

Work done, power and mechanical energy

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These 20 problems train you to use $W = F \times d$, $P = E \div t$, $KE = \frac{1}{2} m v^2$ and $GPE = m g h$. You convert units, read force-distance graphs, link work to kinetic energy and compare powers. The levels rise from recall to multi-step reasoning. They suit GCSE, IGCSE, O Level, Class 9-10 and NGSS HS-PS3-1.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS3-1

Problem 1 Formulas and units (easy)

Revise the key equations.

1. Write the equation for work done in terms of force and distance.
2. Write the equation for power in terms of energy and time.
3. State what 1 watt is equal to in joules and seconds.
4. Write the equations for kinetic energy and gravitational potential energy.

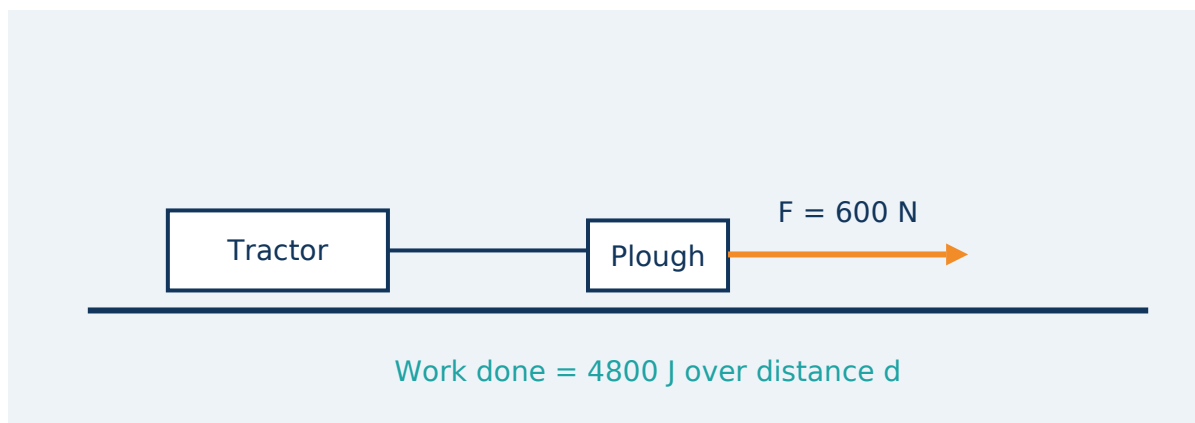
Problem 2 Pushing a handcart (easy)

Kwabena in Kumasi pushes a handcart with a force of 220 N for 35 m.

1. Write the equation you will use.
2. Calculate the work done.

Problem 3 Tractor and plough (easy)

The tractor in the figure pulls a plough with a force of 600 N and does 4800 J of work.



A tractor pulls a plough; the work done is 4800 J.

1. Rearrange $W = F \times d$ to make d the subject.
2. Calculate the distance d .

Problem 4 A motor at work (easy)

A small electric motor does 7500 J of work in 30 s.

1. Calculate its power.
2. State the energy it transfers each second.

Problem 5 Unit conversions (easy)

Convert before you calculate.

1. 2.5 kW to W.
2. 450 kJ to J.
3. 3 minutes to s.
4. A 1.5 kW heater runs for 4 minutes. Calculate the energy transferred in joules.

Problem 6 Is work being done? (easy)

Say whether work is done on the object by the force named, and justify each answer in one sentence.

1. A porter carries a sack along a level road at steady speed (the upward force of her head on the sack).
2. A weightlifter holds a barbell still above his head.
3. A crane lifts a container upwards.

Problem 7 Climbing the stairs (medium)

Mei in Singapore has a mass of 52 kg. She climbs stairs of height 3.6 m in 8.0 s. Use $g = 9.8$ N/kg.

1. Calculate the work she does against gravity.
2. Calculate her power.

Problem 8 Cricket ball (medium)

A cricket ball of mass 0.16 kg leaves the bat at 30 m/s.

1. Calculate its kinetic energy.

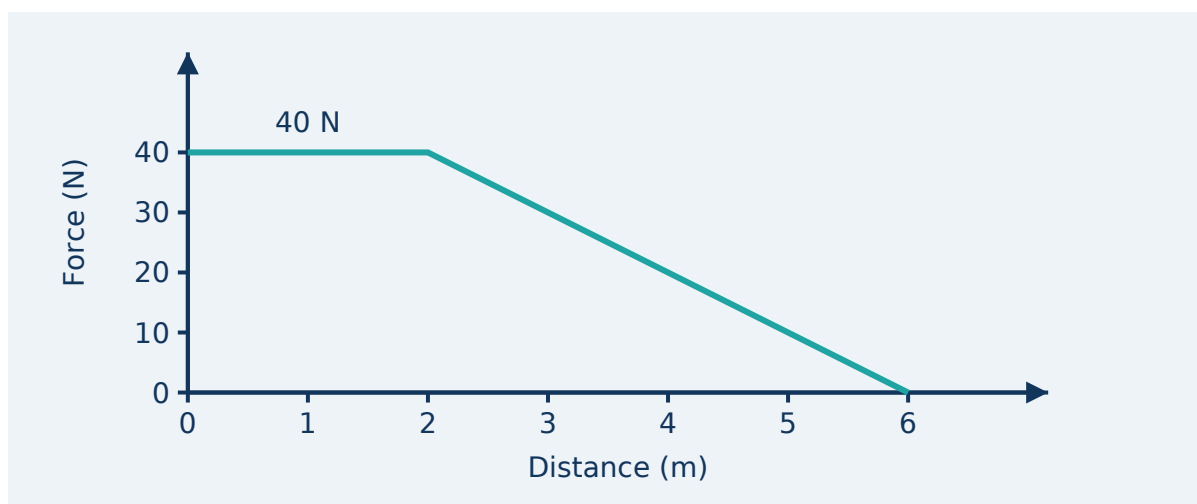
Problem 9 Water on the roof (medium)

A tank of water of mass 800 kg is raised to a roof 12 m high. Use $g = 9.8$ N/kg.

1. Calculate the gain in gravitational potential energy.
2. Express your answer in kilojoules.

Problem 10 Variable force (medium)

The graph shows the force pushing a trolley along a runway.



A force that changes with distance.

1. Calculate the work done during the first 2 m.
2. Calculate the work done between 2 m and 6 m.
3. Calculate the total work done.

Problem 11 Doubling the speed (medium)

A car of mass 1200 kg travels at 10 m/s and later at 20 m/s.

1. Calculate the kinetic energy at each speed.
2. Calculate the ratio of the two energies.

Problem 12 Crane power (medium)

A crane lifts a 500 kg load through 18 m in 25 s. Use $g = 9.8 \text{ N/kg}$.

1. Calculate the work done on the load.
2. Calculate the useful power of the crane in kilowatts.

Problem 13 Speed from energy (medium)

A ball of mass 0.40 kg has 20 J of kinetic energy.

1. Rearrange $KE = \frac{1}{2} m v^2$ to make v^2 the subject.
2. Calculate the speed.

Problem 14 Cement on a scaffold (medium)

A bag of cement of mass 2.5 kg gains 147 J of gravitational potential energy when it is lifted. Use $g = 9.8 \text{ N/kg}$.

1. Rearrange $GPE = m g h$ to make h the subject.
2. Calculate the height it is lifted.

Problem 15 Cyclist braking (medium)

Emma in Leeds and her bicycle have a total mass of 84 kg and travel at 18 km/h. She brakes

to a stop over 10 m.

1. Convert 18 km/h to m/s.
2. Calculate the kinetic energy.
3. Calculate the average braking force.

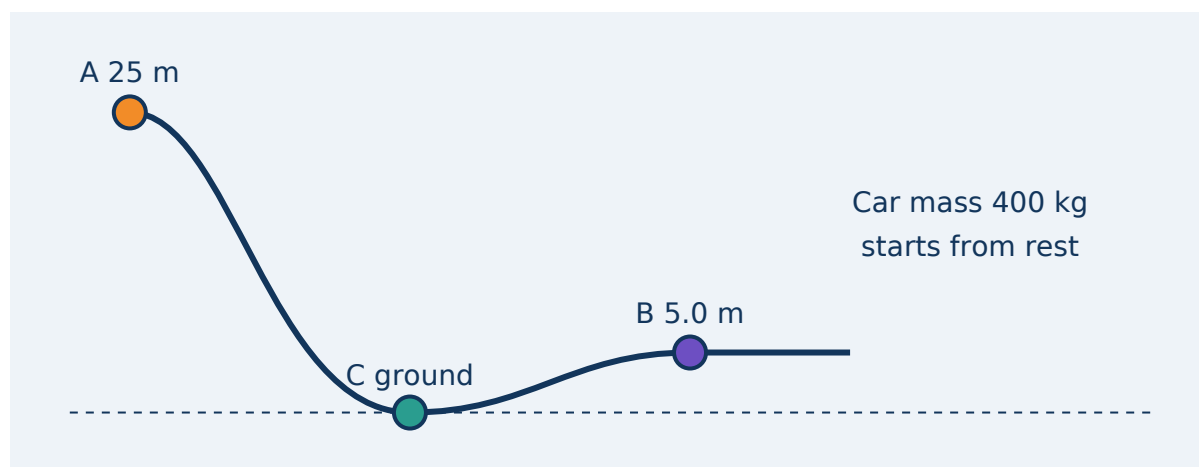
Problem 16 Stopping a truck (hard)

A truck of mass 8000 kg travels at 12 m/s and brakes with a constant force of 24 000 N.

1. Calculate the kinetic energy of the truck.
2. Calculate the stopping distance.
3. The truck now travels at 24 m/s with the same braking force. Calculate the kinetic energy and the stopping distance.
4. Explain, using energy, why doubling the speed multiplies the stopping distance by four.

Problem 17 Roller coaster (hard)

A roller coaster car with riders has a mass of 400 kg and starts from rest at A. Ignore friction and use $g = 9.8 \text{ N/kg}$.



Roller coaster with three marked points A, B and C.

1. Calculate the gravitational potential energy at A, taking the ground as zero.
2. Calculate the kinetic energy and speed at B.
3. Calculate the speed at C.
4. State what happens to your answers if the mass is 800 kg and explain.

Problem 18 Farm pump (hard)

Bilal's pump lifts 1200 kg of water every minute through 9.0 m. Use $g = 9.8 \text{ N/kg}$.

1. Calculate the work done on the water each minute.
2. Calculate the useful power of the pump.
3. Calculate how long the pump needs to deliver 18 000 kg of water.

Problem 19 Power and speed (hard)

A cyclist rides at a steady 8.0 m/s against a total resistive force of 25 N.

1. Show that power = force $\times$ speed.
2. Calculate the power she must supply.
3. Calculate the work she does in 10 minutes.
4. At 16 m/s the air resistance is 4 times larger (100 N). Calculate the new power and compare it with your answer to part 2.

Problem 20 Stair-climbing comparison (hard)

Three students each climb the same 4.0 m staircase. Use $g = 9.8 \text{ N/kg}$.

Student	Mass (kg)	Time (s)
A	45	6.0
B	60	10
C	50	5.5

1. Calculate the work done by each student.
2. Calculate the power of each student.
3. State who did the most work and who had the greatest power.