

CLASS 9 SCIENCE — CHAPTER 7

NCERT SOLUTIONS

Work, Energy, and Simple Machines

New NCERT *Exploration* Textbook | 2026–27

There are **15 questions** in the exercise.

REVISE, REFLECT, REFINE

Q1. State whether the following statements are True or False.

(i) Work is done when a force is applied even if the object does not move.

 **False**

Work is done only when the applied force produces displacement in the object.

If there is no displacement:

Work = 0

(ii) Lifting a bucket vertically upward results in positive work.

 **True**

The force applied on the bucket and its displacement are both upward.

Therefore, work done is positive.

(iii) SI unit of work and energy is joule.

 **True**

The SI unit of both work and energy is **joule (J)**.

(iv) A motionless stretched rubber band has kinetic energy.

 **False**

A motionless stretched rubber band has **elastic potential energy**, not kinetic energy.

(v) Energy can change from one form to another.

 **True**

Energy can be transformed from one form to another.

 **Answer:**

- (i) False
 - (ii) True
 - (iii) True
 - (iv) False
 - (v) True
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Q2. Fill in the blanks.

(i) Work done = ____ × ____

Answer: Force × displacement

(ii) 1 J of work is done when a force of ____ N displaces an object by 1 m.

Answer: 1 N

Because:

$$W = F \times s$$

$$1 \text{ J} = 1 \text{ N} \times 1 \text{ m}$$

(iii) Kinetic energy of mass m moving with velocity v is ____.

Answer: $\frac{1}{2}mv^2$

(iv) Potential energy at height h is ____.

Answer: mgh

(v) Power is the ____ at which work is done.

Answer: rate

✓ **Final Answers:**

1. **Force $\times$ displacement**
 2. **1 N**
 3. **$\frac{1}{2}mv^2$**
 4. **mgh**
 5. **rate**
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Q3. Ball Thrown Upward

Question:

When a ball thrown upwards reaches its highest point, which statements are correct?

- (i) Force acting is zero.
- (ii) Acceleration is zero.
- (iii) Kinetic energy is zero.
- (iv) Potential energy is maximum.

Answer:

At the highest point:

- Instantaneous velocity = **0**
- Therefore, kinetic energy = **0**
- Height is maximum
- Therefore, potential energy is **maximum**

However, gravity continues to act downward.

So:

- Force $\neq 0$
- Acceleration $\neq 0$

✓ **Correct answers:**

(iii) Kinetic energy is zero.

(iv) Potential energy is maximum.

Q4. Identify the Energy Transformations

(i) Truck moving uphill

Kinetic energy → Gravitational potential energy

(ii) Unwinding watch spring

Elastic potential energy → Kinetic energy

(iii) Photosynthesis

Solar/light energy → Chemical energy

(iv) Water flowing from a dam

Gravitational potential energy → Kinetic energy

(v) Burning matchstick

Chemical energy → Thermal + light energy

(vi) Firecracker explosion

Chemical energy → Thermal + light + sound + kinetic energy

(vii) Speaking into a microphone

Mechanical/sound energy → Electrical signal

(viii) Glowing electric bulb

Electrical energy → Light + thermal energy

(ix) Solar panel

Solar/light energy → Electrical energy



Q5. Potential Energy of a Student

Question:

A student of mass **50 kg** is lifted to a height of **72.5 m**. Take:

$$g = 10 \text{ m/s}^2$$

Find the gain in potential energy:

1. When lifted straight up
2. When climbing stairs
3. Does potential energy depend on the path?

Given:

$$m = 50 \text{ kg}$$

$$h = 72.5 \text{ m}$$

$$g = 10 \text{ m/s}^2$$

Formula:

$$\text{Potential energy} = mgh$$

Calculation:

$$PE = 50 \times 10 \times 72.5$$

$$PE = \mathbf{36,250 \text{ J}}$$

(i) Lifted straight up:

$$PE = 36,250 \text{ J}$$

(ii) Climbing stairs:

$$PE = 36,250 \text{ J}$$

(iii) Does it depend on the path?

 No.

Gravitational potential energy depends only on the **initial and final heights**, not on the path taken.

 **Answer:**

Potential energy gained = 36,250 J in both cases.

Potential energy is path-independent.



Q6. Crane and Power

Question:

A crane lifts a mass to the 10th floor in a certain time and then to the 20th floor in double the time. How much more energy and power are required?

Step 1: Energy

Potential energy:

$$PE = mgh$$

The 20th floor is twice the height of the 10th floor.

Therefore:

Energy required = 2 × original energy

Step 2: Power

Formula:

$$P = W/t$$

For the 20th floor:

- Work becomes **2 times**
- Time also becomes **2 times**

Therefore:

$$P = 2W/2t = W/t$$

✓ **Answer:**

Energy required = **2 times**

Power required = **same as before**



Q7. Raising a Flag Using a Pulley

Question:

What factors determine the energy required to raise a flag using a pulley? Does raising it slowly or quickly change the work? If speed is doubled, how does power change?

Answer:

The energy required depends on:

- Mass of the flag (**m**)
- Acceleration due to gravity (**g**)
- Height through which it is raised (**h**)

Formula:

$$\Delta U = mgh$$

Does raising it slowly or quickly change the work?

✗ No.

For the same mass and height, the work required remains the same if losses are ignored.

What happens if speed is doubled?

Power:

$$P = W/t$$

If the same work is completed in half the time:

Power doubles.

✅ **Answer:**

$$\text{Energy} = mgh$$

Work does not change with speed.

If speed is doubled, power doubles.



Q8. Scooter and Fuel Consumption

Question:

A man of mass 60 kg rides a 100 kg scooter. The next day his 40 kg son joins him. Both reach the same speed in the same time. Find the ratio of fuel used.

Day 1:

Scooter mass = 100 kg

Man = 60 kg

Total mass:

$$100 + 60 = 160 \text{ kg}$$

Day 2:

Scooter = 100 kg

Man = 60 kg

Son = 40 kg

Total mass:

$$100 + 60 + 40 = 200 \text{ kg}$$

For the same final speed:

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

Therefore, kinetic energy is proportional to mass.

So fuel required is proportional to mass.

Ratio:

$$160 : 200$$

Divide by 40:

$$4 : 5$$

✓ Answer:

Ratio of fuel used = 4 : 5



Q9. Seesaw

Question:

On a seesaw, an adult weighs twice as much as a child, but the seesaw is balanced. Show where they should sit relative to the fulcrum.

Given:

Child's weight = **W**

Adult's weight = **2W**

Let:

Distance of child from fulcrum = **d**

Distance of adult from fulcrum = D

For a balanced seesaw:

Clockwise moment = Anticlockwise moment

Therefore:

$$W \times d = 2W \times D$$

Cancel W :

$$d = 2D$$

Therefore:

 **Answer:**

The child should sit **twice as far from the fulcrum as the adult**.

Distance ratio:

$$\text{Child : Adult} = 2 : 1$$

Q10. Ball Thrown Upward and Air Resistance

A **2 kg** ball is thrown upward with velocity **20 m/s**.

It reaches a height of **19.4 m**.

Take:

$$g = 10 \text{ m/s}^2$$

(i) Sign of work done by gravity

During upward motion:

Gravity acts downward while displacement is upward.

Therefore:

Work done by gravity = Negative

During downward motion:

Gravity and displacement are in the same direction.

Therefore:

Work done by gravity = Positive

(ii) Work done by air resistance

Initial kinetic energy:

Formula:

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

$$K = \frac{1}{2} \times 2 \times 20^2$$

$$K = 400 \text{ J}$$

Potential energy gained:

$$PE = mgh$$

$$PE = 2 \times 10 \times 19.4$$

$$PE = 388 \text{ J}$$

If there were no air resistance, the gain in potential energy would equal the initial kinetic energy.

Difference:

Work done by air resistance

$$= 388 - 400$$

$$= -12 \text{ J}$$

 **Answer:**

(i) Upward: Negative; Downward: Positive

(ii) Work done by air resistance = -12 J



Q11. Variable Force and Kinetic Energy

A **10 kg** block has initial kinetic energy of **180 J**. A variable force acts from 0 m to 4 m as shown in the textbook graph.

Find:

1. Speed at 0 m
 2. Speed at 4 m
 3. Whether it has negative acceleration anywhere
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(i) Speed at 0 m

Given:

$$K = 180 \text{ J}$$

$$m = 10 \text{ kg}$$

Formula:

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

$$180 = \frac{1}{2} \times 10 \times v^2$$

$$180 = 5v^2$$

$$v^2 = 36$$

$$v = 6 \text{ m/s}$$



Speed = 6 m/s

(ii) Speed at 4 m

From the force-displacement graph, work done from 0–4 m is:

150 J

Using the work-energy theorem:

Final KE = Initial KE + Work done

$$= 180 + 150$$

$$= \mathbf{330 \text{ J}}$$

Now:

$$330 = \frac{1}{2} \times 10 \times v^2$$

$$330 = 5v^2$$

$$v^2 = 66$$

$$\mathbf{v = \sqrt{66} \text{ m/s}}$$

(iii) Negative acceleration?

No.

The force does not become negative in the given graph.

 **Answer:**

Speed at 0 m = 6 m/s

Speed at 4 m = $\sqrt{66}$ m/s

Negative acceleration = No



Q12. Ball Thrown on the Moon

Question:

Lunar gravity is approximately **1/6** of Earth's gravity. An astronaut can throw a ball to a height of **8 m on Earth**. How high will the same ball travel on the Moon with the same initial velocity?

Formula:

For upward motion:

$$v^2 = u^2 - 2gh$$

At maximum height:

$$v = 0$$

Therefore:

$$u^2 = 2gh$$

For the same initial velocity:

$$h \propto 1/g$$

Since:

$$g_{\text{Moon}} = g_{\text{Earth}}/6$$

Therefore:

$$h_{\text{Moon}} = 6 \times h_{\text{Earth}}$$

$$h_{\text{Moon}} = 6 \times 8$$

$$\checkmark h_{\text{Moon}} = 48 \text{ m}$$

So, the ball will rise to:

48 m



Q13. Car Braking

A car of mass **1000 kg** moves at constant speed. The speed-time graph shows its motion before and during braking.

(i) Describe the motion between A and B.

Between A and B, the car moves with:

Constant speed = 35 m/s

(ii) Calculate kinetic energy at A.

Given:

$$m = 1000 \text{ kg}$$

$$v = 35 \text{ m/s}$$

Formula:

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

$$K = \frac{1}{2} \times 1000 \times 35^2$$

$$K = 500 \times 1225$$

$$K = 612,500 \text{ J}$$

(iii) Work done by brakes between B and C

At C, the car comes to rest.

Final kinetic energy:

$$0 \text{ J}$$

Initial kinetic energy:

$$612,500 \text{ J}$$

Change in kinetic energy:

$$\Delta K = 0 - 612,500$$

$$\Delta K = -612,500 \text{ J}$$

By the work-energy theorem:

Work done = change in kinetic energy

Therefore:

Work done by brakes = $-612,500 \text{ J}$

The negative sign indicates that the braking force acts opposite to the motion.

(iv) What does kinetic energy transform into?

The kinetic energy is mainly converted into:

Thermal energy

because of friction in the braking system and between tyres and road.

 **Answers:**

(i) Constant speed

(ii) $612,500 \text{ J}$

(iii) $-612,500 \text{ J}$

(iv) Thermal energy

Q14. Ball on a Frictionless Track

A **0.5 kg** ball moves on a frictionless track.

At O:

- Velocity = 0
- Potential energy = 30 J

Find velocity at P, Q and R using the potential-energy graph.

Key principle:

Because the track is frictionless:

Mechanical energy remains constant.

Total mechanical energy:

$$\mathbf{E = 30\ J}$$

At P:

From the graph:

Potential energy at P leaves **10 J** as kinetic energy.

Therefore:

$$\mathbf{K = 30 - 20 = 10\ J}$$

Using:

$$\mathbf{K = \frac{1}{2}mv^2}$$

$$10 = \frac{1}{2} \times 0.5 \times v^2$$

$$10 = 0.25v^2$$

$$v^2 = 40$$

$$v = \sqrt{40}$$

$$\mathbf{v = 2\sqrt{10}\ m/s}$$

At Q:

Potential energy = **30 J**

Therefore:

Kinetic energy = 30 - 30

$$\mathbf{= 0}$$

So:

$$v = 0 \text{ m/s}$$

At R:

The potential energy at R is greater than the total mechanical energy available.

Therefore, the ball cannot reach R.

✅ **Answer:**

At P: $2\sqrt{10}$ m/s

At Q: 0 m/s

At R: Ball cannot reach R



Q15. Coconut Falling into Wet Sand

A coconut of mass **1.5 kg** falls from a tree of height **10 m**.

Average resistive force of sand = **3000 N**

Take:

$$g = 10 \text{ m/s}^2$$

Find:

1. Speed just before impact
 2. Depth of depression in sand
-

(i) Speed just before impact

Given:

$$u = 0$$

$$h = 10 \text{ m}$$

$$g = 10 \text{ m/s}^2$$

Using:

$$v^2 = u^2 + 2gh$$

$$v^2 = 0 + 2 \times 10 \times 10$$

$$v^2 = 200$$

$$v = \sqrt{200}$$

$$v = 10\sqrt{2} \text{ m/s}$$

Direction is downward.

(ii) Depth of depression

Potential energy lost:

$$PE = mgh$$

$$PE = 1.5 \times 10 \times 10$$

$$PE = 150 \text{ J}$$

This energy is used in doing work against the resistive force of sand.

Work:

$$W = F \times d$$

Therefore:

$$150 = 3000 \times d$$

$$d = 150/3000$$

$$d = 0.05 \text{ m}$$

Convert to cm:

$$0.05 \text{ m} = 5 \text{ cm}$$

✓ **Answer:**

Speed = $10\sqrt{2}$ m/s downward

Depth of depression = 0.05 m = 5 cm



CHAPTER 7 — QUICK ANSWER KEY

Q	Answer
1	F, T, T, F, T
2	Force; displacement; 1 N; $\frac{1}{2}mv^2$; mgh; rate
3	(iii), (iv)
4	Energy transformations as given above
5	36,250 J; 36,250 J; path-independent
6	Energy = 2 times ; Power = same
7	Energy = mgh; work unchanged; power doubles
8	4 : 5
9	Child : Adult = 2 : 1
10	-12 J
11	6 m/s; $\sqrt{66}$ m/s; No
12	48 m
13	612,500 J; -612,500 J; thermal energy
14	$2\sqrt{10}$ m/s; 0 m/s; cannot reach R
15	$10\sqrt{2}$ m/s; 0.05 m

These key answers are consistent with the prepared Chapter 7 NCERT solution set based on the supplied new NCERT chapter.

★ CHAPTER 7 — IMPORTANT FORMULAS

Work

$$W = F \times s$$

Kinetic Energy

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

Potential Energy

$$PE = mgh$$

Mechanical Energy

Mechanical Energy = Kinetic Energy + Potential Energy

$$E = K + U$$

Work-Energy Theorem

Work done = Change in kinetic energy

Power

$$P = W/t$$

SI Units

- Work → joule (J)
- Energy → joule (J)
- Power → watt (W)
- Force → newton (N)

Remember:

Work can be positive, negative or zero.

Kinetic energy depends on mass and velocity.

Potential energy depends on mass, gravity and height.

In the absence of energy loss, mechanical energy remains conserved.

For the same work, less time means greater power.