

A.3 Work, energy and power

Practice Worksheet – name: _____ date: _____

FORMULAS FOR THIS TOPIC

WORK DONE $W = Fs \cos \theta$ KINETIC ENERGY $E_k = \frac{1}{2}mv^2 = \frac{p^2}{2m}$ GRAVITATIONAL PE (NEAR SURFACE) $\Delta E_p = mg\Delta h$ ELASTIC POTENTIAL ENERGY $E_H = \frac{1}{2}k(\Delta x)^2$ POWER $P = \frac{\Delta W}{\Delta t} = Fv$ EFFICIENCY $\eta = \frac{E_{\text{output}}}{E_{\text{input}}} = \frac{P_{\text{output}}}{P_{\text{input}}}$

SECTION A — MULTIPLE CHOICE

A1. A porter carries a heavy suitcase horizontally at constant velocity across a level floor. The work done on the suitcase by the supporting force is:

- A Positive
- B Negative
- C Zero
- D Cannot be determined

A2. A pendulum bob is released from a height h above its lowest point. Ignoring air resistance, its speed at the lowest point is:

- A \sqrt{gh}
- B $\sqrt{2gh}$
- C $2\sqrt{gh}$
- D gh

A3. A motor rated at 1.5 kW raises a 60 kg load at a steady 2.0 m s^{-1} . What is the efficiency of the system?

- A 58%
- B 66%
- C 78%
- D 92%

SECTION B — SHORT ANSWER

B1. A 65 kg skier starts from rest and descends a slope of vertical height 40 m, reaching the bottom at 22 m s^{-1} . Determine the energy dissipated by friction and air resistance. [3 marks]

B2. Explain why the work done in stretching a spring by $2x$ is four times, not twice, the work done in stretching it by x . [2 marks]

B3. Sketch a Sankey diagram for a filament lamp that is 10% efficient, and state what each feature represents. [3 marks]

ANSWER KEY

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Section A

A1: Zero – The supporting force is vertical while the displacement is horizontal, so $\theta = 90^\circ$ and $W = Fs \cos 90^\circ = 0$. Feeling tired is not the physics definition of doing work on the case.

A2: $\sqrt{2gh}$ – Energy conservation: $mgh = \frac{1}{2}mv^2$, so $v = \sqrt{2gh}$. Mass cancels – the answer is independent of the bob's mass, which is why energy methods are so quick here.

A3: 78% – Useful power = $Fv = mgv = 60 \times 9.81 \times 2.0 \approx 1177$ W. Efficiency = $1177/1500 \approx 0.78$, i.e. 78%. The other 22% is dissipated in the motor and transmission.

Section B

B1: Energy available: $mgh = 65 \times 9.81 \times 40 \approx 25.5$ kJ. Kinetic energy gained: $\frac{1}{2}(65)(22^2) \approx 15.7$ kJ. Energy dissipated $\approx 25.5 - 15.7 = 9.8$ kJ, transferred to the surroundings as thermal energy.

B2: The stored energy is $E_H = \frac{1}{2}k(\Delta x)^2$, quadratic in extension. Doubling Δx quadruples the energy because the force grows with extension – the average force over the second stretch is larger than over the first.

B3: A broad arrow enters representing 100% electrical input; a thin straight arrow (one-tenth the width) continues forward for the useful light output; a large arrow bends away (usually downwards) for the 90% dissipated as thermal energy. Arrow width is proportional to power.