CBSE

WORK ENERGY AND POWER WS 8

Class 11 - Physics

Section A

1. A block of mass m falls through a height h on a spring of spring constant k. The maximum displacement in the spring is **[1]**

   a) none of these
   b) $\frac{mg}{k}$
   c) $\sqrt{\frac{2mgh}{k}}$
   d) $\frac{2mgh}{k}$

2. Two similar springs P and Q have spring constants K_P and K_Q, such that $K_P > K_Q$. They are stretched, first by the same amount (case a), then by the same force (case b). The work done by the springs W_P and W_Q are related as, in the case (a) and case (b), respectively **[1]**

   a) $W_P > W_Q$; $W_Q > W_P$
   b) $W_P = W_Q$; $W_P > W_Q$
   c) $W_P = W_Q$; $W_P = W_Q$
   d) $W_P < W_Q$; $W_Q < W_P$

3. If a spring extends by x on loading, then the energy stored by the spring is (if T is tension in the spring and k is spring constant) **[1]**

   a) $\frac{T^2}{2x}$
   b) $\frac{2T^2}{k}$
   c) $\frac{T^2}{2k}$
   d) $\frac{2k}{T^2}$

4. When a spring is stretched by a distance x, it exerts a force given by $F = (-5x - 16x^3)$ N. The work done, when the spring is stretched from 0.1 m to 0.2 m, is **[1]**

   a) 8.7×10^{-2} J
   b) 8.1×10^{-2} J
   c) 12.2×10^{-1} J
   d) 12.2×10^{-2} J

5. Physically, the notion of potential energy is applicable only to: **[1]**

   a) The class of forces where work done against the force gets converted to thermal energy
   b) The class of forces where work is done against the force gets dissipated
   c) The class of forces where work is done against the force gets converted to kinetic energy
   d) The class of forces where work is done against the force gets stored up as energy.

6. Two springs of spring constant 1500 $\frac{N}{m}$ and 3000 $\frac{N}{m}$ respectively are stretched with a same force. Their potential energies will be in the ratio of **[1]**

   a) 1 : 2
   b) 4 : 1
   c) 1 : 4
   d) 2 : 1

7. The dimension of k in the equation $W = \frac{1}{2}\ kx^2$ is **[1]**

a) $[M^1L^0T^{-2}]$

b) $[M^1L^1T^{-2}]$

c) $[M^1L^0T^{-1}]$

d) $[M^0L^1T^{-1}]$

8. Two springs A and B having spring constants k_A and k_B ($k_A = 2\ k_B$) are stretched by applying force of equal magnitude. If the energy stored in spring A is E_A, then the energy stored in B will be **[1]**

a) $\frac{E_A}{2}$

b) 4 E_A

c) 2 E_A

d) $\frac{E_A}{4}$

9. You are asked to design spring bumpers for the walls of a parking garage. A freely rolling 1200-kg car moving at 0.65 m/s is to compress the spring no more than 0.090 m before stopping. What should be the force constant of the spring? Assume that the spring has negligible mass. **[1]**

a) 5.3×10^4 N/m

b) 5.8×10^4 N/m

c) 6.6×10^4 N/m

d) 6.25×10^4 N/m

10. A spring 40 mm long is stretched by the application of a force. If 10 N force is required to stretch the spring through 1 mm, then work done in stretching the spring through 40 mm is **[1]**

a) 23 J

b) 8 J

c) 68 J

d) 84 J

11. A block having a mass of 0.80 kg is given an initial velocity of 1.2 m/s to the right and collides with a spring of negligible mass and force constant k = 50 N/m. Assuming the surface to be frictionless, calculate the maximum compression of the spring after the collision. **[1]**

a) 0.15 m

b) 0.20 m

c) 0.10 m

d) 0.25 m

12. The work done in stretching a spring of force constant k from length l_1 to l_2 is **[1]**

a) $\frac{k}{2}$ ($l_2 + l_1$)

b) k($l_2 - l_1$)

c) $k\left(l_2^2 - l_1^2\right)$

d) $\frac{1}{2}k\left(l_2^2 - l_1^2\right)$

13. The potential energy of a long spring when stretched by 2 cm is U. If the spring is stretched by 8 cm, the potential energy stored in it is **[1]**

a) $\frac{U}{4}$

b) 16U

c) 8U

d) 4U

14. **Assertion (A):** Fault lines in the earth's crust are like compressed springs. **[1]**
Reason (R): Compressed springs possess a large amount of kinetic energy.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

15. **Assertion (A):** Two springs of force constants k_1 and k_2 are stretched by the same force. If $k_1 > k_2$, then work done in stretching the first (W_1) is less than work done in stretching the second (W_2). **[1]**

Reason (R):$F = k_1x_1 = k_2x_2$

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

16. **Assertion:** A heavy weight is suspended from a light spring. A person raises the weight slowly till the spring become slack. The gain in gravitational potential energy of weight is equal to the work done by person plus the energy lost by stretched spring. **[1]**

Reason: Work done by the spring force is always negative.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

17. **Assertion (A):** If two protons are brought near one another, the potential energy of the system will increase. **[1]**

Reason (R): The charge on the proton is $+1.6 \times 10^{-19}$ C.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

18. **Assertion:** A spring has potential energy, both when it is compressed or elongated. **[1]**

Reason: In compressing or stretching, work is done on the spring against the restoring force.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

19. **Assertion (A):** Graph between potential energy of a spring versus the extension or compression of the spring is a straight line. **[1]**

Reason (R): Potential energy of a stretched or compressed spring is proportional to square of extension or compression.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

20. **State True or False:** **[1]**

(a) The work done by the spring force in a cyclic process is zero. **[1]**

21. **Fill in the blanks:** **[1]**

(a) Two springs A and B are identical except that A is stiffer than B. If they are stretched by the same amount, then the work expended in spring A is _____ than in spring B. **[1]**

22. What kind of energy is stored in the spring of a watch? **[1]**

23. An object is attached to a vertical spring and slowly lowered to its equilibrium position. This stretches the spring by a distance d. If the same object is attached to the same vertical spring but permitted to fall freely, through **[1]**

what distance does it stretch the spring?

24. Springs A and B are identical except that A is stiffer than B. In which spring is more work expended if they are stretched by the same force? **[1]**

25. What is the spring constant of a spring? Give its S.I. unit. **[1]**

26. Springs A and B are identical except that A is stiffer than B, i.e., force constant $k_A > k_B$. In which spring is more work expended if they are stretched by the same amount? **[1]**

27. A 16 kg block moving on a frictionless horizontal surface with a velocity of 5 ms^{-1} compresses an ideal spring and comes to rest. If the force constant of the spring be 100 Nm^{-1}, then how much is the spring compressed? **[1]**

28. What kind of energy transformations takes place at a hydro-electric powerhouse? **[1]**

29. Can a body have energy without momentum? **[1]**

30. A spring gun has a spring constant of 80 N cm^{-1}. The spring is compressed 12 cm by a ball of mass 15 g. How much is the potential energy of the spring? If the trigger is pulled, what will the velocity of the ball be? **[1]**

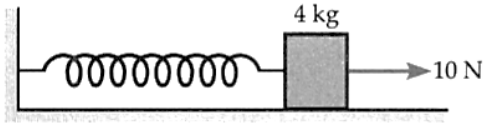
31. Does the potential energy of a spring decrease or increase when it is compressed or stretched? **[1]**

Section B

32. A spring balance reads forces in newtons. The scale is 20 cm long and read from 0 to 60 N. Find potential energy of spring when the scale reads 20 N. **[2]**

33. A vertical spring with constant 200 N/m has a light platform on its top. When a 500 g mass is kept on the platform spring compresses 2.5 cm. Mass is now pushed down 7.50 cm further and released. How far above later position will the mass fly? (g = 10 ms^{-2}). **[2]**

34. The spring shown in Fig. has a force constant of 24 Nm^{-1}. The mass of the block attached to the spring is 4 kg. Initially, the block is at rest and the spring is unstretched. The horizontal surface is frictionless. If a constant horizontal force of 10 N is applied on the block, then what is the speed of the block when it has been moved through a distance of 0.5 m? **[2]**



35. The length of a steel wire increases by 0.5 cm when it is loaded with a weight of 5 kg. Calculate, **[2]**

    i. force constant of the wire and

    ii. work done in stretching the wire.

36. Derive an expression for the potential energy of an elastic stretched spring. **[2]**

37. Two springs have force constants k_1 and k_2 ($k_1 > k_2$). On which spring is more work done, if **[2]**

    i. they are stretched by the same force and

    ii. they are stretched by the same amount?

38. A block of mass 2 kg is dropped from a height of 40 cm on a spring whose force-constant is 1960 Nm^{-1}. What will be the maximum distance x through which the spring is compressed? **[2]**

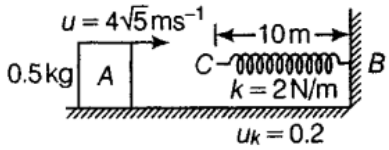
39. A man weighing 50 kg supports a body of 25 kg on his head. What is the work done when he moves a distance of 20 m up an incline of 1 in 10? Take g= 9.8 m /s^2. **[2]**

Section C

40. A 0.5 kg block slides from the point A on a horizontal track with an initial speed $4\sqrt{5} ms^{-1}$ towards a weightless horizontal spring of length 10 m and spring constant 2 N/m. **[3]**

    The initial track is frictionless and part BC under the unstretched length of spring has coefficient of kinetic

friction μ_k = 0.2, Calculate total distance by which the block move before coming finally to rest. (g=10 ms^{-1}).



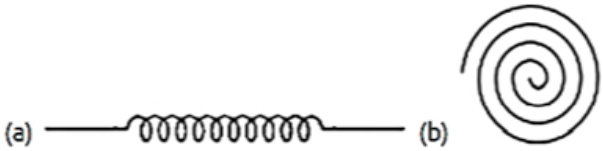
41. A long spring of spring constant 500 N/m is attached to a wall horizontally and surface below the spring is rough with coefficient of friction 0.75. A 100 kg mass block moving with a speed $10\sqrt{2}ms^{-1}$ strikes the spring. Find the maximum compression of the spring. (g =10 ms^{-2}). **[3]**

42. A massless platform is kept on a light elastic spring. When a sand particle of mass 0.1 kg is dropped on the pan from a height of 0.24 m, the particle strikes the pan, and the spring compresses by 0.01 m. From what height should the particle be dropped to cause a compression of 0.04 m? **[3]**

Section D

Question No. 43 to 46 are based on the given text. Read the text carefully and answer the questions: **[4]**

There are many types of spring. Important among these are helical and spiral springs as shown in the figure.

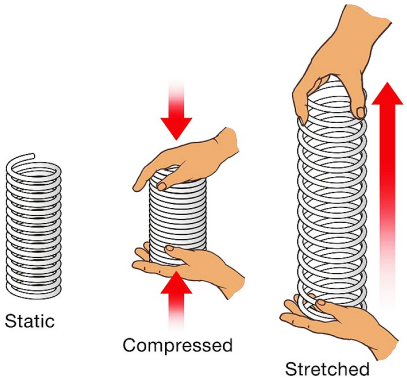


Usually, we assume that the springs are massless. Therefore, work done is stored in the spring in the form of the elastic potential energy of the spring. Thus, the potential energy of a spring is the energy associated with the state of compression or expansion of an elastic spring.

43. When the potential energy of a spring may be considered as zero?
44. The ratio of spring constants of two springs is 2 : 3. What is the ratio of their potential energy, if they are stretched by the same force?
45. The potential energy of a spring increases by 15 J when stretched by 3 cm. If it is stretched by 4 cm, What will be the increase in potential energy?
46. The potential energy of a spring when stretched through a distance x is 10 J. What is the amount of work done on the same spring to stretch it through an additional distance x?

Question No. 47 to 50 are based on the given text. Read the text carefully and answer the questions: **[4]**

Elastic potential energy is Potential energy stored as a result of the deformation of an elastic object, such as the stretching of a spring. It is equal to the work done to stretch the spring, which depends upon the spring constant k as well as the distance stretched



47. If stretch in spring of force constant k is doubled, then what will be the ratio of final to initial forces?
48. A light body and a heavy body have the same kinetic energy. which one has greater linear momentum and why?
49. A spring is cut into two equal halves. How is the spring constant of each half affected?

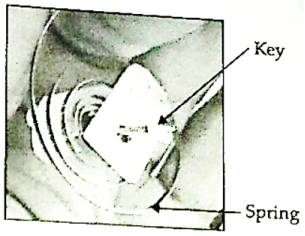
50. When spring is compressed, what happens to its potential energy?

Question No. 51 to 54 are based on the given text. Read the text carefully and answer the questions: **[4]**

Clockwork refers to the inner workings of mechanical clock or watch (where it is known as "movement") and different types of toys which work using a series of gears driven by a spring. Clockwork device is completely mechanical and its essential parts are:

- A key (or crown) which you wind to add energy
- A spiral spring in which the energy is stored
- A set of gears through which the spring's energy is released. The gears control how quickly (or slowly) a clockwork machine can do things. Such as in mechanical clock/watch the mechanism is the set of hands that sweep around the dial to tell the time. In a clockwork car toy, the gears drive the wheels.

Winding the clockwork with the key means tightening a sturdy metal spring, called the mainspring. It is the process of storing potential energy. Clockwork springs are usually twists of thick steel, so tightening them (forcing the spring to occupy a much smaller space) is actually quite hard work. With each turn of the key, fingers do work and potential energy is stored in the spring. The amount of energy stored depends on the size and tension of the spring. Harder a spring is to turn and longer it is wound, the more energy it stores.



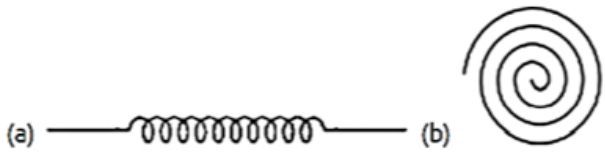
While the spring uncoils, the potential energy is converted into kinetic energy through gears, cams, cranks and shafts which allow wheels to move faster or slower. In an ancient clock, gears transform the speed of a rotating shaft so that it drives the second hand at one speed, the minute hand at $\frac{1}{60}$ of that speed, and the hour hand at $\frac{1}{3600}$ of that speed. Clockwork toy cars often use gears to make themselves race along at surprising speed.

51. What type of energy is stored in the spring while winding it?
52. When the spring of a clockwork uncoils, how the potential energy of spring changes?
53. Which instrument transform the speed of a rotating shaft to drive wheels slower or faster?
54. The amount of energy stored in a spring depends on which factor?

Section E

Question No. 55 to 59 are based on the given text. Read the text carefully and answer the questions: **[5]**

There are many types of spring. Important among these are helical and spiral springs as shown in the figure.



Usually, we assume that the springs are massless. Therefore, work done is stored in the spring in the form of the elastic potential energy of the spring. Thus, the potential energy of a spring is the energy associated with the state of compression or expansion of an elastic spring.

55. The potential energy of a spring increases in which of the following cases?

a) If work is done against conservative force
b) If work is done by non-conservative force
c) If work is done by conservative force
d) If work is done against non-conservative force

56. The potential energy, i.e. U(x) can be assumed zero when

a) gravitational force is constant
b) x = 0
c) infinite distance from the gravitational source
d) All of these

57. The ratio of spring constants of two springs is 2 : 3. What is the ratio of their potential energy, if they are stretched by the same force?

a) 3 : 2
b) 9 : 4
c) 2 : 3
d) 4 : 9

58. The potential energy of a spring increases by 15 J when stretched by 3 cm. If it is stretched by 4 cm, the increase in potential energy is

a) 36 J
b) 30 J
c) 27 J
d) 33 J

59. The potential energy of a spring when stretched through a distance x is 10 J. What is the amount of work done on the same spring to stretch it through an additional distance x?

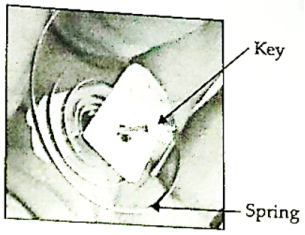
a) 40 J
b) 10 J
c) 30 J
d) 20 J

Question No. 60 to 64 are based on the given text. Read the text carefully and answer the questions: **[5]**

Clockwork refers to the inner workings of mechanical clock or watch (where it is known as "movement") and different types of toys which work using a series of gears driven by a spring. Clockwork device is completely mechanical and its essential parts are:

- A key (or crown) which you wind to add energy
- A spiral spring in which the energy is stored
- A set of gears through which the spring's energy is released. The gears control how quickly (or slowly) a clockwork machine can do things. Such as in mechanical clock/watch the mechanism is the set of hands that sweep around the dial to tell the time. In a clockwork car toy, the gears drive the wheels.

Winding the clockwork with the key means tightening a sturdy metal spring, called the mainspring. It is the process of storing potential energy. Clockwork springs are usually twists of thick steel, so tightening them (forcing the spring to occupy a much smaller space) is actually quite hard work. With each turn of the key, fingers do work and potential energy is stored in the spring. The amount of energy stored depends on the size and tension of the spring. Harder a spring is to turn and longer it is wound, the more energy it stores.



While the spring uncoils, the potential energy is converted into kinetic energy through gears, cams, cranks and shafts which allow wheels to move faster or slower. In an ancient clock, gears transform the speed of a rotating shaft so that it drives the second hand at one speed, the minute hand at $\frac{1}{60}$ of that speed, and the hour hand at $\frac{1}{3600}$ of that speed. Clockwork toy cars often use gears to make themselves race along at surprising speed.

60. What is the meaning of **movement** of old age mechanical clocks?

a) The pendulum of the clock

b) The gears which move the hands of the clock

c) A spring and combination of gears which move the hands of the clock

d) The hands of the clock

61. What type of energy is stored in the spring while winding it?

a) Potential

b) Heat

c) Both kinetic and potential

d) Kinetic

62. When the spring of a clockwork uncoils

a) Kinetic energy is converted into potential energy

b) Potential energy is converted into kinetic

c) Potential energy is converted into heat, light and sound energy

d) Kinetic energy is converted into heat, light and sound energy

63. In clockwork devices, _____ transform the speed of a rotating _____ to drive wheels slower or faster.

a) Shaft, spring

b) shaft, gear

c) Gear, Shaft

d) Spring, gear

64. More energy is stored in a spring if the

a) Spring is larger, harder and wound fur a longer time

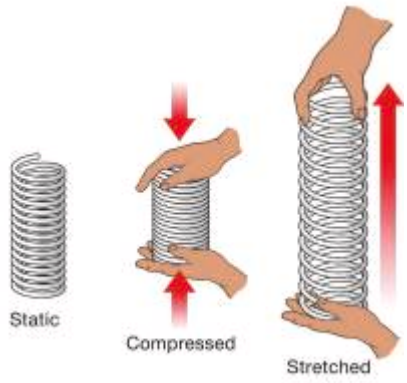
b) Spring is smaller, harder and wound for a shorter time

c) Spring is larger, harder and wound for a shurter time

d) Spring is larger, softer and wound for a shorter time

Question No. 65 to 69 are based on the given text. Read the text carefully and answer the questions: **[5]**

Elastic potential energy is Potential energy stored as a result of the deformation of an elastic object, such as the stretching of a spring. It is equal to the work done to stretch the spring, which depends upon the spring constant k as well as the distance stretched



65. If stretch in spring of force constant k is doubled, then the ratio of final to initial forces is:

a) 4:1

b) 1:4

c) 2:1

d) 1:2

66. A light body and a heavy body have the same kinetic energy. which one has greater linear momentum?

a) light body

b) both heavy and light body

c) Low body d) heavy body

67. A spring is cut into two equal halves. How is the spring constant of each half affected?

a) becomes double b) becomes triple

c) becomes 1/4th d) becomes half

68. What type of energy is stored in the spring of a watch?

a) potential energy b) Electrical energy

c) mechanical energy d) kinetic energy

69. When spring is compressed, its potential energy:

a) fall b) decrease

c) first increase then decrease d) increase

70. To simulate car accidents, auto manufacturers study the collisions of moving cars with mounted springs of different spring constants. Consider a typical simulation with a car of mass 1000 kg moving with a speed 18.0 kmh^{-1} on a smooth road and colliding with a horizontally mounted spring of spring constant 6.25×10^3 Nm^{-1}. What is the maximum compression of the coefficient of friction, μ, to be 0.5 and calculate the maximum compression of the spring? **[5]**

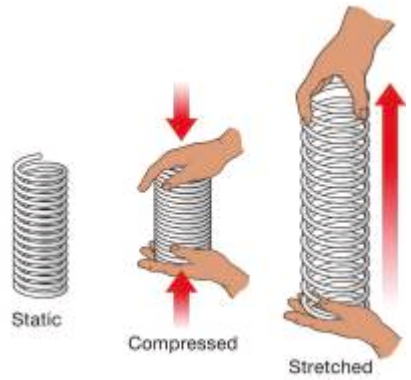
71. Draw a plot of spring force versus displacement x. Hence find an expression for the P.E. of an elastic stretched spring. **[5]**

72. Derive an expression for the potential energy stored in a system of a block attached to a massless spring, when the block is pulled from its equilbrium position. **[5]**

73. Define elastic potential energy. An elastic spring of force constant k is compressed by an amount x. Show that its potential energy is $\frac{1}{2}$ kx^2. **[5]**

74. **Read the case study given below and answer any four subparts:** **[5]**

Elastic potential energy is Potential energy stored as a result of deformation of an elastic object, such as the stretching of a spring. It is equal to the work done to stretch the spring, which depends upon the spring constant k as well as the distance stretched



i. A spring is cut into two equal halves. How is the spring constant of each half affected?

a. becomes 1/4th

b. becomes half

c. becomes double

d. none of these

ii. What type of energy is stored in the spring of a watch?

a. kinetic energy

b. potential energy

c. mechanical energy

d. none of these

iii. When spring is compressed, its potential energy:

a. increase

b. decrease

c. first increase then decrease

d. none of these

iv. If stretch in a spring of force constant k is doubled, then the ratio of final to initial forces is:

a. 1:2

b. 2:1

c. 1:4

d. 4:1

v. A light body and a heavy body have the same kinetic energy. which one has greater linear momentum?

a. heavy body

b. light body

c. both same

d. none of these