a force is measured by a quantity, known as torque".

Q.8 Define centre of mass. **(LHR 2014, 2015)**

Ans: Centre of mass of a system is such a point where an applied force causes the system to move without rotation.

Q.9 Define centre of gravity. **(LHR 2012, 2013, 2014 GRW 2015)**

Ans: A point in a body where the weight of the body appears to act vertically downward is called the centre of gravity.

The centre of gravity can exist inside a body or outside the body. Position of the centre of gravity depends upon the shape of the body.

Q.10 Define couple and give examples.

Ans: A couple is formed by two unlike parallel forces of the same magnitude but not along the same line.

Examples

- While turning a car, the forces applied on the steering wheel by hands provide the necessary couple.
- While opening or closing a water tap,
- While locking or opening the stopper of a bottle or a jar.

Q.11 Define equilibrium.

A body is said to be in equilibrium if no net force acts on it.

Q.12 State conditions of equilibrium.

First Condition of equilibrium:

A body will be in equilibrium if the resultant of all the forces acting on it is zero. This is first condition of equilibrium.

Second Condition of equilibrium:

If a number of forces act on a body so that the total sum of the torques of these forces is zero, the body will be in equilibrium.

Q.13 Define stable equilibrium. **(GRW 2015)**

A body is said to in stable equilibrium if after a slight tilt it returns to its previous position. When body is in stable equilibrium, its centre of gravity is at the lowest position. When it is tilted, its centre of gravity rises. It returns to its stable state by lowering its centre of gravity. A body remains in stable equilibrium as long as the centre of gravity acts through the base of the body.

Examples

Table, chair, box and brick lying on a floor.

Q.14 Define unstable equilibrium. **(GRW 2014)**

If a body does not return to its previous position when sets after a slightest tilt is said to in unstable equilibrium.

The centre of gravity of the body is at its highest point in the state of unstable equilibrium. As the body topples over about its base, its centre of gravity moves towards its lower position and does not return to its previous position.

Examples

- A stick standing vertically on the tip of a finger.
- A cone standing on the tip of a finger.

Q.15 Define neutral equilibrium.

Neutral equilibrium

If a body remains in its new position when disturbed from its previous position, it is said to be in a state of neutral equilibrium. In neutral equilibrium the centre of gravity of body remains at the same height, irrespective to its new position.

Example

- A ball lying on the horizontal surface
- Motion of wheel on plane surface.

Q.16 Define rigid body and axis of rotation. (LHR 2012, 2014, GRW 2015)

Ans: Rigid body

A body is composed of large number of particles. If the distance between all these pairs of particles of the body do not change by applying a force then it is called a rigid body.

Axis of rotation (LHR 2012, 2013 GRW 2011, 2013, 2015)

During rotation, the particles of the rigid body move in circles with their centres all lying on a line. This straight line is called the axis of rotation of the body.

Q.17 What is meant by principle of moments? (GRW 2013, 2014)

A body is balanced, if the sum of clockwise moments acting on the body is equal to the sum of anticlockwise moments acting on it.

A body initially at rest does not rotate if sum of all the clockwise moments acting on it is balanced by the sum of all the anticlockwise moments acting on it. This is known as the principle of moments.

Examples

A pencil, a sphere, and cylinder, a roller, an egg lying horizontally on a flat surface.

Q.18 How stability of a body is related with the Position of centre of mass?

Ans: To make the body stable, their centre of mass must be kept as low as possible. It is due to the reason, racing cars are made heavy at the bottom and their height is kept to be minimum.

Q.18 Differentiate between axis of rotation and point of rotation?

Axis of Rotation	Point of Rotation
Axis of rotation is a line about which the whole body rotates. **Example** When we open the door, the door will move about its hinges or axis of rotation.	Point of rotation is just a point about which the body rotates. **Example** If we move a stick about its centre of gravity , then that point becomes the point of rotation.

Q.19 On what factors rotation produce in a body depend?

Ans: Rotation produced in a body depends on the following two factors:

(i) Magnitude of the force.

(ii) The perpendicular distance between the line of action of the force and the axis of rotation, that is known as moment arm.

Q.20 How can we increase torque by keeping the force constant?

Ans: We can increase the torque by increasing the perpendicular distance from the line of action of force to the point of rotation that is moment arm by keeping the force constant, according to the relation $\tau = rF$

Q.21 Can a moving body be in equilibrium? Explain.

Ans: Yes, if a body is moving with uniform velocity then the body is in equilibrium because neither linear nor rotational acceleration is produced in the body.

Q.22 Will a body be in equilibrium under the action of a single force?

Ans: No, the body will not be in equilibrium because first condition of the equilibrium will not be fulfilled. Since single force can never be zero and linear acceleration will be produced. Therefore we can say that a body cannot be equilibrium under the action of a single force.

Q.23 Can a body be in equilibrium if it is revolving clockwise under the action of a single force?

Ans: No, the body will not be in equilibrium because second condition of the equilibrium will not be fulfilled. Since single torque can never be zero and rotational acceleration will be

produced. Therefore we can say that a body cannot be equilibrium under the action of a single torque.

Q.24 Give an example of a case when the resultant force is zero but resultant torque is not zero.

Ans: In case of couple, two equal and opposite forces are acting on a same body but even then the body rotates. In this case resultant force is zero but resultant torque is not zero.

Example

While turning a car, the forces applied on the steering wheel by hands produce rotation in the steering wheel.

Q.25 How do we know whether a body is in a stable or unstable equilibrium due to position of its centre of gravity?

Ans: If after disturbance, the centre of gravity of the body is raised up as compared to the initial position then the body will be in the state of stable equilibrium and if after disturbance, the centre of gravity of the body is lowered down as compared to the initial position then the body will be in the state of unstable equilibrium.