Laws of Motion

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. A force of 48 N acts on an 8 kg body. Its acceleration is:

(a) 0.17 m/s^2 **(b)** 384 m/s^2 **(c)** 7 m/s^2 **(d)** 6 m/s^2

2. A ball of mass 1.9 kg hits a wall at 22 m/s and rebounds at 28 m/s. The magnitude of the change in its momentum is:

(a) 95 kg m/s **(b)** 11.4 kg m/s **(c)** 41.8 kg m/s **(d)** 190 kg m/s

3. A gun of mass 5 kg fires a bullet of mass 5 g at 728 m/s. The recoil speed of the gun is:

(a) 0.0728 m/s **(b)** 7.28 m/s **(c)** 728 m/s **(d)** 0.728 m/s

4. A force of 41 N pulls a 5 kg block along a floor where the coefficient of kinetic friction is 0.8. The acceleration of the block is: (Take g = 10 m/s^2.)

(a) 0.2 m/s^2 **(b)** 8.2 m/s^2 **(c)** 16.2 m/s^2 **(d)** 1.2 m/s^2

5. Newton's first law of motion defines:

(a) inertia **(b)** impulse **(c)** power **(d)** momentum

6. A 52 kg person stands on a weighing scale in a lift. When the lift accelerates downwards at 3 m/s^2, the scale reads: (Take g = 10 m/s^2.)

(a) 156 N **(b)** 520 N **(c)** 676 N **(d)** 364 N

7. Masses of 9 kg and 2 kg hang over a light frictionless pulley. Their acceleration is: (Take g = 10 m/s^2.)

(a) 6.36 m/s^2 **(b)** 10 m/s^2 **(c)** 15.71 m/s^2 **(d)** 8.18 m/s^2

8. Assertion (A): A 4 kg gun firing a 46 g bullet at 691 m/s recoils at 7.9465 m/s.
Reason (R): The gun and the bullet move off with equal speeds.

(a) Both A and R are true, and R is the correct explanation of A.

(b) Both A and R are true, but R is not the correct explanation of A.

(c) A is true, but R is false.

(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. A car of mass 550 kg moving at 20 m/s is stopped in 8 s. Find the average braking force.

10. A force of 16 N acts on a ball of mass 1 kg for 0.13 s. Find the impulse and the change in the ball's velocity.

11. Two blocks of 9 kg and 8 kg are in contact on a frictionless table. A force of 60 N pushes the 9 kg block. Find the acceleration and the force between the blocks.

12. In an Atwood machine, masses of 7 kg and 2 kg hang over a light frictionless pulley. Find the acceleration and the tension in the string. (Take g = 10 m/s^2.)

13. A 72 kg person stands on a scale in a lift. Find the reading when the lift (a) moves up at constant speed, (b) accelerates up at 4 m/s^2, (c) accelerates down at 4 m/s^2. (Take g = 10 m/s^2.)

14. A 14 kg box rests on a floor (μs = 0.7, μk = 0.5). Find the least horizontal force to start it moving. If a force of 116 N is applied, what is its acceleration? (Take g = 10 m/s^2.)

15. A car takes a level circular turn of radius 200 m. If the greatest safe speed is 23 m/s, find the coefficient of friction between the tyres and the road. (Take g = 10 m/s^2.)

16. A machine gun fires 18 bullets a second, each of mass 43 g, at 225 m/s. Find the force needed to hold the gun in place.

Section C — Word problems — 4 × 4 = 16 marks

17. Three blocks of 10 kg, 4 kg and 3 kg are joined by light strings on a frictionless table. A force of 16 N pulls the 3 kg block (the last one). Find the acceleration and the tension in each string.

18. An 18 kg block slides down an incline at 37° to the horizontal with no friction. Find the normal reaction, and the acceleration. (Take g = 10 m/s^2, sin 37° = 3/5, cos 37° = 4/5.)

19. A cricket ball of mass 0.11 kg moving at 37 m/s is caught and stopped. Find the average force on the hands if the catch takes (a) 0.05 s, (b) 0.37 s. Why do fielders pull their hands back?

20. A 70 kg person stands on a weighing scale in a lift that starts from rest, accelerates up at 1 m/s^2 for 5 s, moves at constant speed for 5 s, then decelerates at 1 m/s^2 to rest. Find the scale reading in each part and the greatest speed of the lift. (Take g = 10 m/s^2.)

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Answer key

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Q	Answer	Working
1	**(d) 6 m/s^2**	a = F/m
2	**(a) 95 kg m/s**	the velocity reverses: m(u_1 + u_2)
3	**(d) 0.728 m/s**	M V = m v: 5V = 0.005 × 728
4	**(a) 0.2 m/s^2**	friction = μmg = 40 N
5	**(a) inertia**	—
6	**(d) 364 N**	R = m(g − a)
7	**(a) 6.36 m/s^2**	a = (m_1 − m_2)g/(m_1 + m_2)
8	**(c) A is true, but R is false.**	A is true: 4 × V = 0.046 × 691, so V = 7.9465 m/s. R is false.
9	**1,375 N**	F = m(v − u)/t
10	**2.08 N s; 2.08 m/s**	impulse = Ft = mΔv
11	**3.53 m/s^2; 28.24 N**	a = F/(m_1 + m_2); contact force = m_2a
12	**5.56 m/s^2; 31.11 N**	a = (m_1 − m_2)g/(m_1 + m_2); T = 2m_1m_2g/(m_1 + m_2)
13	**(a) 720 N; (b) 1,008 N; (c) 432 N**	R = m(g ± a)
14	**98 N; 3.29 m/s^2**	limiting friction μs mg; once moving, friction μk mg
15	**0.2645**	μmg = mv^2/r, so μ = v^2/(rg)
16	**174.15 N**	force = rate of change of momentum = n m v
17	**a = 0.94 m/s^2; tension between the first two blocks = 9.41 N; between the second and third = 13.18 N**	each string pulls everything behind it
18	**N = 144 N; a = 6 m/s^2**	along the slope: mg sin θ − μmg cos θ = ma
19	**(a) 81.4 N; (b) 11 N. Pulling back increases the stopping time, so the same change in momentum needs a smaller force.**	F = change in momentum ÷ time
20	**770 N, then 700 N, then 630 N; greatest speed 5 m/s**	R = m(g + a) going up faster; R = m(g − a) while slowing

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