

How to use this worksheet. Thirty questions, about 35 minutes. Static friction is **self-adjusting**. Always ask which body a force acts on: action and reaction never cancel.

Formula sheet

$$\mathbf{F = ma \mid W = mg \mid p = mv \mid Impulse = F\Delta t = \Delta p}$$

Limiting friction $f = \mu N$ | static friction adjusts to match the applied force, up to that limit

Momentum conserved when no external force acts | Lift up: $T = m(g + a)$ | down: $T = m(g - a)$

Section A · Level 1 — Newton's three laws, momentum and friction

Ten questions. None should take more than twenty seconds.

1. Newton's first law defines:

(1) Force (2) Inertia (3) Momentum (4) Impulse

2. The SI unit of force is the:

(1) Joule (2) Newton (3) Watt (4) Pascal

3. Newton's second law is usually written as:

(1) $F = mv$ (2) $F = ma$ (3) $F = m/a$ (4) $F = ma^2$

4. According to Newton's third law, action and reaction forces:

(1) Act on the same body (2) Act on different bodies (3) Are unequal in magnitude (4) Act in the same direction

5. The momentum of a body of mass m moving with velocity v is:

(1) mv^2 (2) $\frac{1}{2}mv^2$ (3) mv (4) m/v

6. Impulse is equal to the change in:

(1) Kinetic energy (2) Momentum (3) Force (4) Acceleration

7. The force of limiting friction is given by:

(1) μN (2) μ/N (3) N/μ (4) μN^2

8. Momentum is conserved in a system when:

(1) Friction is present (2) No external force acts on the system (3) The bodies are at rest (4) Energy is conserved

9. The apparent weight of a person in a lift falling freely is:

(1) mg (2) $2mg$ (3) Zero (4) $mg/2$

10. A body continues in uniform motion unless acted on by a net external force. This is:

(1) Newton's first law (2) Newton's second law (3) Newton's third law (4) The law of conservation of energy

Working space — Questions 1 to 10

Write the formula before you substitute.

Section B · Level 2 — Direct calculation and motion graphs

Ten questions. Read the slope of a graph before deciding what it shows.

11. A force of 10 N acts on a mass of 2 kg. The acceleration produced is:

(1) 2 m/s^2 (2) 5 m/s^2 (3) 10 m/s^2 (4) 20 m/s^2

12. The weight of a body of mass 5 kg, taking $g = 10 \text{ m/s}^2$, is:

(1) 5 N (2) 10 N (3) 50 N (4) 0.5 N

- 13.** A body of mass 4 kg moves at 5 m/s. Its momentum is:
(1) 9 kg m/s (2) 20 kg m/s (3) 50 kg m/s (4) 0.8 kg m/s
- 14.** A force of 20 N acts for 0.5 s. The impulse delivered is:
(1) 10 N s (2) 40 N s (3) 20 N s (4) 0.025 N s
- 15.** A block of mass 10 kg rests on a surface with coefficient of friction 0.2. Taking $g = 10 \text{ m/s}^2$, the limiting friction is:
(1) 2 N (2) 20 N (3) 100 N (4) 50 N
- 16.** A 2 kg mass hangs from a string in a lift accelerating upward at 2 m/s^2 . Taking $g = 10 \text{ m/s}^2$, the tension is:
(1) 16 N (2) 20 N (3) 24 N (4) 4 N
- 17.** If the same lift accelerated downward at 2 m/s^2 , the tension would be:
(1) 24 N (2) 20 N (3) 16 N (4) 4 N
- 18.** A force of 12 N produces an acceleration of 4 m/s^2 . The mass of the body is:
(1) 3 kg (2) 4 kg (3) 8 kg (4) 48 kg
- 19.** The position-time graph of a body is a straight line inclined to the time axis. The body is moving with:
(1) Increasing acceleration (2) Increasing velocity (3) Constant velocity (4) Decreasing acceleration
- 20.** The velocity-time graph of a body in uniform motion is:
(1) A line through the origin at 45° (2) A line through the origin at 30° (3) A line parallel to the velocity axis (4) A line parallel to the time axis

Working space — Questions 11 to 20 *Write the formula before you substitute.*

Section C · Level 3 — Equilibrium, recoil and the third law

Seven questions. Ask which body each force acts on.

- 21.** A block is at rest on a rough surface and a force smaller than the limiting friction is applied. The frictional force is:
(1) Equal to the limiting friction (2) Equal to the applied force (3) Zero (4) Greater than the applied force
- 22.** A gun recoils when a bullet is fired because of:
(1) Newton's first law (2) Conservation of momentum (3) Friction (4) Gravity
- 23.** Two bodies of different masses are acted on by the same force for the same time. They acquire the same:
(1) Velocity (2) Acceleration (3) Momentum (4) Kinetic energy
- 24.** A person walks forward by pushing backward on the ground. This illustrates:
(1) The first law (2) The second law (3) The third law (4) Conservation of energy
- 25.** Why do action and reaction forces not cancel each other?
(1) They differ in magnitude (2) They act on different bodies (3) They act at different times (4) One is larger than the other
- 26.** A body of mass 1 kg is moving with uniform velocity. The net force acting on it is:
(1) 1 N (2) Zero (3) 10 N (4) Depends on the speed
- 27.** Friction between two surfaces depends on:
(1) The area of contact (2) The nature of the surfaces and the normal reaction (3) The volume of the bodies (4) The colour of the surfaces

Working space — Questions 21 to 27*Write the formula before you substitute.***Section D · Previous year questions — Straight from the AAI ATC papers***Three questions from the 2023 papers, recovered by optical character recognition of the scanned answer sheets and independently re-solved.*

28. A block of 20 kg is lying on a rough horizontal surface. A force of 50 N is applied to the block horizontally, but the block does not move at all. The force of friction acting on the block is (take $g = 10 \text{ m/s}^2$): **[PYQ 2023 · Morning]**

(1) 1000 N (2) 0 N (3) 200 N (4) 50 N

29. Rahul, of mass 60 kg, is standing on a frictionless plane surface. He kicks a box of mass 2.0 kg lying near his feet, giving it a velocity of $(3.0 \text{ m/s})\hat{i}$. The velocity of Rahul after the kick is: **[PYQ 2023 · Morning]**

(1) $-(0.1 \text{ m/s})\hat{i}$ (2) $-(3.0 \text{ m/s})\hat{i}$ (3) 0 (4) $(0.1 \text{ m/s})\hat{i}$

30. An astronaut suddenly gets separated from his small spaceship. If the spaceship is accelerating in interstellar space at a constant rate of 60 m/s^2 , and there are no nearby stars to exert gravitational force on the astronaut, then the acceleration of the astronaut after the instant he is outside the spaceship is: **[PYQ 2023 · Evening]**

(1) 60 m/s^2 (2) 30 m/s^2 (3) Zero (4) 120 m/s^2

Working space — Questions 28 to 30*Write the formula before you substitute.***Answer key***Check only after you have attempted every question. Full worked solutions for each one are on the worksheet page at aviatelearnings.com.*

1. (2)	7. (1)	13. (2)	19. (3)	25. (2)
2. (2)	8. (2)	14. (1)	20. (4)	26. (2)
3. (2)	9. (3)	15. (2)	21. (2)	27. (2)
4. (2)	10. (1)	16. (3)	22. (2)	28. (4)
5. (3)	11. (2)	17. (3)	23. (3)	29. (1)
6. (2)	12. (3)	18. (1)	24. (3)	30. (3)

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