LAWS OF MOTION

Que.1. According to Newtons laws of motion the force depends on the rate of change of momentum. **[Marks :(4)]**

a.Name the law that helps to measure force. (1)

b.Using the above law deduce an expression for force. (3)

Ans. a. Newton's second law of motion

b. according to second law

$$F \alpha \frac{\Delta P}{\Delta t}$$

$$F = K \frac{\Delta P}{\Delta t}$$

where K is a constant of proportionality

$$K = \frac{dP}{dt}$$

But P=mv

$$F = \frac{d mv}{dt}$$

$$F = m \frac{dv}{dt}$$

we have $\frac{dv}{dt} = a$

ie

F=ma

Que.2. State the law of conservation of linear momentum and prove it on the basis of second law. **[Marks :(3)]**

Ans. If no external force is acting on the system the total momentum of the system remains constant.

proof

Fext = $\frac{dp}{dt}$

If Fext = 0

$$\frac{dp}{dt}=0$$

ie P=constant

Que.3. Give reason. **[Marks :(4)]**

a. While catching a ball a cricketer lowers his hand.

b. A person falling from a certain height receives more injuries when he falls on a concrete floor than he falls on a heap of sand.

Ans. a. By moving the hands backwards the cricketer increases the time of catch. Then the force exerted by the ball on his hand becomes much smaller, ie. the impulse force is lesser and does not hurt him.

b. When the person falls on the heap of sand, sand gets depressed under his weight and the person takes longer time to stop this decreases the impulse force and is lesser exerted by the floor on the person.

Que.4. Using Newton's second law of motion explain **[Marks :(3)]**

a. Impulse Momentum principle (2)

b. law of conservation of linear momentum (1)

Ans. a. impulse, I = F dt

or $$I=\frac{dp}{dt}dt$$

ie I = dp

ie impulse = change in momentum

b. in the absence of external force, the total momentum of the system remains constant.

ie. initial momentum = final momentum

Que.5. Recoil of gun is an application of law of conservation of momentum. [Marks :(5)]

a. What do you mean by recoil of gun and recoil velocity? (2)

b. Derive its expression (2)

c. How we can reduce the recoil of gun (1)

Ans. a. The backward motion of a gun just after firing is called recoil of gun. The velocity of gun during its recoil motion is called recoil velocity of gun.

b. let M mass of gun

V velocity of gun

m mass of bullet

v velocity of bullet

by law of conservation of linear momentum, total momentum before firing = total momentum after firing.

Momentum before firing = 0

ie. 0 = MV + mv

- MV = mv

$$V = \frac{-mv}{M}$$

c. To reduce recoil velocity the mass of gun is to be increased

Que.6. The static friction comes into play at the moment the force is applied. [Marks :(3)]

a. write the relation connecting static friction and normal reaction.

b. state the laws of limiting friction.

Ans.

a. $f \leqslant \mu_s N$

b. any two law

Que.7. If the normal force is doubled then coefficient of friction is [Marks :(1)]

a. doubled

b. Halved

c. not changed

Ans. c. not changed;

(coefficient of friction is independent of normal force)

Que.8. Canon after firing recoils due to [Marks :(1)]

a. conservation of energy

b. backward thrust of gases produced

c. Newton's third law of motion

d. Newton's first law of motion

Ans. c. Newton's third law of motion

Que.9. Jet engine works on the principle of [Marks :(1)]

a. conservation of mass b. conservation of energy

c. conservation of linear momentum

d. conservation of angular momentum

Ans. c. conservation of linear momentum

Que.10. China Where are wrapped in straw of paper before packing This is application concept of [Marks :(1)]

a. impulse b. Momentum c. acceleration d. Force

Ans. a. impulse

Que.11. A large force is acting on a body for a short time. The impulse imparted is equal to the change in [Marks :(1)]

a. acceleration b. Momentum c. energy d. Velocity

Ans. b. Momentum

Que.12. The direction of impulse is [Marks :(1)]

a. same as that of the net force

b. opposite to that of the net force

c. same as that of the final velocity

d. same as that of the initial velocity

Ans. b. opposite to that of the net force

Que.13. Newtons first law of motion describes the [Marks :(1)]

a. energy

b. Work

c. Inertia

d. Moment of inertia

Ans. c. Inertia

Que.14. In which of the following cases net force acting on the body is zero? [Marks :(1)]

a. a car moving with uniform velocity b. a book lying on table c. both a and b

d. none of these

Ans. b. a book lying on table

Que.15. which of the following is not a force? [Marks :(1)]

a. impulse b. Tension c. thrust d. Air resistance

Ans. a. impulse

Que.16. Inertia is the property of a body linked to tendency of a body ..... [Marks :(1)]

a. to change its position

b. to change its direction.

c. to change momentum

d. to resist any change in its state

Ans. d. to resist any change in its state

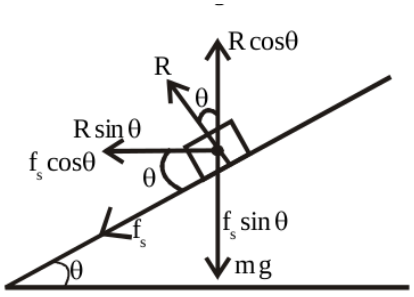
Que.17. Derive an expression for maximum velocity with which the vehicle can negotiate the curve. **[Marks :(5)]**

Ans. Consider a vehicle of mass m moving on a banked curve. The various forces acting on the vehicle.

(i) The weight of car mg acting vertically downwards.

(ii) Normal reaction R acting normal to the road.

(iii) Frictional force fs, acting parallel to the road.



Since there is no vertical acceleration, the vertical force is zero. Now from fig,

R cos θ = mg + f s sin θ

OR R cos θ – f s sin θ = m g

Now to for the car to be at maximum speed, f s = μR

R cos θ - μR sin θ = m g . .....(1)

Now the centripetal force will be provided by the forces acting towards the center i.e, R sinθ and

$$\therefore \quad R\sin\theta + f_s\cos\theta = \frac{mv^2}{r}$$

$$\text{Or} \quad R\sin\theta + \mu R\cos\theta = \frac{mv^2}{r} \quad \text{.....(2)}$$

$$\frac{(2)}{(1)} \quad \Rightarrow \quad \frac{R\sin\theta + \mu R\cos\theta}{R\cos\theta - \mu R\sin\theta} = \frac{mv^2}{mrg}$$

$$\text{Or} \quad \frac{\sin\theta + \mu\cos\theta}{\cos\theta - \mu\sin\theta} = \frac{v^2}{rg}$$

fs cosθ

Th $v = \sqrt{r g \frac{\sin\theta + \mu \cos\theta}{\cos\theta - \mu \sin\theta}}$ erefore maximum velocity with which the vehicle can negotiate the curve,

Que.18. Consider a vehicle of mass m moving on a banked curve. List the various forces acting on the vehicle. [Marks :(3)]

Ans. (i) The weight of car mg acting vertically downwards.

(ii) Normal reaction R acting normal to the road.

(iii) Frictional force fs, acting parallel to the road.

Que.19. To avoid skidding and the wear and tear of tyres of vehicles, the outer part of the road is slightly raised above the inner part so that the road is sloping towards the centre of the curve. [Marks :(2)]

a. Which force provides the necessary centripetal force for a car taking the circular track?

b. Name the process by which the outer side of a curved track is raised a little above the inner side.

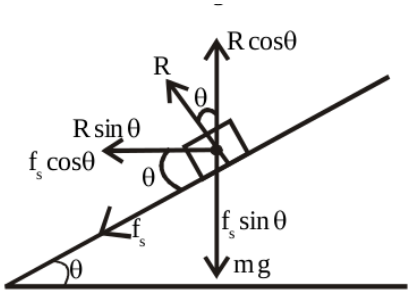
Ans. a. Frictional force

b. Banking of roads

Que.20. Banking of road helps to increase the centripetal force and there by increases the limit of maximum speed of a vehicle with it can take the curve. [Marks :(4)]

With the help of a diagram mark the various forces acting on it.

Ans.



(i) The weight of car mg acting vertically downwards.

(ii) Normal reaction R acting normal to the road.

(iii) Frictional force fs, acting parallel to the road.

Que.21. The optimum speed of a car on a banked road to avoid wear and tear on its tyres is given by [Marks :(1)]

a. $\sqrt{Rg\tan\theta}$

b. $\sqrt{Rg\cot\theta}$

c. $\sqrt{Rg\sin\theta}$

d. $\sqrt{Rg\cos\theta}$

Ans. a. $\sqrt{Rg\tan\theta}$

Que.22. Friction is defined as the force which opposes the relative motion between two surfaces in contact. Friction is a necessary evil explain. [Marks :(1)]

Ans. We are able to hold objects, walk, writ etc. due to friction

Que.23. when a ball hits a wall and bounces back, the force on the ball by the wall acts for a very short time when the two are in contact. Name the force [Marks :(1)]

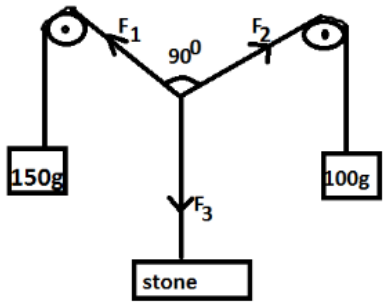
Ans. Impulsive force.

Que.24. State the following statements are True or False. [Marks :(1)]

A spring balance gives the mass of a body while a common balance gives its weight.

Ans. False

Que.25. Observe the following diagram [Marks :(3)]



a) The forces F1 F2 and F3 are together called ---------- concurrent forces

b) Calculate the mass of the stone using parallelogram law of vector addition.

Ans. a. concurrent forces

b.

$F_3=\sqrt{F_1^2+F_2^2+2F_1F_2\cos\theta}$

$\sqrt{150^2+100^2+0}$

where $\cos 90=0$

=180.27g

=180.27 x10-3Kg

Que.26. A car is moving with constant speed on a straight line. [Marks :(4)]

a. What is the net work done by the external force on the car. (1)

b. State work energy theorem. (1)

c. A bullet of mass 10 gram and velocity 800 metre per second is passed through a mud wall of thickness 1 metre Its velocity reduces 100 metre per second Find the average resistance offered by the mud wall. (2)

Ans. a. zero

b. work done by the external force is equal to the difference between final and initial kinetic energies

c. the average resistance offered by the mud wall is equal to the change in kinetic energy.

$$W=\frac{1}{2}mv^2-\frac{1}{2}mu^2=3150\,J$$

F = 3150 N

Que.27. A shell of mass 0.020 kg is fired by a gun of mass 100kg .If muzzle speed of shell is 80m/s, what is the recoil speed of the gun. [Marks :(2)]

Ans. m= 0.020 kg

M= 100kg

u = 80m/s

V =

$$\frac{-mu}{M}$$

$$= \frac{-.020\,x\,80}{100}$$

=- 0.016 m/s

Que.28. Action and reaction are equal and opposite, yet they do not cancel each other. Why? [Marks :(1)]

Ans. because they act on different bodies.

Que.29. While catching a cricket ball falling down, the player experiences a force on his hand for a short time. [Marks :(2)]

a. What is the type of force called? (1)

b. How can the force on his hands be reduced? (1)

Ans. a. Impulsive force.

b. By lowering his hand while catching the ball there by reducing the rate of change of momentum.

Que.30. A motorcycle and a bus are moving with same momentum. Which of them has greater kinetic energy? Justify (3) **[Marks :(3)]**

Ans. Motor Cycle

we have $KE = \frac{p^2}{2m}$

where p is a constant

ie $KE\ \alpha \frac{1}{m}$

motor cycle have less mass compaired to bus

so motorcycle has more KE

Que.31. When a shot is fired from a gun the gun recoils. **[Marks :(3)]**

a) Name the conservation law behind it. (1)

b)State and prove the law. (2)

Ans. a. Law of conservation of linear momentum

b. If no external force is acting on the system the total momentum of the system remains constant.

proof

Fext= $\frac{dp}{dt}$

If Fext=0

$\frac{dp}{dt} = 0$

ie p = constant

Que.32. State the law of conservation of linear momentum and prove it on the basis of second law. **[Marks :(3)]**

Ans. If no external force is acting on the system the total momentum of the system remains constant.

proof

Fext= $\frac{dp}{dt}$

If Fext=0

$$\frac{dp}{dt}=0$$

ie

P=constant

Que.33. A man jumping out of a moving bus falls with his head forward What should he do on order to land safely [Marks :(1)]

Ans. Run forward for inertia of motion

Que.34. When a bus suddenly starts moving, the passengers inside it fails backward. Name and state the law used to explain the above situation. [Marks :(3)]

Ans. Law of inertia OR (Newton's first law of motion)

Every body continues in its state of rest or of its uniform motion unless it is compelled by an external force to change that state. Or statement of Newtons first law.

Que.35. The weakest force found in nature is ..... [Marks :(1)]

a. strong nuclear force

b. weak nuclear force

c. gravitational force

d. electromagnetic force

Ans. c. gravitational force

Que.36. Define inertial mass and gravitational mass [Marks :(3)]

Ans. From newtons second law $a=\frac{F}{m}$

That is the acceleration of an object is inversely proportional to its mass Thus the mass is a measure of inertia of a body. So it is called inertial mass $m=\frac{F}{a}$

inertial mass is the ratio of force applied on an object to the acceleration produced. We know that W = mg

$$m=\frac{W}{g}$$

Gravitational mass is the ratio of weight of an object to the acceleration due to gravity. As the mass of an object increases gravitational force increases.

Gravitational mass can be measured using common balance.

Que.37. Distinguish between mass and weight. [Marks :(2)]

Ans. Mass is the amount of substance contained in a body. It is a scalar quantity. Its SI unit is kg.

Weight is the gravitational force acting on the body. SI unit is Newton. Weight is a vector quantity

Que.38. The maximum speed of a vehicle that can go on a level circular road of radius without skidding will be [Marks :(1)]

a. independent of coefficient of friction

b. independent of mass

c. independent of radius of track

d. independent of g

Ans. b. independent of mass

Que.39. The total mass of a motorcycle and the rider is 100 kilogram. The rider has to negotiate an unbanked curve of radius 50 m at a speed of 10 m/s. If the coefficient of friction is 0.5 [Marks :(4)]

a. Will the rider be able to go around the curve successfully.

b. At what angle should he lean over so as to avoid skid.

Ans. a. Force required for circular motion $\frac{mv^2}{r}=\frac{100\times10^2}{50}=200$ N

The total weight of the motorcycle and the cyclist = mg = 100 X 9.8

maximum force of friction = μ R = μ mg = 0.5 X 100 X 9.8 = 490 N

Since a force of circular motion is less than the force of friction the rider can go around the curve successfully

b. let θ be the angle through which he leans his body from the vertical then

$$\tan\theta=\frac{v^2}{rg}=\frac{10^2}{50\times9.8}=0.204$$

$\theta = 12^0$

Que.40. Sports shoes have rubber soles rather than leather shoes because [Marks :(1)]

a. rubber soul is lighter than leather

b. rubber can be easily washed and clean

c. rubber gives a better appearance

d. rubber provides more fiction than leather

Ans. d. rubber provides more fiction than leather

Que.41. The rolling friction between Tyre and surface can be reduced if [Marks :(1)]

a. the surface is less rigid

b. the surface is more rigid

c. the radius of tyre is small

d. the surface is made rough

Ans. b. the surface is more rigid

Que.42. Why sand is thrown on tracks/roads covered with ice? [Marks :(2)]

Ans. For safe driving there should be sufficient friction between the tracks and wheels. When sand are thrown on snowy track the frictional force is increased which avoid slipping of wheels.

Que.43. Friction is a self adjusting force. Explain [Marks :(2)]

Ans. The frictional force increases with the applied force and in each step of increasing the force. The friction is adjusted to balance with and it attains a maximum. If the force is below this, the force of friction is self adjusting.

Que.44. In which case the observer is in an inertial frame [Marks :(1)]

a. a man in a satellite revolving the earth

b. a man in a car turning a sharp curve

c. a man in a bus moving with constant velocity

d. a man in an aeroplane at the speed of its take-off

Ans. c. a man in a bus moving with constant velocity

Que.45. Calculate the force required to pull a train of mass 500 tone up an inclination of 50 at a uniform speed of 72 km/hr. Coefficient of friction = 0.025 [Marks :(3)]

Ans. m = 500 tons = 500 X 103 kg

for an inclination of 50

F (total) = mg sinθ + μR

= mg sin θ + μ mg cos θ

= mg (sin θ + μ cos θ)

= 500 X 103 X 9.8 X(sin 50 + 0.025 cos 50)

F = 548.81 X 103 N

Que.46. Pulling a lawn roller is easier than pushing it. Why? [Marks :(2)]

Ans. The frictional force in the case of pushing is greater than that on pulling. The vertical component of the applied force is added to the weight of the roller when it is pushed, and it is

acting opposite to the weight when the roller is pulled. thus in the case of pulling the normal reaction and the frictional force are reduced.

Que.47. In equilibrium of particle when net external force of the particle is zero then the particle is **[Marks :(1)]**

a. at rest

b. with uniform velocity

c. moving with uniform acceleration

d. both a and b

Ans. d. both a and b

Que.48. A man of mass 55 kg stands on a weighing scale in a lift which is moving

i. upwards with uniform speed of 20 m/s? (1)

ii. downwards with uniform acceleration of 5 m/s2? (2)

iii. Upwards with uniform acceleration of 10 m/s2? (2)

What is the reading of the weighing scale in each case ? **[Marks :(5)]**

Ans. mass of man = 55 kg

acceleration ≈ 10 m/s2

i. as the lift is moving upward with a uniform speed, therefore, its acceleration a = 0

Normal reaction w = R = mg = 55 X 10 = 550 N

reading on weighing scale = 550/10 = 55 kg

ii. downward acceleration of the lift a = 5 m/s2

Normal reaction R = m(g – a) = 55 (10 – 5) = 275 N

Reading on the weighing scale = $\frac{275\ N}{10\ ms^{-1}}$ = 27.5 kg

iii. upward acceleration of the lift a = 10 m/s2

Normal reaction R = m(g +a) = 55 (10 + 10) = 1100 N

Reading on the weighing scale = $\frac{1100\ N}{10\ ms^{-1}}$ = 110 kg

Que.49. A man in a lift experience more weighs when ..... [Marks :(1)]

a. the lift begins to go up

b. the lift is going up steadily

c. the lift is slowing down

d. the lift is descending freely

Ans. a. the lift begins to go up

Que.50. Why seat belts are preferred while driving? [Marks :(2)]

Ans. To rescue the driver or passengers from the sudden change in motion or direction.

When a person driving a car suddenly applies brakes the lower part of his body slower down with the car while upper part of the body continuous to move forward due to inertia of motion. If he does not wearing seat belt, then he falls forward and his head hit against the steering wheel and get injured.

Que.51. The linear momentum of a particle varies directly as the square of time. The force on it is related to time is ..... [Marks :(1)]

a. $f \alpha t^2$

b. $f \alpha t$

c. $f \alpha \frac{1}{t^2}$

d. $f \alpha \frac{1}{t}$

Ans. b. $f \alpha t$

Que.52. What is the role of spring system in auto mobiles. [Marks :(2)]

Ans. When moving over the rough road the force exerted on the auto mobile is reduced by increasing the time of jerk with the compression action of spring. Therefore journey became comfortable and saves vehicles from damage.

Que.53. A shell at rest explodes into two fragments of mass in the ratio 2:3 The ratio of the speed of the fragment is [Marks :(1)]

a. 2 : 3

b. 3 : 2

c. 4 : 9

d. 9 : 4

Ans. b. 3 : 2

Que.54. Conservation of momentum in collision between particles can be understood from [Marks :(1)]

a. conservation of energy

b. Newton's first law

c. Newton's second law only

d. both Newton's second and third law

Ans. d. both Newton's second and third law

Que.55. Distinguish between impulse and impulsive force **[Marks :(2)]**

Ans. Impulse is the product of force and time for which the force acts.

Impulsive force is a very large force acting for a small interval of time.

Que.56. Apple fall down from the tree when it its branches are shaken. Explain

[Marks :(2)]

Ans. This is due to inertia. When the branches are shaken, apples are set in motion with the branches after a while and they get separated from the branches.

Que.57. While firing a gun, it must be held tight to the shoulder. Why?

[Marks :(1)]

Ans. This is to avoid the recoil effect of gun to the shoulder.

Que.58. A bus need more greater initial efforts than a motorcycle to put them in motion. Why?

[Marks :(2)]

Ans. According to Newton's second law of motion F = ma

For a given acceleration ‘a,’ if m is large, F should be more

ie, greater force will be required to put a larger mass in motion.

Thus bus needs more initial effort than a motorcycle.

Que.59. Newtons first law of motion describes the

a. energy

b. Work

c. Inertia

d. Moment of inertia

[Marks :(1)]

Ans. c. Inertia

Que.60. Suppose the earth suddenly stops attracting objects placed near surface. A person standing on the surface of earth will

a. remain standing

b. fly up

c. sink into Earth

d. either b or c

[Marks :(1)]

Ans. a. remain standing