Grade IX

Lesson : 11 Work and Energy

Chapter at a Glance

WORK

- Work is said to be done when an applied force produces a displacement in the body in it s own direction
  Work = Force x Displacement x cos θ
  (where 0 = angle between force and displacement)
- It is a scalar quantity

SI unit : joule (J)

CGS unit : erg

1J = 10^7 erg

1KJ = 10^3 J

1J : Work done is one joule if force of 1N displaces a body by 1m in its own direction

Conditions for work to be done

- A non-zero force is applied
- The body gets displaced

Positive work (when $0^0 \leq \theta < 90^0$)
i.e. cos θ is positive

Zero work (when $\theta < 90^0$)
i.e. cos θ = 0

Negative work (when $90^0 < \theta \leq 180^0$)
i.e. cos θ is negative

Energy

- Ability to do work

Conservation of energy

Total energy in the universe is constant

Types of energy

Mechanical energy (kinetic + Potential

Heat energy, light energy, sound energy, electrical energy, etc.

Kinetic

- Energy possessed by a body due to its motion

Potential

- Energy possessed by a body due to its position or configuration

- Change in kinetic energy
  $= \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

If u = 0, $E_k = \frac{1}{2}mv^2$

Where Mass of body = m

Initial velocity = u

Final velocity = v

- If ρ = momentum, then
  $E_k = \rho^2 / 2m$

- Potential energy
  E_p = mgh

Where Mass = m

Height = n

Acceleration due to gravity = g

Commercial unit of energy

- Kilowatt hour (kWh) = 1 unit as measured in electricity bill
- Energy consumed is 1kWh if a device of power 1 kW operates for 1h
- 1kWh = 3.6 x 10^6 J

Energy

- Rate of doing work is power
- Power = $\frac{Work}{Time} = \frac{w}{t}$
- SI unit = watt (W)
- 1kW = 10^3W
- 1 horsepower = 746 W
- Average power = $\frac{Total\ work\ done}{Total\ time}$

Know the terms

Activity /Project 1:

Aim : To study variation in kinetic an potential energies

Introduction : Prepare a rocket using an empty plastic bottle, cork and pointer. Make a catapult using a long elastic string and stretching stand. Stretch the catapult and fire the rocket and see where it strikes the ground. This activity helps the students to appreciate the significance of energy conversion and conservation through hands on experience. Students also develop a practical approach towards a concept

Materials Required : Catapults made by using strings of different materials, rockets made by students using empty plastic bottles and pointers, measuring tape, etc.

Method : 1. Set a firing stand in the field
(Caution : Take care and do not stand in front of the firing stand as the rocket may hurt]
2. Attach the catapult to the stand and stretch it with rocket placed in he centre.
3. The rocket is released and the distance covered by it on firing is marked and measured using measuring tape.
4. Steps 2 and 3 are repeated for strings of different materials.

Observations :

S.No.	Materials of catapult	Distance covered by rocket		
		Trial 1	Trial 2	Trial 1

Conclusion : In a catapult, the muscular energy applied on the string is converted into potential energy. This gets converted into kinetic energy of the rocket when fired. The rockets which have greater potential energy of the rocket when fired. The rockets which have greater potential energy acquire higher kinetic energy on firing.

Activity /Project 2:

Aim : To study transformation of energy from one form into another

Materials Required : Flash cards.

Method : 1. The flash cards are placed upside down the table.
2. The students are shown one card at a time. The students are required to answer where energy transformation takes place in the activity/situation shown on the card.
3. The activity continues till all cards are shown. For example, pictures like lighting of bulb, paddling a boat rotation of a fan, stretching or compressing of spring weight lifting exercise, moving car etc. may be shown on the cards

Conclusion : Energy can be converted from one form into another.

Objective Type Questions

I. Multiple choice questions

1. If 1 newton of force displaces a body by I m, the work done is

a) 10 joule   b) 5 joule   c) 1 joule   d) Depends on time

2. On tripling the speed of motion of a body, the change in K.E. is

a) 9 times   b) 8 times   c) 4 times   d) 2 times

Sol. K.E, $\propto V^2$, when V $\rightarrow$ 3V, K.E. $\rightarrow$ 9 K.E.,

3. A mass is moving 5 m/s with speed of along he x - direction on a smooth surface, when a force of 5 N acts on it along the y – $axis$. The work done by against the force is

a) 25 joule   b) 10 joule   c) Depends on time   d) zero

4. An electric bulb of 60W burns for 5 hours a day. The cost of electricity involved in a month of 30 days at Rs.3.00 per unit is (in Rs.)

a) 270   b) 27   c) 2.70   d) 2700

Cost of electricity = P x t x cost per kW = 0.06 kW x (5 x 30) x 3 = Rs.27

5. A bullet entering a metal block of 30 cm length stops on reaching 25cm. The energy with the bullet will be lost

a) in imparting momentum to the block   b) in the form of heat

c) Both (a) and (b)   d) Neither (a) nor (b)

6. A : 50 kg man climbing a 'slant length of 5 m along a 30^0 incline

B : 25 kg man running with 2 m/s speed.

C : A force of 5N acting on an object moving with 5 m/s speed for 5 min.

If the energies in A, B and C are E_A, E_B and E_c respectively, then

a) $E_A < E_B < E_c$ b) $E_A > E_B > E_c$ c) $E_A < E_B > E_c$ d) $E_B < E_A < E_c$

7. A tank contains water of mass 'm' to a height 'h'. The potential energy associated is

a) mgh   b) mg $\frac{h}{2}$

c) Depends on the radius of the tank   d) Zero

8. If a force of F newton moves a body with constant speed v, the power delivered by it is

a) $\frac{F}{v}$ b) Fv c) F^2v d) $\frac{v}{F}$

9. One kWh is

a) 3.6 x 10^6 joule b) 3.6 x 10^3 joule c) 3.6 x 10^8 joule d) 300joule

10. A mass ‘m’ falls from a height ‘h’. At any point on its path the total energy is

a) $\frac{1}{2}$ mgh b) $\frac{mgh}{4}$

c) mgh d) Depends on the height

11. If a 60W bulb and 40 W are connected in series to a 220v potential, the bulb which glows brighter is

a) 60 W b) 40 W

c) Both glow equally bright d) Cannot be found

12. If the bulbs of 60 W and 40 W are connected in series to a 220v source, the bulb which glows brighter is

a) 60 W b) 40 W

c) Both glow equally bright d) Depends on the make of the bulb

13. A mass m is moving in a circle of radius 1 m with a uniform speed of 5 m/s.

a) zero b) 2.5 joule c) 5 joule d) 10 joule

Ans: zero as angle between force and displacement is always 90^0

14. A boy holds a mass on his stretched hand. Then

a) Work done against gravity is zero b) Muscular energy is used

c) Both (a) and (b) d) Neither (a) nor (b)

15. A man holds and displaced a 20 kg mass horizontally in his stretched hand.

a) He does zero work against force of gravity

b) He does 200 jouls of work per metre

c) The work done against gravity cannot be estimated but non-zero

d) The work done against gravity is equal to the muscular energy

16. Two masses m and 2 m are dropped from certain height 'h'. Then on reaching the ground,

a) K.E. of them will be equal

b) K.E. of the heavier is 4 times the K.E. of the lighter

c) K.E. of the lighter is 4 times the K.E. of the heavier

d) K.E. of the heavier is more than that of the lighter

17. Two cars A and B approaching each other with momentum of 50 kg m/s and 25 kg m/s respectively, stick to each other after collision. The momentum after the collision is

a) 50 kg m/s b) 70 kg m/s

c) In the direction of A d) In the direction of B

18. In a collision

a) energy is lost always b) momentum of the system is constant

c) momentum is always transferred d) momentum is always lost

19. In the explosion of a cracker/ bomb

a) energy is produced b) momentum is conserved

c) internal energy is absorbed d) momentum remains unconserved

20. One unit of electricity is consumed by A: P = 40 W bulb used for t = 25 hours

B: P = 20 W bulb used for t = 50 hours

Both A and B are true as, energy E is kWh is best related as

a) E = Pt b) E = $\frac{Pt}{1000}$ c) E = $\frac{p}{1000}$ d) E = $\frac{t}{1000}$

21. Which of the following energy cannot be completely converted into other forms due to transmission system?

a) Solar energy b) Mechancial energy

c) Heat energy d) Nuclear energy

22. In an oscillating simple pendulum,

a) Work is done by the string b) Work is done by the mass

c) Work is done by the force of gravity d) Only energy transformation takes place

23. A microphone converts sound energy to

a) A Pulse
b) A wave
c) Electrical signal/energy
d) Sound energy

24. Two equal forces acting at angles 30^0 and 60^0 with the horizontal displace a body equally on a horizontal surface. Work done in the two cases are W_1 and W_2 respectively. Then

a) $W_1 = W_2$
b) $W_1 > W_2$
c) $W_1 < W_2$
d) $W_1 = 2W_2$

Ans : as cos 30^0 and> 60^0

25. A battery lights a bulb. The sequences of energy transfer in the process is

a) electrical energy to heat and light

b) chemical energy to electrical energy and then to heat and light

d) chemical energy to light

26. When a body falls freely towards the earth then its total energy

a) Increases
b) decreases
c) remains constant
d) first increases and then decreases

27. A car is accelerated on a levelled road and attains a velocity 4 times of its initial velocity. In this process the potential energy of the car

a) does not change
b) becomes twice to that of initial
c) becomes 4 times that of initial
d) becomes 16 times that of initial

28. In case of negative work the angle between the force and displacement is

a) 0^0
b) 45^0
c) 90^0
d) 180^0

29. An iron sphere of mass 10 kg has the same diameter as an aluminium sphere of mass is 3.5 kg. Both sphere of mass is 3.5 kg. Both spheres are dropped simultaneously from a tower. When they are 10m above the ground, they have the same.

a) acceleration
b) momentum
c) Potential energy
d) Kinetic energy.

30. A girl is carrying a school bag of 3 kg mass on her back and moves 200m on a levelled road. The work done against the gravitational force will be (g = 10 ms^{-2}

a) 6 x 10^{-3} J
b) J
c) 0.6 J
d) zero

1. c	2. a	3. d	4. b	5. c	6. d	7. d	8. b	9. a	10. c
11. a	12. b	13. a	14. c	15. a	16. d	17. c	18. b	19. b	20.b
21. c	22. d	23. c	24. b	25. b	26. c	27. a	28. d	29. a	30. d

I. Match the following

31.

Column I	Column II
1. 1 unit	A) Force against displacement
2. Mean position	B) Heat energy
3. Negative work done	C) Newton – metre
4. Hammering a nail	D)3.6 x 10^{-6} J
5. Joule	E)[Maximum K.E.

1. D	2. E	3. A	4. B	5. C

I. Fill in the blanks

32. When non-zero force and displacement are observed with zero work done, the angle between force and displacement is __________

33. 60 W power means the device users 60 joule of energy is__________ hour.

34. __________ work is done by a satellite revolving around the earth

35. Work done can be __________ , __________ or __________ .

36. An athlete takes a round of a field and comes back to starting point, work done by athlete is __________

32. 90^0	33. 1/3600	34. zero	35. negative Positive zero	36. zero

I. True or false

37. A student studying hard for exam does more work than a baby crawling randomly from one corner of a room to another

38. Energy can be converted from one form into another in few cases only.

39. Work done is a vector quantity

40. Momentum is a vector quantity while energy is a scalar quantity.

41. A moving truck has more kinetic energy than a bicycle moving with same speed.

42. To measure power of heavy machines, unit horse power (hP) is generally used.

37. False	38. False	39. False	40. True	41. True	42. True

Direction (Q 43 – Q 47) : In the following Questions, The Assertion and Reason have been put forward. Read the statements carefully and choose the correct alternative from the following.

a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion

b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion

c) Assertion is true but the Reason is false

d) The statement of the Assertion is false but the Reason is true

43. Assertion : We do not work as we push a wall

Reason : The condition for a force to do work is that it should produce motion in object

a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.

44. Assertion : Stretched bow has potential energy

Reason : Catapult has kinetic energy

c) Assertion is true but the Reason is false

45. Assertion : A ball rebounds to the same height on striking the ground, from which it was released

Reason : According to the law of conservation of energy, the total energy of a system remains constant.

d) The statement of the Assertion is false but the Reason is true

46. Assertion : Work done by an athlete completing a round of a field is zero.

Reason : The displacement of a body returning back to the initial position is zero.

a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion

47. Assertion : There is no need to save fuel since the total energy of the universe is constant

Reason : The resources available on earth are limited and once used, they are converted into non-reusable forms of energy

d) The statement of the Assertion is false but the Reason is true

48. What is work done in Physics?

Work is said to be done if an applied force porudces a displacement in abody.

49. Read the following situations:

"Child A is preparing for exam in his study room at his table. Child B climbs a tree several feet high on the ground.: " Who has done more work and why?

Child B has done more work because applied force and displacement are more than that of Child A.

50. A student is writing a three hours science paper. How much work is done by the student? Give reason to your answer

No work is done by the student as there is no displacement produced in anybody.

51. State the SI unit of work

The SI unit of work is Joule

52. Express work mathematically

Work done = Force x Displacement =F.d. Cos.θ

53. Define the SI unit of work

Work done is equal to one joule if an applied force of one newton produces a unit displacement in an object in its own direction.

54. What would be the work done it

a) force on the object is zero?

b) displacement of the object is zero?

Work done will be zero in each case because both applied force and displacement produced are necessary condition for work

55. A 2m high person is holding a 25 kg trunk on his head and is standing at a roadways bus-terminus. How much work is done by the person?

Work done by the person is zero because there is no displacement.

56. A Bullock is pulling a car and the cart moves. Name the object which is doing work and the object on which work is done.

Work is done by the bullock on the cart. This means that the object being displaced is worked up and the object which applied force is doing the work.

57. A coolie is walking on a railway platform with a load of 30 kg on his head. How much work is done by coolie?

No work is done by the coolie because his displacement occurd in the horizontal direction while e applied force on load in upward direction.

58. State the conditions for zero work done

Work done by a body is zero if :

i) no displacement occurs despite applied force

ii) displacement in the body is perpendicular to applied force (because $W = Fs \cos \vartheta$

and $\cos 90^0 = 0$

59. The moon is experiencing a gravitational force due to the earth and is revolving around the earth in a circular orbit. How much work is done by the moon?

Work done by the moon is zero because centripetal force acts towards the centre of the orbit and the direction of displacement is tangential to the orbit.

60. On pushing a mighty stone, a child is unable to move it. If work done is zero, where is the energy he expends, lost?

The energy lost by the child is expanded in causing muscular contraction in him.

61. When is the work down by a body positive?

Work done by a body is positive if an applied force displaces the body in its own direction.

62. When is the work done by a body negative?

Work done by a body is negative if displacement produced is in opposite direction to applied force.

63. Give an example of positive work

When a force of say 5N acts on an object such as a book, continuously and displaces it by, say 2m in its own direction, then work done by, say 2 m in its own direction, then work done by the force on the book. W = 5N x 2m = 10J is positive

64. Give an example of positive work

When a load is lifted up, then work done by force of gravity on the load is negative.

[Note : In this case, work done by the person who is lifting the load, is positive]

65. How is 'work' done in day-to-day life different from its scientific conception?

In day-to-day life, work is any physical or mental a labour /activity doe by a person such as humming a tune writing a letter or playing in a field. In scientific term, work is done if an in a field. In scientific term work is done if an applied force displaces a body in its direction.

66. What is meant by energy?

Energy is defined as the ability of a body to do work.

67. Why do engines require a fuel like petrol and diesel?

Engines require a fuel because the combustion of fuel provides energy to run them

68. Why do living being and machines need energy?

Living beings and machines need energy to work. Living beings get energy from food and machines get that energy from electricity and fuel.

69. Why is the Sun called the biggest source of energy?

The Sun is called the biggest source of energy because all of our energy sources are derived directly or indirectly from the sun e.g. energy stored in fossil fuels is converted into electricity in power plants, energy due to wing does useful work, etc.

70. What happens to energy of an object which does work and on which work is done?

An object which doe work loses energy and the object on which work is done gains energy.

71. How does an object with energy do work?

An object possessing energy exerts a force on another object. In doing, so, energy from the former gets transferred to the latte and it moves to do some work.

72. List a few forms of energy

Kinetic energy, potential energy, light energy thermal energy electrical energy etc 73. State the SI unit of energy.

The SI unit of energy is joule (J)

74. State the CGS unit of energy and relate it with its SI unit

The CGS unit of energy is erg

1 joule = 10^7 erg

75. Relate (a) caloric (b) kilojoule with SI unit of energy

a) Caloric = 4.186 joule

(b) kilojoule = 10^3 joule

76. Name the term used for the sum of kinetic energy and potential energy of a body.

Mechanical energy = Kinetic energy + Potential energy

77. Define kinetic energy

Kinetic energy is defined as the energy possessed by a body by virtue of ite motion.

78. Identify the kind of energy possessed by a running athlete.

Kinetic energy

79. Give a few examples of energy possessed by different objects due to their motion.

Energy possessed by a falling coconut, by a speeding car, by a flying air craft, by flowing water etc.

80. Define potential energy

The energy possessed by a body by virtue of its position or configuration is called potential energy.

81. A rubber band is stretched. What happens to the work done on the rubber band in stretching it?

Work done on the runner band is stored as its potential energy since it is not used to cause a change in speed or velocity of an object

82. Name the type of energy possessed by (a) moving car (b) water stores in a dam reservoir

a) Kinetic energy b) Potential energy

83. A slinky is (a) compressed (b) stretched. What happens to its potential energy in each case?

The potential energy of the slinky increases in each case.

84. Name the type of energy possessed by a raised hammer.

Potential energy

85. I an oscillating pendulum, at what position the potential and kinetic energies are maximum?

Potential energy is maximum at extreme positions and kinetic energy is maximum at mean position.

86. A stone of mass m lying on ground is raised to height h. Which energy does it acquire? What is the magnitude of this energy?

The stone acquires potential energy

Magnitude of potential energy = mgh

87. Two balls of masses m each are raised to height h and 2h respectively. What will be the ratio of their potential energies?

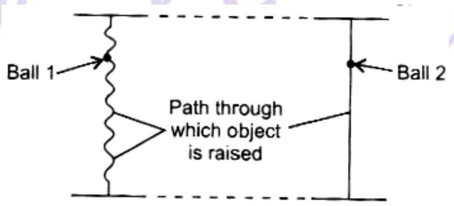
Potential energy of first ball, E_1 = mgh

Potential energy of second ball, E_2 = mg (2h)

$\therefore \frac{E_1}{E_2} = \frac{mgh}{mg(2h)} = \frac{1}{2}$

$\Rightarrow E_1 : E_2 = 1 : 2$

88. Which of the following balls having equal mass has the maximum potential energy? Why?



Both balls have equal potential energy as potential energy depends on the height of the object and not on the path through which it moves to raise to that height.

89. A body of mass m is moving with velocity v. What is its kinetic energy?

Kinetic energy = $\frac{1}{2}mr^2$

90. At what speed a body of mass 1 kg will have a kinetic energy of 1 J?

Given K.E. =1 J; m = 1

$\because$K.E. = $\frac{1}{2}\ mr^2$

$\therefore$ 1 = $\frac{1}{2}$ x 1 v^2

$\Longrightarrow v^2$ = 2 or v = $\sqrt{2}$ m/s

91. If the speed of the body is halved, what is the change in its kinetic energy?

$\because$ K.E. = $\frac{1}{2}\ mr^2$

Or K.E. $\propto\ v^2$

If v is becomes $\frac{v}{2}$, v^2 becomes $\frac{v^2}{4}$

92. A horse of mass 210 kg and a dog of mass 25 kg are running at the same speed. Which of the two possesses more kinetic energy? How?

Kinetic energy is directly proportional to mass. Since mass of a horse (210kg) is greater than that of a dog (25 kg) the horse has greater kinetic energy for the same speed.

93. What will cause greater change in kinetic energy of a body-changing its mass or changing its velocity?

The changing the velocity of a body will cause a greater change in K.E as K.E $\propto v^2$ but K.E. $\propto$ m.

94. A bag of wheat is dropped from a height h. What energy conversion takes place as it reaches the ground?

The energy of wheat bag changes from potential to kinetic.

95. State the energy conversion occurring in (a) hydel power station (b) electrochemical cell.

a) Potential energy of water $\rightarrow$ kinetic energy $\rightarrow$ Kinetic energy of turbine $\rightarrow$ Electrical energy

b) Chemical energy $\rightarrow$ Electrical energy

96. What energy transformation occurs in the following:

a) release of arrow from bow b) use of solar cell ?

a) Potential energy of bow string → Kinetic energy of arrow

b) Light energy → Electrical energy

97. State law of conservation of energy.

It states that energy can neither be created nor destroyed, but it can only be converted from one form to another.

98. What happens to kinetic energy and potential energy of a stone if it is thrown upwards?

When a stone is thrown upwards, its kinetic energy progressively decreases till the stone reaches its maximum height. But the loss in kinetic energy of stone is equal to gain in its potential energy.

99. What is the rate of consumption or transfer of energy by a machine called?

Electric power

100. Define power

Power is defined as rate of doing work

Power = $\frac{Work\ done}{Time\ taken}$

101. Two persons A and B complete a given work in 1 h and 2 h respectively. Who is more powerful and why?

Person A is more powerful because he does work in relatively less time.

102. What is the SI unit of power?

The SI unit of power is watt (W)

103. Define I W of power

Power is said to be 1W if 1J work is done in 1 second

104. If the heart works 60 jouls in one minute, what is its power?

Given : Work = 60 j : time = 60 s (i.e. 1 minute)

Power = $\frac{work}{Time}$ = $\frac{60\ J}{60\ s}$ 1 Js^{-1} = 1W

105. a) Relate one horsepower to the SI unit of power

b) How many watt constitute one kilowatt?

a) 1 horsepower = 746 watt

b) 1 kilowatt = 1000 watt

106. Define commercial unit of energy

Electrical energy consumed by a device is measure din terms of Board of Trade Unit (BoTU) called commercial unit of energy. The commercial unit of energy is kilowatt hour (kW h).

107. How many jouls is one kWh of energy equal to?

1 unit = 1kWh = 1kW x 1 h = 1000 W x 3600s = 3.6×10^6 J

108. A machine of 500W works for 2 hours. Find the number of units of Electricity consumed .

Given : Power P = 500W = 0.5 kW; Time, t = 2h

Units consumed = Pt = 0.5 x 2

=1kWh = 1 unit

109. A porter lifts a luggage of 15 kg from the ground and puts it on his head 1.5m above the ground. Calculate the work done by him on the luggage.

Given: m = 15 kg, h = 1.5 m,g = 9.8 m/S^2

W = mgh = 15 x 9.8 x 1.5 = 220.50 J

110. Give one example each of the following:

a) a body having potential energy due to change of shape.

b) a body having potential energy due to its position.

a) A compressed spring b) A raised hammer

111. An archer stretches a bow to release an arrow to hit the target at a distance of 10 m, Explain who does the work, in which form is the energy possessed by the bow and the arrow.

Archer does the work and the bow possesses potential energy which is converted into kinetic energy of the arrow.

112. Define 1 watt.

Power is equal to 1 W if any device does 1J of work in 1 second

113. An electric bulb of 60 W is used for 6 hours per day. Calculate the units of energy consumed in one day by the bulb.

P = 60 W = 0.06 kW, t = 6h

Units of energy consumed Pt

=0.06 kW x 6h = 0.36 kWh = 0.36 units.

114. A man of mass 60 kg runs up a flight of 30 steps in 40s. If each step is 20cm his , calculate his power.

Given : m = 60kg, t = 40 s, h = 30 x 20 cm = $\left(30 \times \frac{20}{100}\right)$ m

Power $= \frac{W}{t} = \frac{mgh}{t} = \frac{60 \times 10 \times 30 \times \frac{20}{100}}{40}$

= 90W

115. An electric bulb of 100 W works for 4 hours a day. Calculate the units of energy consumed in 15 days.

Given: Power P = 100 W; Time t = 4 hours

Energy = Power x Time

= P x (No.of days) x (No.of hours)

= 100 x 15 x 4 = 6000W

= 6k Wh = 6 units

I. Short answer type questions

116. Give an example in each case where work done by a force is:

a) zero   b) positive   c) negative

a) Work done by gravity on a rolling ball

b) Hitting a stationary ball

c) Work done by friction on a rolling ball.

117. A student lifts an object in the upward direction and displaces it in that direction : (However, the force of gravity is also acting on the object)

a) State the direction in which force of gravity is action on it

b) Which one of these forces is doing positive work? Give reason

a) Downward direction

b) Applied force as force and displacement are in the same direction

c) Force of gravity as force and displacement are in opposite direction

118. a) When is the work done by a body said to be negative?

b) An object of mass 5 kg is dropped from a height of 10m. Find its kinetic energy when it is half way down.

a) Work done is said to be negative when the displacement produced in the body is in opposite direction to the force applied.

b) Mass m = 5 kg; height, h = 10 m;

g = 9.8 m/s^2

W = mgh = x 9.8 x 10 = 490 J

Half-way down, h reduced to $\frac{h}{2}$

Thus, the potential energy become half

∴ Loss in potential energy

= Gain in kinetic energy = $\frac{490}{2}$ = 245 J

119. A body of mass 5kg is thrown ? Find its potential energy when it is thrown ? Find its potential energy when it reaches at the highest point. Also find the maximum height attained by the body . (g = 10 m/s2)

Given : Mass; m=5kg : Initial velocity u = 10ms^{-1}

Kinetic energy = $\frac{1}{2}mv^2$ = $\frac{1}{2}$ x 5 x $(10)^2$ 250J

At highest point potential energy = Kinetic energy at lowest point =250J

Height attained h = $\frac{Potential\ energy}{mg}$ = $\frac{250J}{5\ kg\ x\ 10ms^{-2}}$ = 5 m

120. A force of 10N acts on a body of 2kg for 3 seconds Find the kinetic energy acquired by the body in 3 seconds.

Kinetic energy work done on the body

F = 10N

Acceleration a = $\frac{F}{m}$ = $\frac{10N}{2kg}$ = 5ms^{-2}

Displacement = s = ut + $\frac{1}{2}$at^2

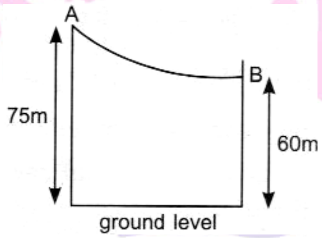
$= 0 + \frac{1}{2} \times 5 \times (3)^2 = 22.5$ m

Worked one = Fs = 10N x 22.5m = 225 J

121. a) Define 'potential energy'

b) Give an example where potential energy is acquired by a body due to change in its shape

c) A skier of mass 50 kg stands at A at the top off a A for his jump to B. Calculate the change in his gravitational potential energy between A and B



a) The energy possessed due to the position of a body is called potential energy.

b) Stretching of a bow

c) P.E. at A = mg x 75 = 75 mg

P.E. at B = mg x 60 = 60 mg

So, difference in P.E. = mg (75 – 60)

= 15 mg

= 15 x 50 x 10

= 7500 joules

= 7.5 kJ

122. A truck of mass 1800 kg is moving with a speed 54 km/h. When brakes are applied, it stops with uniform negative acceleration at a distance of 200m. Calculate the force applied by the brakes of the truck and the work done before stopping.

En Mass m = 1800 kg. Velocity

U = 54 km/h = 54 x $\frac{5}{8}$ m/s = 15 m/s = 15 m/s; v = 0;

Distance s = 200 m

Retardation, a = $\frac{v^2 - u^2}{2s} = \frac{0-(15)^2}{2 \times 200} = \frac{-9}{16}$ m/s^2

Force, F = ma = 1800 x $\left(\frac{-9}{16}\right)$

= -1012.5 N

The negative sign indicates force acts in the opposite direction to motion

Work done = $F_s = 1012.5$ x200

= 202500 J

123. a. Define kinetic energy.

b. The masses of scooter and bike are in the ratio of 2: 3 but both are moving with the same speed of 108 km/h. Compute the ratio of their kinetic energy.

a) The energy possessed by a body by virtue of its motion is called kinetic energy.

b) Kinetic energy ∝ Mass og body

Let mass of scooter = m_s = 2m

And mass of bike = m_b = 3m

$\therefore \frac{\text{Kinetic energy of scooter}}{\text{Kinetic energy } of\ bike}$

= $\frac{m_s}{m_b}$ = $\frac{2\,m}{3\,m}$ = 2: 3

124 . A care weighing 1200 kg is uniformly accelerated from rest and covers a distance of 40 m in 5 seconds. Calculate the work done by the engine of car during this time. What is the final kinetic energy of car?

Given : Mass, m = 1200kg ; Initial velocity u = 0; Displacement s = 40 m Time t = 5s

By second equation of motion,

S = ut + $\frac{1}{2}$ at^2 = 0 + $\frac{1}{2}$ at^2

Or a = $\frac{2s}{t^2}$ = $\frac{2\,x\,40}{(5)^2}$ = 3.2 ms^{-2}

Work done = Force x Displacement

= ma.s = 1200 x 3.2 x 40

= 153600 J

Final K.E. = workdone = 153600 J

125 a) An object of mass m is moving with a constant velocity v. How much work should be done on the object to bring it to rest.

b) Earth is revolving round the son. What is the work done by the gravitational force exerted by the sun on earth? Justify your answer

a) Work done is equal to the K.E. possessed by the object, i.e. $\frac{1}{2}mv^2$

b) Work doneis zero as the direction of force of attraction is perpendicular to displacement

126. A heavy ball falls on a thick bed of wet sand from different heights 50cm 1m and 2m respectively and the depressions created in the wet sand are carefully measured.

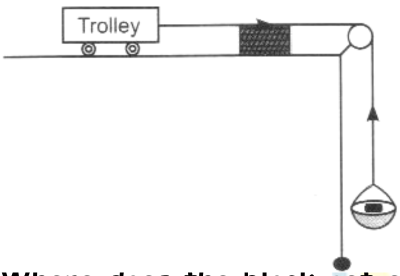
a) Which impression is the deepest and why?

b) Which impression is the shallowest and why?

The potential energy of the ball at height 2 m is maximum and that at height 50 cm is minimum.

a) The impression made when ball was dropped from 2m height is the shallowest because it transfers the least energy to wet sand.

127. A block of known mass is placed in front of a trolley as shown in the figure. When a known mass is kept on the pan, the trolley moves and hits the block and the block gets displaced



a) Where does the block get energy from?

b) If mass on pan is increased, will there be more work done?

c) What type of energy is possessed by the trolley?

a) The block gets energy because work is done on it by the moving trolley.

b) Yes more work will be done on the block as trolley moves faster

c) kinetic energy.

128. **Explain the following phenomena in the light of your understanding of energy conversions:**

a) How do green plants prepare food?

b) How does air move from place to place?

c) How are fossil fuels formed?

a) Green plants prepare food by converting light energy from the sum into chemical energy of food (in the form of sugars)

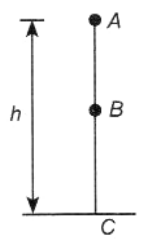
b) Thermal energy from the sun gets converted into kinetic energy of air, so convection currents are set up in air due to uneven heating of the earth by the sun

c) Fossil fuels are formed when solar energy is stored in plants as chemical energy. These remain buried in the earth over millions of years and eventually get converted into fossils.

129. With the help of an example explain the law conversation of energy.

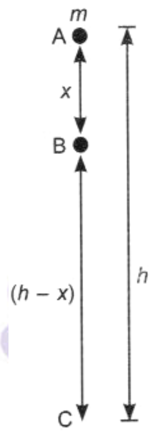
OR

State Law of Conservation of Energy and express it in the form of an equation for a body of mass m falling from a point A at height h, above the ground at (a) A, (b) B at a height from ground (c) C.



The law of conservation of energy state that energy can neither be created nor destroyed. It can only be converted from one form into another.

Consider a stone of mass m dropped from a height h



At A P.E. = mgh, K.E. = 0

∴ Total energy = mph

At B P.E. = mg (h – x)

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

Where v^2 =2gx

$\frac{1}{2}$ m x 2gx = mg$x$

Total energy mg$x$ + mg (h – x)

= mgh

Total energy = mgh

At C P.E. = 0

K.E. = $\frac{1}{2}mv^2$ = $\frac{1}{2}$ m (2gh) = mgh

Total energy = mgh

Variation of P.E. and K.E. for a body dropped from a height (h)

It does not violate the conservation of energy since total energy remains constant, law of conservation of energy holds true.

130. Define power State commercial unit and SI unit of electrical energy. An electric heater of 400 W works for 2 hours. Find the electrical energy units consumer in a day

Power of a device is defined as work done by it per unit time.

Commercial unit of energy : kilowatt hour (kWh)

SI unit of energy : joule (J)

Given : power, P = 400 W = 0.4 kW;

Time t = 2h

Energy unit consumed in a day + Pt

= 0.4 kW x 2h = 0. 8 k Wh.

131. Calculate units of electricity consumed in a month for 30 days. Also find the total expenditure if 1 unit of electricity costs Rs.1.5.

Total power consumed in 1 day

= 25 W x 5 bulbs = 125W = 0.125 kW

Hours for which bulbs work in 30 days

= 6 hours x 30 days = 180 hours

Electrical consumed = Power x Time

= 0.125 kW x 180 h = 22.5 units

∵ Cost of 1 unit = Rs .1.5

$\therefore$ Cost of 22.5 units = 22.5 x Rs.1.5 = Rs33.75

132. A lamp consumes 500J of electrical energy in 20 seconds. What is the power of the lamp? Also find the electrical energy consumed in units if the lamp operates for 2 hours daily for 15days.

Energy consumed., E = 500 J; Time t = 20s

P= $\frac{E}{t}$ = $\frac{500 J}{20\ s}$

= 25 W = 0.025 kW

Total time in 15 days at the rate 2h/day

= t =15 x 2 = 30 h

Number of units consumed = Pt = 0.025 x 30 = 0.750 units

133. a) A moving body of mass 20 kg climbs 4 min 10 seconds. Calculate the work done and his power . (g = 10 m/s^2)

a) Given : Mass m= 20kg; kinetic energy E_k = 40J;

Speed, v = $\sqrt{\frac{2\,E_k}{20}}$ = $\sqrt{\frac{2 \times 40}{20}}$

= 2 m/s

b) Given: Mass m= 20kg; Height, h = 4m

Time t = 10s; g = 10 ms^{-2}

Workdone, W = mgh

= 20 x 10 x 4 = 800 j

And P = = $\frac{W}{t}$ = $\frac{800}{10}$ = 80 W

134. a) Give one situation where force is applied but no work is done. Explain why

b) A pump is used to raise water to a height of 20 m.. It transfers 2000 kg of water in 15 minutes. Calculate power of the pump. [g= 10 ms^{-2}]

a) When a body moves along a circular path, work done is zero but force is not zero.

b) Given ; m = 2000 kg; t = 15 minutes = 15 x 60 =900s, h = 20m

P = $\frac{mgh}{t}$ = $\frac{2000 \times 10 \times 20}{15 \times 60}$ = $\frac{2 \times 10^4}{45}$

= 4.44 x 10^2 W = 0.444 kW

135. Water is falling on the blades of a turbine at the rate of 8×10^2 kg per minute, height of fall is 50 m. Calculate 10 m/s^2te the power given to turbine. [g= 10 m/s^2]

Given ; h = 50 m, g = 10 m/s^2, m = 8 x $10\ m/s^2$ m =8 x 10^2 kg t= 1 min = 60s

$\therefore$ P = $\frac{1}{2}$ = $\frac{8 \times 10^2 \times 10 \times 50}{60}$

= 6.67 x 10^3W

136. A force applied on a body of mass 4 kg for 5 seconds changes its velocity from 10 m/s to 20 m/s. Find the power required.

Given m = 4 kg t =5s, u = 10 m/s

V = 20 m/s

W = $\frac{1}{2}$m $(v^2 - u^2)$

= $\frac{1}{2}$ x 4 x (400 – 100)

= 600J

Power = $\frac{W}{t}$ = $\frac{600J}{5s}$

= 120W.

137. Calculate the electricity bill amount for a month of April if 4 bulbs of 40 W for 5hrs, 4 tube lights of 60 W for 5 hrs, a T.V. of 100 W for 6 hrs, a washing machine of 400 w for 3 hrs are sued per day. The cost per unit is Rs. 1.80

Energy consumed (kWh) = Power (kW) x Time (h)

S. No.	Item	Wattage	Number	Power	In kW	Time	Energy (units)
1	Bulb	40W	4	40 x4=160W	0.16kW	5h	0.16x5=0.8 unit
2	Tube lights	60W	4	60 x4=240W	0.24kW	5h	0.24x5=1.20 unit
3.	TV	100W	1	100 W	0.1 kW	6h	0.1 x 6 = 0.6 unit
4.	Washing machine	400 W	1	400 W	0.4 kW	3 h	0.4 x 3 = 1.2 unit

Electricity consumer in 1day = 0.8 + 1.20 + 0.6 + 1.20 = 3.8 units

Electricity consumed in 30 days = 3.8 x 30 = 114 units

Cost per unit = Rs.1.80

Total cost = 114 s 1.80 = Rs.205.2

138. Two women Shanti and Kamala each of mass 50 kg and 60 kg respectively climb up through a height of 10 m. Shanti takes 20 s while Kamala takes 40s to reach. Calculate the difference in the power expended by Shanti and Kamla.

(Assuming g = 10 ms^{-2})

$\because$ P = $\frac{mgh}{t}$

Power of Shanti = P_{sh} = $\frac{50 \times 10 \times 10}{20}$

= 250 watt

Power of Kamla = P_k = $\frac{60 \times 10 \times 10}{40}$ = 150 watt

Difference in power expended = 250 – 150 = 100W

139. A lamp consumes 500J of electrical energy in 20 seconds. What is the power of the lamp? Also find the electrical energy consumed in units if the lamp operates for 2 hours daily for 15 days.

Given : Energy = 500J Time = 20 s

Power = $\frac{Energy}{Time}$ = $\frac{500J}{20S}$

= 25W

Total time for 15 days at the rate 2 h per day

= 15 x 2 =30 h

Power = 25 W = 0.025 kW

Units of energy consumed

= Pt = 0.025 x 30

= 0.750 kWh = 0.75 units.

140. Write the form of energy possessed by the body in the following situation:

a) a coconut falling from tree

b) an object raised to a certain height

c) blowing wind **d) A child driving a bicycle on road**

a) Kinetic energy b) Potential energy

c) Kinetic energy d) Kinetic energy

141. Derive an expression for kinetic energy of an object and also give its SI unit

a) The energy possessed by a body by virtue of its motion is called Kinetic energy.

b) Work done = Force x Displacement or W = Fs

By second law of motion F = ma

By third law of motion s = $\frac{v^2 - u^2}{2a}$

For u = 0, s = $v^2/2a$

∴ W = Fs = ma x $v^2/2a$

Or K.E. W = $^1/_2 mv^2$

Its SI unit is joule

142. Derive an expression for potential energy of a body.

Work done = Force x Displacement

Weight of body = F = mg

Displacement = height to which a body is raised = h

∴ W =Fs = mg x h = mgh

Or P.E. = mgh

143. A body of mass 2 kg is thrown up with a speed of 25 m/s. Find its maximum potential energy.

Given : Mass, m = 2 kg; Initial Velocity

U = 25 ms^{-1}; Final velocity v = 0

G = - 9.8 ms^{-2}

Height to which mass rises,

h = $\frac{v^2 - u^2}{-2g}$ = = $\frac{0 - (25)^2}{2 \times (-9.8)}$ = $\left(\frac{625}{19.6}\right)$m

Maximum potential energy, E_p = mgh

= 2 x 9.8 x $\frac{625}{19.6}$ = 625 J

144. In what form is energy possessed by a) water stored in a dam

b) a stretched bow c) a raised bat and d) a running horse?

a) Potential energy b) Potential energy

c) Potential energy d) Kinetic energy

145. 16 bulbs of 40W are used for 6 hours a day along with one 100W bulb for 2 hours. Calculate the 'units' of energy consumed in one day by all bulbs.

Energy consumed by 40 W bulbs

= 16 x 40 x 6 = 3840 Wh

Energy consumed by 100 W bulbs

= 1 x 100 x 2 = 200 Wh

Total energy consumed in a day by all bulbs

= 4040 Wh or 4.04 kWh

= 4.04 units

I. Long answer type questions

146. What do you mean by work? Give an example of negative work done. What is the work to be done to increase the velocity of a car from 18 km/h to 90km/h if the mass of the car is 2000kg.

Work is said to be done if an applied force displaces an object in its own direction

Example of negative work : When an object is sliding on a surface, work done by force of friction id negative.

Given : m = 2000kg, u = 18 km/h = 5 m/s, v= 90 km/h = 25 m/s

Work done to increase velocity,

W = $\frac{1}{2}$ m (v^2 - u^2) = $\frac{1}{2} \times 2000\,(25^2 - 5^2)$

= 1000 (625-25) = 6 x 10^5 J.

147 a) Define work. Give SI unit of work. Write an expression for positive work done.

b) Calculate the work done in pushing a cart through a distance of 50m against the force of friction equal to 250 N. Also state the type of work done.

c) Sarita lives on 3rd floor of building at the height of 15m. She carries her school bag weighting 5.2 kg from the ground floor to her house. Find the amount of work done by her and identity the force against which she has done work (g=10ms^{-2})

a) Work is said to be done if an applied force displaces a body in its own direction.

Its SI unit is joule(J)

Positive work done W = F.s.

Where F = force ; s = displacement is direction of force.

b) Given : Distance, s = 50m; Force, f = 250 N (opposite to direction of friction)

Work, W =F.s. = 250N x50 m = 12500 J

Work done = mgh = 5.2 kg; g= 10ms^{-2}

Height h =15 m

Work done = mgh = 5.2 x 10x 15 = 780 J

Work is done against the force of gravity acting on the bag.

148 a) Define kinetic energy of an object. Can kinetic energy of an object be negative ? Give reason.

b) A car weighing 1200 kg is uniformly accelerated from rest and covers a distance of 40m in 5 seconds. Calculate the work, the car engine had to do during this time

a) The energy possessed by an object by virtue of its motion is called kinetic energy.

Consider a mass m moving with a speed u and a force F applied on it, which changes its velocity of v on displacing by s.

Work done, W = ms$\left(\frac{v^2 - u^2}{2a}\right)$

[∵ W = Fs)

So, W = $\frac{1}{2}$ m $(v^2 - u^2)$

If initial velocity, u is zero

Then $W = \frac{1}{2} mv^2$

Or $K.E. = \frac{1}{2} mv^2$

K.E. cannot be negative as it has all positive quantities. It is a scalar quantity, so no direction is taken into consideration.

b) Given: m= 1200 kg, s = 40 m, r= 5 s

Using $s = ut + \frac{1}{2}at^2$ and u =0,

We get $a = \frac{2s}{t^2} = \frac{2\times40}{(5)^2} = \frac{80}{25} \times 40\ m/s^2$

Work done = F.s. = ma x s

$= 1200 \times \frac{80}{25} \times 40$

= 153600 joule =153.6 kJ

149. Justify that " a body at greater height has larger energy".

a) A body of mass 2 kg is thrown up at a velocity of 10 m/s. Find the kinetic energy of the body at the time of throw. Also, find the potential energy of the body at the highest point. The value of g = $10 m/s^2$.

a) Potential energy = mgh

$\therefore$ Potential energy $\propto$ h

Or greater the height of the body, more is its potential energy.

b) Given: m = 2kg, v = 10 m/s

Kinetic energy $= \frac{1}{2} mv^2 = \frac{1}{2} \times 2 \times (10)^2$

= 100 J

At highest point v = 0

$\therefore$ K.E. = 0

Thus, potential energy = 100 J

Because energy is conserved and K.E. gets converted to PE

150. a) Give reason for the following :

i) The kinetic energy of a freely falling object increases, yet it holds law of conservation of energy.

ii) A girl fill sup 10 pages of a notebook in order to practise sums, yet she has not done 'work' in terms of Science / Scientific concept

iii) Work, done by gravitational force on an object moved along a horizontal path is zero

b) Find the energy in kWh consume din 24 hours by two electric devices, one of _100 W and other of 500W.

a) i) The kinetic energy gained is due to loss in P.E. so the conservation of energy holds good. Gain in K.E. = Loss in P.E.

ii) Work done is zero as force applied by girl has not displaced the pages from its place.

Since displacement = 0, so work = 0.

iii) Because gravitational force is perpendicular to displacement.

b) Energy consumed by two electric devices

$= p_1 t_1 + p_2 t_2$

= [100 x 24 + 500 x 24]

= [100 + 500] x 24

= 600 x 24 = 14400 Wh

= 14.4 kWh.

151. a) State the principle of conservation of energy. What are the various energy transformations that occur when you are riding a bicycle?

b) A body of mass 25 g has a momentum of 0.40 kg m/s. Find its kinetic energy.

a) Energy can neither be created nor destroyed. It can only be transformed from one form to another.

While riding a bicycle, following energy transformations take place:

Muscular energy of rider → Kinetic energy of bicycle

b) Given : m = 25g = 0.025kg

p = 0.40 kg m/s

Kinetic energy = $\frac{p^2}{2m} = \frac{(0.40)^2}{2 \, x \, 0.025}$ = 3.2 J

152. What is meant by energy? How is energy related to work done? A person pushed a wall and fails to move its. What is the work done? Why does he get tired?.

A body possessing energy applied a force and moves an object in the direction of force. Energy and work are related as energy is nothing but capacity of an object to do work.

The person does zero work because there is no displacement in the wall, so work done is zero. He gets tired because he has expended energy in the form of muscular contractions, some heat etc.

153. a) Two bodies of equal masses move with uniform velocities v and 3v respectively. Find the ratio of their kinetic energies.

b) Define power. An electric heater is rated 1500 W. How much energy does it use in 10 h? Express your answer in (i) kWh (ii) joules.

a) Kinetic energy $\propto v^2$

$\therefore$ For energies KE_1 and KE_2

$$\frac{KE_1}{KE_2} = \frac{v_1^2}{v_2^2} = \frac{v^2}{(3v)^2} = \frac{v^2}{9v^2}$$

$$\therefore \frac{KE_1}{KE_2} = \frac{1}{9}$$

b) Power is defined as work done by an object per unit time

Given : P = 1500 W = 1.5 k W, t = 10 h

i) E = P_t = 1.5 x 10 = 15 k Wh

ii) 1 kWh = 3.6 x 10^6J

15 kWh = 15 x 3.6 x 10^6 J

= 5.40 x 10^7 J

154. a) A ball thrown vertically upwards returns to the thrower. How do the kinetic and potential energies of the ball change?

b) Calculate the power of a pump which lifts 100 kg of water to a water tank placed at a height of 20 m in 10s. (Given g = $10\, ms^{-2}$)

a) The law of conservation of energy state that energy can neither be created nor destroyed. It can only be converted from one form into another.

Consider a stone of mass m dropped from a height h

At A P.E. = mgh, K.E. = 0

$\therefore$ Total energy = mph

At B P.E. = mg (h – x)

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

Where v^2 =2gx

$\frac{1}{2}$ m x 2gx = mg$x$

Total energy mg$x$ + mg (h – x)

= mgh

Total energy = mgh

At C P.E. = 0

K.E. = $\frac{1}{2}mv^2$ = $\frac{1}{2}$ m (2gh) = mgh

Total energy = mgh

Variation of P.E. and K.E. for a body dropped from a height (h)

Pict

It does not violate the conservation of energy since total energy remains constant, law of conservation of energy holds true.

Loss in kinetic energy = Gain in potential energy

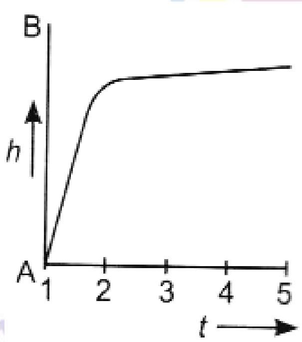
b) Given : m = 100 kg, h = 20 m, t = 10s

P = $\frac{mgh}{t}$ = $\frac{100\ x\ 10\ x\ 20}{10}$

= 2000 watt = 2kW

155. Read the graph depicting change in height of an object with time.

a) Explain the changes in components of total mechanical energy with reasons



b) Find the velocity with which the object is projected.

c) Find the maximum height achieved by the stone if it takes 4s to reach that height.

d) Find out the maximum P.E. of the stone if its mass is 200g

a) Mechanical energy remains constant. Kinetic energy constantly reduces but potential energy increases.

b) From graph, t = 4 s.v. = 0, g = - 10ms^{-2}

u = v - gt = 0 - $(-10)^4$ = 40 ms^{-1}

c) h = $\frac{v^2 - u^2}{2g}$ = $\frac{(0.40)^2}{2 \times (-10)}$ = 80 m

d) Given : m = 200g = 0.2 kg

∴ P.E. = mgh

P.E. = 0.2 x 10 x 80 = 160 J

156 a) Define 1 kWh

b) A crane is lifting a body to a height h in time t. Find the relation between the power of crane to he speed at which it is lifting the object.

c) If an electric iron of 1600W is used for 45 minutes everyday,. Find the electric energy consumed in the month of March.

a) Energy consumed by a device is 1kWh if a device of power 1 kW is operated for 1 h

b) Power = $\frac{workdone}{Timetaken}$

If mass = m, height = h, work done = mgh

∴ P = $\frac{mgh}{t}$ = mg $\left(\frac{h}{t}\right)$

If speed at which body is lifted , v = $\frac{h}{t}$

(i.e. $\frac{Distance}{Time)}$

Force = F = mg

Then, power = (mg) $\left(\frac{h}{t}\right)$ = mg v = F.v

i.e. P = mg v = F v

c) P = 1600 W = 1.6 kW t = 45 = $\frac{45}{60}$ h

Time of consumption in March i.e. 31 days

= T = $\left(\frac{45}{60} \times 31\right)$h

Energy consumed = PT = 1.6 x $\frac{45}{60}$ x 31

= 37.2 units.

157. a) List two conditions which need to be satisfied for the work tobe done on an object.

b) Given below are a few situations. Study them and state in which of the given cases work is said to be done. Give reasons for your answer.

i)A person pushing hard a huge rock but the rock does not move.

ii) A bullock pulling a cart upto 1 km on road.

iii) A girl pulling a trolley for about 2 m distance.

iv) A person standing with a heavy bag on his head.

a) i) A force should act on the object.

ii) There should be a displacement in the object

b) i) Work done is zero as displacement is zero.

ii) Positive work done

iii) Positive work done

iv) Work done is zero as displacement is zero.

NCERT EXEMPLER

I. Short answer type questions

1. Avinash can run with a speed of 8ms^{-1} against the frictional force of 10N, and Kapil can move with a speed of 3ms^{-1} against the frictional force of 25N. Who is more powerful and why?

Power of Avinash P_1 = $F_1.v_1$ = 10 x 8 = 80 watt

Power of Kapil, P_2 = $F_2.v_2$ = 25 x 3 = 75 watt

So, Avinash is more powerful the kapil

2. Can any object have mechanical energy even i its momentum is zero? Explain

Yes, when a body is thrown up. P.E.(in the form of mechanical energy) is non-zero at the highest point of a projectile, even if K.E. is zero due to zero velocity.

3. Can any object have momentum even if its mechanical energy is zero? Explain.

No. as zero energy means both P.E. and K.E. are zero. This makes velocity as well as momentum zero.

4. The power of a motor pump is 2kW. How much water per minute the pump can raise to a eight of 10m? (g= 10ms^{-2})

As m is raised to height 'h'

P.E. gained = mgh

Power, P = $\frac{workdone}{Time}$ = $\frac{mgh}{t}$

Thus, $\frac{m}{t}$ = $\frac{P}{gh}$ = $\frac{2 \times 10^3}{10 \times 10}$ = 20kg /s

∴ Mass of water pumped per minute

= 20 x 60 = 1200 kg

5. The weight of a person on a planet A is about half that on the earth. He can jump upto 0.4m height on the surface of the earth. How high he can jump on the planet A?

By the law of conservation of energy

mg_1h_1 = mg_2h_2

[Where, g_1 = force of gravity on earth,

g_2 = force of gravity on planet A]

As g_2 = $\frac{g^1}{2}$ $\Longrightarrow h_2$ = $2h_1$

Therefore, the height on the earth. He can jump upto 0.4 =0.8m

6. The velocity of a body moving in a straight line is increased by applying a constant force F, for some distance in the direction of the motion. Prove that the increase in the kinetic energy of the body is equal to the work done by the force on body.

Workdone = F.S. = ma.s = m $\left(\frac{v^2 - u^2}{2}\right)$

$[\because v^2 = u^2 + 2as]$

$\frac{1}{2}$ mv^2 - $\frac{1}{2}$ mu^2 = change in K.E.

7. Is it possible that an object is in the state of accelerated motion due to external force acting on it, but no work is being done by the force? Explain it with an example.

Yes, it is possible. As the body moves in a circle it experiences centripetal acceleration towards the centre and the displacement is along the tangent at any point of the circle. Since force and displacement are perpendicular, work done is zero.

8. A ball is dropped from a height of 10m. If the energy of the ball reduces by 40% after striking the ground, how much high can the ball bounce back? (g = 10ms^{-2})

40% of the initial energy is lost. So the ball will bounce back with $\frac{1}{6}^{th}$ of the initial height with the remaining 60% energy i.e. 6 m

I. Long answer type questions

9. A light object and a heavy object have the same momentum. Find out the ratio of their kinetic energies. Which one has a larger kinetic energy?

K.E. = $\frac{1}{2}$ mv^2 = $\frac{1p^2}{2\,m}$ where p = mv

When momentum is same $\frac{(K.E.)_1}{(K.E.)_H}$ = $\frac{m_h}{m_1}$

Lighter mass will have larger kinetic energy.

10. A girl having mass of 35 kg sits on a trolley of mass 5 kg. The trolley is given an initial velocity of $4ms^{-1}$ by applying a force. The trolley comes to rest after travelling a distance of 16 m

a) How much work is done on the trolley?

b) How much work is done by the girl?

Given : u = $4ms^{-1}$, v=0, s = 16m

$\therefore$ a = $\frac{v^2 - u^2}{2s}$= $\frac{0-16}{2 \times 16}$ =- $\frac{1}{2}$ ms^{-2}

(Neglecting –ve sign)

W = Fs = mas= (35 + 5) $\frac{1}{2}$ x 16

=20 x 16 = 320 joule

So, (a) 320 joule of work is done on the trolley (b) work done by the girl is zero.

11. Four men lift a 250kg box to height of 1 m and hold it without raising or lowering it.

a) How much work done they do in just holding it?

b) How much work do they in just holding it?

c) Why do they get tired while holding it?

(g = $10ms^{-2}$)

a) Workdone in lifting = mgh

= 250 x 10 x 1

= 2500 joule

b) Work done is zero as displacement is zero

c) Muscular energy is used up in holding. So, they get tired on just holding.

12. What is power? How do you differentiate kilowatt from kilowatt hour? The Jog Falls in Karnataka state are nearly 20 m high. 2000 tonnes of water falls from it in a minute. Calculate the equivalent power if all this energy can be utilized.

(g = $10ms^{-2}$)

Power is the rate of doing work. Kilowatt is a unit for power while kilowatt hour is a unit for electrical energy consumed

M = 2000 x 10^3 kg, h = 20 m

T = 1 min = 60 s

Power of falling water

= $\frac{mgh}{t}$ = $\frac{2000\times10^3\times10\times 20}{60}$

= 6.67 x 10^6 W or 6.67 MW

13. How is the power related to the speed at which a body can be lifted? How many kilograms will a man working at the power of 100W, be able to lift at constant speed of 1 ms^{-2} vertically? (g = 10ms^{-2})

Power = Force x velocity or P = Fv

P = 100 W and v = 1ms^{-1}.

F = $\frac{P}{v}$ = 100 N

F = mg or m = F/g = 100 N/10 ms^2 = 10 kg

Therfore10kg can be lifted by a man

14. Compare the power at which each of the following is moving upwards against the force of gravity

a) a butterfly of mass 1.0g that files upward at a rate of 0.5 ms^{-1}

b) a 250g squirrel climbing up on a tree at a rate of 3-0.5 ms^{-1}

a) Since, P = Fv = mgv

Given : m = 1 g = 10^{-3}kg, v = 0.5 ms^{-1}

Power of butterfly = 10^{-3} x 10 x 0.5

= 5 x 10^{-3} = 0.005 watt

b) Given m = 250 g = 250 x 10^{-3}kg v = 0.5 ms^{-1}

Power of squirrel = 250 x 10^{-3} x 10 x 0.5

= 1250x 10^{-3} = 1.25 watt

Therefore, power of the squirrel is more than that of butterfly.

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