Physics Grade 9 — Chapter 6

Work and Energy · Tests from supplied DeepSeek notes PDF

Chapter Test 1 — Foundation and Understanding

Instructions:
Section A: 15 MCQs (1 mark each)
Section B: 5 Short Questions (2 marks each)
Section C: 2 Long Questions (5 marks each)
Section D: 3 Numerical Problems (3 marks each)
Total: 40 marks
Section A — Multiple Choice Questions (15 × 1 = 15 marks)
MCQ 1. Work is defined as:
A. Force × time
B. Force × distance
C. Force / distance
D. Force / time
Correct Answer: B. Force × distance
Explanation: Work is force multiplied by distance moved in the direction of the force.
MCQ 2. The SI unit of work is the:
A. Newton
B. Joule
C. Watt
D. Pascal
Correct Answer: B. Joule
Explanation: The SI unit of work is the joule (J).
MCQ 3. Work is a:
A. Vector quantity
B. Scalar quantity
C. Base quantity
D. Derived quantity
Correct Answer: B. Scalar quantity
Explanation: Work is a scalar quantity; it has magnitude but no direction.
MCQ 4. The energy possessed by a body due to its motion is called:
A. Potential energy
B. Kinetic energy
C. Thermal energy
D. Chemical energy
Correct Answer: B. Kinetic energy
Explanation: Kinetic energy is the energy of a moving object.
MCQ 5. The formula for kinetic energy is:
A.
B.
C.
D.
Correct Answer: B.
Explanation: Kinetic energy is given by .
MCQ 6. The energy possessed by a body due to its position is called:
A. Kinetic energy
B. Potential energy

C. Thermal energy
D. Electrical energy
Correct Answer: B. Potential energy
Explanation: Potential energy is the energy possessed by a body by virtue of its position.
MCQ 7. The formula for gravitational potential energy is:
A.
B.
C.
D.
Correct Answer: A.
Explanation: Gravitational potential energy is given by .
MCQ 8. The law of conservation of energy states that energy:
A. Can be created
B. Can be destroyed
mgh
mv21 2
mgh2
kx21 2
mv21 2
KE= mv21 2
mgh
mv21 2
mgh2
kx21 2
mgh
PE=mgh
C. Cannot be created or destroyed
D. Can be created and destroyed
Correct Answer: C. Cannot be created or destroyed
Explanation: Energy can neither be created nor destroyed; it can only be converted from one form to another.
MCQ 9. Power is defined as:
A. Work × time
B. Work / time
C. Time / work
D. Work + time
Correct Answer: B. Work / time
Explanation: Power is the time rate at which work is done, .
MCQ 10. The SI unit of power is the:
A. Joule
B. Newton
C. Watt
D. Pascal
Correct Answer: C. Watt
Explanation: The SI unit of power is the watt (W).
MCQ 11. Efficiency is defined as:
A. Input / Output
B. Output / Input
C. Input × Output
D. Input + Output
Correct Answer: B. Output / Input

Explanation: Efficiency is the ratio of useful output work to input work, .
MCQ 12. Which of the following is a non-renewable energy resource?
A. Solar energy
B. Wind energy
P=W/t
η=W /W
out in
C. Coal
D. Hydroelectric energy
Correct Answer: C. Coal
Explanation: Coal is a fossil fuel and is non-renewable; the others are renewable.
MCQ 13. Which of the following is a renewable energy resource?
A. Natural gas
B. Petroleum
C. Wind
D. Uranium
Correct Answer: C. Wind
Explanation: Wind is a renewable resource, while natural gas, petroleum, and uranium are non-renewable.
MCQ 14. No machine is 100% efficient because:
A. Energy is destroyed
B. Friction causes energy loss
C. Energy is created
D. Machines are not designed well
Correct Answer: B. Friction causes energy loss
Explanation: Friction lowers the efficiency of a machine by converting useful energy into heat.
MCQ 15. The energy stored in food is an example of:
A. Kinetic energy
B. Chemical potential energy
C. Elastic potential energy
D. Gravitational potential energy
Correct Answer: B. Chemical potential energy
Explanation: Food stores chemical potential energy.
Section B — Short Questions (5 × 2 = 10 marks)
Q1. Define work and state its SI unit. Give one example where work is done and one where it is not.
Answer:
Work is said to be done when a force displaces a body in its own direction. Mathematically, work is the product of force and displacement in the direction of the force: . The SI unit of work is the joule (J), where . An example where work is done is pushing a box across the floor; the force causes a displacement, so work is done. An example where work is not done is pushing against a wall that does not move; there is no displacement, so no work is done (in the physics sense). This distinction is important because work requires both a force and a displacement in the direction of the force.
Q2. Define kinetic energy and potential energy with one example each.
Answer:
Kinetic energy is the energy possessed by an object due to its motion. It is given by , where is the mass and is the velocity. An example is a moving car or a rolling ball. Potential energy is the energy possessed by an object due to its position or state. The most common form is gravitational potential energy, given by ,

where is the mass, is the acceleration due to gravity, and is the height above a reference point. An example is a book on a high shelf or a stretched spring (elastic potential energy). Both forms of energy are measured in joules.

Q3. State the law of conservation of energy and give one example.

Answer:

The law of conservation of energy states that energy can neither be created nor destroyed in any process. It can be converted from one form to another, but the total amount of energy remains constant. For example, when a ball falls from a height, its gravitational potential energy is converted into kinetic energy. At the top, the ball has maximum potential energy and zero kinetic energy. As it falls, potential energy decreases and kinetic energy increases. Just before hitting the ground, the potential energy is zero and the kinetic energy is maximum. The total mechanical energy (potential + kinetic) remains constant throughout the fall, assuming air resistance is neglected. This illustrates the conservation of energy.

Q4. What is power? Write its formula and SI unit.

Answer:

Power is the time rate at which work is done or the rate at which energy is consumed or converted. It measures how quickly work is performed. The formula for power is , where is the work done and is the time taken. The SI unit of power is the watt

W=F×d 1 J=1 N×1 m

KE= mv21 2 m v

PE=mgh

m g h

P=

W/t W t

(W), where . One watt is the power of a machine that does one joule of work in one second. For practical purposes, larger units like the kilowatt (kW,) and horsepower (hp, 746 W) are used. Power is a scalar quantity. The concept of power is important for comparing the performance of machines and engines.

Q5. What is the difference between renewable and non-renewable energy resources? Give one example of each.

Answer:

Renewable energy resources are sources of energy that are naturally replenished on a human timescale. They include sunlight, wind, flowing water, biomass, geothermal heat, tides, and waves. These resources are continuously renewed by natural processes and will not run out. An example is solar energy, which is continuously supplied by the Sun.

Non-renewable energy resources are sources of energy that are limited and cannot be replaced naturally in a short time. They include fossil fuels (coal, oil, natural gas) and nuclear fuels (uranium). These resources took millions of years to form and are being consumed much faster than they are being formed. An example is coal, which is a finite resource.

Section C — Long Questions (2 × 5 = 10 marks)

Q1. Describe the major energy resources, distinguishing between renewable and non-renewable resources.

Answer:

Introduction: Energy resources are the natural sources from which we can extract energy for useful purposes. They are classified into non-renewable and renewable resources.

Non-Renewable Energy Resources: These are limited and cannot be replaced naturally in a short time.

Fossil Fuels: Coal, oil (petroleum), and natural gas. These are formed from the remains of ancient plants and animals over millions of years. They are the dominant

global energy source but contribute to climate change and air pollution.
Nuclear Fuels: Uranium and plutonium. Nuclear power plants generate electricity through nuclear fission. Nuclear energy does not emit greenhouse gases but produces radioactive waste.
Renewable Energy Resources: These are replenished naturally on a human timescale.
Solar Energy: Energy from the Sun, harnessed using photovoltaic cells or solar thermal systems. It is clean and abundant but intermittent.
1 W=1 J/s
10 W3

Wind Energy: Kinetic energy of moving air, harnessed using wind turbines. It is clean and renewable but depends on weather conditions.
Hydroelectric Energy: Energy from flowing or falling water, harnessed using dams and turbines. It is reliable and efficient but requires suitable geography.
Biomass: Organic matter (wood, agricultural waste) that can be burned or converted into biofuels. It is renewable and carbon-neutral if managed sustainably.
Geothermal Energy: Heat from the Earth's core, harnessed for electricity and heating. It is reliable but location-specific.
Tidal and Wave Energy: Energy from ocean tides and waves. It is predictable but still in early stages of development.
Conclusion: Fossil fuels currently dominate global energy consumption, but they are finite and environmentally harmful. The transition to renewable energy sources (solar, wind, hydro, biomass, geothermal, tidal) is essential for a sustainable future. Improving energy efficiency and developing new technologies are also crucial.
Q2. Explain the concepts of energy conversion and conservation. Illustrate with examples of a falling ball and a pendulum.
Answer:
Introduction: Energy conversion is the process of changing energy from one form to another. The law of conservation of energy states that the total energy of an isolated system remains constant.
Energy Conversion: Energy can be converted from one form to another. For example, electrical energy is converted into light and heat in a bulb, and chemical energy in food is converted into kinetic energy by the body.
Conservation of Energy: The total energy before and after a conversion remains the same. Energy is never created or destroyed.
Example 1: A Falling Ball: A ball held at height has gravitational potential energy . As it falls, its potential energy decreases, and its kinetic energy increases.
At the top, and . At the bottom, and . By conservation of energy, . The total mechanical energy (PE + KE) remains constant throughout the fall (neglecting air resistance).
Example 2: A Pendulum: A pendulum bob swings back and forth. At the highest point of its swing, it has maximum potential energy and zero kinetic energy. As it swings down, potential energy is converted into kinetic energy. At the lowest point, kinetic energy is maximum and potential energy is minimum. As it swings up on the other side, kinetic energy is converted back into potential energy. The total mechanical energy remains constant.
h
PE=mgh
KE=0 PE=mgh PE=0 KE= mv21 2
mgh= mv21 2

Conclusion: Energy conversion and conservation are fundamental principles of physics. They explain how energy changes form in natural and technological processes while the total amount remains constant. This principle is applied in designing machines,

understanding motion, and managing energy resources.

Section D — Numerical Problems (3 × 3 = 9 marks)

Q1. A force of 100 N pushes a box 200 m. Calculate the work done.

Solution:

Given:

Force

Distance

Required:

Work

Formula:

Substitution:

Final Answer:

Verification: Units: . Correct.

Q2. A person of mass 60 kg jumps 1.5 m high. Calculate his potential energy at the highest point. (Take)

Solution:

Given:

Mass

Height

Acceleration due to gravity

Required:

Potential energy

Formula:

F=100 N

d=200 m

W

W=F×d

W=100×200=20,000 J=20 kJ

W=20,000 J=20 kJ

N×m=J

g=9.8 m/s2

m=60 kg

h=1.5 m

g=9.8 m/s2

PE

PE=mgh

Substitution:

Final Answer:

Verification: Units: . Correct.

Q3. A machine does 3000 J of work in 10 seconds. Calculate its power.

Solution:

Given:

Work

Time

Required:

Power

Formula:

Substitution:

Final Answer:

Verification: Units: . Correct.

Answer Key and Detailed Solutions — Test 1

MCQ Answers

1. B
2. B
3. B
4. B
5. B
PE=60×9.8×1.5
PE=60×14.7=882 J
PE=882 J
kg×m/s ×2 m=J
W=3000 J
t=10 s
P
P=
tW
P= =103000 300 W
P=300 W
J/s=W
6. B
7. A
8. C
9. B
10. C
11. B
12. C
13. C
14. B
15. B
Short Answers
(Provided above in Section B.)
Long Answers
(Provided above in Section C.)
Numerical Solutions
(Provided above in Section D.)

Chapter Test 2 — Understanding and Application

Board: FBISE
Class: 9
Subject: Physics
Section A — Multiple Choice Questions (15 × 1 = 15 marks)
MCQ 1. If a force of 10 N moves an object 5 m in the direction of the force, the work done is:
A. 2 J
B. 50 J
C. 15 J
D. 0.5 J
Correct Answer: B. 50 J
Explanation: .
MCQ 2. Work done is zero when:
A. Force and displacement are in the same direction
B. Force and displacement are in opposite directions
C. Force and displacement are perpendicular
D. Force is zero
Correct Answer: C. Force and displacement are perpendicular
Explanation: When force is perpendicular to displacement, the work done is zero.
$W = F \times d = 10 \times 5 = 50$ J
MCQ 3. A ball of mass 0.12 kg has a kinetic energy of 50 J. Its speed is approximately:
A. 10 m/s
B. 28.9 m/s
C. 50 m/s
D. 100 m/s
Correct Answer: B. 28.9 m/s
Explanation: .
MCQ 4. A person of mass 60 kg jumps 1.5 m high. His potential energy at the highest point is: (Take)
A. 882 J
B. 600 J
C. 90 J
D. 150 J
Correct Answer: A. 882 J
Explanation: .
MCQ 5. When a book falls from a shelf, its potential energy is converted into:
A. Chemical energy
B. Kinetic energy
C. Electrical energy
D. Nuclear energy
Correct Answer: B. Kinetic energy
Explanation: As the book falls, gravitational potential energy is converted into kinetic energy.
MCQ 6. A machine does 1000 J of work in 5 seconds. Its power is:
A. 200 W
B. 50 W
C. 500 W
D. 5000 W
Correct Answer: A. 200 W
Explanation: .
$v = = 2KE/m = 2 \times 50/0.12$ 28.9 m/s
$g = 9.8$ m/s2

PE=60×9.8×1.5=882 J
P=W/t=1000/5=200 W

MCQ 7. A 100 W light bulb is left on for 10 hours. The energy consumed is:
A. 1 kWh
B. 10 kWh
C. 100 kWh
D. 1000 kWh
Correct Answer: A. 1 kWh
Explanation: Energy = .
MCQ 8. One horsepower is equal to:
A. 100 W
B. 550 W
C. 746 W
D. 1000 W
Correct Answer: C. 746 W
Explanation: .
MCQ 9. A petrol engine takes in 400 J of fuel energy and does 120 J of useful work. Its efficiency is:
A. 10%
B. 20%
C. 30%
D. 40%
Correct Answer: C. 30%
Explanation: .
MCQ 10. The efficiency of a typical incandescent light bulb is about:
A. 5%
B. 25%
C. 50%
D. 95%
Correct Answer: A. 5%
Explanation: The efficiency of an incandescent light bulb is about 5%.
100×10=1000 Wh=1 kWh
1 hp=746 W
η=120/400=0.3=30%

MCQ 11. The efficiency of a typical automobile engine is about:
A. 5%
B. 25%
C. 50%
D. 95%
Correct Answer: B. 25%
Explanation: The efficiency of an automobile engine is about 25%.
MCQ 12. Which of the following has the highest efficiency?
A. Incandescent light bulb
B. Automobile engine
C. Electric generator
D. Fossil fuel power plant
Correct Answer: C. Electric generator
Explanation: The efficiency of an electric generator is 98%, which is higher than the others.
MCQ 13. Which of the following is a non-renewable energy resource?
A. Solar
B. Wind

C. Nuclear
D. Hydroelectric
Correct Answer: C. Nuclear
Explanation: Nuclear fuel (uranium) is a non-renewable resource.
MCQ 14. Which of the following is a renewable energy resource?
A. Coal
B. Natural gas
C. Biomass
D. Petroleum
Correct Answer: C. Biomass
Explanation: Biomass is a renewable resource; coal, natural gas, and petroleum are non-renewable.

MCQ 15. The energy conversion in a hydroelectric power plant is from:
A. Chemical energy to electrical energy
B. Gravitational potential energy to electrical energy
C. Nuclear energy to electrical energy
D. Thermal energy to electrical energy
Correct Answer: B. Gravitational potential energy to electrical energy
Explanation: Potential energy of water stored at a height is converted into kinetic energy, then into electricity.
Section B — Short Questions (5 × 2 = 10 marks)
Q1. Explain why work done can be zero even when a force is applied.
Answer:
Work is defined as the product of force and displacement in the direction of the force: . If there is no displacement (e.g., pushing a wall that does not move), the work done is zero. Even if there is displacement, if the force is perpendicular to the direction of motion (e.g., carrying a book horizontally while walking), the angle and , so the work done is zero. This is because the force does not contribute to the motion in the direction of displacement. Thus, work is zero when either there is no displacement or the force is perpendicular to the displacement.
Q2. Explain why a cricketer moves his hands backward while catching a fast-moving ball.
Answer:
When a cricketer catches a fast-moving ball, the ball has a certain momentum. To stop the ball, its momentum must be reduced to zero. According to Newton's second law, the force required to change momentum is . If the hands are kept stationary, the time interval for stopping the ball is very short, resulting in a very large force that can cause injury. By moving his hands backward, the cricketer increases the time interval over which the ball's momentum changes. Since the change in momentum is the same, a longer time interval results in a smaller force on his hands. This is an application of the impulse-momentum relationship and reduces the risk of injury.
Q3. Explain the difference between kinetic energy and potential energy.
Answer:
Kinetic energy is the energy possessed by an object due to its motion. It depends on the mass and velocity of the object ( ). For example, a moving car has kinetic energy. Potential energy is the energy possessed by an object due to its position or
$W = Fd\cos\theta$
$\theta = 90^\circ$
$\cos 90 = 0$
$F = \Delta p / \Delta t$
$KE = mv^2 1\ 2$

state. The most common form is gravitational potential energy, which depends on the mass, height, and acceleration due to gravity ( ). For example, a book on a high shelf has gravitational potential energy. Another form is elastic potential energy, stored in a stretched or compressed spring. Both forms of energy are measured in joules and can be converted into each other, as seen when a falling object converts potential energy into kinetic energy.

Q4. Explain why no machine can be 100% efficient.

Answer:

No machine can be 100% efficient because some energy is always lost due to friction and other dissipative forces. When a machine operates, moving parts rub against each other, and friction converts some of the input energy into heat. This heat is not useful for the intended purpose of the machine. Additionally, air resistance, sound, and vibrations can also cause energy losses. According to the law of conservation of energy, energy is not destroyed but is converted into less useful forms. Therefore, the useful output energy is always less than the total input energy. The efficiency of a machine is the ratio of useful output to total input, and because some energy is always lost, this ratio is always less than 1 (or less than 100%).

Q5. Explain the difference between renewable and non-renewable energy resources with examples.

Answer:

Renewable energy resources are sources of energy that are naturally replenished on a human timescale. They include sunlight, wind, flowing water, biomass, geothermal heat, tides, and waves. These resources are continuously renewed by natural processes and will not run out. Examples include solar energy (from the Sun) and wind energy. Non-renewable energy resources are sources of energy that are limited and cannot be replaced naturally in a short time. They include fossil fuels (coal, oil, natural gas) and nuclear fuels (uranium). These resources took millions of years to form and are being consumed much faster than they are being formed. Examples include coal and petroleum. The transition to renewable energy is essential for a sustainable future.

Section C — Long Questions (2 × 5 = 10 marks)

Q1. Explain the concept of power. How is it related to work and energy? Include the formula and units.

Answer:

Introduction: Power is the time rate at which work is done or the rate at which energy is consumed or converted.

$PE=mgh$

Definition: Power measures how quickly work is performed or energy is transferred. A more powerful machine can do the same work in less time or more work in the same time.

Formula: Power is calculated as work divided by time:

where is power, is work done, and is the time taken. It can also be expressed as the rate of energy conversion:

Unit: The SI unit of power is the watt (W), where . One watt is the power of a machine that does one joule of work in one second. Larger units include the kilowatt (kW,) and horsepower (hp, 746 W).

Relationship to Work and Energy: Power is directly related to work and energy. Work is the amount of energy transferred, and power is the rate at which this transfer occurs. For example, a 100 W light bulb converts 100 J of electrical energy into light and heat every second. A 1000 W microwave converts 1000 J every second. Thus, a higher power rating means faster energy conversion.

Practical Examples: The power of a car engine determines its acceleration and top speed. The power of a light bulb determines its brightness. The power of a power plant determines how much electricity it can supply.

Conclusion: Power is a fundamental concept in physics and engineering. It measures the rate of energy transfer and is essential for comparing the performance of machines and devices. Understanding power helps in selecting appropriate devices for specific tasks and in managing energy consumption.
Q2. Explain the law of conservation of energy and describe how energy is converted in a hydroelectric power plant.
Answer:
Introduction: The law of conservation of energy states that energy can neither be created nor destroyed in any process. It can only be converted from one form to another, but the total amount of energy remains constant.
Statement: The total energy of an isolated system remains constant over time.
Hydroelectric Power Plant: A hydroelectric power plant converts the gravitational potential energy of water into electrical energy through a series of energy conversions.
Step 1: Water Storage: Water is stored in a reservoir behind a dam. At this stage, the water has gravitational potential energy due to its height above the turbine.
P=
t
W
P W t
P=
tE
1 W=1 J/s
10 W3

Step 2: Water Flow: When the water is released, it flows down through pipes (penstocks) to the turbine. As it falls, its potential energy is converted into kinetic energy.
Step 3: Turbine Rotation: The flowing water strikes the blades of the turbine, causing them to spin. The kinetic energy of the water is transferred to the turbine as mechanical energy.
Step 4: Electricity Generation: The spinning turbine is connected to a generator. The generator converts the mechanical energy into electrical energy through electromagnetic induction.
Energy Conservation: Throughout this process, the total energy remains constant. The potential energy of the water is converted into kinetic energy, then into mechanical energy, and finally into electrical energy. Some energy is lost as heat due to friction in the pipes and turbine, but the total energy is conserved.
Conclusion: The hydroelectric power plant is a practical example of energy conversion. It harnesses the potential energy of water to generate electricity, demonstrating the law of conservation of energy.
Section D — Numerical Problems (3 × 3 = 9 marks)
Q1. A car of mass 1000 kg is moving at 20 m/s. Calculate its kinetic energy.
Solution:
Given:
Mass
Velocity
Required:
Kinetic energy
Formula:
Substitution:
Final Answer:
Verification: Units: . Correct.
m=1000 kg
v=20 m/s

KE
KE= mv21 2
KE= ×2
1 1000×(20)2
KE=500×400=200,000 J=2×10 J5
KE=2×10 J5
kg×(m/s) =2 J

Q2. A machine has an input power of 500 W and an efficiency of 80%. Calculate its output power.
Solution:
Given:
Input power
Efficiency
Required:
Output power
Formula:
Substitution:
Final Answer:
Verification: . Correct.

Q3. A ball is dropped from a height of 20 m. Calculate its speed just before hitting the ground. (Take)
Solution:
Given:
Height
Acceleration due to gravity
Initial velocity
Required:
Final speed
Formula:
By conservation of energy:
Substitution:
P =in 500 W
η=80%=0.8
P
out
η=
P
in
P
out
P =out η×P
in
P =out 0.8×500=400 W
P =out 400 W
η=400/500=0.8=80%
g=10 m/s2
h=20 m
g=10 m/s2
u=0 m/s
v
mgh= mv21 2
v= 2gh

Final Answer:
Verification: Using : .
Correct.

Answer Key and Detailed Solutions — Test 2

MCQ Answers

1. B
2. C
3. B
4. A
5. B
6. A
7. A
8. C
9. C
10. A
11. B
12. C
13. C
14. C
15. B

Short Answers

(Provided above in Section B.)

Long Answers

(Provided above in Section C.)

Numerical Solutions

(Provided above in Section D.)

v= =2×10×20 =400 20 m/s

v=20 m/s

v =2 u+2 2ghv =2 0+2(10)(20)=400□v=20 m/s

Chapter Test 3 — Application, Reasoning, and Exam Preparation

Board: FBISE
Class: 9
Subject: Physics
Section A — Multiple Choice Questions (15 × 1 = 15 marks)
MCQ 1. A force of 50 N is applied at an angle of 60° to the horizontal to move a box 10 m. The work done is: (Take)
A. 250 J
B. 500 J
C. 1000 J
D. 125 J
Correct Answer: A. 250 J
Explanation: .
cos60°=0.5
W=Fdcosθ=50×10×0.5=250 J

MCQ 2. A car of mass 1000 kg is moving at 20 m/s. Its kinetic energy is:
A.
B.
C.
D.
Correct Answer: A.
Explanation: .
MCQ 3. A body of mass 5 kg is lifted to a height of 10 m. The gain in potential energy is: (Take)
A. 500 J
B. 50 J
C. 5000 J
D. 5 J
Correct Answer: A. 500 J
Explanation: .
MCQ 4. A motor lifts a 200 kg load to a height of 10 m in 20 s. The power of the motor is: (Take)
A. 1000 W
B. 100 W
C. 10,000 W
D. 2000 W
Correct Answer: A. 1000 W
Explanation: Work = . Power =
.
MCQ 5. A machine with an input power of 500 W has an efficiency of 80%. The output power is:
A. 400 W
B. 500 W
C. 100 W
D. 600 W
Correct Answer: A. 400 W
2×10 J5
2×10 J4
2×10 J6
2×10 J3
2×10 J5
KE= mv =21 2
×21 1000×20 =2 2×10 J5

g=10 m/s2
PE=mgh=5×10×10=500 J
g=10 m/s2
mgh=200×10×10=20,000 J 20,000/20=
1000 W

Explanation: .
MCQ 6. A ball is dropped from a height of 20 m. Its speed just before hitting the ground is: (Take)
A. 20 m/s
B. 10 m/s
C. 40 m/s
D. 200 m/s
Correct Answer: A. 20 m/s
Explanation: By conservation of energy:
.
MCQ 7. A 2 kg object is moving at 6 m/s. Its momentum is:
A. 12 kg·m/s
B. 3 kg·m/s
C. 6 kg·m/s
D. 24 kg·m/s
Correct Answer: A. 12 kg·m/s
Explanation: .
MCQ 8. A 2 kg object is moving at 6 m/s. Its kinetic energy is:
A. 36 J
B. 12 J
C. 6 J
D. 72 J
Correct Answer: A. 36 J
Explanation: .
MCQ 9. A body is thrown vertically upward with a velocity of 20 m/s. The maximum height reached is: (Take)
A. 20 m
B. 10 m
C. 40 m
D. 5 m
P =out η×P =in 0.8×500=400 W
g=10 m/s2
mgh= mv 21 2 v= =2gh
=2×10×20 20 m/s
p=mv=2×6=12 kg m/s
KE= mv =21 2
×21 2×6 =2 36 J
g=10 m/s2

Correct Answer: A. 20 m
Explanation: By conservation of energy: .
MCQ 10. A machine has an input energy of 1000 J and an output energy of 250 J. Its efficiency is:
A. 25%
B. 50%
C. 75%
D. 4%
Correct Answer: A. 25%
Explanation: .
MCQ 11. A car engine converts 5000 J of chemical energy into 1500 J of kinetic energy. The energy lost as heat is:
A. 3500 J

B. 1500 J
C. 5000 J
D. 6500 J
Correct Answer: A. 3500 J
Explanation: Energy lost = input - useful output = .
MCQ 12. A 100 g ball is thrown with a velocity of 10 m/s. Its kinetic energy is:
A. 5 J
B. 10 J
C. 50 J
D. 100 J
Correct Answer: A. 5 J
Explanation: .
MCQ 13. A 5 kg object is lifted from the ground to a height of 4 m. The work done against gravity is: (Take)
A. 200 J
B. 20 J
mgh= mv 21 2 h= =2gv2
=20400 20 m
η=250/1000=0.25=25%
5000−1500=3500 J
KE= mv =21 2
×21 0.1×10 =2 5 J
g=10 m/s2
C. 2000 J
D. 50 J
Correct Answer: A. 200 J
Explanation: Work done = .
MCQ 14. A body of mass 2 kg is moving with a velocity of 4 m/s. Its kinetic energy is:
A. 16 J
B. 8 J
C. 4 J
D. 32 J
Correct Answer: A. 16 J
Explanation: .
MCQ 15. A 60 W bulb is used for 5 hours. The energy consumed in kWh is:
A. 0.3 kWh
B. 3 kWh
C. 30 kWh
D. 0.03 kWh
Correct Answer: A. 0.3 kWh
Explanation: Energy = .
Section B — Short Questions (5 × 2 = 10 marks)
Q1. Explain why a hybrid car is more efficient than a conventional petrol car.
Answer:
A hybrid car combines a petrol engine with an electric motor and battery. It is more efficient than a conventional petrol car because it recovers energy during braking (regenerative braking), which would otherwise be lost as heat. The electric motor can also assist the petrol engine during acceleration, allowing the engine to operate at its most efficient speed. Additionally, the engine can shut off when the car is stationary or moving slowly, reducing fuel consumption. These features increase the overall efficiency of the vehicle, reducing fuel consumption and emissions. The efficiency of a hybrid car can be significantly higher than the 25% typical of conventional petrol engines.
Q2. Explain why a machine cannot have an efficiency greater than 100%.
mgh=5×10×4=200 J
KE= mv =21 2

×21 2×4 =2 16 J
60×5=300 Wh=0.3 kWh

Answer:
Efficiency is defined as the ratio of useful output energy to total input energy. According to the law of conservation of energy, energy cannot be created. The useful output energy cannot exceed the input energy, so the efficiency cannot exceed 100%. In any real machine, some energy is always lost due to friction, air resistance, and other dissipative forces. These losses convert some of the input energy into heat or sound, which are not useful for the intended purpose. Therefore, the useful output is always less than the input, and the efficiency is always less than 100%. A machine with an efficiency greater than 100% would violate the law of conservation of energy.

Q3. Explain the concept of energy conversion in a car engine, from fuel to motion.

Answer:
In a car engine, the chemical energy stored in the fuel (petrol or diesel) is converted into kinetic energy of the car through a series of energy conversions. First, the fuel is burned in the engine's cylinders, converting chemical energy into thermal energy (heat) and expanding gases. The expanding gases push the pistons, converting thermal energy into mechanical energy. The pistons turn the crankshaft, which drives the wheels, converting mechanical energy into kinetic energy of the car. Throughout this process, some energy is lost as heat through the exhaust and cooling system, and some is lost to friction. The overall efficiency of a car engine is typically about 25%, meaning only 25% of the chemical energy is converted into useful motion.

Q4. Explain why it is important to develop renewable energy resources.

Answer:
Renewable energy resources are important for several reasons. First, they are sustainable and will not run out, unlike fossil fuels, which are finite. Second, they produce little or no greenhouse gas emissions, helping to mitigate climate change. Third, they reduce dependence on imported fuels, improving energy security. Fourth, they can create jobs and stimulate economic growth in the renewable energy sector. Fifth, they reduce air and water pollution, improving public health and protecting ecosystems. As the global population and energy demand grow, renewable resources offer a clean, sustainable, and reliable path to meeting our energy needs without compromising the ability of future generations to meet theirs.

Q5. Explain the concept of power and how it differs from energy.

Answer:
Power is the rate at which work is done or energy is converted. It is defined as work divided by time ( ) and is measured in watts (W). Power tells us how quickly energy is used or transferred. Energy, on the other hand, is the capacity to do work and is measured in joules (J). Energy is an amount, while power is a rate. For example, a 100 P=W/t

W light bulb uses 100 J of energy every second. A 1000 W microwave uses 1000 J every second—it is more powerful. A machine with high power can do the same work in less time or more work in the same time. Understanding the distinction between power and energy is important for selecting devices and managing energy consumption.

Section C — Long Questions (2 × 5 = 10 marks)

Q1. Explain the working principle of a hydroelectric power plant. Describe the energy conversions involved and the factors that affect its efficiency.

Answer:
Introduction: A hydroelectric power plant generates electricity by harnessing the gravitational potential energy of water.

Construction: A hydroelectric plant consists of a dam that creates a reservoir, penstocks (pipes) that carry water to the turbine, a turbine that spins as water flows through it, and

a generator connected to the turbine.
Working: Water stored in the reservoir has gravitational potential energy due to its height above the turbine. When released, the water flows down through the penstocks, converting its potential energy into kinetic energy. The flowing water strikes the blades of the turbine, causing it to spin. The spinning turbine drives the generator, converting mechanical energy into electrical energy.
Energy Conversions:
1. Gravitational potential energy → Kinetic energy (as water falls)
2. Kinetic energy → Mechanical energy (as water turns the turbine)
3. Mechanical energy → Electrical energy (as the generator spins)
Factors Affecting Efficiency: The efficiency of a hydroelectric plant depends on the head (height the water falls) and the flow rate (volume of water per second). A larger head or flow rate produces more power. The efficiency is also affected by friction losses in the penstocks and turbine, and the efficiency of the generator. Modern hydroelectric plants can convert up to 90% of the available energy into electricity.
Conclusion: Hydroelectric power is a renewable, efficient, and reliable source of electricity. It converts the potential energy of water into electrical energy, with minimal environmental impact during operation. However, large dams can have significant environmental and social impacts, which must be carefully managed.
Q2. Explain the law of conservation of energy and apply it to a pendulum. Include a discussion of the energy transformations and the effect of friction.
Answer:

Introduction: The law of conservation of energy states that energy cannot be created or destroyed, only converted from one form to another. The total energy of an isolated system remains constant.
Pendulum: A simple pendulum consists of a mass (bob) attached to a string. When the bob is displaced and released, it swings back and forth.
Energy Transformations:
At the highest point of the swing: The bob has maximum gravitational potential energy (PE) and zero kinetic energy (KE), as it momentarily stops.
As it swings down: The potential energy decreases, and the kinetic energy increases. The total mechanical energy (PE + KE) remains constant (ignoring friction).
At the lowest point: The potential energy is minimum, and the kinetic energy is maximum. The bob is moving fastest.
As it swings up the other side: The kinetic energy is converted back into potential energy. The bob slows down as it rises.
Effect of Friction: In a real pendulum, air resistance and friction at the pivot dissipate some of the mechanical energy as heat. This causes the pendulum to gradually lose energy, and its swings become smaller over time. Eventually, the pendulum stops. The total energy (including heat) is still conserved, but the mechanical energy decreases.
Conservation of Energy: The total energy of the pendulum at any point is the sum of its potential and kinetic energy. In the absence of friction, this sum remains constant. With friction, the total mechanical energy decreases, but the total energy (including heat) remains constant.
Conclusion: The pendulum is a classic example of energy conversion between potential and kinetic forms. It demonstrates the law of conservation of energy, and shows how dissipative forces like friction cause mechanical energy to be converted into heat.
Section D — Numerical Problems (3 × 3 = 9 marks)
Q1. A 2 kg ball is dropped from a height of 10 m. Calculate its kinetic energy and speed just before hitting the ground. (Take)
Solution:
Given:

Mass
Height
Acceleration due to gravity
Initial velocity
Required:
Kinetic energy and speed
g=10 m/s2
m=2 kg
h=10 m
g=10 m/s2
u=0 m/s
KE v

Formula:
By conservation of energy:
Substitution for KE:
Substitution for speed:
Final Answer:
Verification: . Correct.
Q2. A machine with an input power of 800 W has an efficiency of 75%. Calculate its output power and the energy it produces in 10 seconds.
Solution:
Given:
Input power
Efficiency
Time
Required:
Output power and energy produced
Formula:
Substitution for output power:
Substitution for energy:
PE =initial KE
final
mgh= mv21 2
v= 2gh
KE=mgh=2×10×10=200 J
v= =2×10×10 ≈200 14.14 m/s
KE=200 J
v≈14.14 m/s
v =2 2gh=200□v=14.14 m/s
P =in 800 W
η=75%=0.75
t=10 s
P
out E
P =out η×P
in
E=P ×out t
P =out 0.75×800=600 W
E=600×10=6000 J

Final Answer:
Verification: . Correct.
Q3. A car of mass 1200 kg is moving at 15 m/s. It accelerates to 25 m/s. Calculate the

work done by the engine.
Solution:
Given:
Mass
Initial velocity
Final velocity
Required:
Work done
Formula:
By the work-energy theorem:
Substitution:
Final Answer:
Verification: Change in KE =
. Correct.

Answer Key and Detailed Solutions — Test 3
MCQ Answers
1. A
2. A
P =out 600 W
E=6000 J
η=600/800=0.75=75%
m=1200 kg
u=15 m/s
v=25 m/s
W
W=ΔKE= mv −21 2
mu21 2
W= ×21 1200×(25 −2 15)2
W=600×(625−225)
W=600×400=240,000 J=2.4×10 J5
W=2.4×10 J5
×21 1200×625− ×21 1200×225=375,000−
135,000=240,000 J

3. A
4. A
5. A
6. A
7. A
8. A
9. A
10. A
11. A
12. A
13. A
14. A
15. A
Short Answers
(Provided above in Section B.)
Long Answers
(Provided above in Section C.)
Numerical Solutions
(Provided above in Section D.)