Work, Energy and Power

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 18 N moves a body 11 m, at 180° to the direction of the force. The work done is:
(a) 99 J **(b)** 198 J **(c)** −199 J **(d)** −198 J

2. The kinetic energy of a 19 kg body moving at 19 m/s is:
(a) 3,429.5 J **(b)** 6859 J **(c)** 180.5 J **(d)** 1,714.75 J

3. A machine does 4000 J of work in 7 s. Its power is:
(a) 0.00175 W **(b)** 9.52 W **(c)** 28000 W **(d)** 571.43 W

4. A spring of spring constant 1450 N/m is stretched by 1 cm. The energy stored is:
(a) 0.0725 J **(b)** 14.5 J **(c)** 0.145 J **(d)** 7.25 J

5. The work done by a force perpendicular to the displacement is:
(a) zero **(b)** negative **(c)** equal to Fs **(d)** maximum

6. 1,800 J of work is done on a 4 kg body at rest. Its speed becomes:
(a) 32 m/s **(b)** 30 m/s **(c)** 60 m/s **(d)** 450 m/s

7. A 6 kg body moving at 19 m/s collides with a 2 kg body at rest, and they stick together. Their common speed is:
(a) 14.25 m/s **(b)** 19 m/s **(c)** 9.5 m/s **(d)** 4.75 m/s

8. Assertion (A): If the speed of a 5 kg body increases from 12 m/s to 36 m/s, its kinetic energy increases from 360 J to 3,240 J.
Reason (R): Kinetic energy is proportional to the square of the speed.
(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 12 kg ball falls from rest through a height of 45 m. Find its potential energy at the top and its speed just before it hits the ground (ignore air resistance). (Take g = 10 m/s^2.)

10. A 16 kg box is pulled 15 m across a floor by a horizontal force of 33 N. The coefficient of friction is 0.1. Find the work done by the applied force, by friction, and the gain in kinetic energy. (Take g = 10 m/s^2.)

11. A pump lifts 2900 kg of water through a height of 40 m in 10 minutes. Find the power of the pump (in W and kW). (Take g = 10 m/s^2.)

12. A 2 kg ball moving at 18 m/s makes a head-on elastic collision with a 4 kg ball at rest. Find their velocities after the collision.

13. A 10 kg trolley moving at 14 m/s hits an 8 kg trolley at rest, and they move off together. Find the common speed and the loss of kinetic energy.

14. A 4 kg block moving at 10 m/s on a smooth floor hits a spring of spring constant 64 N/m. Find the greatest compression of the spring.

15. A motor takes in 3500 J of electrical energy and lifts a load, doing 2,625 J of useful work. Find its efficiency and the energy wasted.

16. A force increases steadily from 0 to 90 N over the first 1 m, then stays at 90 N for the next 5 m. Find the work done (area under the F–x graph).

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

17. A 4 kg cart moves at 0 m/s at the top of a frictionless track 170 m high and runs down to a point 45 m high. Find (a) its loss of potential energy, (b) its kinetic energy at the lower point, (c) its speed there (2 decimal places if needed). (Take g = 10 m/s^2.)

18. A bullet of mass 50 g moving at 443 m/s embeds itself in a 5 kg block hanging from a string. Find (a) the speed of the block just after impact, (b) the height it rises through. (2 decimal places.) (Take g = 10 m/s^2.)

19. A car of mass 1700 kg has an engine of power 23 kW. Its greatest speed on a level road is 42 m/s. (a) What is the resistance to motion at that speed? (b) If the resistance stays the same, what is the car's acceleration when it moves at 32 m/s at full power?

20. Two balls of 4 kg and 2 kg move towards each other at 9 m/s and 4 m/s and collide elastically head-on. Find their velocities after the collision (take the first ball's direction as positive), and check that kinetic energy is conserved.

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Answer key

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Q	Answer	Working
1	**(d) −198 J**	$W = Fs\cos\theta = 18 \times 11 \times -1$
2	**(a) 3,429.5 J**	$KE = \frac{1}{2}mv^2$
3	**(d) 571.43 W**	$P = W/t$
4	**(a) 0.0725 J**	$U = \frac{1}{2}kx^2$
5	**(a) zero**	—
6	**(b) 30 m/s**	$W = \frac{1}{2}mv^2$
7	**(a) 14.25 m/s**	$m_1u_1 = (m_1 + m_2)v$
8	**(a) Both A and R are true, and R is the correct explanation of A.**	A is true: $\frac{1}{2} \times 5 \times 36^2 = 3{,}240$ J. R is true and explains A.
9	**5,400 J; 30 m/s**	$mgh = \frac{1}{2}mv^2$
10	**495 J; −240 J; 255 J**	work–energy theorem: net work = change in KE
11	**1,933.33 W = 1.93 kW**	$P = mgh/t = 2900 \times 10 \times 40 \div 600$
12	**−6 m/s and 12 m/s**	$v_1 = (m_1 - m_2)u_1/(m_1 + m_2)$; $v_2 = 2m_1u_1/(m_1 + m_2)$
13	**7.78 m/s; 435.56 J**	KE before 980 J; after 544.44 J
14	**2.5 m**	$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$, so $x = v\sqrt{(m/k)}$
15	**75%; 875 J**	efficiency = useful output ÷ input × 100
16	**495 J**	triangle $\frac{1}{2} \times 1 \times 90$ + rectangle 5×90
17	**(a) 5,000 J; (b) 5,000 J; (c) 50 m/s**	energy is conserved: $\frac{1}{2}mv_1^2 + mgh_1 = \frac{1}{2}mv_2^2 + mgh_2$
18	**(a) 4.39 m/s; (b) 0.96 m**	momentum: $0.05 \times 443 = (0.05 + 5)V$; then $\frac{1}{2}V^2 = gh$
19	**(a) 547.62 N; (b) 0.10 m/s²**	at top speed $P = Rv$; at lower speed driving force = P/v
20	**0.33 m/s and 13.33 m/s; KE before = 178 J = KE after**	$v_1 = [(m_1 - m_2)u_1 + 2m_2u_2]/(m_1 + m_2)$; $v_2 = [(m_2 - m_1)u_2 + 2m_1u_1]/(m_1 + m_2)$

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