KHYBER PAKHTUNKHWA TEXTBOOK BOARD · CLASS 9

9th Class Physics Notes Full Book

Complete Chapter-wise Notes, Short Questions, Long Questions and MCQs with Answer Key

For students of the Khyber Pakhtunkhwa Textbook Board (KPTBB), Peshawar
Boards served: Peshawar, Mardan, Swat, Abbottabad, Bannu, Kohat, Malakand and D.I. Khan

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Original notes written for the KPTBB Grade IX Physics book.
Check your board for the current model paper before the exam.

Contents and Paper Pattern

Chapters in this Book

1. Chapter 1: Physical Quantities and Measurement
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6. Chapter 6: Work and Energy
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How to Use These Notes

Read the key concepts and definitions of one chapter, learn its formulas, then test yourself with the MCQs and questions at the end of the chapter. Use the answer key on the last page to check your MCQs. Practise the numericals with a calculator and revise the weak chapters again.

Board Paper Pattern (Physics, Class 9, KPK Boards)

Section	What it contains	Marks
Section A – MCQs	12 multiple choice questions, 1 mark each (15 minutes)	12
Section B – Short questions	Answer any 8 out of 11 questions, 4 marks each	32
Section C – Long questions	Answer any 3 out of 4 questions, 7 marks each	21
Theory paper total	Time allowed: 3 hours (2 hours 45 minutes for Sections B and C)	**65**
Practical	Practical examination in Physics	10
Subject total	Theory 65 + Practical 10	**75**

Note on the pattern: the theory split (12 + 32 + 21 = 65) is taken from the BISE Kohat Table of Specifications for Physics 9th and the BISE model papers for Physics 9th, which show the same Section A/B/C structure. The practical figure of 10 marks is third-party reproduced from published KPK board date-sheet reports, not read off an official BISE document, so confirm it from your own board before the exam. Paper patterns can change; always check the current model paper of your board.

Chapter weightage is highest for Kinematics, Dynamics and Thermal Properties of Matter, and lowest for Transfer of Heat, according to the BISE Kohat Table of Specifications. Give extra revision time to the heavier chapters.

Chapter 1: Physical Quantities and Measurement

Physics begins with measurement. Every physical quantity is measured by comparing it with a standard unit. This chapter introduces physical quantities, SI units, prefixes, measuring instruments and the errors that can occur while measuring.

Key Concepts

- Physics is the study of matter, energy and their mutual interaction. Its main branches are mechanics, heat, light, sound, electricity and magnetism, and atomic and nuclear physics.
- A physical quantity is a quantity that can be measured, for example length, mass, time and temperature. Non-physical quantities, such as love or beauty, cannot be measured.
- Base quantities are the seven quantities of the SI system: length, mass, time, electric current, temperature, amount of substance and luminous intensity. All other quantities are derived from them.
- Derived quantities are defined in terms of base quantities, for example speed (length/time), area (length x length) and force (mass x acceleration).
- The SI system is used all over the world. Its base units are metre (m), kilogram (kg), second (s), ampere (A), kelvin (K), mole (mol) and candela (cd).
- Prefixes such as kilo (10^3), centi (10^-2), milli (10^-3) and micro (10^-6) are used to write very large or very small numbers easily. Scientific notation writes a number as a digit term times a power of ten.
- Every measurement has some error. Zero error, parallax error and random error can be reduced by careful reading, taking the mean of several readings and using a correct instrument.
- A vernier caliper measures small lengths accurately to 0.1 mm or 0.01 cm. A screw gauge (micrometer) measures very small thicknesses to 0.01 mm.

Important Definitions

Term	Definition
Physical quantity	A quantity that can be measured, such as length, mass, time, force and temperature.
Base quantity	A quantity that is defined on its own, such as length, mass and time. There are seven base quantities in SI.
Derived quantity	A quantity defined in terms of base quantities, such as speed, area, volume and force.
SI unit	The internationally accepted system of units, with seven base units including metre, kilogram and second.
Least count	The smallest value that an instrument can measure accurately. For a vernier caliper it is 0.1 mm and for a screw gauge it is 0.01 mm.
Significant figures	The digits in a measured number that are known reliably plus one uncertain digit. They show the precision of the measurement.
Precision	How close repeated measurements of the same quantity are to each other. Accurate instruments give both precise and accurate results.

Important Formulas

> Least count of vernier caliper = 1 main scale division / number of vernier divisions = 1 mm / 10 = 0.1 mm

Least count of screw gauge = pitch / number of circular scale divisions = 1 mm / 100 = 0.01 mm

Total reading (vernier) = main scale reading + (vernier coinciding division x least count)

Volume of a cube = length x width x height; Area of a rectangle = length x width

Density = mass / volume; 1 km = 1000 m; 1 cm = 0.01 m; 1 mm = 0.001 m

Key Terms to Remember

physical quantity, **base quantity**, **derived quantity**, **SI units**, **prefix**, **scientific notation**, **least count**, **vernier caliper**, **screw gauge**, **significant figures**, **precision**, **accuracy**, **zero error**

Chapter 1: Physical Quantities and Measurement — Questions

Multiple Choice Questions

1. Physics is the branch of science that deals with the study of:

(a) Living things and their functions (b) Matter, energy and their interaction (c) Chemical reactions only (d) Rocks and the Earth

2. Which of the following is a physical quantity?

(a) Love (b) Length (c) Beauty (d) Kindness

3. The SI unit of mass is:

(a) Gram (b) Pound (c) Kilogram (d) Tonne

4. Which of the following is a base quantity?

(a) Speed (b) Force (c) Temperature (d) Volume

5. The SI unit of electric current is:

(a) Volt (b) Ohm (c) Watt (d) Ampere

6. Which of the following is a derived quantity?

(a) Length (b) Mass (c) Time (d) Area

7. The prefix 'milli' stands for:

(a) 10^3 (b) 10^-2 (c) 10^-3 (d) 10^6

8. The least count of a vernier caliper is:

(a) 1 mm (b) 0.1 mm (c) 0.01 mm (d) 0.001 mm

9. A screw gauge is used to measure:

(a) Long distances (b) Very small thickness (c) Heavy weights (d) High temperatures

10. The number 0.0045 has how many significant figures?

(a) Four (b) Three (c) Two (d) One

Short Questions

1. Define physics and name its main branches.
2. Differentiate between base quantities and derived quantities with one example of each.
3. What is the SI system? Name its seven base quantities with their units.
4. What is meant by the least count of an instrument? Give the least count of a vernier caliper and a screw gauge.
5. Define significant figures and precision.

Long Questions

1. Describe the construction and working of a vernier caliper. How is the total reading found? Explain with an example.
2. Explain scientific notation and prefixes. Convert 2500 m into kilometres, 0.05 m into millimetres, and write 0.00042 in scientific notation.

Chapter 2: Kinematics

Kinematics is the study of motion without considering the forces that cause it. This chapter explains rest and motion, types of motion, distance and displacement, speed and velocity, acceleration, the equations of motion and motion graphs.

Key Concepts

- A body is at rest if its position does not change with time, and in motion if its position changes with time. Rest and motion are relative to the observer.
- Motion is of three types: translatory motion (a body moves in a straight or curved path), rotatory motion (a body turns about a fixed axis) and vibratory motion (a body moves to and fro about a mean position).
- Distance is the total length of the path travelled and is a scalar quantity. Displacement is the shortest distance from the starting point to the final point in a given direction and is a vector quantity.
- Speed is distance covered per unit time. Velocity is displacement per unit time and has direction. Average speed = total distance / total time.
- Acceleration is the rate of change of velocity. Positive acceleration is increase of velocity; negative acceleration (retardation) is decrease of velocity.
- The three equations of motion apply to uniformly accelerated motion: vf = vi + at; S = vit + (1/2)at^2; 2aS = vf^2 - vi^2.
- A distance-time graph gives speed from its slope; a flat line means rest and a straight sloping line means uniform speed. A velocity-time graph gives acceleration from its slope and distance from the area under the graph.
- Free fall is motion under gravity alone. Near the surface of the Earth the acceleration due to gravity is about 10 m/s^2, so a freely falling body gains about 10 m/s of speed every second.

Important Definitions

Term	Definition
Rest	The state of a body whose position does not change with respect to its surroundings as time passes.
Motion	The state of a body whose position changes with respect to its surroundings as time passes.
Distance	The total length of the path travelled by a moving body. It is a scalar quantity.
Displacement	The shortest distance between the initial and final positions of a body in a specified direction. It is a vector quantity.
Speed	Distance covered per unit time. Its SI unit is metre per second (m/s).
Velocity	Displacement per unit time in a specified direction. Its SI unit is m/s.
Acceleration	The rate of change of velocity with time. Its SI unit is m/s^2.
Uniform acceleration	Acceleration that stays constant with time, so velocity changes by equal amounts in equal intervals of time.

Important Formulas

> Speed = distance / time; Velocity = displacement / time; Average speed = total distance / total time

> Acceleration a = (vf - vi) / t
>
> First equation: vf = vi + at
>
> Second equation: S = vit + (1/2) at^2
>
> Third equation: 2aS = vf^2 - vi^2

Key Terms to Remember

rest, **motion**, **translatory motion**, **rotatory motion**, **vibratory motion**, **distance**, **displacement**, **speed**, **velocity**, **acceleration**, **retardation**, **equations of motion**, **free fall**

Chapter 2: Kinematics — Questions

Multiple Choice Questions

1. A body is said to be at rest when its position:

(a) Changes with time (b) Does not change with time (c) Changes rapidly (d) Changes slowly

2. Which of the following is an example of rotatory motion?

(a) A car moving on a straight road (b) A spinning fan blade (c) A swinging pendulum (d) A falling stone

3. Distance is a:

(a) Vector quantity (b) Scalar quantity (c) Derived unit (d) Base quantity

4. The SI unit of velocity is:

(a) m/s^2 (b) km/h (c) m/s (d) m

5. A car travels 120 km in 2 hours. Its average speed is:

(a) 40 km/h (b) 60 km/h (c) 120 km/h (d) 240 km/h

6. Acceleration is the rate of change of:

(a) Distance (b) Speed (c) Displacement (d) Velocity

7. A body moving with uniform velocity has acceleration equal to:

(a) 10 m/s^2 (b) Zero (c) 9.8 m/s^2 (d) 1 m/s^2

8. The slope of a velocity-time graph gives:

(a) Distance (b) Speed (c) Acceleration (d) Displacement

9. In the equation vf = vi + at, the symbol 'a' stands for:

(a) Area (b) Acceleration (c) Amplitude (d) Angle

10. The acceleration due to gravity near the surface of the Earth is about:

(a) 1 m/s^2 (b) 5 m/s^2 (c) 10 m/s^2 (d) 100 m/s^2

Short Questions

1. Differentiate between distance and displacement.
2. Define speed and velocity. Why is velocity a vector quantity?
3. What is acceleration? Write its formula and SI unit.
4. State the three equations of motion.
5. What does the slope of a distance-time graph tell us?

Long Questions

1. Define translatory, rotatory and vibratory motion and give two examples of each.
2. A car starts from rest and moves with a uniform acceleration of 2 m/s^2. Find its velocity after 5 seconds and the distance covered in that time. Also explain how the distance can be found from a velocity-time graph.

Chapter 3: Dynamics

Dynamics is the study of motion and the forces that cause it. This chapter explains force, Newton's three laws of motion, momentum, the law of conservation of momentum, friction, mass and weight.

Key Concepts

- Force is a push or a pull that can change the state of rest or motion of a body, or change its shape. Its SI unit is the newton (N).
- Newton's first law (law of inertia): a body remains at rest or in uniform motion unless an unbalanced force acts on it. Inertia is the property of a body that resists a change in its state.
- Mass is the measure of the inertia of a body. A heavier body has more inertia and is harder to move or stop.
- Newton's second law: the acceleration produced in a body is directly proportional to the applied force and inversely proportional to its mass: F = ma.
- Momentum is the product of mass and velocity (p = mv). Its SI unit is kg m/s. A heavy fast-moving body has more momentum and is harder to stop.
- Newton's third law: to every action there is an equal and opposite reaction. Action and reaction act on different bodies, so they never cancel each other.
- The law of conservation of momentum states that in the absence of an external force, the total momentum of a system remains constant, for example when two bodies collide.
- Friction is the force that opposes motion between two surfaces in contact. It depends on the nature of the surfaces and the pressing force, but not on the area of contact.
- Mass is the quantity of matter in a body and stays the same everywhere. Weight is the force with which the Earth attracts a body (W = mg) and changes with the value of g.

Important Definitions

Term	Definition
Force	A push or a pull that can change the state of rest or motion of a body, or its shape. Its SI unit is newton (N).
Inertia	The property of a body that resists any change in its state of rest or uniform motion.
Mass	The quantity of matter in a body. It is a measure of inertia and its SI unit is kilogram (kg).
Weight	The force with which the Earth attracts a body towards its centre. W = mg, and its SI unit is newton.
Momentum	The product of the mass and velocity of a body: p = mv. Its SI unit is kg m/s.
Friction	The force that opposes the relative motion of two surfaces in contact.
Newton	The SI unit of force: 1 N is the force that produces an acceleration of 1 m/s^2 in a mass of 1 kg.

Important Formulas

> Newton's second law: F = ma
>
> Momentum: p = mv
>
> Force in terms of momentum: F = change in momentum / time = (mvf - mvi) / t
>
> Weight: W = mg

> Law of conservation of momentum: total momentum before collision = total momentum after collision

Key Terms to Remember

force, **inertia**, **mass**, **weight**, **momentum**, **friction**, **Newton's laws**, **action and reaction**, **conservation of momentum**, **newton**, **retardation**

Chapter 3: Dynamics — Questions

Multiple Choice Questions

1. The SI unit of force is:

(a) Joule (b) Watt (c) Newton (d) Pascal

2. Inertia depends on the:

(a) Velocity of the body (b) Mass of the body (c) Shape of the body (d) Colour of the body

3. Newton's first law of motion is also called the law of:

(a) Action and reaction (b) Inertia (c) Gravitation (d) Conservation of energy

4. If a force of 10 N acts on a mass of 2 kg, the acceleration produced is:

(a) 2 m/s^2 (b) 5 m/s^2 (c) 10 m/s^2 (d) 20 m/s^2

5. Momentum is the product of:

(a) Mass and acceleration (b) Force and time (c) Mass and velocity (d) Weight and height

6. The SI unit of momentum is:

(a) N (b) kg m/s (c) kg m/s^2 (d) J

7. According to Newton's third law, action and reaction are:

(a) Equal and in the same direction (b) Equal and opposite (c) Unequal and opposite (d) Unequal and in the same direction

8. Friction opposes the:

(a) Weight of a body (b) Motion of a body (c) Mass of a body (d) Volume of a body

9. The weight of a body of mass 5 kg on Earth (g = 10 m/s^2) is:

(a) 5 N (b) 10 N (c) 50 N (d) 25 N

10. Which of the following remains the same everywhere?

(a) Weight (b) Mass (c) Value of g (d) Friction

Short Questions

1. Define force and write its SI unit.
2. State Newton's first law of motion. What is inertia?
3. Define momentum and write its formula and SI unit.
4. State Newton's third law and give two examples from daily life.
5. Differentiate between mass and weight.

Long Questions

1. State and explain Newton's second law of motion. Derive F = ma and define one newton.
2. State the law of conservation of momentum and explain it with the example of two colliding bodies. A body of mass 2 kg moving at 4 m/s collides with a stationary body of mass 3 kg and they move together after the collision. Find their common velocity.

Chapter 4: Turning Effect of Forces

A force can turn a body about a fixed point as well as move it in a straight line. This chapter explains the moment of a force, torque, centre of mass, centre of gravity, equilibrium and the stability of bodies.

Key Concepts

- The turning effect of a force is called its moment or torque. It depends on the size of the force and the perpendicular distance of the force from the pivot (moment arm).
- Moment of a force = force x perpendicular distance from the pivot. Its SI unit is newton-metre (N m). A larger moment arm gives a larger turning effect, which is why a long spanner opens a tight nut easily.
- A couple is a pair of equal, opposite and parallel forces that produce rotation without translation, for example turning a steering wheel or opening a tap.
- The principle of moments states that when a body is in equilibrium, the sum of the clockwise moments about any point equals the sum of the anticlockwise moments about that point.
- The centre of mass is the point at which the whole mass of a body can be taken to be concentrated. The centre of gravity is the point at which the whole weight of a body acts. For a uniform body they are at the same point.
- A body is in equilibrium when the net force and the net torque on it are both zero. Static equilibrium means the body is at rest; dynamic equilibrium means it moves with uniform velocity.
- There are three states of equilibrium: stable (the body returns to its position after a small displacement), unstable (it moves further away) and neutral (it stays in its new position).
- The stability of a body increases when its centre of gravity is low and its base is wide. Racing cars are built low and wide for this reason, and a tall narrow object topples easily.

Important Definitions

Term	Definition
Moment of a force (torque)	The turning effect of a force about a pivot: moment = force x perpendicular distance from the pivot. Its SI unit is N m.
Pivot (fulcrum)	The fixed point about which a body turns when a moment acts on it.
Couple	A pair of equal, opposite and parallel forces whose resultant is zero but which produce rotation.
Centre of mass	The point at which the whole mass of a body can be taken to be concentrated.
Centre of gravity	The point at which the whole weight of a body can be taken to act.
Equilibrium	The state of a body when the net force and the net torque acting on it are both zero.
Stable equilibrium	The state in which a body returns to its original position after being slightly displaced.

Important Formulas

> Moment of a force (torque) = F x d, where d is the perpendicular distance from the pivot
>
> Principle of moments: sum of clockwise moments = sum of anticlockwise moments (in equilibrium)

> For equilibrium: net force = 0 and net torque = 0

Key Terms to Remember

moment, **torque**, **pivot**, **fulcrum**, **couple**, **centre of mass**, **centre of gravity**, **equilibrium**, **stable equilibrium**, **unstable equilibrium**, **neutral equilibrium**, **principle of moments**

Chapter 4: Turning Effect of Forces — Questions

Multiple Choice Questions

1. The turning effect of a force is called its:

(a) Momentum (b) Moment (c) Pressure (d) Power

2. The SI unit of torque is:

(a) N (b) N m (c) J (d) W

3. Moment of a force depends on the force and the:

(a) Mass of the body (b) Distance from the pivot (c) Velocity of the body (d) Volume of the body

4. A long spanner opens a tight nut easily because it increases the:

(a) Force only (b) Moment arm (c) Mass (d) Friction

5. A couple consists of:

(a) Two equal and opposite parallel forces (b) Two unequal forces (c) A single force (d) Two forces in the same direction

6. The centre of gravity of a uniform rod is at its:

(a) One end (b) Centre (c) Quarter point (d) Edge

7. A body is in equilibrium when the net force and net torque are:

(a) Maximum (b) Zero (c) Equal to its weight (d) Equal to its mass

8. A body in stable equilibrium returns to its position after:

(a) A large push (b) A small displacement (c) Being heated (d) Being cooled

9. Stability of a body increases when its centre of gravity is:

(a) High (b) Low (c) At the top (d) Outside the body

10. Turning a steering wheel is an example of a:

(a) Single force (b) Couple (c) Friction (d) Moment of inertia

Short Questions

1. Define the moment of a force. Write its formula and SI unit.
2. What is a couple? Give two examples.
3. State the principle of moments.
4. Differentiate between centre of mass and centre of gravity.
5. What are the conditions for equilibrium? Differentiate between stable and unstable equilibrium.

Long Questions

1. Explain the turning effect of a force with daily-life examples. A force of 20 N is applied at the end of a spanner 0.3 m long. Find the moment of the force and explain how increasing the length of the spanner helps.
2. Define equilibrium and explain its three states with examples. Why is a racing car made low and wide? How does the position of the centre of gravity affect the stability of a body?

Chapter 5: Gravitation

Gravitation is the force of attraction between any two masses in the universe. This chapter explains Newton's law of universal gravitation, the gravitational constant, the mass of the Earth, the variation of g and artificial satellites.

Key Concepts

- Newton's law of universal gravitation states that every body in the universe attracts every other body with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.
- The gravitational constant G has the value 6.673 x 10^-11 N m^2/kg^2. It is the same everywhere in the universe and was first measured by Henry Cavendish.
- The force of gravity is always attractive and is very weak compared with other forces, but it holds the planets in their orbits and keeps us on the Earth.
- The acceleration due to gravity g is the acceleration produced in a freely falling body by the Earth's attraction. Near the surface of the Earth g is about 9.8 m/s^2 (about 10 m/s^2).
- The value of g is greater at the poles than at the equator, because the Earth is slightly flattened at the poles, and it decreases with height above the surface of the Earth.
- The mass of the Earth can be found from g = GM/R^2, where M is the mass of the Earth and R is its radius. The mass of the Earth is about 6 x 10^24 kg.
- The weight of a body is the gravitational force on it (W = mg). The weight of a body decreases as it goes higher above the Earth, but its mass stays the same.
- Artificial satellites are put into orbit around the Earth by giving them a very high horizontal velocity (about 8 km/s). Geostationary satellites stay above one point on the equator and are used for communication and television.

Important Definitions

Term	Definition
Gravitation	The force of attraction between any two bodies in the universe due to their masses.
Gravity	The force with which the Earth attracts a body towards its centre.
Gravitational constant (G)	The constant in Newton's law of gravitation: G = 6.673 x 10^-11 N m^2/kg^2.
Acceleration due to gravity (g)	The acceleration produced in a freely falling body by the Earth's gravitational pull. Its value is about 9.8 m/s^2.
Artificial satellite	A man-made object placed in orbit around the Earth, used for communication, weather study and navigation.
Geostationary satellite	A satellite that orbits above the equator with the same period as the Earth's rotation, so it stays over one point on the Earth.
Gravitational field	The region around a mass in which another mass feels a gravitational force.

Important Formulas

> Newton's law of gravitation: F = G m1 m2 / r^2
>
> Acceleration due to gravity: g = G M / R^2
>
> Weight: W = mg

Mass of the Earth: M = g R^2 / G

Key Terms to Remember

gravitation, **gravity**, **gravitational constant**, **acceleration due to gravity**, **artificial satellite**, **geostationary satellite**, **orbit**, **gravitational field**, **mass of the Earth**

Chapter 5: Gravitation — Questions

Multiple Choice Questions

1. The force of gravitation between two bodies is:

(a) Always repulsive (b) Always attractive (c) Sometimes attractive (d) Zero

2. According to Newton's law of gravitation, the force is inversely proportional to the:

(a) Product of the masses (b) Square of the distance (c) Distance (d) Sum of the masses

3. The value of the gravitational constant G is:

(a) 9.8 N m^2/kg^2 (b) 6.673 x 10^-11 N m^2/kg^2 (c) 6.673 x 10^11 N m^2/kg^2 (d) 10 N m^2/kg^2

4. The acceleration due to gravity g is greater at the:

(a) Equator (b) Poles (c) Centre of the Earth (d) Moon

5. The value of g decreases when we go:

(a) Towards the poles (b) Higher above the Earth's surface (c) Towards the centre (d) Underground only

6. The mass of the Earth is about:

(a) 6 x 10^24 kg (b) 6 x 10^14 kg (c) 6 x 10^4 kg (d) 6 x 10^34 kg

7. The weight of a body on the Moon is about:

(a) The same as on Earth (b) One-sixth of its weight on Earth (c) Six times its weight on Earth (d) Zero

8. A geostationary satellite stays above:

(a) The North Pole (b) One point on the equator (c) The South Pole (d) The Moon

9. The orbital speed of a satellite close to the Earth is about:

(a) 1 km/s (b) 8 km/s (c) 80 km/s (d) 800 km/s

10. The value of g on the surface of the Earth is about:

(a) 1 m/s^2 (b) 9.8 m/s^2 (c) 98 m/s^2 (d) 0.98 m/s^2

Short Questions

1. State Newton's law of universal gravitation and write its mathematical form.
2. What is the gravitational constant? Write its value and SI unit.
3. Define acceleration due to gravity. Why is g greater at the poles than at the equator?
4. Differentiate between mass and weight with reference to the Moon.
5. What is an artificial satellite? Name two of its uses.

Long Questions

1. State and explain Newton's law of universal gravitation. Derive the formula for the acceleration due to gravity g = GM/R^2 and explain why g decreases with height.
2. Explain how artificial satellites are put into orbit and what a geostationary satellite is. Why are geostationary satellites useful for communication? Also find the mass of the Earth if g = 10 m/s^2, R = 6.4 x 10^6 m and G = 6.67 x 10^-11 N m^2/kg^2.

Chapter 6: Work and Energy

Work and energy are central ideas in physics. This chapter explains work, kinetic energy, potential energy, power, efficiency and the law of conservation of energy, with examples from daily life and machines.

Key Concepts

- Work is done when a force moves a body through a distance in the direction of the force. Work = force x distance. Its SI unit is the joule (J). No work is done if there is no displacement or if the force is perpendicular to the displacement.
- Energy is the ability of a body to do work. Its SI unit is also the joule. Energy exists in many forms: kinetic, potential, heat, light, electrical, chemical and nuclear energy.
- Kinetic energy is the energy of a body due to its motion: K.E. = (1/2)mv^2. A fast heavy body has more kinetic energy than a slow light one.
- Potential energy is the energy stored in a body due to its position or state. Gravitational potential energy is P.E. = mgh, where h is the height above a chosen level.
- The law of conservation of energy states that energy can neither be created nor destroyed; it can only change from one form to another. The total energy of an isolated system stays constant.
- When a body falls, its potential energy changes into kinetic energy. At the top of its fall it has maximum potential energy, and just before hitting the ground it has maximum kinetic energy.
- Power is the rate of doing work: Power = work / time. Its SI unit is the watt (W). 1 watt = 1 joule per second. A more powerful machine does the same work in less time.
- Efficiency is the ratio of useful output energy (or power) to input energy (or power), usually written as a percentage. No machine is 100% efficient because some energy is always lost as heat or sound.

Important Definitions

Term	Definition
Work	The product of the force and the distance moved in the direction of the force: W = Fd. Its SI unit is joule (J).
Energy	The ability of a body to do work. Its SI unit is joule (J).
Kinetic energy	The energy of a body due to its motion: K.E. = (1/2)mv^2.
Potential energy	The energy stored in a body due to its position or state. Gravitational P.E. = mgh.
Power	The rate of doing work: P = W/t. Its SI unit is watt (W).
Efficiency	The ratio of useful energy output to total energy input, expressed as a percentage.
Joule	The SI unit of work and energy: 1 J is the work done when a force of 1 N moves a body through 1 m.
Watt	The SI unit of power: 1 W = 1 J/s.

Important Formulas

> Work: W = F d (when force acts in the direction of motion)
>
> Kinetic energy: K.E. = (1/2) m v^2
>
> Potential energy: P.E. = m g h

Power: P = W / t

Efficiency = (useful output energy / total input energy) x 100%

Key Terms to Remember

work, **energy**, **kinetic energy**, **potential energy**, **power**, **efficiency**, **joule**, **watt**, **conservation of energy**

Chapter 6: Work and Energy — Questions

Multiple Choice Questions

1. The SI unit of work is:

(a) Watt (b) Newton (c) Joule (d) Pascal

2. Work is done when a force moves a body:

(a) In any direction (b) In the direction of the force (c) Against the force only (d) Without any displacement

3. Kinetic energy of a body depends on its:

(a) Height only (b) Mass and velocity (c) Mass only (d) Temperature

4. The formula for kinetic energy is:

(a) mgh (b) mv (c) (1/2)mv^2 (d) Fd

5. Potential energy of a body of mass 2 kg at a height of 5 m (g = 10 m/s^2) is:

(a) 10 J (b) 25 J (c) 100 J (d) 50 J

6. The SI unit of power is:

(a) Joule (b) Newton (c) Watt (d) Erg

7. One watt is equal to:

(a) 1 J/s (b) 1 J (c) 1 N (d) 1 kg m/s

8. According to the law of conservation of energy, energy can:

(a) Be created (b) Be destroyed (c) Change form but not be created or destroyed (d) Disappear

9. A machine with an efficiency of 80% converts 100 J of input into:

(a) 80 J of useful output (b) 20 J of useful output (c) 100 J of useful output (d) 180 J of useful output

10. When a ball falls freely, its potential energy is converted into:

(a) Heat energy only (b) Kinetic energy (c) Chemical energy (d) Sound energy

Short Questions

1. Define work. When is no work done even if a force acts?
2. Define kinetic energy and write its formula.
3. Define potential energy and write its formula.
4. State the law of conservation of energy.
5. Define power and efficiency. Write their SI units.

Long Questions

1. Define work and energy. Derive the formula for kinetic energy K.E. = (1/2)mv^2 and explain the law of conservation of energy with the example of a freely falling body.
2. A body of mass 5 kg is lifted to a height of 4 m in 10 seconds (g = 10 m/s^2). Find the work done, the potential energy gained and the power used. Also explain why no real machine is 100% efficient.

Chapter 7: Properties of Matter

Matter has properties that decide how it behaves under forces. This chapter explains density, pressure, Pascal's law, Archimedes' principle, elasticity, stress, strain and Young's modulus, and the kinetic molecular model of matter.

Key Concepts

- Density is mass per unit volume (density = mass / volume). Its SI unit is kg/m^3. A body floats in a liquid if its density is less than the density of the liquid, and sinks if its density is greater.
- Pressure is force per unit area (P = F/A). Its SI unit is pascal (Pa). The same force produces more pressure on a small area, which is why a sharp knife cuts easily and a wide base spreads weight.
- Pressure in a liquid increases with depth: P = density x g x depth. Dams are built thicker at the bottom because water pressure is greatest there.
- Pascal's law states that pressure applied to an enclosed liquid is transmitted equally in all directions. It is used in hydraulic brakes, hydraulic lifts and hydraulic presses.
- Archimedes' principle states that when a body is immersed in a fluid, it experiences an upthrust equal to the weight of the fluid it displaces. This upthrust is why ships float and balloons rise.
- Elasticity is the property of a body by which it returns to its original shape after the deforming force is removed. A spring is elastic within its elastic limit.
- Hooke's law states that within the elastic limit, the extension of a spring is directly proportional to the applied force: F = k x, where k is the spring constant.
- Stress is the deforming force per unit area (stress = F/A) and strain is the fractional change in length (strain = change in length / original length). Young's modulus is the ratio of stress to strain for a stretched wire.
- According to the kinetic molecular model, matter is made of tiny particles that are always in motion. The particles of a solid vibrate in fixed positions, those of a liquid can slide past each other, and those of a gas move freely.

Important Definitions

Term	Definition
Density	Mass per unit volume of a substance: density = mass / volume. Its SI unit is kg/m^3.
Pressure	Force per unit area: P = F/A. Its SI unit is pascal (Pa); 1 Pa = 1 N/m^2.
Pascal's law	Pressure applied to an enclosed liquid is transmitted equally in all directions.
Archimedes' principle	A body immersed in a fluid experiences an upthrust equal to the weight of the fluid displaced by it.
Upthrust (buoyant force)	The upward force exerted by a fluid on a body immersed in it.
Elasticity	The property of a body by which it regains its original shape and size after the deforming force is removed.
Hooke's law	Within the elastic limit, the extension produced in a spring is directly proportional to the applied force.
Young's modulus	The ratio of tensile stress to tensile strain for a material within its elastic limit.

Important Formulas

> Density = mass / volume
>
> Pressure: P = F / A
>
> Pressure in a liquid at depth h: P = rho g h
>
> Hooke's law: F = k x
>
> Stress = F / A; Strain = change in length / original length; Young's modulus Y = stress / strain

Key Terms to Remember

density, **pressure**, **pascal**, **Pascal's law**, **Archimedes' principle**, **upthrust**, **elasticity**, **Hooke's law**, **stress**, **strain**, **Young's modulus**, **kinetic molecular model**

Chapter 7: Properties of Matter — Questions

Multiple Choice Questions

1. Density is defined as:

(a) Volume / mass (b) Mass / volume (c) Mass x volume (d) Weight / volume

2. The SI unit of pressure is:

(a) Newton (b) Joule (c) Pascal (d) Watt

3. Pressure in a liquid increases with:

(a) Area (b) Depth (c) Volume (d) Temperature only

4. Pascal's law is used in:

(a) Hydraulic brakes (b) Electric fans (c) Pendulum clocks (d) Thermometers

5. According to Archimedes' principle, the upthrust on a body equals the weight of the:

(a) Body (b) Fluid displaced (c) Container (d) Air above

6. A ship floats because the upthrust of water is:

(a) Less than its weight (b) Equal to its weight (c) Zero (d) Greater than its weight always

7. Hooke's law holds within the:

(a) Plastic limit (b) Elastic limit (c) Breaking point (d) Melting point

8. Stress is defined as force per unit:

(a) Volume (b) Length (c) Area (d) Mass

9. Young's modulus is the ratio of:

(a) Stress to strain (b) Strain to stress (c) Force to mass (d) Pressure to volume

10. The particles of a gas:

(a) Vibrate in fixed positions (b) Slide past each other (c) Move freely in all directions (d) Do not move

Short Questions

1. Define density and pressure. Write their SI units.
2. Why does a sharp knife cut more easily than a blunt one?
3. State Pascal's law and name two of its applications.
4. State Archimedes' principle. Why does a ship float on water?
5. State Hooke's law and define Young's modulus.

Long Questions

1. Define pressure and derive the formula for pressure in a liquid at a depth h. Why are dams built thicker at the bottom? A diver is 10 m below the surface of water (density 1000 kg/m^3, g = 10 m/s^2). Find the pressure due to the water at that depth.
2. State and explain Archimedes' principle. How does it explain why some bodies float and others sink? Also explain Hooke's law and Young's modulus, and why a spring must not be stretched beyond its elastic limit.

Chapter 8: Thermal Properties of Matter

Heat and temperature are different quantities, and matter changes when it is heated. This chapter explains temperature, heat, thermal expansion, specific heat capacity, latent heat and the changes of state of matter.

Key Concepts

- Temperature is the measure of the average kinetic energy of the particles of a body, or the degree of hotness. Heat is the energy that flows from a hot body to a cold body because of a temperature difference.
- Heat and temperature are different: temperature is measured in kelvin or degree Celsius, while heat is a form of energy measured in joules. Two bodies can have the same temperature but different amounts of heat.
- Most solids, liquids and gases expand when heated and contract when cooled. This thermal expansion is used in thermometers and bimetallic strips, and gaps are left in railway tracks and bridges to allow for it.
- Linear expansion is the increase in length of a solid on heating: change in length = original length x coefficient of linear expansion x rise in temperature.
- Specific heat capacity is the amount of heat needed to raise the temperature of 1 kg of a substance by 1 K (or 1 degree C). Water has a very high specific heat capacity (4200 J/kg K), which is why it is used in cooling systems and why the sea warms and cools slowly.
- The heat absorbed or given out when the temperature of a body changes is Q = m c (change in temperature), where m is mass and c is specific heat capacity.
- Latent heat is the heat absorbed or given out during a change of state without any change in temperature. The latent heat of fusion melts a solid, and the latent heat of vaporisation turns a liquid into a gas.
- Evaporation is the change of liquid into vapour from its surface at any temperature. It causes cooling, because the fastest molecules escape and take energy with them. Evaporation is faster at high temperature, in dry air and in wind.
- Melting and boiling take place at fixed temperatures: the melting point and the boiling point. During melting or boiling the temperature stays constant while heat is absorbed as latent heat.

Important Definitions

Term	Definition
Temperature	The measure of the degree of hotness of a body, related to the average kinetic energy of its particles. Its SI unit is kelvin (K).
Heat	Energy that flows from a body at higher temperature to a body at lower temperature. Its SI unit is joule (J).
Thermal expansion	The increase in the size of a substance when its temperature rises.
Specific heat capacity	The heat required to raise the temperature of 1 kg of a substance by 1 K. Its SI unit is J/kg K.
Latent heat of fusion	The heat needed to change 1 kg of a solid into liquid at its melting point without any change in temperature.
Latent heat of vaporisation	The heat needed to change 1 kg of a liquid into vapour at its boiling point without any change in temperature.
Evaporation	The change of a liquid into vapour from its surface at any temperature below its boiling point.

Calorimetry	The measurement of heat exchanged between bodies, using the principle that heat lost by a hot body equals heat gained by a cold body.

Important Formulas

> Heat for a temperature change: Q = m c (T2 - T1)
>
> Linear expansion: change in length = alpha x L x change in temperature
>
> Heat for a change of state: Q = m L, where L is the latent heat
>
> Temperature in kelvin: T(K) = T(C) + 273

Key Terms to Remember

temperature, **heat**, **thermal expansion**, **specific heat capacity**, **latent heat**, **fusion**, **vaporisation**, **evaporation**, **melting point**, **boiling point**, **calorimetry**

Chapter 8: Thermal Properties of Matter — Questions

Multiple Choice Questions

1. The SI unit of temperature is:

(a) Degree Celsius (b) Kelvin (c) Joule (d) Fahrenheit

2. Heat is a form of:

(a) Force (b) Energy (c) Power (d) Pressure

3. Water has a specific heat capacity of:

(a) 420 J/kg K (b) 4200 J/kg K (c) 42 J/kg K (d) 42000 J/kg K

4. Gaps are left between railway tracks to allow for:

(a) Contraction (b) Thermal expansion (c) Vibration (d) Friction

5. The heat needed to melt 1 kg of ice at 0 C without changing its temperature is called the latent heat of:

(a) Vaporisation (b) Fusion (c) Expansion (d) Conduction

6. Evaporation causes:

(a) Heating (b) Cooling (c) Freezing (d) Boiling

7. During boiling, the temperature of water:

(a) Keeps rising (b) Keeps falling (c) Stays constant (d) Becomes zero

8. The amount of heat required to raise the temperature of 1 kg of water by 1 K is:

(a) 4200 J (b) 420 J (c) 42 J (d) 4.2 J

9. A bimetallic strip bends on heating because the two metals have different:

(a) Densities (b) Coefficients of expansion (c) Masses (d) Colours

10. Which of the following has the highest specific heat capacity?

(a) Iron (b) Copper (c) Water (d) Aluminium

Short Questions

1. Differentiate between heat and temperature.
2. Define specific heat capacity and write its SI unit.
3. What is thermal expansion? Why are gaps left in railway tracks?
4. Define latent heat of fusion and latent heat of vaporisation.
5. What is evaporation? Why does evaporation cause cooling?

Long Questions

1. Explain thermal expansion in solids, liquids and gases. Describe the construction and working of a bimetallic strip and name two places where thermal expansion must be allowed for.
2. Define specific heat capacity and latent heat. A mass of 2 kg of water at 20 C is heated to 80 C. How much heat is needed? (Specific heat capacity of water = 4200 J/kg K.) Also explain why water is used in car radiators and hot water bottles.

Chapter 9: Transfer of Heat

Heat moves from a hot body to a cold body in three ways: conduction, convection and radiation. This chapter explains each method, the factors that affect them, and their applications in daily life, including the thermos flask and the greenhouse effect.

Key Concepts

- Conduction is the transfer of heat through a solid by the vibration of particles, without the particles themselves moving from place to place. Metals are good conductors; wood, plastic and air are poor conductors (insulators).
- The rate of conduction depends on the area of cross-section, the temperature difference, the thickness of the material and its thermal conductivity. A thick metal rod conducts heat faster than a thin one of the same material.
- Convection is the transfer of heat by the actual movement of the particles of a liquid or gas. Hot fluid rises because it becomes less dense, and cold fluid sinks, setting up a convection current.
- Sea breeze and land breeze are caused by convection. During the day the land heats faster than the sea, so cool air blows from the sea to the land; at night the land cools faster and the breeze reverses.
- Radiation is the transfer of heat by electromagnetic waves. It needs no medium and can travel through a vacuum, which is how heat from the Sun reaches the Earth.
- Good absorbers of heat are also good emitters. Black, dull surfaces absorb and emit heat well; shiny, white surfaces are poor absorbers and poor emitters and are good reflectors.
- The rate of radiation depends on the temperature of the body and the nature of its surface. A hot black surface radiates heat much faster than a cool shiny one.
- A thermos flask (vacuum flask) keeps liquids hot or cold for a long time. Its vacuum between the double walls stops conduction and convection, and its shiny silvered walls reduce radiation.
- The greenhouse effect is the trapping of heat by gases such as carbon dioxide in the atmosphere. It keeps the Earth warm, but too much of these gases raises the Earth's temperature and causes global warming.

Important Definitions

Term	Definition
Conduction	The transfer of heat through a solid by particle vibration, without the particles moving from place to place.
Convection	The transfer of heat in a liquid or gas by the actual movement of its particles.
Radiation	The transfer of heat by electromagnetic waves, which can travel through a vacuum.
Thermal conductivity	A measure of how well a material conducts heat. Metals have high thermal conductivity; insulators have low thermal conductivity.
Conductor	A material that allows heat to pass through it easily, such as copper and aluminium.
Insulator	A material that does not allow heat to pass through it easily, such as wood, plastic, wool and air.
Greenhouse effect	The trapping of heat in the Earth's atmosphere by gases such as carbon dioxide and water vapour.

Thermos flask	A double-walled flask with a vacuum between the walls and shiny inner surfaces, used to keep liquids hot or cold.

Important Formulas

> Rate of conduction: Q/t = k A (T1 - T2) / d, where k is thermal conductivity, A is area and d is thickness
>
> For conduction, heat transferred is greater when the temperature difference is greater and the thickness is smaller

Key Terms to Remember

conduction, **convection**, **radiation**, **thermal conductivity**, **conductor**, **insulator**, **sea breeze**, **land breeze**, **greenhouse effect**, **thermos flask**, **electromagnetic waves**

Chapter 9: Transfer of Heat — Questions

Multiple Choice Questions

1. Heat is transferred in solids mainly by:

(a) Convection (b) Radiation (c) Conduction (d) Evaporation

2. Which of the following is the best conductor of heat?

(a) Wood (b) Plastic (c) Copper (d) Air

3. Convection takes place in:

(a) Solids only (b) Liquids and gases (c) Vacuum (d) Metals only

4. Heat from the Sun reaches the Earth by:

(a) Conduction (b) Convection (c) Radiation (d) Evaporation

5. A black dull surface is a:

(a) Good absorber and good emitter of heat (b) Poor absorber and poor emitter (c) Good reflector (d) Good insulator

6. A thermos flask keeps liquids hot because its vacuum stops:

(a) Radiation only (b) Conduction and convection (c) Evaporation only (d) Melting

7. The shiny walls of a thermos flask reduce heat loss by:

(a) Conduction (b) Convection (c) Radiation (d) Evaporation

8. During the day, the sea breeze blows from the:

(a) Land to the sea (b) Sea to the land (c) Sky to the sea (d) Mountains to the sea

9. The greenhouse effect is caused mainly by:

(a) Oxygen (b) Nitrogen (c) Carbon dioxide (d) Hydrogen

10. Which of the following is a good insulator of heat?

(a) Iron (b) Aluminium (c) Wool (d) Copper

Short Questions

1. Define conduction, convection and radiation.
2. Why are metals good conductors of heat while wood is a poor conductor?
3. How is a sea breeze caused? How is it different from a land breeze?
4. Why are the walls of a thermos flask shiny and why is there a vacuum between them?
5. What is the greenhouse effect? Name one gas that causes it.

Long Questions

1. Explain the three methods of transfer of heat with one example of each. Why does heat from the Sun reach the Earth by radiation and not by conduction or convection?
2. Describe the construction of a thermos flask and explain how each part reduces heat loss by conduction, convection and radiation. Also explain why black clothes feel warmer in sunlight than white clothes.

MCQ Answer Key

Check your answers below. Count your correct answers out of 10 for each chapter. Re-read the notes for every chapter in which you scored less than 7 out of 10.

Chapter	1	2	3	4	5	6	7	8	9	10
Ch. 1	B	B	C	C	D	D	C	B	B	C
Ch. 2	B	B	B	C	B	D	B	C	B	C
Ch. 3	C	B	B	B	C	B	B	B	C	B
Ch. 4	B	B	B	B	A	B	B	B	B	B
Ch. 5	B	B	B	B	B	A	B	B	B	B
Ch. 6	C	B	B	C	C	C	A	C	A	B
Ch. 7	B	C	B	A	B	B	B	C	A	C
Ch. 8	B	B	B	B	B	B	C	A	B	C
Ch. 9	C	C	B	C	A	B	C	B	C	C

Revision Checklist

- Can you write the three equations of motion and use them in a numerical?
- Can you state Newton's three laws of motion with one example of each?
- Can you derive $g = GM/R^2$ and explain why g changes with height?
- Can you find kinetic energy, potential energy and power from given values?
- Can you state Pascal's law and Archimedes' principle and give their uses?
- Can you explain conduction, convection and radiation with examples?

End of notes. Good luck with your studies — revise regularly, practise the numericals, and check your board's website (for example bisep.edu.pk) for the current model paper.