Combining equations

PHYSICS EQUATION PRACTICE

USEFUL Equations

GRAVITATIONAL POTENTIAL ENERGY = MASS x g x HEIGHT

WORK DONE = FORCE X DISTANCE

KINETIC ENERGY = ½ X MASS X VELOCITY²

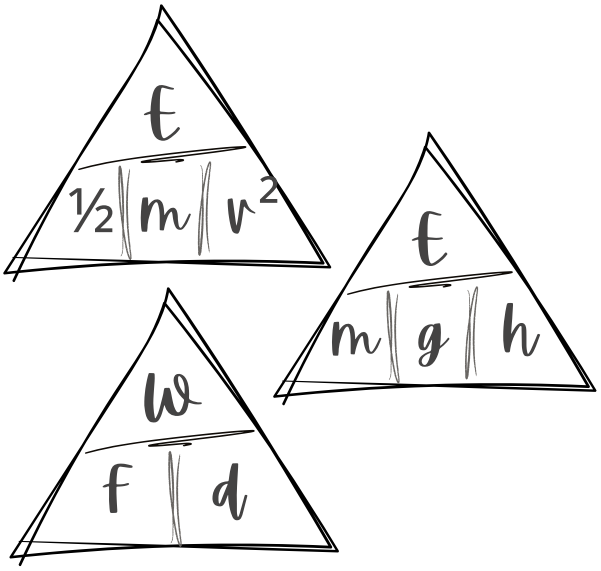
Understand

UNDERSTAND, DON'T MEMORISE

These questions involve two equations. You'll need to identify which are involved to answer the question.

Make a list of variables you have on the left of the answer space, so you can figure out which equations you need.

Equation TRIANGLES



Example QUESTION

QUESTION:

A 2000 kg rocket engine applies a constant thrust of 5000 N over 300 m along the launchpad. Find the rocket's speed at the end.

Mass — distance — Force — velocity

ANSWER:

List

m = 2000 kg

v = ?

d = 300 m

F = 5000 N

Equations

$W = F \times d$

= 5000 × 300 =

1,500,000 J;

$KE = \frac{1}{2}mv^2$

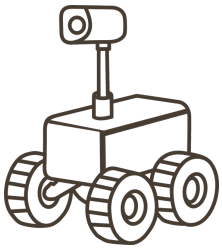
$1{,}500{,}000 = \frac{1}{2} \times 2000 \times v^2$

$v = \sqrt{(2 \times 1{,}500{,}000 / 2000)}$

≈ 38.7 m/s

Challenge QUESTIONS

1. Space Rover Push: A 350 kg Mars rover is pushed 6 m with a 400 N force along flat ground. Find its final speed from rest.

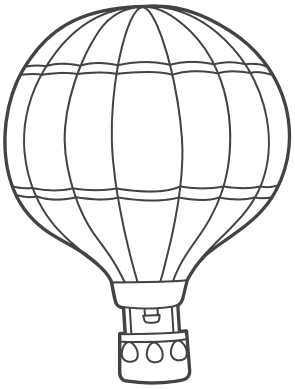


2. Diving Platform: A 60 kg diver jumps from a 10 m high platform. Find the speed just before hitting the water.

3. Skateboard Ramp: A 50 kg skateboarder descends a 5 m ramp from rest. Find the speed at the bottom.

4. Hot Air Balloon: A 200 kg basket is lifted 15 m by a balloon. Find the minimum work done.

5. Space Capsule Landing: A 1000 kg capsule falls 120 m onto a moon base. Find its impact speed ignoring air resistance.



Challenge QUESTIONS

6. Alien Sled Push: An alien pushes a 80 kg sled 12 m on flat ground with 150 N. Find the sled's final speed.

7. Wizard's Lift Spell: A 5 kg magical stone is lifted 20 m using a spell. Find the work done.

8. Catapult Launch: A 10 kg pumpkin is hurled 15 m horizontally by a catapult applying a constant force of 600 N. Find its speed.

9. Mountain Biker Drop: A 70 kg biker drops from a cliff 12 m high. Find the speed just before landing.

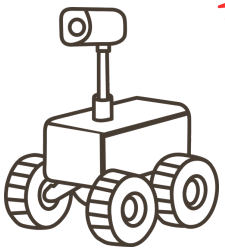
10. Roller Coaster Lift Hill: A 400 kg roller coaster car is lifted 25 m. Find the work done.

Working SPACE

Combining Equations - Wd, GPE, KE

Challenge QUESTIONS — Worked Answers

1. Space Rover Push: A 350 kg Mars rover is pushed 6 m with a 400 N force along flat ground. Find its final speed from rest.



$d = 6m$
$F = 400\ N$

$W = Fd = 400 \times 6 = 2400\ J;$

$KE = \frac{1}{2} \times m \times v^2$

$v = ?$
$m = 350\ kg$

$2400 = \frac{1}{2} \times 350 \times v^2$
$v = \sqrt{(2 \times 2400 / 350)} \approx 3.7\ m/s$

2. Diving Platform: A 60 kg diver jumps from a 10 m high platform. Find the speed just before hitting the water.

$h = 10\ m$
$m = 60\ kg$
$v = ?$

$GPE = mgh = 60 \times 10 \times 10 = 6000\ J;$

$KE = \frac{1}{2} \times m \times v^2$

$6000 = \frac{1}{2} \times 60 \times v^2$
$v = \sqrt{(2 \times 6000 / 60)} \approx 14.1\ m/s$

$g = 10\ m/s^2$

3. Skateboard Ramp: A 50 kg skateboarder descends a 5 m ramp from rest. Find the speed at the bottom.

$h = 5\ m$
$m = 50\ kg$
$v = ?$

$GPE = mgh = 50 \times 10 \times 5 = 2500\ J;$

$KE = \frac{1}{2} \times m \times v^2$

$2500 = \frac{1}{2} \times 50 \times v^2$
$v = \sqrt{(2 \times 2500 / 50)} = 10\ m/s$

$g = 10\ m/s^2$

4. Hot Air Balloon: A 200 kg basket is lifted 15 m by a balloon. Find the minimum work done.

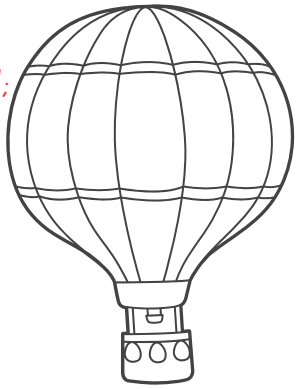
$m = 200\ kg$
$h = 15\ m$

Work done = GPE gained by balloon.

$W = mgh = 200 \times 10 \times 15 = 30{,}000\ J$

$g = 10\ m/s^2$

5. Space Capsule Landing: A 1000 kg capsule falls 120 m onto a moon base. Find its impact speed ignoring air resistance.



$h = 120\ m$
$m = 1000\ kg$
$v = ?$

$GPE = mgh = 1000 \times 1.62 \times 120 = 194{,}400\ J;$

$KE = \frac{1}{2} \times m \times v^2$

$194{,}400 = \frac{1}{2} \times 1000 \times v^2$
$v = \sqrt{(2 \times 194{,}400 / 1000)} \approx 19.7\ m/s$

$g = 10\ m/s^2$

Challenge QUESTIONS

Worked Answers

6. Alien Sled Push: An alien pushes a 80 kg sled 12 m on flat ground with 150 N. Find the sled's final speed.

$d = 12$ m
$F = 150$ N
$m = 80$ kg
$v = ?$

$W = Fd = 150 \times 12 = 1800$ J;

$KE = \frac{1}{2} \times m \times v^2$

$1800 = \frac{1}{2} \times 80 \times v^2$
$v = \sqrt{(2 \times 1800 / 80)} \approx 6.7$ m/s

7. Wizard's Lift Spell: A 5 kg magical stone is lifted 20 m using a spell. Find the work done.

$m = 5$ kg
$h = 20$ m

$g = 10$ m/s^2

Work done = GPE gained by stone

$W = mgh = 5 \times 10 \times 20 = 1000$ J

8. Catapult Launch: A 10 kg pumpkin is hurled 15 m horizontally by a catapult applying a constant force of 600 N. Find its speed.

$d = 15$ m
$F = 600$ N
$m = 10$ kg
$v = ?$

$W = Fd = 600 \times 15 = 9000$ J;

$KE = \frac{1}{2} \times m \times v^2$

$9000 = \frac{1}{2} \times 10 \times v^2$
$v = \sqrt{(2 \times 9000 / 10)} \approx 42.4$ m/s

9. Mountain Biker Drop: A 70 kg biker drops from a cliff 12 m high. Find the speed just before landing.

$h = 12$ m
$g = 10$ m/s^2
$m = 70$ kg
$v = ?$

$GPE = mgh = 70 \times 10 \times 12 = 8400$ J;

$KE = \frac{1}{2} \times m \times v^2$

$8400 = \frac{1}{2} \times 70 \times v^2$
$v = \sqrt{(2 \times 8400 / 70)} \approx 15.5$ m/s

10. Roller Coaster Lift Hill: A 400 kg roller coaster car is lifted 25 m. Find the work done.

$m = 400$ kg
$h = 25$ m
$g = 10$ m/s^2

Work done = GPE gained by roller coaster

$W = mgh = 400 \times 10 \times 25 = 100{,}000$ J