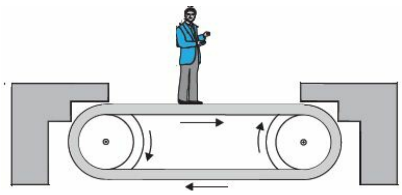
# CBSE Test Paper 02

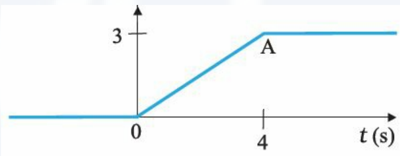
## Chapter 5 Laws of Motion

1. Figure shows a man standing stationary with respect to a horizontal conveyor belt that is accelerating with 1 m $s^{-2}$. What is the net force on the man? Mass of the man = 65 kg **1**



   a. 70 N
   b. 55 N
   c. 65 N
   d. 60 N

2. Figure shows the position-time graph of a particle of mass 4 kg. What is the impulse at t = 0 and t = 4 s? (Consider one-dimensional motion only) **1**




   a. 3 kg m $s^{-1}$ at t = 0 and -3 kg m $s^{-1}$ at t = 4 s
   b. 2 kg m $s^{-1}$ at t = 0 and -2 kg m $s^{-1}$ at t = 4 s
   c. 5 kg m $s^{-1}$ at t = 0 and -3 kg m $s^{-1}$ at t = 4 s
   d. 4 kg m $s^{-1}$ at t = 0 and -4 kg m $s^{-1}$ at t = 4 s

3. A body of mass 5 kg is acted upon by two perpendicular forces 8 N and 6 N. Give the magnitude and direction of the net force acting on the body. **1**

   a. 16 N at an angle of 46$^\circ$ to the 8 N force
   b. 10 N at an angle of $36^o 52^o$ towards the 8 N force
   c. 14 N at an angle of 37$^\circ$ to the 8 N force
   d. 12 N at an angle of 38$^\circ$ to the 8 N force

4. In which of the following cases is the net force non zero? **1**

a. a drop of rain falling down with a constant speed
b. a cork of mass 10 g floating on water
c. a coin falling under gravity
d. a kite skillfully held stationary in the sky

5. Give the magnitude and direction of the net force acting on a stone of mass 0.1 kg lying on the floor of a train which is accelerating with 1 m $s^{-2}$, the stone being at rest relative to the train. Neglect air resistance. **1**

   a. 1.0 N in the direction of motion
   b. 0.1 N opposite to the direction of motion
   c. 0.1 N along the direction of motion
   d. 0.2 opposite to the direction of motion

6. A soda water bottle is falling freely. Will the bubbles of the gas rise in the water of the bottle? **1**

7. A body is acted upon by a number of external forces. Can it remain at rest? **1**

8. The two ends of spring - balance are pulled each by a force of 10 kg.wt. What will be the reading of the balance? **1**

9. A passenger of mass 72.2 kg is standing on a weighing scale in an elevator. What does the scale read when the elevator cab is **2**

   1. descending with constant velocity?
   2. ascending with constant acceleration, 3.5 m /$s^2$?

10. Give the magnitude and direction of the net force acting on a stone of mass 0.1 kg, Neglect air resistance throughout. **2**

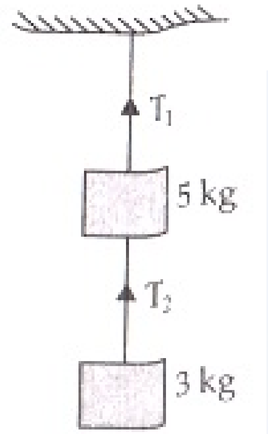
    a. just after it is dropped from the window of a stationary train,
    b. just after it is dropped from the window of a train running at a constant velocity of 36 km/h.

11. A block of mass M is held against a rough vertical wall by pressing it with a finger. If the coefficient of friction between the block and the wall is μ and the acceleration due

to gravity is g, calculate the minimum force required to be applied by the finger to hold the block against the wall? **2**

12. The driver of a three-wheeler moving with a speed of 36 km/h sees a child standing in the middle of the road and brings his vehicle to rest by the brake in 4.0 s just in time to save the child. What is the average retarding force on the vehicle by the brake? The mass of the three-wheeler is 400 kg and the mass of the driver is 65 kg. **3**

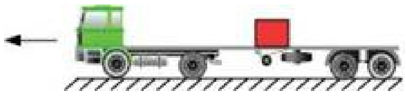
13. Two masses of 5 kg and 3 kg are suspended with help of massless inextensible strings as shown in Figure. Calculate $T_1$ and $T_2$ when whole system is going upwards with acceleration = 2 $ms^{-2}$ (use g = 9.8 $ms^{-2}$) **3**




14. Ten one rupee coins are put on top of one another on a table. Each coin has a mass m kg. Give the magnitude and direction of **3**

    a. The force on the $7^{th}$ coin (counted from the bottom) due to all coins above it.
    b. The force on the $7^{th}$ coin by the eighth coin (counted from the bottom) and
    c. The reaction of the sixth coin on the seventh coin (counted from the bottom).

15. The rear side of a truck is open and a box of 40 kg mass is placed 5 m away from the open end. The coefficient of static friction between the box and the surface below it is 0.15. On a straight road, the truck starts from rest and accelerates with 2 $ms^{-2}$. At what distance from the starting point does the box fall off the truck? (Given, g = 10 $m/s^2$) **5**



## Answer

1. c. 65 N

   **Explanation:** Net force on the man = ma = 65 $\times$ 1 = 65 N

2. a. 3 kg m s$^{-1}$ at t = 0 and -3 kg m s$^{-1}$ at t = 4 s

   **Explanation:** Initial velocity $u = 0$, between t = 0s and t = 4s, the particle has a constant velocity,
   therefore slope of OA is $v = \frac{3}{4}\ m/s$
   At t = 0,Impulse=Change in momentum = $m(v-u) = 4(\frac{3}{4} - 0) = 3\ kg\ m/s$
   At t = 4s, initial velocity is $\frac{3}{4}$ m/s,
   So, the Impulse = $m(v-u) = 4(0 - \frac{3}{4})$= -3 kg m/s

3. b. 10 N at an angle of $36^o 52^o$ towards the 8 N force

   **Explanation:** Let $F_1$ = 8N & $F_2$ = 6 N.
   then the resultant force is $F = \sqrt{F_1^2 + F_2^2}$
   =$\sqrt{8^2 + 6^2}$ = 10N
   The direction is determined as $tan\theta = \frac{F_2}{F_1}$
   = 6/8
   therefore $\theta = 36^o 52^o$

4. c. a coin falling under gravity

   **Explanation:** The force acting on a coin is due to gravitational force which causes an acceleration in downward direction.

5. c. 0.1 N along the direction of motion

   **Explanation:** Weight of the stone is balanced by the reaction of the floor. The only acceleration is provided by the horizontal motion of the train.
   a = 1ms$^{-2}$
   force in horizontal direction
   F = ma = 0.1 x 1 = 0.1N

6. Reaction force or apparent weight of the bottle, R = m(g - a) = 0, as the bottle as well as the water bubbles including water falls freely i.e. a = g. That's why bubbles will not rise in water because water in freely falling bottle is in the state of weight lessness. Hence, no upthrust force acts on the bubbles.

7. Yes it can be at rest, only if the external forces acting on the body can be represented in magnitude and direction by the sides of a closed polygon taken in the same order. OR in simple words if the vector sum of all the forces acting on a body is zero.

8. The reading of the balance will be 10 kg wt.

9. Given, mass of the man, m = 72.2 kg

   Acceleration due to gravity, g = 9.8 m /$s^2$

   To find : Scale reading = apparent weight = Reaction force = R in the following two cases,

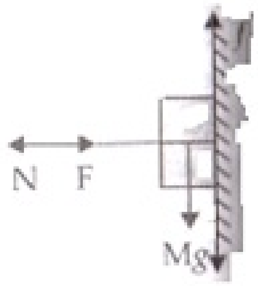
   i. While descending with constant velocity, a = 0
      R = mg
      R = $72.2 \times 9.8$
      $\Rightarrow$ R = 707.56 N
   ii. While ascending with a = 3.2 m / $s^2$
      R = m ( g + a)
      R =72.2 (9.8+ 3.2) = 938.6 N

10. a. When stone is dropped just after from the window of a stationary train,

    Force on stone, F = Force due to gravity = mg = 0.1 kg $\times$ 10 m/$s^2$ = 1 N in the vertically downward direction.

    b. As the train is running with constant velocity, acceleration is zero in horizontal direction i.e. direction of motion of train. Hence no force in horizontal direction. So, only force due to gravity in vertically downward direction exists. In this case too, force is same as in (a) i.e., F = 1 N downwards.

11. Let F force is applied by the finger on a body of mass M to hold rest against the wall. Under the balanced condition




F = N

And f = Mg

$\Rightarrow \mu F = Mg$

or $F = \frac{Mg}{\mu}$ is the minimum force to hold the block against the wall at rest.

12. Initial speed of the three-wheeler, u = 36 km/h = (36×5)÷18 m/s = 10 m/s

    Final speed of the three-wheeler, v = 0 m/s

    Time, t = 4 s

    Mass of the three-wheeler, m = 400 kg

    Mass of the driver, m' = 65 kg

    Total mass of the system, M = m + m' = (400 + 65) = 465 kg

    Using Newton's first law of motion, the acceleration (a) of the three-wheeler can be calculated as:

    v = u + at

    $\therefore a = \frac{v-u}{t} = \frac{0-10}{4} = -2.5 m/s^2$

    The negative sign indicates that the velocity of the three-wheeler is decreasing with time.

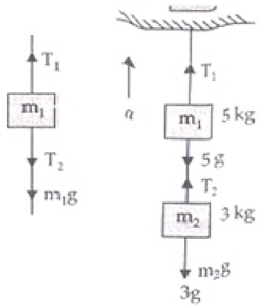
    Using Newton's second law of motion, the net force acting by the three-wheeler can be calculated as:

    F = Ma $= 465 \times (-2.5) = -1162.5$N

    [The negative sign indicates that the force is acting against the direction of motion of the three-wheeler.]

13. As the whole system is going up with acceleration = a = 2ms$^{-2}$

    As given that, $m_1 = 5kg, m_2 = 3kg, g = 9.8 m/s^2$




Tension in a string is equal and opposite in all parts of a string.

For the upper block of mass 5 kg, the forces on mass $m_1$

$T_1 - T_2 - m_1g = m_1a$

$T_1 - T_2 - 5g = 5a$

$T_1 - T_2 = 5(g + a)$

For the lower block of mass 3 kg, the force on mass

$T_2 - m_2g = m_2a$

$T_2 = m_2(g + a) = 3(9.8 + 2) = 3 \times 11.8$

$T_2 = 35.4N$

$T_1 = T_2 + 5(g + a)$

$\Rightarrow T_1 = 35.4 + 5(9.8 + 2) = 94.4N$

14. a. The force on $7^{th}$ coin is due to weight of the three coins lying above it (i.e. the sum of weights of 8th, 9th and 10th coins).
    Therefore, F = (3 m) kgf = (3 mg) N
    Where g is acceleration due to gravity. This force acts vertically downwards.
    b. The eighth coin is already under the weight of two coins above it and it has its own weight too. Hence force on $7^{th}$ coin due to $8^{th}$ coin is sum of the two forces i.e.
    F = weight of $9^{th}$ and $10^{th}$ coin + weight of $8^{th}$ coin = (2m + m) kgf = (3m) kgf = (3mg) N
    The force acts vertically downwards.
    c. The sixth coin is under the weight of four coins (i.e. $7^{th}$, $8^{th,}$ $9^{th}$ and $10^{th}$) above it. Now in this case reaction force on the 6th coin will equal and opposite to the sum of weights of mentioned four coins. Hence, reaction, R = -F = -4 m (kgf) = - (4 mg) N
    -ve sign indicates that reaction acts vertically upwards.

15. In this problem the backward reaction force produced in the box by the movement of the truck exceeds the static frictional force offered by the floor of the truck on the box

in the direction of motion of the truck and the box falls off the truck after a certain time.

Mass of the box, m = 40 kg

Coefficient of static friction, $\mu_s$ = 0.15

Initial velocity, u = 0

Acceleration, a = 2 m/s$^2$

Distance of the box from the end of the truck, s' = 5 m

As per Newton's second law of motion, the force on the box caused by the accelerated motion of the truck is given by:

F = ma = 40 $\times$ 2 = 80 N

As per Newton's third law of motion, an equal and opposite reaction force of 80 N is acting on the box in the backward direction. A portion of this backward reaction force on the box is opposed by the force of static friction $f_s$, acting between the box and the floor of the truck in the direction of motion of the truck. This force is given by:

$$f_s = \mu_s mg$$

$$= 0.15 \times 40 \times 10 = 60N$$

$\therefore$ Net force acting on the block:

$F_{net}$ = 80 - 60 = 20 N, directed backward, which is responsible for the falling of the box from the truck.

The backward acceleration produced in the box is given by:

$$a_{back} = \frac{F_{net}}{mass\ of\ the\ box(m)} = \frac{20}{40} = 0.5\text{m/s}^2$$

Using Newton's second equation of motion, time t can be calculated as:

$$s' = ut + \frac{1}{2}a_{back}t^2$$

$$\Rightarrow 5 = 0 + \frac{1}{2} \times 0.5 \times t^2$$

$$\therefore t = \sqrt{20}\, s$$

Hence, the box will fall from the truck after $\sqrt{20}\, s$ from the starting point.

The distance s, travelled by the truck in $\sqrt{20}\, s$ is given by Newton's 2nd law of motion :

$$s = ut + \frac{1}{2}at^2$$

$= 0 + \frac{1}{2} \times 2 \times (\sqrt{20})^2$ = 20m

i.e. when the truck covers a distance of 20m from the starting point, the box falls off the truck.