

Applied Physics 1

Chapter: Force and Motion

Exercise Notes (Set 3): MCQs, Fill in the Blanks, True/False, Match the Following and Give-Reason Questions

For Engineering Students | Objective Type with Answers | Exam Oriented

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Note: Take $g = 9.8 \text{ m/s}^2$ and $\pi = 3.14$ unless stated otherwise. In each MCQ choose the one correct option.

PART A: MULTIPLE CHOICE QUESTIONS

1. The SI unit of force is

- (a) watt (b) joule (c) newton (d) pascal

2. The dimensional formula of linear momentum is

- (a) $[M L T^{-2}]$ (b) $[M L^2 T^{-1}]$ (c) $[M L^{-1} T^{-1}]$ (d) $[M L T^{-1}]$

3. Newton's second law gives a measure of

- (a) power (b) inertia (c) energy (d) force

4. The momentum of a 2 kg body moving at 5 m/s is

- (a) 10 kg m/s (b) 7 kg m/s (c) 2.5 kg m/s (d) 25 kg m/s

5. The unit N s is the unit of

- (a) power (b) pressure (c) impulse (d) energy

6. Impulse is equal to

- (a) force $\div$ time (b) change in momentum (c) rate of change of momentum (d) mass $\times$ acceleration

7. The total linear momentum of an isolated system is

- (a) always zero (b) always increasing (c) constant (d) always decreasing

8. The recoil velocity of a gun of mass M firing a bullet of mass m with velocity v is

- (a) Mv/m (b) mv/M (c) $-mv/M$ (d) $-Mv/m$

9. A heavier gun, firing the same bullet, has a recoil velocity that is

- (a) smaller (b) larger (c) the same (d) infinite

10. A rocket works on the principle of

- (a) conservation of energy (b) Newton's first law only (c) conservation of linear momentum (d) Bernoulli's theorem

11. A cricketer pulls his hands back while catching a ball to

- (a) increase the momentum (b) increase the time of contact (c) decrease the time of contact (d) decrease the mass of the ball

12. An impulsive force is a

- (a) zero force (b) small force acting for a long time (c) constant force (d) large force acting for a very short time

13. The momentum of a 10 g bullet moving at 300 m/s is

- (a) 30 kg m/s (b) 3 kg m/s (c) 3000 kg m/s (d) 300 kg m/s

14. A force of 10 N acts on a body for 3 s. The impulse is

- (a) 30 N s (b) 7 N s (c) 13 N s (d) 3.3 N s

15. One complete revolution corresponds to an angular displacement of

- (a) 360 rad (b) 2π rad (c) π rad (d) $\pi/2$ rad

16. The SI unit of angular velocity is

- (a) rad/s (b) rad/s^2 (c) m/s (d) rad

17. 60 rpm is equal to

- (a) 120π rad/s (b) 60 rad/s (c) π rad/s (d) 2π rad/s

18. The relation between linear velocity v and angular velocity ω is

- (a) $v = r\omega$ (b) $v = \omega/r$ (c) $v = r\omega^2$ (d) $v = r/\omega$

19. If the frequency is 50 Hz, the time period is

- (a) 50 s (b) 0.2 s (c) 0.02 s (d) 2 s

20. The relation between angular velocity and frequency is

- (a) $\omega = \pi f$ (b) $\omega = 2\pi f$ (c) $\omega = f/2\pi$ (d) $\omega = f^2$

21. The unit of angular acceleration is

- (a) rad/s (b) rad (c) m/s^2 (d) rad/s^2

22. The tangential acceleration of a particle in circular motion is

- (a) r/α (b) $r\alpha$ (c) $\omega^2 r$ (d) v^2/r

23. The centripetal acceleration of a particle in uniform circular motion is

- (a) $r\alpha$ (b) vr (c) v^2/r (d) v/r

24. The centripetal force acts

- (a) towards the centre (b) perpendicular to the plane of the circle (c) along the tangent (d) away from the centre

25. Centrifugal force is

- (a) directed towards the centre (b) an apparent (pseudo) force (c) always zero (d) a real force

26. When a stone is whirled in a horizontal circle by a string, the centripetal force is provided by

- (a) friction (b) normal reaction (c) tension in the string (d) gravity

27. Water is thrown out of wet clothes in a spin dryer due to the

- (a) gravity (b) friction (c) centripetal force on water (d) centrifugal effect

28. A particle moves in a circle of radius 2 m with $\omega = 10$ rad/s. Its linear speed is

- (a) 5 m/s (b) 20 m/s (c) 0.2 m/s (d) 12 m/s

29. A 1 kg stone is whirled in a circle of radius 1 m at 4 m/s. The tension in the string is

- (a) 8 N (b) 16 N (c) 1 N (d) 4 N

30. The angle of banking θ of a road is given by

- (a) $\cos \theta = v^2/(rg)$ (b) $\tan \theta = rg/v^2$ (c) $\sin \theta = v^2/(rg)$ (d) $\tan \theta = v^2/(rg)$

31. The angle of banking does NOT depend on the

- (a) mass of the vehicle (b) radius of the curve (c) speed of the vehicle (d) value of g

32. For $v = 14 \text{ m/s}$, $r = 100 \text{ m}$ and $g = 9.8 \text{ m/s}^2$, $\tan \theta$ for a banked road is

- (a) 0.1 (b) 1.4 (c) 0.2 (d) 0.5

33. The maximum safe speed on a flat road of radius r and friction coefficient μ is

- (a) $\mu\sqrt{rg}$ (b) $\sqrt{rg/\mu}$ (c) $\sqrt{\mu rg}$ (d) μrg

34. A cyclist leans inward while turning in order to

- (a) increase his weight (b) increase his speed (c) reduce friction (d) get the required centripetal force and avoid toppling

35. Banking of a road reduces the

- (a) dependence on friction (b) mass of the vehicle (c) radius of the curve (d) speed of the vehicle

36. A 0.5 kg ball hits a wall at 10 m/s and rebounds at 10 m/s. The impulse on the ball is

- (a) 10 N s (b) 0 (c) 5 N s (d) 20 N s

37. A 4 kg gun fires a 20 g bullet at 200 m/s. The recoil velocity of the gun is

- (a) 10 m/s (b) 100 m/s (c) 0.1 m/s (d) 1 m/s

38. A 2 kg body at 6 m/s collides with a stationary 2 kg body and they stick. The common velocity is

- (a) 12 m/s (b) 3 m/s (c) 4 m/s (d) 6 m/s

39. A wheel of radius 0.5 m rotates at 120 rpm. The speed of a point on its rim is

- (a) 12.56 m/s (b) 3.14 m/s (c) 62.8 m/s (d) 6.28 m/s

40. The work done by the centripetal force on a body in uniform circular motion is

- (a) zero (b) negative (c) infinite (d) positive

Answer Key with Explanations

No.	Ans.	Correct answer and explanation
1	(c)	newton. $1 \text{ N} = 1 \text{ kg m/s}^2$.
2	(d)	[M L T⁻¹]. $p = mv$, so $[M][L T^{-1}]$.
3	(d)	force. $F = ma$ defines force.
4	(a)	10 kg m/s. $p = 2 \times 5 = 10$.
5	(c)	impulse. $\text{N s} = \text{kg m/s}$, the unit of impulse and momentum.
6	(b)	change in momentum. $J = F\Delta t = mv - mu$.
7	(c)	constant. Law of conservation of linear momentum.
8	(c)	$-mv/M$. $0 = mv + MV$ gives $V = -mv/M$.
9	(a)	smaller. $V \propto 1/M$.
10	(c)	conservation of linear momentum. Backward momentum of gases equals forward momentum of rocket.
11	(b)	increase the time of contact. $F = \Delta p/\Delta t$, larger Δt gives smaller force.
12	(d)	large force acting for a very short time. Definition of impulsive force.
13	(b)	3 kg m/s. $p = 0.01 \times 300 = 3$.
14	(a)	30 N s. $J = F \times t = 10 \times 3$.
15	(b)	$2\pi \text{ rad}$. 1 revolution = $2\pi \text{ rad} = 360^\circ$.
16	(a)	rad/s. $\omega = \theta/t$.
17	(d)	$2\pi \text{ rad/s}$. $\omega = 2\pi \times 60/60 = 2\pi$.

No.	Ans.	Correct answer and explanation
18	(a)	$v = r\omega$. Arc $s = r\theta$, divide by t .
19	(c)	0.02 s. $T = 1/f = 1/50$.
20	(b)	$\omega = 2\pi f$. $\omega = 2\pi/T = 2\pi f$.
21	(d)	rad/s². $\alpha = \Delta\omega/\Delta t$.
22	(b)	$r\alpha$. $a_t = r\alpha$.
23	(c)	v^2/r. $a_c = v^2/r = \omega^2 r$.
24	(a)	towards the centre. It points along the radius, inward.
25	(b)	an apparent (pseudo) force. It is felt in a rotating frame.
26	(c)	tension in the string. Tension acts along the string towards the centre.
27	(d)	centrifugal effect. Water moves outward by inertia as the drum rotates.
28	(b)	20 m/s. $v = r\omega = 2 \times 10$.
29	(b)	16 N. $T = mv^2/r = 1 \times 16/1$.
30	(d)	$\tan \theta = v^2/(rg)$. $N \sin \theta = mv^2/r$ and $N \cos \theta = mg$.
31	(a)	mass of the vehicle. Mass cancels in $\tan \theta = v^2/(rg)$.
32	(c)	0.2. $196/980 = 0.2$.
33	(c)	$\sqrt{(\mu rg)}$. $mv^2/r = \mu mg$.
34	(d)	get the required centripetal force and avoid toppling. Reaction $R \sin \theta$ gives mv^2/r .
35	(a)	dependence on friction. The normal reaction supplies the centripetal force.
36	(a)	10 N s. $J = 0.5 \times (10 + 10) = 10$.
37	(d)	1 m/s. $V = 0.02 \times 200/4 = 1$.
38	(b)	3 m/s. $12 = 4v$, $v = 3$.
39	(d)	6.28 m/s. $\omega = 4\pi = 12.56 \text{ rad/s}$; $v = 12.56 \times 0.5 = 6.28$.
40	(a)	zero. Force is perpendicular to displacement.

PART B: FILL IN THE BLANKS

1. Force is a _____ quantity.

Ans. vector

2. The SI unit of momentum is _____.

Ans. kg m/s

3. Impulse = force $\times$ _____.

Ans. time

4. Linear momentum of a system is conserved only when the net _____ force on it is zero.

Ans. external

5. A rocket works on the principle of conservation of _____.

Ans. linear momentum

6. One revolution = _____ radian.

Ans. 2π

7. Angular velocity $\omega = 2\pi/\text{_____}$.

Ans. T (time period)

8. The relation between linear and angular velocity is $v = \text{_____}$.

Ans. $r\omega$

9. Centripetal force acts _____ the centre of the circle.

Ans. towards

10. Centrifugal force is a _____ force.

Ans. pseudo (apparent)

11. For a banked road, $\tan \theta =$ _____.

Ans. $v^2/(rg)$

12. The unit of angular acceleration is _____.

Ans. rad/s^2

13. The recoil velocity of a gun is _____ proportional to the mass of the gun.

Ans. inversely

14. The safe speed on a flat road depends on the coefficient of _____.

Ans. friction

15. The centripetal acceleration in uniform circular motion is $a_c =$ _____.

Ans. $v^2/r (= \omega^2 r)$

PART C: TRUE OR FALSE (WITH CORRECTIONS)

1. Momentum is a scalar quantity.

Ans. False. Momentum is a vector, with the direction of velocity.

2. Impulse and change in momentum have the same unit.

Ans. True. Both are measured in N s (kg m/s).

3. If no external force acts, the momentum of a system remains constant.

Ans. True. Law of conservation of linear momentum.

4. A gun recoils in the same direction as the bullet.

Ans. False. It recoils in the opposite direction, $V = -mv/M$.

5. A rocket cannot work in vacuum.

Ans. False. It works in vacuum because it pushes against its own exhaust, not air.

6. An impulsive force acts for a long time.

Ans. False. It acts for a very short time.

7. The unit of angular velocity is m/s.

Ans. False. The unit is rad/s.

8. Frequency is the reciprocal of the time period.

Ans. True. $f = 1/T$.

9. Centripetal force is a real force.

Ans. True. Examples: tension, gravity, friction.

10. Centrifugal force acts towards the centre.

Ans. False. It acts away from the centre.

11. A body in uniform circular motion has zero acceleration.

Ans. False. It has centripetal acceleration v^2/r towards the centre.

12. The angle of banking depends on the mass of the vehicle.

Ans. False. $\tan \theta = v^2/(rg)$ has no mass term.

13. A cyclist leans outward while turning a curve.

Ans. False. The cyclist leans inward.

14. Centripetal force does work on a body in circular motion.

Ans. False. Work is zero as the force is perpendicular to the displacement.

15. The maximum speed on a flat curve increases when the coefficient of friction increases.

Ans. True. $v = \sqrt{\mu rg}$.

PART D: MATCH THE FOLLOWING

Set 1: Quantity and its unit

Column A	Column B
1. Force	(a) newton (N)
2. Momentum	(b) N s
3. Impulse	(c) rad/s
4. Angular velocity	(d) hertz (Hz)
5. Angular acceleration	(e) rad/s ²
6. Frequency	(f) kg m/s

Answers: 1-(a), 2-(f), 3-(b), 4-(c), 5-(e), 6-(d)

Set 2: Concept and its formula or meaning

Column A	Column B
1. Recoil velocity of gun	(a) $\tan \theta = v^2/(rg)$
2. Banking of road	(b) $V = -mv/M$
3. Centripetal force	(c) $r\alpha$
4. Tangential acceleration	(d) change in momentum
5. Angular velocity	(e) mv^2/r
6. Impulse	(f) $2\pi/T$

Answers: 1-(b), 2-(a), 3-(e), 4-(c), 5-(f), 6-(d)

Set 3: Situation and the idea behind it

Column A	Column B
1. Moon revolving around the Earth	(a) $\tan \theta = v^2/(rg)$
2. Clothes in a spin dryer	(b) gravity gives centripetal force
3. Rocket launch	(c) centrifugal effect
4. Cricketer pulling hands back	(d) conservation of momentum
5. Car on a banked road	(e) normal reaction gives centripetal force
6. Cyclist leaning on a turn	(f) increases time of contact

Answers: 1-(b), 2-(c), 3-(d), 4-(f), 5-(e), 6-(a)

PART E: GIVE REASONS / CONCEPTUAL QUESTIONS

R1. Why do passengers in a bus jerk forward when the bus stops suddenly?

Ans. The lower part of the body stops with the bus, but the upper part tends to continue its state of motion due to inertia (Newton's first law), so passengers lurch forward.

R2. Why are airbags and crumple zones provided in cars?

Ans. In a collision the change in momentum is fixed. They increase the time of impact, so the average force $F = \Delta p/\Delta t$ on the passengers is reduced.

R3. Why is it harder to stop a loaded truck than a car moving at the same speed?

Ans. The truck has more mass, so more momentum ($p = mv$). A larger change in momentum needs a larger impulse, i.e. a larger force or a longer time.

R4. Why does a released inflated balloon fly in the direction opposite to the escaping air?

Ans. Air rushes out backward, taking momentum with it. By conservation of momentum, the balloon gains equal forward momentum. This is the principle of a rocket.

R5. Why does a boat move backward when a man jumps forward from it onto the shore?

Ans. Total momentum of man and boat was zero. When the man gains forward momentum, the boat gets an equal backward momentum.

R6. A heavy and a light body have the same kinetic energy. Which has more momentum?

Ans. $p = \sqrt{2mK}$. For the same K , the heavier body has the larger momentum.

R7. Can a body move with constant speed and still have acceleration?

Ans. Yes. In uniform circular motion the speed is constant, but the direction changes, giving a centripetal acceleration v^2/r .

R8. Why does mud fly off tangentially from a rotating wheel?

Ans. When the adhesive force on the mud is less than the required centripetal force mv^2/r , the mud cannot follow the circle and moves along the tangent by inertia.

R9. Why do people feel pushed outward on a circular ride?

Ans. Their bodies tend to move in a straight line (inertia) while the seat pushes them inward. In the rotating frame, this is felt as an outward (centrifugal) push.

R10. Why are roads banked at sharp curves?

Ans. A component of the normal reaction provides the centripetal force, so safe turning does not depend only on friction. This reduces skidding and tyre wear.

R11. Why do vehicles skid more easily on a wet curved road?

Ans. Wet road has a smaller coefficient of friction μ . The maximum safe speed $v = \sqrt{\mu rg}$ decreases, so friction may not supply the required centripetal force.

R12. Why does centripetal force not change the speed of a body in circular motion?

Ans. It acts perpendicular to the velocity, so it does zero work. It changes only the direction of velocity, not the speed.

Exam tips:

- In MCQs, first eliminate options with wrong units or wrong dimensions.
- Remember: momentum and impulse share the unit N s (kg m/s). Angular quantities use radians, not degrees.
- Centripetal = real, towards the centre. Centrifugal = apparent, away from the centre.
- Banking angle depends on v , r and g only, never on mass.