Work, Power & Energy

Multiple Choice Questions:

1. A bicyclist comes to a skidding stop in 10 m. During this process, the force on the bicycle due to the road is 200N and is directly opposed to the motion. The work done by the cycle on the road is

(a) + 2000 J (b) -200J (c) zero (d) -20 ,000 J

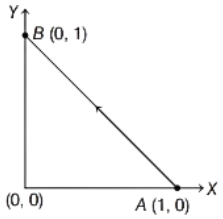
2. Force of 50 Nacting on a body at an angle θ with horizontal. If 150 J work is done by displacing it 3 m, then θ is

(a) 60° (b) 30° (c) 0° (d) 45°

3. A particle is pushed by forces $2\hat{\imath} + 3\hat{\jmath} - 2k$ and $5\hat{\imath}$ -j $-3\hat{k}$ simultaneously and it is displaced from point$2\hat{\imath} + 3\hat{\jmath} - 2\hat{k}$ to point$2\hat{\imath} - \hat{\jmath} + 3\hat{k}$. The work done is

(a) 7 units (b) -7 units (c) 10 units (d) -10 units

4. Consider a force $F = -x\hat{\jmath} + y\hat{\jmath}$. The work done by this force in moving a particle from point A (1, 0) to B (0, 1) along the line segment is (all quantities are in SI units)



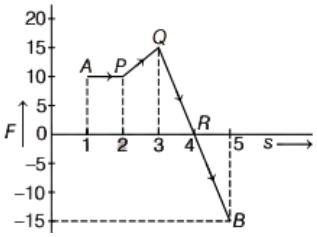
(a) $\frac{3}{2}$

(b) 2

(c) 1

(d) $\frac{1}{2}$

5. A body moves from point A to B under the action of a force varying in magnitude as shown in figure, then the work done is (force is expressed in newton and displacement in meter)



(a) 30 J

(b) 22.5 J

(c) 25 J

(d) 27 J

6. A string of length L and force constant K is stretched to obtain extension l . It is further stretched to obtain extension l_1. The work done in second stretching is

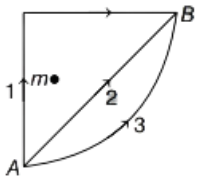
(a) $\frac{1}{2}kl_1(2l + l_1)$ (b) $\frac{1}{2}kl_1^2$ (c) $\frac{1}{2}k(l^2 + l_1^2)$ (d) $\frac{1}{2}k(l_1^2 + l^2)$

7. A uniform chain of length l and mass m is lying on a smooth table and one-third of its length is hanging vertically down over the edge of the table. If g is acceleration due to gravity, work required to pull the hanging part on to the table is

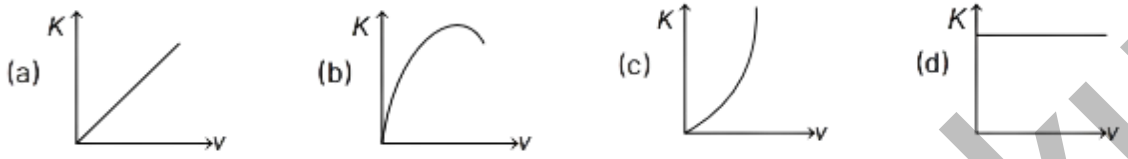
(a) mgl (b) $\frac{mgl}{3}$ (c) $\frac{mgl}{9}$ (d) $\frac{mgl}{18}$

8. If W_1, W_2 and W_3 are the work done in moving a particle from $A$and Balong three different paths 1, 2 and 3 respectively (as shown) in the gravitational field of a point mass m, the relation betweenW_1, W_2 and W_3 is

(a) $W_1 > W_2 > W_3$
(b) $W_1 = W_2 = W_3$
(c) $W_1 < W_2 < W_3$
(d) $W_2 > W_1 > W_3$



9. Amongst the given graphs which one correctly represents the variation of the kinetic energy (K) of a body with velocity (v)?



10. The kinetic energy of a body of mass 4 kg and momentum 6 N-s will be
(a) 3.5 J (b) 5.5 J (c) 2.5 J (d) 4.5 J

11. For a moving particle (mass m , velocity v) having a momentum ρ, which one of the following correctly describes the kinetic energy of the particle?
(a) $\frac{p^2}{2m}$ (b) $\frac{p}{2m}$ (c) $\frac{V^2}{2m}$ (d) $\frac{V}{2m}$

12. Two bodies of masses 4 kg and 5 kg are moving with equal momentum. Then, the ratio of their respective kinetic energies is
(a) 4 : 5 (b) 2 : 1 (c) 1: 3 (d) 5: 4

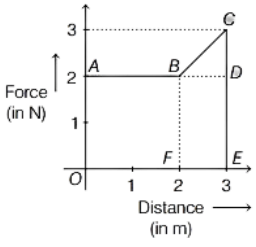
13. A heavy body and a light body have same kinetic energy. Which will have larger linear momentum?
(a) Heavy body (b) Light body
(c) Both have same linear momenta (d) None of the above

14. A mass of 5 kg is moving along a circular path of radius 1 m. If the mass moves with 300 rev/min, its kinetic energy (in J) would be
(a) 250 π^2 (b) 100 π^2 (c) 5 π^2 (d) zero

15. Two moving objects ($m_1 > m_2$) having same kinetic energy are stopped by application of equal retarding force. Which object will come to rest at shorter distance?
(a) Bigger (b) Smaller
(c) Both at same distance (d) Cannot say

16. A particle which is experiencing a force, is given by $= 3\,\hat{\imath} - 12\,\hat{\jmath}$, undergoes a displacement of $d = 4\,\hat{\imath}$. If the particle had a kinetic energy of 3 J at the beginning of the displacement, what is its kinetic energy at the end of the displacement?
(a) 9 J (b) 15 J (c) 12 J (d) 10 J

17. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled 3 m is
(a) 4 J (b) 2.5 J (c) 6.5 J (d) 5 J



18. When a person lifts a brick above the surface of the earth, then its potential energy
(a) increases (b) decreases (c) remains same (d) None of these

19. A massless spring of spring constant k , has extension y and potential energy E. It is now stretched from y to 2 y. The increase in its potential energy is
(a) 3 E (b) 2 E (c) E (d) 4 E

20. A bread gives 5 kcal of energy to a boy. How much height he can climbs by using this energy, if his efficiency is 28% and mass is 60 kg?
(a) 15m (b) 5m (c) 2.5 m (d) 10 m

21. A body is falling freely under the action of gravity alone in vacuum. Which of the following quantities remain constant during the fall?
(a) Kinetic energy (b) Potential energy
(c) Total mechanical energy (d) Total linear momentum

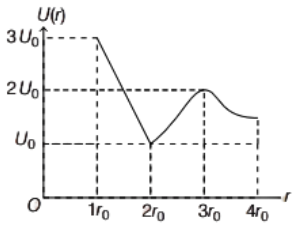
22. A stone is projected vertically up to reach maximum height h. The ratio of its kinetic energy to its potential energy at a height $\frac{4}{5}h$, will be
(a) 5: 4 (b) 4 : 5 (c) 1: 4 (d) 4 : 1

23. A spring of force constant 800 N/m has an extension of 5 cm. The work done in extending it from 5 cm to 15 cm is
(a) 16 J (b) 8 J (c) 32 J (d) 24 J

24. A 2 kg block slides on a horizontal floor with a speed of 4 m/s. It strikes a uncompressed spring and compresses it till the block is motionless. The kinetic friction force is 15 N and spring constant is 10000 N/m. The spring compresses by
(a) 5.5 cm (b) 2.5 cm (c) 11.0 cm (d) 8.5 cm

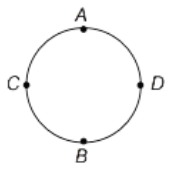
25. 300 J of work is done in sliding a 2 kg block up an inclined plane of height 10 m ($taking, g = -10$ ms^2). Work done against friction is
(a) 200 J (b) 100 J (c) zero (d) 1000 J

26. The graph below represents the potential energy U as a function of position r for a particle of mass. If the particle is released from rest at position r_0, what will its speed be at position $3r_0$?



(a) $\sqrt{\frac{3U_0}{m}}$ (b) $\sqrt{\frac{4U_0}{m}}$ (c) $\sqrt{\frac{2U_0}{m}}$ (d) $\sqrt{\frac{36}{m}}$

27. A pebble is attached to one end of a string and rotated in a vertical circle. If string breaks at the position of maximum tension, so from the figure shown below, it will break at
(a) A
(b) B
(c) C
(d) D



28. What is the ratio of kinetic energy of a particle at the bottom to the kinetic energy at the top, when it just loops a vertical loop of radius r?
(a) 5: 1 (b) 2 : 3 (c) 5: 2 (d) 7: 2

29. A man can do work of 600 J in 2 min, then man's power is
(a) 7.5 W (b) 10 W (c) 5 W (d) 15 W

30. A particle is acted by a constant power. Then, which of the following physical quantity remains constant?
(a) Speed (b) Rate of change of acceleration
(c) Kinetic energy (d) Rate of change of kinetic energy

31. An object of mass m moves horizontally, increasing in speed from 0 to v in a time t. The power necessary to accelerate the object during this time period is
(a) $\frac{mV^2 t}{2}$ (b) $\frac{mV^2}{2}$ (c) $2\,mV^2$ (d) $\frac{mV^2}{2t}$

32. A 60 HP electric motor lifts an elevator having a maximum total load capacity of 2000 kg. If the frictional force on the elevator is 4000 N, the speed of the elevator at full load is close to $(take, 1\ HP\ =\ 746\ W\ and\ g\ =\ 10\ ms^{-2}\ )$
(a) 2.0 ms $^{-1}$ (b) 1.5 ms $^{-1}$ (c) 1.9 ms $^{-1}$ (d) 1.7 ms $^{-1}$

33. A car of mass m starts from rest and accelerates, so that the instantaneous power delivered to the car has a constant magnitude P_0. The instantaneous velocity of this car is proportional to
(a) t^2 P (b) $t^{1/2}$ (c) $t^{-1/2}$ (d) $t/\sqrt{m}$

34. For a system to follow the law of conservation of linear momentum during a collision, the condition is
I. total external force acting on the system is zero
II. total external force acting on the system is finite and time of collision is negligible
III. total internal force acting on the system is zero
(a) Only I (b) Only II (c) Only III (d) I or II

35. Two identical balls A and B having velocities of 0.5 ms^{-1} and -0 3. ms^{-1} respectively, collide elastically in one dimension. The velocities of B and A after the collision respectively will be
(a) -05. ms $^{-1}$ and 0.3 ms $^{-1}$ (b) 0.5 m/s $^{-1}$ and -0 3. ms $^{-1}$
(c) -0 3. ms $^{-1}$ and 0.5 ms $^{-1}$ (d) 0.3 ms $^{-1}$ and 0.5 ms $^{-1}$

36. A particle of mass 1g moving with a velocity $V_1 = (3\hat{\imath} - 2\,\hat{\jmath})$ ms^{-1} experiences a perfectly elastic collision with another particle of mass 2 g and velocity V_2 $=(4\,\hat{\jmath} - 6\,\hat{k})$ ms^{-1}. The velocity of the particle is
(a) 2.3 ms^{-1} (b) 4 6. ms^{-1} (c) 9.2 ms^{-1} (d) 6ms^{-1}

37. A particle of mass m_1 moves with velocity v ^{1} collides with another particle at rest of equal mass. The velocity of second particle after the elastic collision is
(a) $2v_1$ (b) v_1 (c) $-v_1$ (d) zero

38. During inelastic collision between two bodies, which of the following quantities always remain conserved?
(a) Total kinetic energy (b) Total mechanical energy
(c) Total linear momentum (d) Speed of each body

39. Two objects of mass m each moving with speed u ms -1 collide at 90°, then final momentum is (assume collision is inelastic)
(a) mu (b) 2 mu (c) $\sqrt{2}$ mu (d) 2 $\sqrt{2}$ mu

40. A body of mass 5 $\times 10^3$ kg moving with speed 2 ms $^{-1}$ collides with a body of mass15$\times$ 10^3 kg inelastically and sticks to it. Then, loss in kinetic energy of the system will be
(a) 7.5 kJ (b) 15 kJ (c) 10 kJ (d) 5 kJ

41. If the linear momentum of a body is increased by 50%, then the kinetic energy of that body increases by …… .
(a) 100% (b) 125% (c) 225% (d) 25%

42. A ball of mass m moves with speed v and strikes a wall having infinite mass and it returns with same speed, then the work done by the ball on the wall is …… .
(a) zero (b) mv J (c) m/v J (d) v/mJ

43. A body of mass 5 kg is thrown vertically up with a kinetic energy of 490 J. The height at which the kinetic energy of the body becomes half of the original value is …… .
(a) 12.5 m (b) 10 m (c) 2.5 m (d) 5 m

44. If two persons A and B take 2 s and 4 s, respectively to lift an object to the same height h, then the ratio of their powers is ……
(a) 1:2 (b) 1:1 (c) 2 :1 (d) 1:3

45. At time $t = 0$, particle starts moving along the x-axis. If its kinetic energy increases uniformly with time t, the net force acting on it must be proportional to t^n where the value of n is …… .
(a) 1 (b) - ½ (c) 2 (d) 1/2

46. A man of mass m, standing at the bottom of the staircase, of height L climbs it and stands at its top. Which amongst the following statement is correct?
(a) Work done by all forces on man is equal to the rise in potential energy mgL.
(b) Work done by all forces on man is zero.
(c) Work done by the gravitational force on man is mgL.
(d) The reaction force from a step does some work because the point of application of the force does not move while the force exists.

47. Which of the following statement is correct about non-conservative force?
(a) It depends on velocity of the object.
(b) It depends on the particular path taken by the object.
(c) It depends on the initial and final positions of the object.
(d) Both (a) and (b)

48. Which of the following statement is correct?
(a) Conservation of mechanical energy does not consider only conservative force.
(b) Conservation of energy consider both conservative and non-conservative forces.
(c) Conservation of energy consider only conservative force.
(d) Mass converted into energy in nuclear reaction is called mass-defect.

49. Which of the following statement does not specify an example of perfectly inelastic collision?
(a) A bullet fired into a block if bullet gets embedded into block.
(b) Capture of electrons by an atom.
(c) Aman jumping on to moving boat.
(d) A ball bearing striking another ball bearing.

50. Match the Column I (angle) with Column II (work done) and select the correct option from the codes given below.

	Column I		Column II
A.	$0 < 90^\circ$	p.	Friction
B.	$0 = 90^\circ$	q.	Satellite rotating around the earth
C.	$0 > 90^\circ$	r.	Coolie is lifting a luggage

Codes

	A	B	C
(a)	p	q	r
(b)	r	q	p
(c)	p	r	q
(d)	r	p	q

51. A body is moved along a straight line by a machine delivering a power proportional to time ($P \propto t$). Then, match the Column I with Column II and select the correct option from the codes given below.

	Column I		Column II
A.	Velocity is proportional to	p.	t
B.	Displacement is proportional to	q.	t^2
C.	Work done is proportional to	r.	t^3

Codes

	A	B	C
(a)	p	q	r
(b)	r	q	p
(c)	p	q	q
(d)	r	p	p

Assertion-Reasoning MCQs

(For question numbers 52 to 60, two statements are given-one labelled)Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) are as given below

(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 and R is also false.

52. Assertion Stopping distance $\frac{Kinetic\ energy}{Stopping\ force}$
Reason Work done in stopping a body is equal to change in kinetic energy of the body.

53. Assertion *A* spring of force constant k is cut into two pieces having lengths in the ratio 1 : 2. The force constant of series combination of the two parts is $2k$ /3.
Reason The spring connected in series are represented by $k = k_1 + k_2$.

54. Assertion According to the law of conservation of mechanical energy, change in potential energy is equal and opposite to the change in kinetic energy.
Reason Mechanical energy is not conserved.

55. Assertion Decrease in mechanical energy is more in case of an object sliding up a relatively less inclined plane due to friction.
Reason The coefficient of friction between the block and the surface decreases with the increase in the angle of inclination.

56. Assertion For looping a vertical loop of radius r, the minimum velocity at lowest point should be $\sqrt{5gr}$. **Reason** In this event, the velocity at the highest point will be zero.

57. Assertion Kilowatt-hour is the unit of energy.
Reason One kilowatt hour is equal to $3.6\times 10^6\ J$

58. Assertion There is no loss in energy in elastic collision.
Reason Linear momentum is conserved in elastic collision.

59. Assertion Quick collision between two bodies is more violent than a slow collision; even when the initial and final velocities are identical.
Reason The momentum is greater in first case.

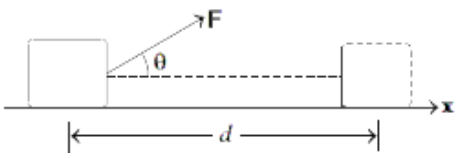
60. Assertion Two particles are moving in the same direction do not lose all their energy in completely inelastic collision.
Reason Principle of conservation of momentum does not holds true for all kinds of collisions.

Case Based MCQs

Direction *Answer the questions from 61-65 on the following case.*

Work:

A farmer ploughing the field, a construction worker carrying bricks, a student studying for a competitive examination, an artist painting a beautiful landscape, all are said to be working. In physics, however, the word 'Work' covers a definite and precise meaning. Work refers to the force and the displacement over which it acts. Consider a constant force F acting on an object of mass m. The object undergoes a displacement d in the positive x-direction as shown in figure. The work done by the force is defined to be the product of component of the force in the direction of the displacement and the magnitude of this displacement, thus
$W = (F\cos\theta)\, d = F \times d.$



61. The earth is moving around the sun in a circular orbit, is acted upon by a force and hence work done on the earth by the force is
(a) zero (b) positive (c) negative (d) None of the above

62. In which case, work done will be zero?
(a) A weight-lifter while holding a weight of 100 kg on his shoulders for 1 min
(b) A locomotive against gravity is running on a level plane with a speed of 60 kmh^{-1}
(c) A person holding a suitcase on his head and standing at a bus terminal
(d) All of the above

63. Find the angle between force $\mathbf{F} = (3\,\hat{\mathbf{i}} + 4\,\hat{j} - 5\,\hat{K})$ unit and displacement $\mathbf{d} = (5\,\hat{\mathbf{i}} + 4\,\hat{j} - 3\,\hat{K})$ unit.
(a) $\cos^{-1}(0.49)$ (b) $\cos^{-1}(0.32)$ (c) $\cos^{-1}(0.60)$ (d) $\cos^{-1}(0.90)$

64. Which of the following statement(s) is/are correct for work done to be zero?
I. If the displacement is zero.
II. If force applied is zero.
III. If force and displacement are mutually perpendicular to each other.
(a) Only I (b) I and II (c) Only II (d) I, II and III

65. A proton is kept at rest. A positively charged particle is released from rest at a distance d in its field. Consider two experiments; one in which the charged particle is also a proton and in another, a positron. In same time t , the work done on the two moving charged particles is
(a) same as the same force law is involved in the two experiments
(b) less for the case of a positron, as the positron moves away more rapidly and the force on it weakens
(c) more for the case of a positron, as the positron moves away a larger distance
(d) same as the work is done by charged particle on the stationary proton

Direction *Answer the questions from 66-70 on the following case.*

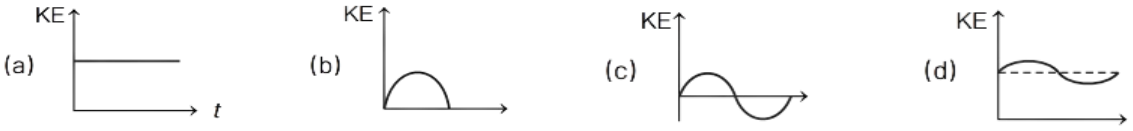
Kinetic Energy:

The energy possessed by a body by virtue of its motion is called kinetic energy. In other words, the amount of work done, a moving object can do before coming to rest is equal to its kinetic energy.

∴ Kinetic energy, $\mathrm{KE} = \frac{1}{2}mv^2$

where, m is a mass and v is the velocity of a body.
The units and dimensions of KE are Joule (in SI) and $[ML^2T^{-2}]$, respectively. Kinetic energy of a body is always positive. It can never be negative.

66. Which of the diagrams shown in figure most closely shows the variation in kinetic energy of the earth as it moves once around the sun in its elliptical orbit?



67. *A* force which is inversely proportional to the speed is acting on a body. The kinetic energy of the body starting from rest is
(a) a constant (b) inversely proportional to time
(c) directly proportional to time (d) directly proportional to square of time

68. The kinetic energy of an air molecule ($10^{-21}\ J$) in eV is
(a) 6.2me$V$ (b) 4.2me$V$ (c) 10.4 me$V$ (d) 9.7 me$V$

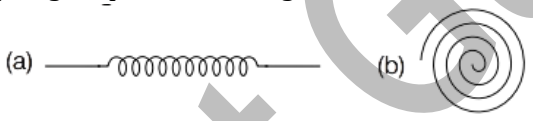
69. Two masses of 1 g and 4 g are moving with equal kinetic energy. The ratio of the magnitudes of their momentum is
(a) 4 : 1 (b) $\sqrt{2}$:1 (c) 1: 2 (d) 1: 16

70. An object of mass 10 kg is moving with velocity of 10 ms^{-1}. Due to a force, its velocity become 20 ms^{-1}. Percentage increase in its KE is
(a) 25% (b) 50% (c) 75% (d) 300%

Direction *Answer the questions from 71-75 on the following case.*

PE of Spring:

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



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

71. The potential energy of a body is increases in which of the following cases?
(a) If work is done by conservative force
(b) If work is done against conservative force
(c) If work is done by non-conservative force
(d) If work is done against non- conservative force

72. The potential energy, $i.e.\ U(x)$ can be assumed zero when
(a) x =0
(b) gravitational force is constant
(c) infinite distance from the gravitational source
(d) All of the above

73. 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) 2: 3 (b) 3: 2 (c) 4: 9 (d) 9: 4

74. 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) 27 J (b) 30 J (c) 33 J (d) 36 J

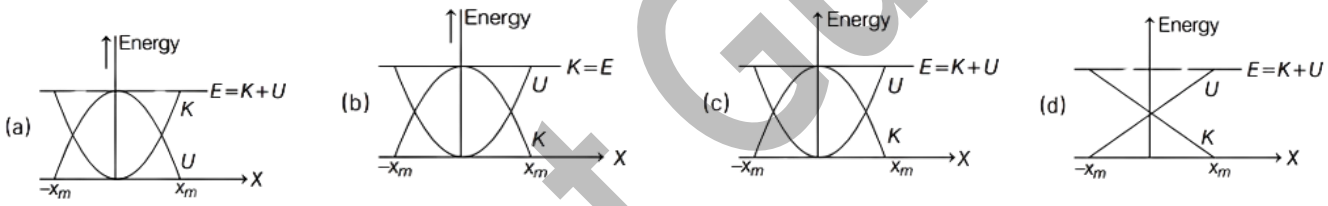
75. The potential energy of a spring when stretched through a distance x is 10 J. What is the amount of work done on the same spring to stretch it through an additional distance x?
(a) 10 J (b) 20 J (c) 30 J (d) 40 J

Direction *Answer the questions from 76-80 on the following case.*

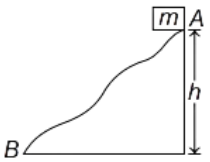
Principle of Conservation of Energy:
Total energy of an isolated system always remains constant. Since, the universe as a whole may be viewed as an isolated system, total energy of the universe is constant. If one part of the universe loses energy, then other part must gain an equal amount of energy. The principle of conservation of energy cannot be proved as such. However, no violation of this principle has been observed.

76. When we rub two flint stones together, got them to heat up and to ignite a heap of dry leaves in the form of
(a) chemical energy (b) sound energy
(c) heat energy (d) electrical energy

77. Which graph represents conservation of total mechanical energy?



78. In the given curved road, if particle is released from A, then
(a) kinetic energy at B must be mgh
(b) kinetic energy at B must be zero
(c) kinetic energy at B must be less than mgh
(d) kinetic energy at B must not be equal to potential energy



79. U is the potential energy, K is the kinetic energy and E is the mechanical energy. Which of the following is not possible for a stable system?
(a) $U > E$ (b) $U < E$ (c) $E > K$ (d) $K > E$

80. A body of mass 5 kg is thrown vertically up with a kinetic energy of 490 J. The height at which the kinetic energy of the body becomes half of the original value is
(a) 12.5 m (b) 10 (c) 2.5 m (d) 5 m

ANSWERS

Multiple Choice Questions

01. (c) 02. (c) 03. (b) 04. (c) 05. (b) 06. (d) 07. (d) 08. (b) 09. (c) 10. (d) 11. (a) 12. (d)
13. (a) 14. (a) 15. (c) 16. (b) 17. (c) 18. (a) 19. (a) 20. (d) 21. (c) 22. (c) 23. (b) 24. (a)
25. (b) 26. (c) 27. (b) 28. (a) 29. (c) 30. (d) 31. (d) 32. (c) 33. (b) 34. (a) 35. (b) 36. (b)
37. (b) 38. (c) 39. (c) 40. (a) 41. (b) 42. (a) 43. (d) 44. (c) 45. (b) 46. (b) 47. (d) 48. (b)
49. (d) 50. (b) 51. (c)

Assertion-Reasoning MCQs

52. (a) 53. (c) 54. (d) 55. (c) 56. (c) 57. (b) 58. (b) 59. (a) 60. (c)

Case Based MCQs

61. (a) 62. (d) 63. (b) 64. (d) 65. (c) 66. (d) 67. (c) 68. (a) 69. (c) 70. (d)

71. (b) 72. (d) 73. (b) 74. (a) 75. (c) 76. (a) 77. (c) 78. (a) 79. (a) 80. (d)