LAWS OF MOTION

FACT/DEFINITION TYPE QUESTIONS

1. Inertia is the property of a body linked to tendency of a body
   (a) to change its position
   (b) to change its direction
   (c) to change the momentum
   (d) to resist any change in its state
2. Physical independence of force is a consequence of
   (a) third law of motion (b) second law of motion
   (c) first law of motion (d) all of these
3. Newton's first law of motion describes the
   (a) energy (b) work
   (c) inertia (d) moment of inertia
4. Force depends on
   (a) change in momentum
   (b) how fast the change in momentum is brought about
   (c) Both (a) & (b) (d) None of these
5. Which motion does not require force to maintain it ?
   (a) Uniform circular motion
   (b) Elliptical motion
   (c) Uniform straight line motion
   (d) Projectile motion
6. A ball is travelling with uniform translatory motion. This means that
   (a) it is at rest.
   (b) the path can be a straight line or circular and the ball travels with uniform speed.
   (c) all parts of the ball have the same velocity (magnitude and direction) and the velocity is constant.
   (d) the centre of the ball moves with constant velocity and the ball spins about its centre uniformly.
7. An object will continue moving uniformly when
   (a) the resultant force on it is increasing continuously
   (b) the resultant force is at right angles to its rotation
   (c) the resultant force on it is zero
   (d) the resultant force on it begins to decrease
8. External agencies like gravitational and magnetic forces ...X... exerts force on a body from a distance.
   Here, X refers to
   (a) can (b) cannot
   (c) never (d) None of these
9. According to Galileo's experiment for a double inclined plane, if slope of second plane is zero and planes are smooth, then a ball is released from rest on one of the planes rolls down and move on the second plane ...X... distance.
   Here, X is
   (a) zero
   (b) infinite
   (c) equal to length of first plane
   (d) None of these
10. When a body is stationary
    (a) there is no force acting on it
    (b) the force acting on it is not in contact with it
    (c) the combination of forces acting on it balances each other
    (d) the body is in vacuum
11. No force is required for
    (a) an object moving in straight line with constant velocity
    (b) an object moving in circular motion
    (c) an object moving with constant acceleration
    (d) an object moving in elliptical path.
12. If a stone is thrown out of an accelerated train, then acceleration of the stone at any instant depends on
    (a) force acting on it at that instant
    (b) acceleration of the train
    (c) Both (a) & (b) (d) None of these
13. Which of the following expression is correct?
    (a) $F = ma$ (b) $F = \frac{m}{a}$
    (c) $F = \frac{a}{m}$ (d) None of these
14. Newton's second law measures the
    (a) acceleration (b) force
    (c) momentum (d) angular momentum
15. A reference frame attached to the earth
    (a) is an inertial frame by definition
    (b) cannot be an inertial frame because earth is revolving round the sun
    (c) is an inertial frame because Newton's laws are applicable
    (d) is an inertial frame because the earth is rotating about its own axis

16. Impulse equals
(a) rate of change of momentum
(b) change in momentum
(c) momentum multiplied by time
(d) rate of change of force

17. The direction of impulse is
(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

18. A particle of mass m is moving with velocity v_1, it is given an impulse such that the velocity becomes v_2. Then magnitude of impulse is equal to
(a) $m(\vec{v}_2 - \vec{v}_1)$ (b) $m(\vec{v}_1 - \vec{v}_2)$
(c) $m \times (\vec{v}_2 - \vec{v}_1)$ (d) $0.5m(\vec{v}_2 - \vec{v}_1)$

19. Impulse is
(a) a scalar quantity
(b) equal to change in the momentum of a body
(c) equal to rate of change of momentum of a body
(d) a force

20. A large force is acting on a body for a short time. The impulse imparted is equal to the change in
(a) acceleration (b) momentum
(c) energy (d) velocity

21. China wares are wraped in straw of paper before packing. This is the application of concept of
(a) impulse (b) momentum
(c) acceleration (d) force

22. Which one of the following is not a force?
(a) Impulse (b) Tension
(c) Thrust (d) Air resistance

23. In which of the following cases, net force acting on the body is zero?
(a) A car moving with uniform velocity
(b) A book lying on the table
(c) Both (a) & (b)
(d) None of these

24. If the net external force on a body is ...X..., its acceleration is zero. Acceleration can be ...Y... only, if there is a net external force on the body. Here, X and Y refer to
(a) zero, zero (b) zero, non-zero
(c) non-zero, zero (d) non-zero, non-zero

25. The same change in momentum about in ...X... time needs ...Y... force applied. Here, X and Y refer to
(a) longer, lesser (b) shorter, greater
(c) both (a) and (b) (d) longer, greater

26. We can derive Newton's
(a) second and third laws from the first law
(b) first and second laws from the third law
(c) third and first laws from the second law
(d) All the three laws are independent of each other

27. Swimming is possible on account of
(a) first law of motion
(b) second law of motion
(c) third law of motion
(d) newton's law of gravitation

28. Newton's second and third laws of motion lead to the conservation of
(a) linear momentum (b) angular momentum
(c) potential energy (d) kinetic energy

29. Rocket engines lift a rocket from the earth surface, because hot gases with high velocity
(a) push against the air
(b) push against the earth
(c) react against the rocket and push it up
(d) heat up the air which lifts the rocket.

30. A cannon after firing recoils due to
(a) conservation of energy
(b) backward thrust of gases produced
(c) Newton's third law of motion
(d) Newton's first law of motion

31. A man is standing at the centre of frictionless pond of ice. How can he get himself to the shore?
(a) By throwing his shirt in vertically upward direction
(b) By spitting horizontally
(c) He will wait for the ice to melt in pond
(d) Unable to get at the shore

32. The acceleration of an astronaut is zero once he steps out of his accelerated spaceship in the intersteller space. this statement is in accordance with
(a) Newton's second law of motion
(b) Newton's first law of motion
(c) Newton's third law of motion
(d) All of these

33. Law of conservation of momentum follows from
(a) Newton's first law of motion
(b) Newton's second law of motion
(c) Newton's third law of motion
(d) Both (b) & (c)

34. A body whose momentum is constant must have constant
(a) velocity (b) force
(c) acceleration (d) All of the above

35. In an explosion, a body breaks up into two pieces of unequal masses. In this
(a) both parts will have numerically equal momentum
(b) lighter part will have more momentum
(c) heavier part will have more momentum
(d) both parts will have equal kinetic energy

36. A jet engine works on the principle of
(a) conservation of mass
(b) conservation of energy
(c) conservation of linear momentum
(d) conservation of angular momentum

37. Which one of the following motions on a smooth plane surface does not involve force?
(a) Accelerated motion in a straight line
(b) Retarded motion in a straight line
(c) Motion with constant momentum along a straight line
(d) Motion along a straight line with varying velocity

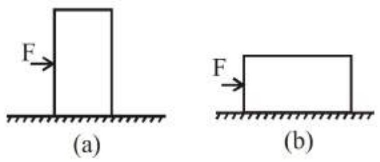
38. Identify the correct statement.
(a) Static friction depends on the area of contact
(b) Kinetic friction depends on the area of contact
(c) Coefficient of kinetic friction does not depend on the surfaces in contact
(d) Coefficient of kinetic friction is less than the coefficient of static friction

39. If the resultant of all the external forces acting on a system of particles is zero, then from an inertial frame, one can surely say that
(a) linear momentum of the system does not change in time
(b) kinetic energy of the system does not change in time
(c) angular momentum of the system does not change in time
(d) potential energy of the system does not change in time

40. Frictional force that opposes relative motion between surfaces in contact is called ...X... and denoted by ...Y.... Here, X and Y refer to
(a) static friction, f_s (b) kinetic friction, f_s
(c) kinetic friction, f_k (d) static friction, f_k

41. The coefficient of static friction between two surfaces depends upon
(a) the normal reaction
(b) the shape of the surface in contact
(c) the area of contact
(d) None of the these

42. A rectangular block is placed on a rough horizontal surface in two different ways as shown, then



(a) friction will be more in case (a)
(b) friction will be more in case (b)
(c) friction will be equal in both the cases
(d) friction depends on the relations among its dimensions.

43. If the normal force is doubled, then coefficient of friction is
(a) halved (b) tripled
(c) doubled (d) not changed

44. When a box is in stationary position with respect to train moving with acceleration, then relative motion is opposed by the ...X.... Which provides the same acceleration to the box as that of the train, keeping it stationary relative to the train. Here, X refers to
(a) kinetic friction (b) static friction
(c) limiting friction (d) None of these

45. If μ_s, μ_k and μ_r are coefficients of static friction, kinetic friction and rolling friction, then
(a) $\mu_s < \mu_k < \mu_f$ (b) $\mu_k < \mu_r < \mu_s$
(c) $\mu_r < \mu_k < \mu_s$ (d) $\mu_r = \mu_k = \mu_s$

46. It is difficult to move a cycle with brakes on because
(a) rolling friction opposes motion on road
(b) sliding friction opposes motion on road
(c) rolling friction is more than sliding friction
(d) sliding friction is more than rolling friction

47. Which of the following statements about friction is true?
(a) Friction can be reduced to zero
(b) Frictional force cannot accelerate a body
(c) Frictional force is proportional to the area of contact between the two surfaces
(d) Kinetic friction is always greater than rolling friction

48. A thin cushion of air maintained between solid surfaces in ...X... is another effective way of ...Y... friction. Here, X and Y refer to
(a) relative motion, reducing
(b) motion, increasing
(c) relative motion, increasing
(d) None of these

49. What are the effects if force is acting on a moving body in a direction perpendicular to the direction of motion?
(a) The speed changes uniformly
(b) The acceleration changes uniformly
(c) The direction of motion changes
(d) All of these

50. When a car moves on a level road, then the centripetal force required for circular motion is provided by ________
(a) weight of the car
(b) normal reaction
(c) component of friction between the road & tyres along the surface.
(d) All of these

51. On a banked road, which force is essential to provide the necessary centripetal force to a car to take a turn while driving at the optimum speed?
(a) Component of normal reaction
(b) Component of frictional force
(c) Both (a) & (b) (d) None of these

52. Which of the following forces does not act on a body moving in uniform circular motion?
(a) Centripetal force (b) Weight of the body
(c) Normal reaction (d) Force of friction

53. A particle revolves round a circular path. The acceleration of the particle is inversely proportional to
(a) radius (b) velocity
(c) mass of particle (d) both (b) and (c)

54. A cyclist taking turn bends inwards while a car passenger taking the same turn is thrown outwards. The reason is
(a) car is heavier than cycle
(b) car has four wheels while cycle has only two
(c) difference in the speed of the two
(d) cyclist has to counteract the centrifugal force while in the case of car only the passenger is thrown by this force

55. A car takes a circular turn with a uniform speed u. If the reaction at inner and outer wheels be denoted by R_1 and R_2, then
(a) $R_1 = R_2$ (b) $R_1 < R_2$
(c) $R_1 > R_2$ (d) None of these

56. A cyclist bends while taking turn in order to
(a) reduce friction
(b) provide required centripetal force
(c) reduce apparent weight
(d) reduce speed

STATEMENT TYPE QUESTIONS

57. Consider the following statements and select the incorrect statement(s).
I. To move a football at rest, some one must kick it.
II. To throw a stone upwards, one has to give it an upward push.
III. A breeze causes the branches of a tree to become stationary.
IV. A strong wind can move even heavy objects.
(a) Only I (b) Only III
(c) III and IV (d) I and II

58. Which of the following statements is/are correct ?
I. Newton's first law of motion defines force
II. Newton's first law of motion defines inertia
III. Newton's first law of motion is a measure of force
(a) I only (b) II and III
(c) I and III (d) I and II

59. Choose the incorrect statement(s) from the following.
I. If a body is not in rest position, then the net external force acting on it cannot be zero.
II. If the net force acting on a body be zero then the body will essentially remain at rest.
(a) I only (b) II only
(c) I and II (d) None of these

60. There are different types of inertia called
I. Inertia of rest.
II. Inertia of motion.
III. Inertia of direction.
IV. Inertia of shape.
Choose the correct option.
(a) I and II (b) I, II and III
(c) I, II, III and IV (d) None of these

61. Which of the following statements is/are correct about action and reaction forces?
I. Action and reaction are simultancous forces
II. There is no cause-effect relation between action and reaction.
III. Action and reaction always on two different body
(a) I only (b) II only
(c) III only (d) I, II and III

62. Which of the following statements is/are incorrect, when a person walks on a rough surface?
I. The frictional force exerted by the surface keeps him moving
II. The force which the man exerts on the floor keeps him moving
III. The reaction of the force which the man exerts on floor keeps him moving
(a) I only (b) II only
(c) I and III (d) I and II

63. Select the wrong statement(s) from the following.
I. Newton's laws of motion hold good for both inertial and non-inertial frames
II. During explosion, linear momentum is conserved
III. Force of friction is zero when no driving force is applied
(a) I only (b) II only
(c) I and II (d) II and III

64. Choose the correct statement(s) from the following.
I. Recoiling of a gun is an application of principle of conservation of linear momentum.
II. Explosion of a bomb is based on second law of motion
(a) I only (b) II only
(c) I and II (d) None of these

65. Select the incorrect statement(s) about static friction.
I. Static friction exists on its own
II. In the absence of applied force static friction is maximum
III. Static friction is equal and opposite to the applied force upto a certain limit
(a) I only (b) II and III
(c) I and III (d) I and II

66. Select the incorrect statement(s) from the following.
I. Limiting friction is always greater than the kinetic friction
II. Limiting friction is always less than the static friction
III. Coefficient of static fiction is always greater than the coefficient of kinetic fiction
(a) I only (b) I and III
(c) II and III (d) I and II

MATCHING TYPE QUESTIONS

67. Match the column I and II.

Column I	Column II
(A) Inertia	(1) 10^5 $gcms^{-1}$
(B) Recoil of gun	(2) kg f
(C) 1 kg ms^{-1}	(3) Newton's third law of motion
(D) Weight	(4) Newton's first law of motion

(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(4); (B)→(3); C→(1); (D)→(2)
(c) (A)→(3); (B)→(2); C→(4); (D)→(1)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

68.

Column I	Column II
(A) Unbalanced	(1) Acts on two different bodies
(B) Action & Reaction	(2) Inability to change the state
(C) Inertia	(3) *mv*
(D) Momentum	(4) Variable velocity

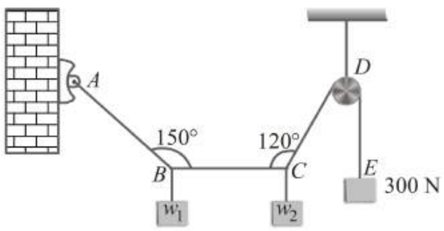
(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(1); (B)→(2); C→(4); (D)→(3)
(c) (A)→(3); (B)→(2); C→(4); (D)→(1)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

69.

Column I	Column II
(A) Accelerated motion	(1) Newton's 1st law
(B) Impulse	(2) Mass
(C) Law of inertia	(3) Force×time
(D) Measure of inertia	(4) Change in speed and direction

(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(4); (B)→(2); C→(1); (D)→(3)
(c) (A)→(3); (B)→(4); C→(1); (D)→(2)
(d) (A)→(4); (B)→(3); C→(1); (D)→(2)

70. A light string *ABCDE* whose extremity *A* is fixed, has weights W_1 and W_2 attached to it at *B* and *C*. It passes round a small smooth peg at *D* carrying a weight of 300 N at the free end *E* as shown in figure. If in the equilibrium position, *BC* is horizontal and *AB* and *CD* make 150° and 120° with *CB*. Match the columns :



Column I	Column II
(A) Tension in portion *AB*, T_{AB}	(1) 150 N
(B) Tension in portion *BC*, T_{BC}	(2) 173 N
(C) Weight, W_1	(3) 260 N
(D) Weight, W_2	(4) 87 N

(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(2); (B)→(1); C→(4); (D)→(3)
(c) (A)→(3); (B)→(4); C→(1); (D)→(3)
(d) (A)→(4); (B)→(3); C→(1); (D)→(2)

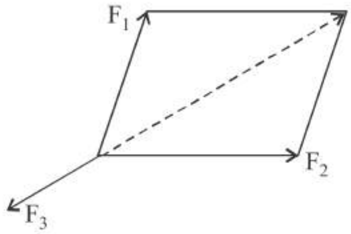
71.

Column I	Column II
(A) Rocket's work	(1) Momentum
(B) $F = ma$	(2) Uniform motion
(C) Quantity of motion	(3) Conservation of momentum
(D) Constant force	(4) Newton's second law

(a) (A)→(4); (B)→(1); C→(2); (D)→(3)
(b) (A)→(4); (B)→(3); C→(1); (D)→(2)
(c) (A)→(3); (B)→(4); C→(1); (D)→(2)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

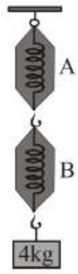
DIAGRAM TYPE QUESTIONS

72. Which equation holds true for the given figure?



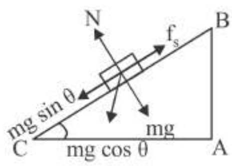
(a) $F_1 - F_2 = F_3$
(b) $F_1 + F_2 = F_3$
(c) $F_1 + F_2 + F_3 = 0$
(d) $F_2 + F_3 = F_1$

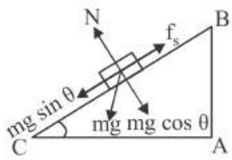
73. A block of mass 4 kg is suspended through two light spring balances A and B. Then A and B will read respectively :

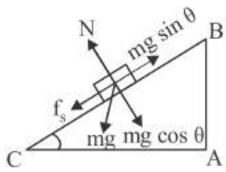


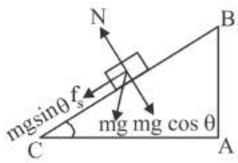
(a) 4 kg and zero kg
(b) zero kg and 4 kg
(c) 4 kg and 4 kg
(d) 2 kg and 2 kg

74. Which figure shows the correct force acting on the body sliding down an inclined plane? (m → mass, f_s → force of friction)

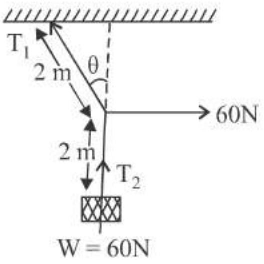
(a)


(b)


(c)


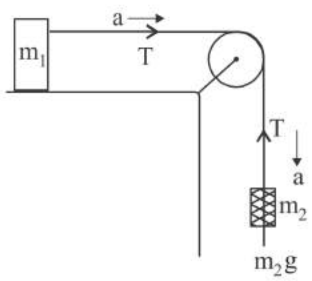
(d)


75. For the given situation as shown in the figure, the value of θ to keep the system in equilibrium will be



(a) 30° (b) 45°
(c) 0° (d) 90°

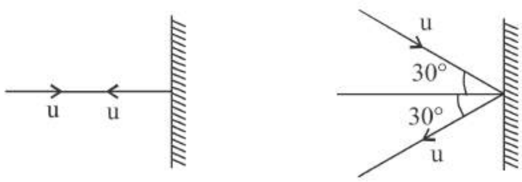
76. The acceleration of the system shown in the figure is given by the expression (ignore force of friction)



(a) $a = \frac{m_2 g}{(m_1 + m_2)}$ (b) $a = \frac{m_1 g}{(m_1 + m_2)}$

(c) $a = \frac{m_1}{(m_1 + m_2) g}$ (c) $a = \frac{m_2}{(m_1 + m_2) g}$

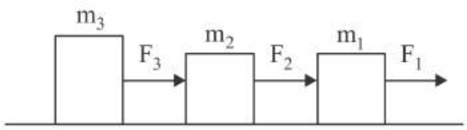
77. What is the direction of force on the wall due to the ball in two cases shown in the figures?



(a) (b)

(a) In (a) force is normal to the wall and in (b) force is inclined at 30° to the normal.
(b) In (a) force is normal to the wall and in (b) force is inclined at 60° to the normal.
(c) In (a) the force is along the wall and in (b) force is normal to the wall.
(d) In (a) and (b) both the force is normal to the wall.

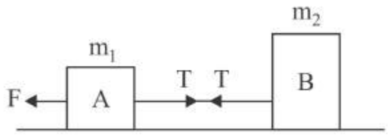
78. For the system shown in figure, the correct expression is



(a) $F_3 = F_1 + F_2$ (b) $F_3 = \frac{m_3 F}{F_1 + F_2 + F_3}$

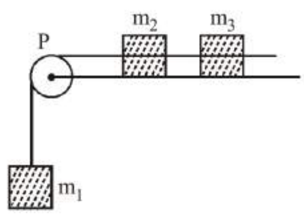
(c) $F_3 = \frac{m_3 F}{m_1 + m_2 + m_3}$ (d) $F_3 = \frac{m_3 F}{m_1 + m_2}$

79. Which of the following is true about acceleration, a for the system?



(a) Acceleration is more in A, when force is applied on A.
(b) Acceleration is more in B, when force is applied on B.
(c) Acceleration is same and does not depend on whether the force is applied on m_1 or m_2
(d) Acceleration depends on the tension in the string.

80. A system consists of three masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (the coefficient of friction = μ). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is : (Assume $m_1 = m_2 = m_3 = m$)



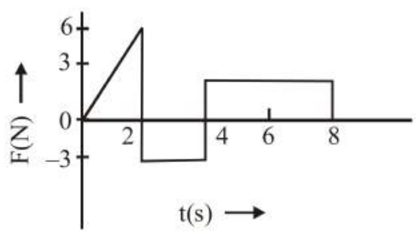
(a) $\frac{g(1 - g\mu)}{g}$

(b) $\frac{2g\mu}{3}$

(c) $\frac{g(1 - 2\mu)}{3}$

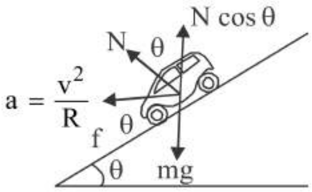
(d) $\frac{g(1 - 2\mu)}{2}$

81. The force 'F' acting on a particle of mass 'm' is indicated by the force-time graph shown below. The change in momentum of the particle over the time interval from zero to 8 s is :



(a) 24 Ns (b) 20 Ns
(c) 12 Ns (d) 6 Ns

82. The motion of a car on a banked road is shown in the figure. The centripetal force equation will be given by



(a) $N\sin\theta + f\cos\theta = \frac{mv^2}{R}$ (b) $f = \frac{mv^2}{R}$

(c) $N\cos\theta + f = \frac{mv^2}{R}$ (d) $N\sin\theta + f = \frac{mv^2}{R}$

ASSERTION- REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

83. Assertion : Mass is a measure of inertia of the body in linear motion.
Reason : Greater the mass, greater is the force required to change its state of rest or of uniform motion.

84. Assertion : An object can move with constant velocity if no net force acts on it.
Reason : No net force is needed to move an object with constant velocity.

85. Assertion : If the net external force on the body is zero, then its acceleration is zero.
Reason : Acceleration does not depend on force.

86. Assertion : For the motion of electron around nucleus, Newton's second law is used.
Reason : Newton's second law can be used for motion of any object.

87. Assertion : Impulse of force and momentum are same physical quantities.
Reason : Both quantities have same unit.

88. Assertion: A cricketer moves his hands forward to catch a ball so as to catch it easily without hurting.
Reason: He tries to decrease the distance travelled by the ball so that it hurts less.

89. Assertion: Same force applied for the same time causes the same change in momentum for different bodies
Reason: The total momentum of an isolated system of interacting bodies remains conserved.

90. Assertion : A bullet is fired from a rifle. If the rifle recoils freely, the kinetic energy of rifle is more than that of the bullet.
Reason : In case of rifle bullet system, the law of conservation of momentum violates.

91. Assertion : A rocket works on the principle of conservation of linear momentum.
Reason : Whenever there is change in momentum of one body, the same change occurs in the momentum of the second body of the same system but in the opposite direction.

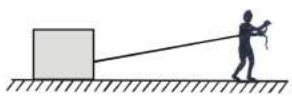
92. Assertion : The two bodies of masses M and m ($M > m$) are allowed to fall from the same height if the air resistance for each be the same then both the bodies will reach the earth simultaneously.
Reason : For same air resistance, acceleration of both the bodies will be same.

93. Assertion : A block placed on a table is at rest, because action force cancels the reaction force on the block.
Assertion : The net force on the block is zero.

94. Assertion : On a rainy day, it is difficult to drive a car or bus at high speed.
Reason : The value of coefficient of friction is lowered due to wetting of the surface.

95. Assertion : Frictional forces are conservating forces.
Reason : Potential energy can be associated with frictional forces.

96. Assertion : A man and a block rest on smooth horizontal surface. The man holds a rope which is connected to block. The man cannot move on the horizontal surface.



Reason : A man standing at rest on smooth horizontal surface cannot start walking due to absence of friction (The man is only in contact with floor as shown).

97. Assertion: Friction is a necessary evil
Reason: Though friction dissipates power, but without friction we cannot walk.

98. Assertion: There is a stage when frictional force is not needed at all to provide the necessary centripetal force on a banked road.
Reason: On a banked road, due to its inclination the vehicle tends to remain inwards without any chances of skidding.

99. Assertion : Force is required to move a body uniformly along a circle.
Reason : When the motion is uniform, acceleration is zero.

100. **Assertion :** Linear momentum of a body changes even when it is moving uniformly in a circle.
Reason : In uniform circular motion, velocity remains constant.

101. **Assertion :** A cyclist always bends inwards while negotiating a curve.
Reason : By bending, cyclist lowers his centre of gravity.

CRITICALTHINKING TYPE QUESTIONS

102. A boy, sitting on the topmost birth in the compartment of a train which is just going to stop on the railway station, drops an apple aiming at the open hand of his brother situated vertically below his own hand at a distance of 2m. The apple will fall
(a) in the hand of his brother
(b) slightly away from the hand of his brother in the direction of motion of the train
(c) slightly away from the hand of his brother opposite to the direction of motion of the train
(d) None of the above

103. A person sitting in an open car moving at constant velocity throws a ball vertically up into air. The ball falls
(a) outside the car
(b) in the car ahead of the person
(c) in the car to the side of the person
(d) exactly in the hand which threw it up

104. If a stone of mass 0.05 kg is thrown out a window of a train moving at a constant speed of 100 km/h then magnitude of the net force acting on the stone is
(a) 0.5 N (b) zero
(c) 50 N (d) 5 N

105. A closed compartment containing gas is moving with same acceleration in horizontal direction. Neglect effect of gravity. Then the pressure in the compartment is
(a) same everywhere (b) lower in front side
(c) lower in rear side (d) lower in upper side

106. When an elevator cabin falls down, the cabin and all the bodies fixed in the cabin are accelerated with respect to
(a) ceiling of elevator (b) floor of elevator
(c) man standing on earth
(d) man standing in the cabin

107. A monkey is climbing up a rope, then the tension in the rope
(a) must be equal to the force applied by the monkey on the rope
(b) must be less than the force applied by the monkey on the rope.
(c) must be greater than the force applied by the monkey on the rope.
(d) may be equal to, less than or greater the force applied by the monkey on the rope.

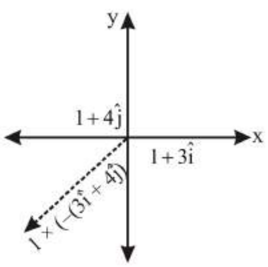
108. A metre scale is moving with uniform velocity. This implies
(a) the force acting on the scale is zero, but a torque about the centre of mass can act on the scale.
(b) the force acting on the scale is zero and the torque acting about centre of mass of the scale is also zero.
(c) the total force acting on it need not be zero but the torque on it is zero.
(d) neither the force nor the torque need to be zero.

109. A body of mass M hits normally a rigid wall with velocity V and bounces back with the same velocity. The impulse experienced by the body is
(a) MV (b) 1.5 MV (c) 2 MV (d) zero

110. If rope of lift breaks suddenly, the tension exerted by the surface of lift (a = acceleration of lift)
(a) mg (b) $m(g + a)$
(c) $m(g - a)$ (d) 0

111. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1 kg moves with a speed of 12 ms^{-1} and the second part of mass 2 kg moves with speed 8 ms^{-1}. If the third part flies off with speed 4 ms^{-1} then its mass is
(a) 5 kg (b) 7 kg
(c) 17 kg (d) 3 kg

112. A stationary body of mass 3 kg explodes into three equal pieces. Two of the pieces fly off in two mutually perpendicular directions, one with a velocity of $3\hat{i}\ ms^{-1}$ and the other with a velocity of $4\hat{j}\ ms^{-1}$. If the explosion occurs in 10^{-4} s, the average force acting on the third piece in newton is
(a) $(3\hat{i}+4\hat{j})\times 10^{-4}$
(b) $(3\hat{i}-4\hat{j})\times 10^{-4}$
(c) $(3\hat{i}-4\hat{j})\times 10^{4}$
(d) $-(3\hat{i}+4\hat{j})\times 10^{4}$



113. A spacecraft of mass 100 kg breaks into two when its velocity is 10^4 m s^{-1}. After the break, a mass of 10 kg of the space craft is left stationary. The velocity of the remaining part is
(a) 10^3 m s^{-1} (b) 11.11×10^3 ms^{-1}
(c) 11.11×10^2 m s^{-1} (d) 10^4 m s^{-1}

114. A ball is thrown up at an angle with the horizontal. Then the total change of momentum by the instant it returns to ground is
(a) acceleration due to gravity × total time of flight
(b) weight of the ball × half the time of flight
(c) weight of the ball × total time of flight
(d) weight of the ball × horizontal range

115. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of $5\,m/s^2$, the reading of the spring balance will be

(a) 24 N (b) 74 N
(c) 15 N (d) 49 N

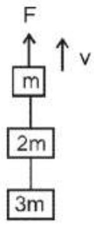
116. A block of mass *m* is placed on a smooth wedge of inclination θ. The whole system is accelerated horizontally so that the block does not slip on the wedge. The force exerted by the wedge on the block (g is acceleration due to gravity) will be

(a) $mg/\cos\theta$ (b) $mg\cos\theta$
(c) $mg\sin\theta$ (d) mg

117. A person of mass 60 kg is inside a lift of mass 940 kg and presses the button on control panel. The lift starts moving upwards with an acceleration $1.0\ m/s^2$. If $g = 10\ ms^{-2}$, the tension in the supporting cable is

(a) 8600 N (b) 9680 N
(c) 11000 N (d) 1200 N

118. Three blocks with masses m, 2 m and 3 m are connected by strings as shown in the figure. After an upward force F is applied on block m, the masses move upward at constant speed v. What is the net force on the block of mass 2m? (g is the acceleration due to gravity)



(a) 2 mg
(b) 3 mg
(c) 6 mg
(d) zero

119. The net force on a rain drop falling down with a constant speed is ________

(a) weight of drop W
(b) viscous drag of air F
(c) W + F + force of buoyany
(d) zero

120. If two masses (M & m) are connected on a horizontal plane and a force is applied on the combination, then the tension T depends on

(a) the force applied on the system
(b) whether force is applied on M or m
(c) both (a) and (b)
(d) Can't be predicted.

121. A body is imparted motion from rest to move in a straight line. If it is then obstructed by an opposite force, then

(a) the body may necessarily change direction
(b) the body is sure to slow down
(c) the body will necessarily continue to move in the same direction at the same speed
(d) None of these

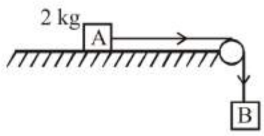
122. The force required to just move a body up the inclined plane is double the force required to just prevent the body from sliding down the plane. The coefficient of friction is μ. The inclination θ of the plane is

(a) $\tan^{-1}\mu$ (b) $\tan^{-1}(\mu/2)$
(c) $\tan^{-1}2\mu$ (d) $\tan^{-1}3\mu$

123. A hockey player is moving northward and suddenly turns westward with the same speed to avoid an opponent. The force that acts on the player is

(a) frictional force along westward
(b) muscles force along southward
(c) frictional force along south-west
(d) muscle force along south-west

124. The coefficient of static friction μ_s, between block A of mass 2 kg and the table as shown in the figure is 0.2. What would be the maximum mass value of block B so that the two blocks do not move? The string and the pulley are assumed to be smooth and massless. $(g = 10\ m/s^2)$



(a) 0.4 kg (b) 2.0 kg
(c) 4.0 kg (d) 0.2 kg

125. A conveyor belt is moving at a constant speed of 2m/s. A box is gently dropped on it. The coefficient of friction between them is $\mu = 0.5$. The distance that the box will move relative to belt before coming to rest on it taking $g = 10\ ms^{-2}$, is

(a) 1.2 m (b) 0.6 m (c) zero (d) 0.4 m

126. The upper half of an inclined plane of inclination θ is perfectly smooth while lower half is rough. A block starting from rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by

(a) $\mu = \dfrac{2}{\tan\theta}$ (b) $\mu = 2\tan\theta$
(c) $\mu = \tan\theta$ (d) $\mu = \dfrac{1}{\tan\theta}$

127. A marble block of mass 2 kg lying on ice when given a velocity of 6 m/s is stopped by friction in 10 s. Then the coefficient of friction is (Take $g = 10\ ms^{-2}$)

(a) 0.06 (b) 0.03
(c) 0.04 (d) 0.01

128. A block rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force on the block is 10 N, the mass of the block (in kg) is (take $g = 10\ m/s^2$)

(a) 1.6 (b) 4.0
(c) 2.0 (d) 2.5

129. A given object takes n times as much time to slide down a 45° rough incline as it takes to slide down a perfectly smooth 45° incline. The coefficient of kinetic friction between the object and incline is given by

(a) $\left(1-\frac{1}{n^2}\right)$ (b) $\frac{1}{1-n^2}$

(c) $\sqrt{\left(1-\frac{1}{n^2}\right)}$ (d) $\sqrt{\left(\frac{1}{1-n^2}\right)}$

130. The minimum force required to start pushing a body up rough (frictional coefficient μ) inclined plane is F_1 while the minimum force needed to prevent it from sliding down is F_2. If the inclined plane makes an angle θ from the horizontal such that $\tan\theta = 2\mu$ then the ratio $\frac{F_1}{F_2}$ is

(a) 1 (b) 2

(c) 3 (d) 4

131. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion of the particle takes place in a plane. It follows that

(a) its velocity is constant

(b) its acceleration is constant

(c) its kinetic energy is constant

(d) it moves in a straight line.

132. If n bullets each of mass m are fired with a velocity v per second from a machine gun, the force required to hold the gun in position is

(a) $(n+1)mv$ (b) $\frac{mv}{n^2}$

(c) $\frac{mv}{n}$ (d) mnv

133. A car moves at a speed of 20 ms^{-1} on a banked track and describes an arc of a circle of radius $40\sqrt{3}$ m. The angle of banking is ($g = 10\ ms^{-2}$)

(a) 25° (b) 60°

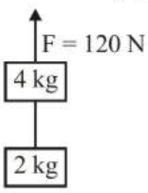
(c) 45° (d) 30°

134. A ball of mass 10 g moving perpendicular to the plane of the wall strikes it and rebounds in the same line with the same velocity. If the impulse experienced by the wall is 0.54 Ns, the velocity of the ball is

(a) 27 ms^{-1} (b) 3.7 ms^{-1}

(c) 54 ms^{-1} (d) 37 ms^{-1}

135. Two blocks of masses 2 kg and 4 kg are attached by an inextensible light string as shown in the figure. If a force of 120 N pulls the blocks vertically upward, the tension in the string is (take $g = 10\ ms^{-2}$)



(a) 20 N

(b) 15 N

(c) 35 N

(d) 40 N

136. A block of mass m is placed on a surface with a vertical cross section given by $y = \frac{x^3}{6}$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is:

(a) $\frac{1}{6}$m (b) $\frac{2}{3}$m

(c) $\frac{1}{3}$m (d) $\frac{1}{2}$m

137. Two bodies of masses 1 kg and 2 kg moving with same velocities are stopped by the same force. Then the ratio of their stopping distances is

(a) 1 : 2 (b) 2 : 1

(c) $\sqrt{2}$: 1 (d) 1 : $\sqrt{2}$

138. A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the table is μ_k. When the block A is sliding on the table, the tension in the string is

(a) $\frac{(m_2 - \mu k\, m_1)g}{(m_1 + m_2)}$ (b) $\frac{m_1 m_2(1+\mu_k)g}{(m_1 + m_2)}$

(c) $\frac{m_1 m_2(1-\mu_k)g}{(m_1 + m_2)}$ (d) $\frac{(m_2 + \mu_k\, m_1)g}{(m_1 + m_2)}$

139. The retarding acceleration of 7.35 m s^{-2} due to frictional force stops the car of mass 400 kg travelling on a road. The coefficient of friction between the tyre of the car and the road is

(a) 0.55 (b) 0.75

(c) 0.70 (d) 0.65

140. A hammer weighing 3 kg strikes the head of a nail with a speed of 2 ms^{-1} drives it by 1 cm into the wall. The impulse imparted to the wall is

(a) 6Ns (b) 3Ns

(c) 2Ns (d) 12 Ns

141. A balloon with mass 'm' is descending down with an acceleration 'a' (where a < g). How much mass should be removed from it so that it starts moving up with an acceleration 'a'?

(a) $\frac{2ma}{g+a}$ (b) $\frac{2ma}{g-a}$

(c) $\frac{ma}{g+a}$ (d) $\frac{ma}{g-a}$

142. The time required to stop a car of mass 800 kg, moving at a speed of 20 ms^{-1} over a distance of 25 m is

(a) 2s (b) 2.5s
(c) 4s (d) 4.5s

143. A particle rests on the top of a hemisphere of radius R. Find the smallest horizontal velocity that must be imparted to the particle if it is to leave the hemisphere without sliding down is

(a) $\sqrt{gR}$ (b) $\sqrt{2gR}$
(c) $\sqrt{3gR}$ (d) $\sqrt{5gR}$

144. A train is moving with a speed of 36 km/hour on a curved path of radius 200 m. If the distance between the rails is 1.5 m, the height of the outer rail over the inner rail is

(a) 1m (b) 0.5m
(c) 0.75m (d) 0.075m

145. A car moving on a horizontal road may be thrown out of the road in taking a turn

(a) by the gravitational force
(b) due to the lack of proper centripetal force
(c) due to the rolling frictional force between the tyre and road
(d) due to the reaction of the ground

146. A car sometimes overturns while taking a turn. When it overturns, it is

(a) the inner wheel which leaves the ground first
(b) the outer wheel which leaves the ground first
(c) both the wheel leave the ground simultaneously
(d) either wheel will leave the ground first

147. On a railway curve the outside rail is laid higher than the inside one so that resultant force exerted on the wheels of the rail car by the tops of the rails will

(a) have a horizontal inward component
(b) be vertical
(c) equilibriate the centripetal force
(d) be decreased

148. A sphere is suspended by a thread of length ℓ. What minimum horizontal velocity has to be imparted to the sphere for it to reach the height of the suspension?

(a) $g\ell$ (b) $2g\ell$
(c) $\sqrt{g\ell}$ (d) $\sqrt{2g\ell}$

149. A car when passes through a bridge exerts a force on it which is equal to

(a) $Mg + \frac{Mv^2}{r}$ (b) $\frac{Mv^2}{r}$
(c) $Mg - \frac{Mv^2}{r}$ (d) None of these

150. A bridge is in the from of a semi-circle of radius 40m. The greatest speed with which a motor cycle can cross the bridge without leaving the ground at the highest point is ($g = 10\ m\ s^{-2}$) (frictional force is negligibly small)

(a) $40\ m\ s^{-1}$ (b) $20\ m\ s^{-1}$
(c) $30\ m\ s^{-1}$ (d) $15\ m\ s^{-1}$

151. A particle tied to a string describes a vertical circular motion of radius r continually. If it has a velocity $\sqrt{3\,gr}$ at the highest point, then the ratio of the respective tensions in the string holding it at the highest and lowest points is

(a) 4:3 (b) 5:4
(c) 1:4 (d) 3:2

HINTS AND SOLUTIONS

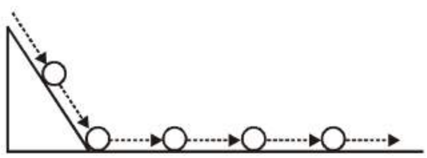
FACT/DEFINITION TYPE QUESTIONS

1. **(d)** Inertia is defined as the ability of a body to oppose any change in its state of rest or of uniform motion.
2. **(c)** Newton's first law of motion is related to the physical independence of force.
3. **(c)** Newton's first law of motion defines the inertia of body. It states that every body has a tendency to remain in its state (either rest or motion) due to its inertia.
4. **(c)** According to Newton's 2nd law of motion

$$F = \frac{\text{change in momentum}}{\text{time}}$$

Thus force depends directly on the rate of change of momentum.

5. **(c)** According to Newton's second law of motion,
$F = ma$
When body is moving uniformly along a straight line and there is no force of friction, acceleration / retardation of the body $a = 0$,
$\therefore \quad F = ma = 0$
i.e, no external force is required.
For accelerated motion, force is necessary. In uniform circular motion, elliptical motion and projectile motion direction of velocity changes due to which force is imposed.
6. **(c)**
7. **(c)** The body will continue accelerating until the resultant force acting on the body becomes zero.
8. **(a)** External agencies like gravitational and magnetic forces can exert force on body from distance. When ball is released from some height. Earth exerts gravitational force from distance, ball moves faster with time.
9. **(b)**



On second plane ball will move with constant velocity because no external force is there to provide acceleration or retardation.

10. **(c)** From Newton's second law if $\Sigma F_i = 0$ then the body is in translational equilibrium.
11. **(a)** No force is required for an object moving in straight line with constant velocity or for non acceleration motion.
12. **(a)** Since force at a point at any instant is related to the acceleration at that point, at that instant and acceleration is determined only by the instantaneous force and not by any history of the motion of the particle. Therefore, the moment the stone is thrown out of an accelerated train, it has no horizontal force and acceleration, if air resistance is neglected.
13. **(a)**
14. **(b)** $F = \frac{dp}{dt}$
15. **(b)** The frame of reference which are at rest or in uniform motion are called inertial frames while frames which are accelerated with respect to each other are non–inertial frames. Spinning or rotating frames are accelerated frame, hence these are non-inertial frames.
16. **(b)** Impulse = Force × time duration. ...(1)
According to Newton's second law

$$\text{Force} = \frac{\text{Change in momentum}}{\text{time duration}} \quad ...(2)$$

$\therefore$ Force × time = change in momentum
i.e., Impulse = change is momentum.
17. **(a)**
18. **(a)** Impulse = change in momentum = $m\vec{v}_2 - m\vec{v}_1$
19. **(b)** $F = \frac{\Delta P}{\Delta t}$ and impulse = F. ΔT
20. **(b)** If a large force F acts for a short time dt the impulse imparted I is

$$I = F.dt = \frac{dp}{dt}.dt$$

$I = dp$ = change in momentum
21. **(a)**
22. **(a)** Impulse is not a force.
Impulse = Force × Time duration
23. **(c)** A book lying on the table is acted by its weight downwards and a reaction upwards.
A car moving on a road, has an applied forward force and force of friction acts backwards. Thus it moves with constant velocity.
Force, F = ma, if a = 0, then $F_{net} = 0$
24. **(b)** If the net external force on a body is **zero**, its acceleration is zero.
Acceleration can be **non-zero** only if there is net external force on the body. This is concluded from Newton's first law of motion.
25. **(c)** As $f_{ext} = \frac{\Delta P}{\Delta t}$, if $\frac{\Delta P}{\Delta t}$ = constant
i.e, $f_{ext} \propto \Delta t$ = constant. If force is small time taken is more and if force is large time taken is less.

26. (c)

27. (c) Swimming is a result of pushing water in the opposite direction of the motion.

28. (a) Newton's second and third laws of motion leads to the conservation of linear momentum.

29. (c) Hot gases with high velocity react against the rocket and push it up.

30. (c) The gun applied a force F_{12} on the bullet in forward direction & according to Newton's third law bullet applies a reaction force on gun F_{21} in backward direction. But the recoil speed of gun is very low in comparison to bullet due to large mass.

31. (b)

32. (b) Since no nearby stars are there to exert gravitational force on the astronaut, so the net force acting on him is zero when he moves out of the spaceship. Thus in accordance with first law of motion the acceleration of astronaut will be zero.

33. (d)

34. (a) It works on the principle of conservation of linear momentum.

35. (a) If m_1, m_2 are masses and u_1, u_2 are velocity then by conservation of momentum $m_1u_1 + m_2u_2 = 0$ or $|m_1u_1| = |m_2u_2|$

36. (c)

37. (c) Motion with constant momentum along a straight line. According to Newton's second law rate of change of momentum is directly proportional to force applied.

38. (d) $\mu_k < \mu_s$ coefficient of static friction is always greater than kinetic friction.

39. (a) Since there in no resultant external force, linear momentum of the system remains constant.

40. (c) Frictional force that opposes relative motion between surfaces in contact is called kinetic friction and denoted by f_k.

41. (a) Coefficient of static friction $= \dfrac{\text{force of friction}}{\text{normal reaction}}$

Therefore, coefficient of static friction depends upon the normal reaction.

42. (c) Friction does not depend on area of surfaces in contact.

43. (d) Coefficient of friction is independent of normal force.

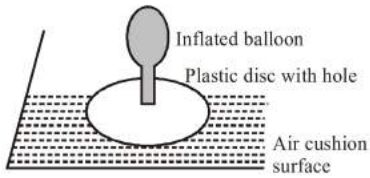
44. (b) When a box is in stationary position with respect to train moving with acceleration, then relative motion is opposed by the static friction.

45. (c)

46. (d) When brakes are on, the wheels of the cycle will slide on the road instead of rolling there. It means the sliding friction will come into play instead of rolling friction. The value of sliding friction is more than that of rolling friction.

47. (d)

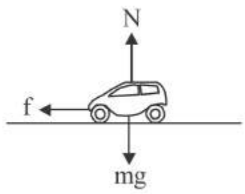
48. (a) A thin cushion of air maintained between solid surfaces in relative motion is another effective way or reducing friction



Because of air cushion between plastic disc and surface, there is very less friction between plastic disc and surface. So plastic disc can be moved on surface with very less frictional dissipation of energy. This is because friction between solid and air is very small.

49. (c) When force is applied on a moving body in a direction perpendicular to the direction of motion, then it takes a circular path. Thus the direction of motion changes without changes in the speed.

50. (c) Normal reaction N = weight mg thus the centripetal force required by the car for circular motion is provided by the component of the force of friction b/w the road and the car tyres.



51. (a) Optimum speed is given by $V_0 = (Rg\tan\theta)^{1/2}$ on a banked road, the normal reaction's component is enough to provide the necessary centripetal force to a car driven at optimum speed.

52. (a) Material forces like friction, gravitational force etc. act on the body and provide the centripetal force. The centripetal force cannot be regarded as any kind of force acting externally. It is simple name given to the force that provides inward radial acceleration to a body in circular motion.

53. (a) Acceleration (centripetal) $a = \dfrac{v^2}{r}$ i.e., $a \propto \dfrac{1}{r}$

54. (d)

55. (b) Due to centrifugal force, the inner wheel will be left up when car is taking a circular turn. Due to this, the reaction on outer wheel is more than that on inner wheel.

56. (b) The cyclist bends while taking turn in order to provide necessary centripetal force.

STATEMENT TYPE QUESTIONS

57. (b) A breeze causes branches of tree to swing. In general force is required to put a stationary object in motion.

58. (d) Newton's 2nd law of motion gives F = ma. Thus it is a measure of force. Newton's first law of motion simply gives a qualitative definition of force.

59. **(d)** If a body is moving with a constant velocity then the net force on the body is zero. Also if net force is zero, the body may be moving uniformly along a straight line. Thus both the given statements are false.

60. **(b)** There are three types of inertia.

Inertia of rest : The resistance of a body to change its state of rest is called inertia of rest.

Inertia of motion : The resistance of a body to change its state of motion is called inertia of motion.

Inertia of direction : The resistance of a body to change its direction of motion is called inertia of direction.

61. **(d)** Action & reaction forces act simultaneously: There is no cause effect relation between action and reaction as any of the two mutual forces can be called action and the other reaction since action & reaction act on different bodies, so they cannot be cancelled out.

62. **(c)** When the men push the rough surface on walking, then surface (from Newton' third Law) applies reaction force in forward direction. It occurs because there is friction between men & surface. If surface is frictionless (such as ice), then it is very difficult to move on it.

63. **(a)** Newton's laws of motion are applicable only for inertial frames. All refrence frames present on surface of earth are supposed to be inertial frame of refrence.

64. **(a)** According to third law of motion bullet experiences a force F then, give experiences an equal and opposite force F. According to second law, $F\Delta t$ is change in momentum of the bullet, then $-F\Delta t$ is change in momentum of the gun. Since initially both are at rest, the final momentum = 0. $\therefore P_b + P_g = 0$. Thus the total momentum of (bullet + gun) is conserved.

65. **(d)** The static friction comes into play, the moment there is an applied force. As the applied force increases, static friction also increases, remaining equal and opposite to the applied force upto a certain limit. But if the applied force increases so much, it overcomes the static friction and the body starts moving.

66. **(c)** Limiting friction is the maximum static friction beyond which the object starts moving. It decreases a little bit before the object comes into motion. Thus limiting friction is less than the kinetic friction.

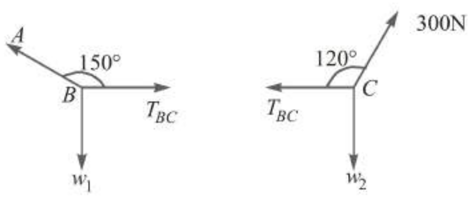
MATCHING TYPE QUESTIONS

67. **(b)** (A)→(4); (B)→(3); C→(1); (D)→(2)

68. **(a)** (A)→(4); (B)→(1); C→(2); (D)→(3)

69. **(d)** (A)→(4); (B)→(3); C→(1); (D)→(2)

70. **(b)** (A) → (2) ; (B) → (1) ; (C) → (4) ; (D) → (3)



Applying Lami's equation, we have

$$\frac{T_{BC}}{\sin 150°} = \frac{W_2}{\sin 120°} = \frac{300}{\sin 90°}$$

and $\frac{T_{AB}}{\sin 90°} = \frac{W_1}{\sin 150°} = \frac{T_{BC}}{\sin 120°}$

After simplifying, we get

$T_{AB} = 173$ N, $T_{BC} = 150$ N, $W_1 = 87$ N, $W_2 = 260$ N.

71. **(c)** (A)→(3); (B)→(4); C→(1); (D)→(2)

DIAGRAM TYPE QUESTIONS

72. **(c)** Equilibrium under three concurrent forces F_1, F_2 and F_3 requires that vector sum of the three forces is zero.

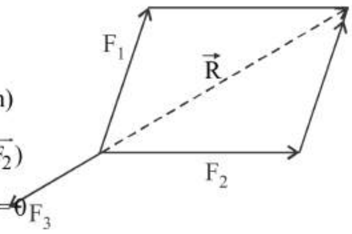
$F_1 + F_2 + F_3 = 0.$

$\vec{R} = \vec{F_1} + \vec{F_2}$

$\vec{F_3} = -\vec{R}$ (In eqbm)

$\therefore \quad \vec{F_3} = -(\vec{F_1} + \vec{F_2})$

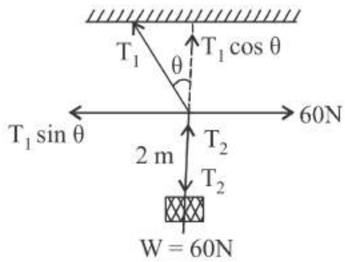
$\therefore \quad \vec{F_1} + \vec{F_2} + \vec{F_3} = 0$



73. **(c)** In series each spring will have same force. Here it is 4 kg-wt.

74. **(b)** If a body slides down, then the force of friction acts upwards along the plane weight(mg) act vertically downwards.

75. **(b)**



In eqbm $T_1 \cos\theta = T_2 = 60N$. ...(1)

$T_1 \sin\theta = 60$ N ...(2)

$\therefore \tan\theta = 1$

$\theta = 45°$.

76. **(a)** Equations of motion of m_1 & m_2 are as:

$T = m_1 a$ ...(1)

$m_2 g - T = m_2 a$ ...(2)

Adding eqn. (i) and (ii)

$m_2 g = (m_1 + m_2) a$

$$\therefore a = \frac{m_2 g}{m + m_2}$$

77. **(d)** Case (a)

$(P_x)_i = mu$ $\quad P_y(\text{initial}) = 0$

$(P_x)_f = f = -mu$ $\quad P_y(\text{final}) = 0$

Impulse = $\Delta P = -2mu$ (along x–axis)

Impulse = 0 along y–axis

parallaly in case (b)

$(P_x)_i = mu \cos 30°$ $\quad (P_y)_i = -mu \sin 30°$

$(P_x)_f = f = -mu \cos 30°$ $\quad (P_y)_f = -mu \sin 30°$

$\therefore$ Impulse = $-2mu \cos 30°$ (along x-axis)

Impulse = 0 (along y–axis)

Force and impulse are in the same direction the force on wall due to the ball is normal to the wall along positive x–direction in both (a) & (b) case.

78. **(c)** Common acceleration of system is

$$a = \frac{F}{m_1 + m_2 + m_3}$$

$\therefore$ Force on m_3 is $F_3 = m_3 \times a = \dfrac{m_3 F}{m_1 + m_2 + m_3}$

79. **(c)** $a = \dfrac{F}{m_1 + m_2}$

So the acceleration is same whether the force is applied on m_1 or m_2.

80. **(c)** Acceleration

$$= \frac{\text{Net force in the direction of motion}}{\text{Total mass of system}}$$

$$= \frac{m_1 g - \mu(m_2 + m_3)g}{m_1 + m_2 + m_3} = \frac{g}{3}(1 - 2\mu)$$

($\because$ $m_1 = m_2 = m_3 = m$ given)

81. **(c)** Change in momentum,

$\Delta p = \int F dt$

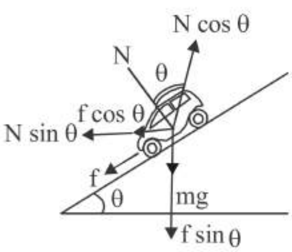
= Area of F-t graph

= ar of Δ – ar of □ + ar of □

$= \frac{1}{2} \times 2 \times 6 - 3 \times 2 + 4 \times 3$

= 12 N-s

82. **(a)**



Clearly form the figure, N sinθ and f cosθ contribute to the centripetal force.

$\therefore N \sin\theta + f \cos\theta = \dfrac{mv^2}{R}$

ASSERTION- REASON TYPE QUESTIONS

83. **(a)** According to Newton's second law of motion $a = \dfrac{F}{m}$

i.e. magnitude of the acceleration produced by a given force is inversely proportional to the mass of the body. Higher is the mass of the body, lesser will be the acceleration produced i.e. mass of the body is a measure of the opposition offered by the body to change a state, when the force is applied i.e. mass of a body is the measure of its inertia.

84. **(a)**

85. **(c)** According to Newton's second law

Acceleration = $\dfrac{\text{force}}{\text{mass}}$ i.e. if net external force on the body is zero then acceleration will be zero

86. **(c)** Newton's second law can not be used for any object.

87. **(d)** Impulse and momentum are different quantities, but both hae same unit (N–s).

88. **(d)** A cricket player moves his hands backward to increase the time interval for reducing the momentum of the ball to zero. Thus the ball does not hit him hard as force is directly proportional to change of momentum.

89. **(b)** According to 2nd law of motion;

$F_1 = \dfrac{\Delta P_1}{\Delta t_1}$ $\qquad F_2 = \dfrac{\Delta P_2}{\Delta t_2}$

$\therefore$ $F_1 \times \Delta t_1 = F_2 \times \Delta t_2$

$\Rightarrow$ $\Delta P_1 = \Delta P_2$

Thus the same force for the same time causes the same change in momentum for different bodies.

90. **(d)** Law of conservation of linear momentum is correct when no external force acts. When bullet is fired form a rifle then both should possess equal momentum but different kinetic energy. $E = \dfrac{p^2}{2m}$ $\therefore$ Kinetic energy of the rifle is less than that of bullet because $E \propto 1/m$

91. **(a)**

92. **(a)** The force acting on the body of mass M are its weight Mg acting vertically downward and air resistance F acting vertically upward.

$\therefore$ Acceration of the body , $a = g - \dfrac{F}{M}$

Now M > m, therefore, the body with larger mass will have great acceleration and it will reach the ground first.

93. (d) The net force on the block is zero, but action cannot cancel the reaction because these two act on different bodies.

94. (a) On a rainy day, the roads are wet. Wetting of roads lowers the coefficient of friction between the types and the road. Therefore, grip on a road of car reduces and thus chances of skidding increases.

95. (d)

96. (d) The man can exert force on block by pulling the rope. The tension in rope will make the man move. Hence statement-1 is false.

97. (a) Friction causes wear & tear and loss of energy, so it is an evil but without friction walking. Stopping a vehicle etc. would not be possible. So it is necessary for us.

98. (c) The assertion is true for a reason that when the car is driven at optimum speed. Then the normal reaction component is enough to provide the centripetal force.

99. (b) When a body is moving in a circle, its speed remains same but velocity changes due to change in the direction of motion of body. According to first law of motion, force is required to change the state of a body. As in circular motion the direction of velocity of body is changing so the acceleration cannot be zero. But for a uniform motion acceleration is zero (for rectilinear motion).

100. (c) In uniform circular motion, the direction of motion changes, therefore velocity changes.
As P = mv therefore momentum of a body also changes uniform circular motion.

101. (c) The purpose of bending is to acquire centripetal force for circular motion. By doing so component of normal reaction will counter balance the centrifugal force.

CRITICALTHINKING TYPE QUESTIONS

102. (b) The apple will fall slightly away from the hand of his brother in the direction of motion of the train due to inertia of motion. When train is just going to stop, the boy and his brother slows down with train but the apple which is in free fall continue to move with the same speed and therefore, falls slightly away from the hand in the direction of motion of the train.

103. (d) Horizontal velocity of ball and person are same so both will cover equal horizontal distance in a given interval of time and after following the parabolic path the ball falls exactly in the hand which threw it up.

104. (a) After the stone is thrown out of the moving train, the only force acting on it is the force of gravity i.e. its weight.

$\therefore$ $F = mg = 0.05 \times 10 = 0.5\,N$.

105. (b) The pressure on rear side would be more due to fictious force on the rear face. Consequently the pressure in the front side would be lowered.

106. (c) When an elevator cabin falls down, it is accelerated down with respect to earth i.e. man standing on earth.

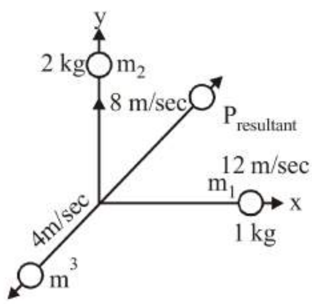
107. (a)

108. (b)

109. (c) Impulse experienced by the body
= change in momentum
$= MV - (-MV)$
$= 2MV$.

110. (d) If rope of lift breaks suddenly, then acceleration becomes equal to g so that tension $T = m(g - g) = 0$

111. (a)



$P_{resultant} = \sqrt{12^2 + 16^2}$

$= \sqrt{144 + 256} = 20$

$m_3 v_3 = 20$ (momentum of third part)

or, $m_3 = \frac{20}{4} = 5\,kg$

112. (d) According to law of conservation of momentum the third piece has momentum

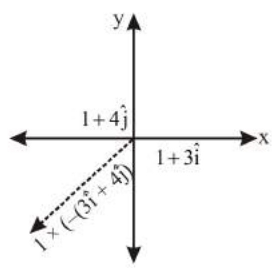
$= 1 \times -(3\hat{i} + 4\hat{j})\ kg\ ms^{-1}$

Impulse = Average force × time

$\Rightarrow$ Average force $= \frac{\text{Impulse}}{\text{time}}$

$= \frac{\text{Change in momentum}}{\text{time}}$

$= \frac{-(3\hat{i} + 4\hat{j})kg\ ms^{-1}}{10^{-4}s}$



113. (b) From law of conservation of momentum
$MV = m_1 v_1 + m_2 v_2$
Here, $M = 100\,kg$, $v = 10^4\,m\,s^{-1}$
$m_1 = 10\,kg$, $v_1 = 0$
$m_2 = 90\,kg$, $v_2 = ?$

$\therefore\ 100 \times 10^4 = 10 \times 0 + 90 \times v_2 \quad \therefore\ v_2 = \dfrac{100 \times 10^4}{90}$

$v_2 = 11.11 \times 10^3\ \text{m s}^{-1}$.

114. (c) Change in momentum of the ball

$= mv \sin\theta - (-\,mv \sin\theta)$

$= 2\,mv \sin\theta$

$= mg \times \dfrac{2v\sin\theta}{g}$

= weight of the ball × total time of flight

115. (a) $\text{Mass} = \dfrac{49}{9.8} = 5\ \text{kg}$

When lift is moving downward

Apparent weight $= 5(9.8 - 5) = 5 \times 4.8 = 24\ \text{N}$

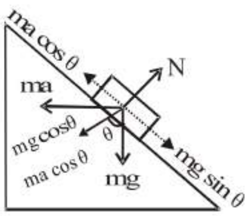
116. (a) $N = m\,a \sin\theta + mg\cos\theta$ ......(1)

also $m\,g \sin\theta = m\,a\cos\theta$ ......(2)

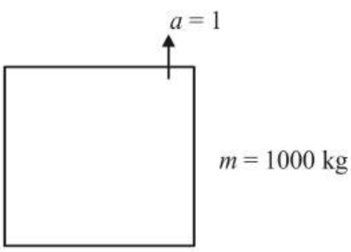
from (2) $a = g\tan\theta$

$\therefore N = mg\dfrac{\sin^2\theta}{\cos\theta} + mg\cos\theta,$

or $N = \dfrac{mg}{\cos\theta}$



117. (c)



Total mass = (60 + 940) kg = 1000 kg

Let T be the tension in the supporting cable, then

$T - 1000g = 1000 \times 1$

$\Rightarrow T = 1000 \times 11 = 11000\ \text{N}$

118. (d) $\because\ v = \text{constant}$

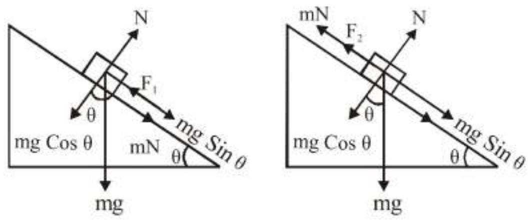
so, $a = 0$, Hence, $F_{net} = ma = 0$

119. (d) When a rain drop falls down with the constant speed, its weight is balanced by the upward viscous drag of air and the force of buoyancy. Thus the net force acting on it is zero.

120. (b) When force is applied on m_1 then $T = m_2 a$ and when force is applied on m_2, then $T = m_1 a$. Thus value of T is different for each case. And it depends on whether the force is applied on m_1, or m_2.

121. (b) Opposite force causes retardation.

122. (d) In case (a) In case (b)



$mg\sin\theta = F_1 - \mu N$

$N = mg\cos\theta$

$\therefore\ mg\sin\theta + \mu\,mg\cos\theta = F_1$

In second case (b)

$\mu N + F_2 = mg\sin\theta$

$\mu\,mg\cos\theta - F_2 = mg\sin\theta$

or $F_2 = mg\sin\theta - \mu mg\cos\theta$

but $F_1 = 2F_2$

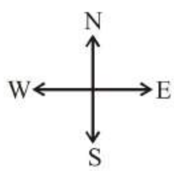
therefore $mg\sin\theta + \mu\,mg\cos\theta$

$= 2(mg\sin\theta - \mu\,mg\cos\theta)$

$mg\sin\theta = 3\,\mu\,mg\cos\theta$

or $\tan\theta = 3\mu$ or $\theta = \tan^{-1}(3\mu)$

123. (c) Frictional force is always opposite to the direction of motion



124. (a) $m_B g = \mu_s m_A g \quad \{\because\ m_A g = \mu_s m_A g\}$

$\Rightarrow m_B = \mu_s m_A$

or $m_B = 0.2 \times 2 = 0.4\ \text{kg}$

125. (d) Frictional force on the box $f = \mu mg$

$\therefore$ Acceleration in the box

$a = \mu g = 5\ \text{ms}^{-2}$

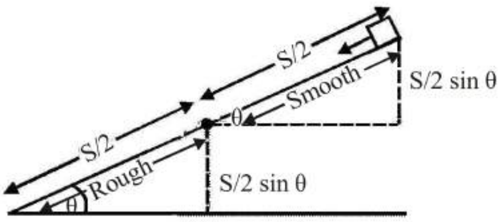
$v^2 = u^2 + 2as$

$\Rightarrow\ 0 = 2^2 + 2 \times (5)\,s$

$\Rightarrow\ s = -\dfrac{2}{5}$ w.r.t. belt

$\Rightarrow$ distance = 0.4 m

126. (b)



For upper half of inclined plane

$v^2 = u^2 + 2a\,S/2 = 2\,(g \sin\theta)\,S/2 = gS \sin\theta$

For lower half of inclined plane

$0 = u^2 + 2\,g\,(\sin\theta - \mu\cos\theta)\,S/2$

$\Rightarrow -gS\sin\theta = gS\,(\sin\theta - \mu\cos\theta)$

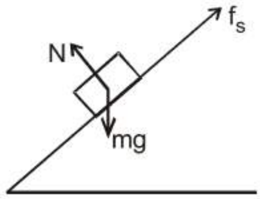
$\Rightarrow 2\sin\theta = \mu\cos\theta$

$\Rightarrow \mu = \dfrac{2\sin\theta}{\cos\theta} = 2\tan\theta$

127. (a) $a = \mu g = \dfrac{6}{10}$ [using $v = u + at$]

$\Rightarrow \mu = \dfrac{6}{10 \times g} = \dfrac{6}{10 \times 10} = 0.06$

128. (c)



$mg \sin\theta = f_s$ (for body to be at rest)

$\Rightarrow m \times 10 \times \sin 30° = 10$

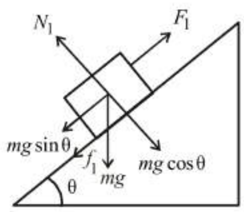
$\Rightarrow m = 2.0$ kg

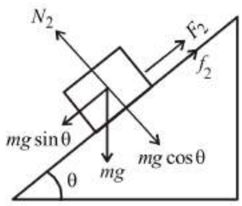
129. (a) We have $\sqrt{\dfrac{2s}{g(\sin\theta - \mu\cos\theta)}} = n\sqrt{\dfrac{2s}{g\sin\theta}}$

$\dfrac{2s}{g(\sin\theta - \mu\cos\theta)} = \dfrac{2s \times n^2}{g\sin\theta}$

here $\theta = 45° \Rightarrow \dfrac{1}{1-\mu} = n^2$ or $\mu = (1 - 1/n^2)$

130. (c)





For the upward motion of the body

$mg\sin\theta + f_1 = F_1$

or, $F_1 = mg\sin\theta + \mu mg\cos\theta$

For the downward motion of the body,

$mg\sin\theta - f_2 = F_2$

or $F_2 = mg\sin\theta - \mu mg\cos\theta$

$\therefore \dfrac{F_1}{F_2} = \dfrac{\sin\theta + \mu\cos\theta}{\sin\theta - \mu\cos\theta}$

$\Rightarrow \dfrac{\tan\theta + \mu}{\tan\theta - \mu} = \dfrac{2\mu + \mu}{2\mu - \mu} = \dfrac{3\mu}{\mu} = 3$

131. (c) It is a case of uniform circular motion in which velocity and acceleration vectors change due to change in direction. As the magnitude of velocity remains constant, the kinetic energy is constant.

132. (d) By Newton's second law of motion

$F = n(mv) = nmv$

133. (d) Angle of banking is $\tan\theta = \dfrac{v^2}{rg} = \dfrac{20^2}{40\sqrt{3} \times 10}$

$\tan\theta = \dfrac{1}{\sqrt{3}}$

$\therefore \theta = 30°$

134. (a) As the ball, m = 10 g = 0.01 kg rebounds after striking the wall

$\therefore$ Change in momentum $= mv - (-mv) = 2\,mv$

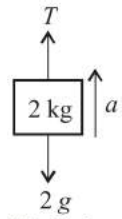
Inpulse = Change in momentum = $2mv$

$\therefore v = \dfrac{\text{Impulse}}{2m} = \dfrac{0.54 \text{ N s}}{2 \times 0.01 \text{ kg}} = 27 \text{ m s}^{-1}$

135. (d) Acceleration of the system

$a = \dfrac{F - 4g - 2g}{4 + 2} = \dfrac{120 - 40 - 20}{6}$

$= 10 \text{ ms}^{-2}$



FBD of block

From figure

$T - 2g = 2a$

$T = 2\,(a + g) = 2\,(10 + 10)$

$= 40$ N

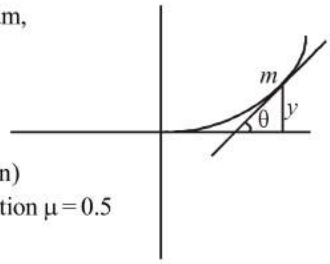
136. (a) At limiting equilibrium,

$\mu = \tan\theta$

$\tan\theta = \mu = \dfrac{dy}{dx} = \dfrac{x^2}{2}$

(from question)

$\because$ Coefficient of friction $\mu = 0.5$



$\therefore \quad 0.5 = \frac{x^2}{2}$

$\Rightarrow \quad x = \pm 1$

Now, $y = \frac{x^3}{6} = \frac{1}{6} m$

137. (a) Energy of both bodies is given by

$KE_1 = F.S_1$

$KE_2 = F.S_2$

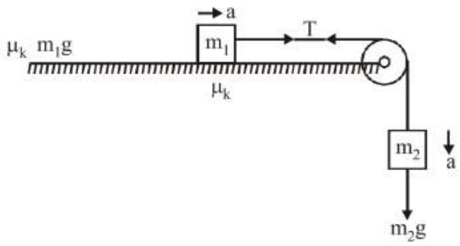
As force is equal

$\therefore \frac{S_1}{S_2} = \frac{m_1 v_1^2}{m_2 v_2^2} = \frac{m_1}{m_2} = \frac{1}{2} \quad [\because v_1 = v_2]$

138. (b) For the motion of both the blocks

$m_1 a = T - \mu_k m_1 g$

$m_2 g - T = m_2 a$



$a = \frac{m_2 g - \mu_k m_1 g}{m_1 + m_2}$

$m_2 g - T = (m_2)\left(\frac{m_2 g - \mu_k m_1 g}{m_1 + m_2}\right)$

solving we get tension in the string

$T = \frac{m_1 m g (1 + \mu_k) g}{m_1 + m_2}$

139. (b) As we know, coefficient of friction $\mu = \frac{F}{N}$

$\Rightarrow \mu = \frac{ma}{mg} = \frac{a}{g}$ $(a = 7.35 \text{ m s}^{-2}$ given)

$\therefore \mu = \frac{7.35}{9.8} = 0.75$

140. (a) As we know, |impulse| = |change in momentum|

$= |p_2 - p_1|$

$= |0 - mv_1| = |0 - 3 \times 2| = 6$ Ns

141. (a) Let upthrust of air be F_a then

For downward motion of balloon

$F_a = mg - ma$

$mg - F_a = ma$

For upward motion

$F_a - (m - \Delta m)g = (m - \Delta m)a$

Therefore $\Delta m = \frac{2ma}{g + a}$

142. (b) As we know, $S = \left(\frac{u+v}{2}\right)t$

$\left(\frac{0+20}{2}\right)t = 25 \quad \therefore t = 2.5s$

143. (a) The velocity should be such that the centripetal acceleration is equal to the acceleration due to gravity

$\frac{v^2}{R} = g$ or $v = \sqrt{gR}$

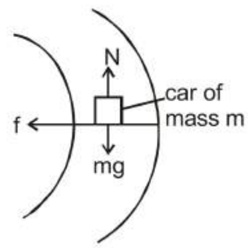
144. (d) $\tan\theta = v^2/rg$, $\tan\theta = H/1.5$, $r = 200$ m, $b = 1.5$ m

$v = 36$ km/hour $= 36 \times (5/18) = 10$ m/s.

Putting these values, we get H = 0.075 m.

145. (b) It means that car which is moving on a horizontal road & the necessary centripetal force, which is provided by friction (between car & road) is not sufficient.

If μ is friction between car and road, then max speed of safely turn on horizontal road is determined from figure.



$N = mg$ ...(i)

$f = \frac{mv^2}{r}$ ...(ii)

Where f is frictional force between road & car, N is the normal reaction exerted by road on the car. We know that

$f = \mu_s N = \mu_s mg$ ......(iii)

where μ_s is static friction

so from eq (ii) & (iii) we have

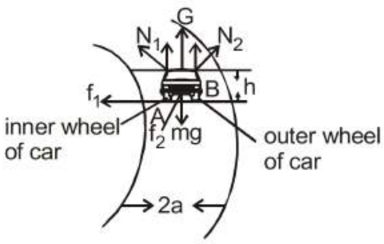
$\frac{mv^2}{r} \le \mu_s mg \Rightarrow v^2 \le \mu_s rg$ or $v \le \sqrt{\mu_s rg}$

& $v_{max} = \sqrt{\mu_s rg}$

If the speed of car is greater than v_{max} at that road, then it will be thrown out from road i.e., skidding.

146. (a) The car over turn, when reaction on inner wheel of car is zero, i.e., first the inner wheel of car leaves the ground (where G is C.G of car, h is height of C.G from the ground, f_1 & f_2 are frictional force exerted by ground on inner &

outer wheel respectively). The max. speed for no over turning is

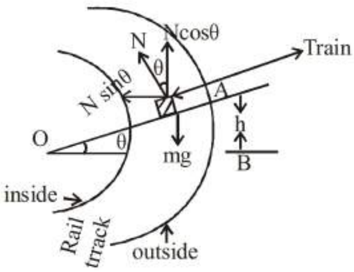


$$v_{max} = \sqrt{\frac{gra}{h}}$$

where r is radius of the path followed by car for turn & 2a is distance between two wheels of car (i.e., AB)

147. (a) If the outside rail is h units higher than inside of rail track as shown in figure then

$N\cos\theta = mg$..................(i)



$$N\sin\theta = \frac{mv^2}{r} \text{ ....(ii)}$$

$$\& \ \tan\theta = \frac{v^2}{rg} \text{ ....(iii)}$$

Where θ is angle of banking of rail track, N is normal reaction exerted by rail track on rail.

It is clear from the equation (i) & (ii) that N cosθ balance the weight of the train & N sinθ provide the necessary centripetal force to turn.

If width of track is ℓ (OB) & h (AB) be height of outside of track from the inside, then

$$\tan\theta = \frac{h}{\ell} = \frac{v^2}{rg} \text{ or } h = \frac{v^2 \ell}{rg} \text{ ....(iv)}$$

So it is clear from the above analysis that if we increase the height of track from inside by h metre then resultant force on rail is provided by railway track & whose direction is inwards.

148. (d) $\frac{1}{2}mv^2 = mg\ell$ or $v = \sqrt{(2g\ell)}$

149. (c) Force exerted by a car when passes through a bridge

$$F = Mg - \frac{Mv^2}{r}.$$

150. (b) $v = \sqrt{gr} = \sqrt{10 \times 40} = 20 \text{ m s}^{-1}$

151. (c) Tension at the highest point

$$T_{top} = \frac{mv^2}{r} - mg = 2mg \quad (\because v_{top} = \sqrt{3gr})$$

Tension at the lowest point

$T_{bottom} = 2mg + 6mg = 8mg$

$$\therefore \frac{T_{top}}{T_{bottom}} = \frac{2mg}{8mg} = \frac{1}{4}.$$