

How to use this worksheet. Thirty-three questions, about 40 minutes. Power is the **scalar product** $F \cdot v$, so a perpendicular force component delivers no power. A force opposing the motion does **negative** work. When bodies move off together, only momentum is conserved.

Formula sheet

$$W = F \cdot d = Fd \cos\theta \quad | \quad KE = \frac{1}{2}mv^2 \quad | \quad PE = mgh \quad | \quad \text{Spring energy} = \frac{1}{2}kx^2$$

$$\text{Work-energy theorem: } W_{\text{net}} = \Delta KE \quad | \quad P = W/t = F \cdot v \quad | \quad 1 \text{ hp} \approx 746 \text{ W}$$

Perfectly inelastic: $m_1u_1 + m_2u_2 = (m_1 + m_2)v$ | **momentum conserved in all collisions, KE only in elastic ones**

Section A · Level 1 — Work, energy, power and collisions

Ten questions. None should take more than twenty seconds.

1. The work done by a force F acting through a displacement d at an angle θ is:
(1) Fd (2) $Fd \sin\theta$ (3) $Fd \cos\theta$ (4) $Fd \tan\theta$
2. The SI unit of work is the:
(1) Newton (2) Joule (3) Watt (4) Pascal
3. The SI unit of power is the:
(1) Joule (2) Newton (3) Watt (4) Newton metre
4. The kinetic energy of a body of mass m moving with speed v is:
(1) mv (2) $\frac{1}{2}mv$ (3) $\frac{1}{2}mv^2$ (4) mv^2
5. The work done by a force acting perpendicular to the displacement is:
(1) Maximum (2) Zero (3) Negative (4) Equal to Fd
6. The work-energy theorem states that the net work done on a body equals its change in:
(1) Momentum (2) Kinetic energy (3) Potential energy (4) Power
7. The potential energy stored in a spring stretched by x is:
(1) kx (2) $\frac{1}{2}kx$ (3) $\frac{1}{2}kx^2$ (4) kx^2
8. In a perfectly inelastic collision, the two bodies:
(1) Separate with equal speeds (2) Move together after impact (3) Bounce back (4) Come to rest
9. Which quantity is conserved in every collision, elastic or inelastic?
(1) Kinetic energy (2) Momentum (3) Velocity (4) Potential energy
10. Work done against friction is always:
(1) Positive (2) Negative (3) Zero (4) Equal to the kinetic energy

Working space — Questions 1 to 10

Write the formula before you substitute.

Section B · Level 2 — Direct calculation

Ten questions. Convert centimetres to metres before squaring anything.

11. A force of 10 N moves a body 5 m in the direction of the force. The work done is:
(1) 2 J (2) 15 J (3) 50 J (4) 0.5 J
12. A body of mass 2 kg moves at 3 m/s. Its kinetic energy is:
(1) 3 J (2) 6 J (3) 9 J (4) 18 J

- 13.** A body of mass 2 kg is raised 5 m. Taking $g = 10 \text{ m/s}^2$, the potential energy gained is:
(1) 10 J (2) 50 J (3) 100 J (4) 20 J
- 14.** If 100 J of work is done in 10 s, the power developed is:
(1) 1 W (2) 10 W (3) 100 W (4) 1000 W
- 15.** If the speed of a body is doubled, its kinetic energy becomes:
(1) Twice (2) Half (3) Four times (4) Unchanged
- 16.** A spring of constant 200 N/m is compressed by 0.1 m. The energy stored is:
(1) 1 J (2) 2 J (3) 10 J (4) 20 J
- 17.** One horsepower is approximately equal to:
(1) 100 W (2) 746 W (3) 1000 W (4) 550 W
- 18.** A body moves in a horizontal circle at constant speed. The work done by the centripetal force in one revolution is:
(1) Maximum (2) Zero (3) Negative (4) Equal to mv^2
- 19.** The area under a force-displacement graph represents:
(1) Power (2) Work done (3) Momentum (4) Acceleration
- 20.** A body of mass 1 kg falls freely from a height of 20 m. Taking $g = 10 \text{ m/s}^2$, its kinetic energy just before hitting the ground is:
(1) 100 J (2) 200 J (3) 400 J (4) 20 J

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

Section C · Level 3 — Conservation, efficiency and proportionality

Eight questions. Decide first which quantity is conserved.

- 21.** In an elastic collision between two bodies:
(1) Only momentum is conserved (2) Only kinetic energy is conserved (3) Both momentum and kinetic energy are conserved (4) Neither is conserved
- 22.** A body of mass m moving with speed v collides head-on with an identical stationary body. If the collision is perfectly elastic, the first body:
(1) Continues with speed v (2) Stops and the second moves with speed v (3) Both move with speed $v/2$ (4) Both stop
- 23.** If a force of constant magnitude acts on a body and the acceleration is proportional to t^2 , then the velocity is proportional to:
(1) t (2) t^2 (3) t^3 (4) t^4
- 24.** Power delivered by a force F to a body moving with velocity v is given by:
(1) $F \times v$ as a cross product (2) The dot product $F \cdot v$ (3) F / v (4) Fv^2
- 25.** A light body and a heavy body have the same kinetic energy. The one with greater momentum is:
(1) The light body (2) The heavy body (3) Both equal (4) Cannot be determined
- 26.** A body is thrown vertically upward. At the highest point its kinetic energy is:
(1) Maximum (2) Zero (3) Equal to its potential energy (4) Negative
- 27.** Energy stored in a stretched rubber band is a form of:
(1) Kinetic energy (2) Elastic potential energy (3) Heat energy (4) Chemical energy
- 28.** A machine that is 80% efficient delivers 400 J of useful work. The energy supplied to it was:
(1) 320 J (2) 480 J (3) 500 J (4) 600 J

Working space — Questions 21 to 28

Write the formula before you substitute.

Section D · Previous year questions — Straight from the AAI ATC papers

Five questions from the 2023 papers, recovered by optical character recognition of the scanned answer sheets and independently re-solved.

29. A block of mass 0.4 kg is moving with a velocity of 6 m/s and it makes a head-on collision with a stationary block of mass 0.8 kg. After the collision, both the blocks move together. The final velocity with which they move will be: **[PYQ 2023 · Evening]**

(1) 6 m/s (2) 0 (3) 2 m/s (4) 4 m/s

30. A biker comes to a sudden stop in 50 m. During this process, the force experienced by the bike due to the road is 200 N and this force directly opposes the motion. The work done by the road on the bike is: **[PYQ 2023 · Evening]**

(1) 5000 J (2) -10000 J (3) 10000 J (4) -5000 J

31. A block of mass 2 kg is attached to a spring of spring constant 800 N/m. If the block is displaced 15 cm from its equilibrium position and released, it executes simple harmonic motion. The maximum potential energy of the block is: **[PYQ 2023 · Evening]**

(1) 12.0 J (2) 9.0 J (3) 3.0 J (4) 6.0 J

32. Starting from rest, if a system undergoes one-dimensional motion with acceleration proportional to t^2 , where t is the elapsed time, the power delivered to it at time t is proportional to: **[PYQ 2023 · Evening]**

(1) t^2 (2) t^3 (3) t^5 (4) t^4

33. A point mass has velocity $\mathbf{v} = (1.0 \text{ m/s})\mathbf{i} + (3.0 \text{ m/s})\mathbf{j}$ at a certain instant. At the same instant it experiences a force $\mathbf{F} = -(2.0 \text{ N})\mathbf{i} + (4.0 \text{ N})\mathbf{j} + (5.0 \text{ N})\mathbf{k}$. The power delivered by the force at that instant is: **[PYQ 2023 · Morning]**

(1) 12 W (2) 20 W (3) 10 W (4) 14 W

Working space — Questions 29 to 33

Write the formula before you substitute.

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