Answer Key

Work and Power

Whenever a force moves something, **work** is done. It is a measure of the amount of energy used in moving the object. Work is measured in joules (J). If a force acts but nothing moves then no work is done.

Work can be calculated using the following equation:

Work done = force applied x distance moved or **W = F x d**

where W is the work done (J), F is the force applied (N) and d is the distance moved (m).

Power is the rate at which work is done, or how fast energy is used. Power is measured in Watts (W), work in Joules (J) and time measured in seconds (s).

$$\textbf{Power} = \frac{\textbf{work done}}{\textbf{time}} \quad \text{or} \quad P = \frac{W}{t}$$

1. Calculate the work done if a force of:
   a. 8N causes an object to move 12m.

W = ?
F = 8 N
d = 12m

$W = F \times d$
$= 8 \times 12$
$= 96$

W = 96 J

   b. 6N causes an object to move 14m.

W = ?
F = 6N
d = 14m

$W = F \times d$
$= 6 \times 14$
$= 84$

W = 84J

   c. 12N causes an object to move 4m.

W = ?
F = 12N
d = 4m

$W = F \times d$
$= 12 \times 4$
$= 48$

W = 48J

2. A force of 4N is applied to an object until 20J of work is done. How far has the object moved?

W = 20J
F = 4N
d = ?

$W = F \times d$

$d = \frac{W}{F}$

$d = \frac{W}{F}$
$= \frac{20}{4}$
$= 5$

d = 5m

3. What force is needed to push a toy car for 2m if 12J of work is done?

W = 12J
F = ?
d = 2m

$W = F \times d$

$F = \frac{W}{d}$

$F = \frac{W}{d}$
$= \frac{12}{2} = 6$

F = 6N

4. A crane lifts an iron girder with a weight force of 350N, to a height of 13m in 30 seconds. Find:
   a. The work done.

W = ?
F = 350N
d = 13m

$W = F \times d$
$= 350 \times 13$
$= 4550$

W = 4550J

   b. The power used.

P = ?
W = 4550J
t = 30 s

$P = \frac{W}{t}$
$= \frac{4550}{30}$
$= 151.7\ W$

P = 151.7 W.

5. A painter climbs 1.5m up a ladder with a can of paint in 4 seconds. If the power used is 60 W, then find

   a. The work done by the painter.

   $P = 60W$, $W = ?$, $t = 4s$

   $P = \frac{W}{t}$

   $W = P \times t$

   $W = 60 \times 4$

   $= 240$

   $W = 240J$

   b. The weight force of the can of paint.

   $W = 240$, $F = ?$, $d = 1.5$

   $W = F \times d$

   $F = \frac{W}{d}$

   $F = \frac{240}{1.5}$

   $= 160$

   $F = 160N$

6. Jenny moves a shopping trolley 50 metres by applying a force of 75N.

   a. How much work did Jenny do?

   $W = ?$, $F = 75N$, $d = 50m$

   $W = F \times d$

   $= 75 \times 50$

   $= 3750$

   $W = 3750J$

   b. What was the power Jenny used if she pushed the trolley the 50m in 45 seconds?

   $P = ?$, $W = 3750$, $t = 45s$

   $P = \frac{W}{t}$

   $= \frac{3750}{45} = 83.3$

   $P = 83.3W$

7. A cyclist exerts an average force of 100N in pedalling her bike 3000m.

   a. How much work did she do?

   $W = ?$, $F = 100N$, $d = 3000m$

   $W = F \times d$

   $= 100 \times 3000$

   $= 300\,000$

   $W = 300\,000J$

   b. How much power did she generate if she completed the 3km in 15 minutes?

   $P = ?$, $W = 300\,000$, $t = 15min = 900s$

   $P = \frac{W}{t}$

   $= \frac{300\,000}{900} = 333.3W$

8. Sally uses a force of 60N to lift a pile of books onto a shelf in 5 seconds. If the power Sally used was 18 Watts, determine

   a. The work done by Sally.

   $P = 18W$, $W = ?$, $t = 5s$

   $P = \frac{W}{t}$

   $W = P \times t$

   $W = 18 \times 5$

   $= 90$

   $W = 90J$

   b. The vertical height of the shelf.

   $W = 90J$, $F = 60N$, $d = ?$

   $W = F \times d$

   $d = \frac{W}{F}$

   $d = \frac{90}{60}$

   $= 1.5$

   $d = 1.5m$