WORK ENERGY POWER IMP QUESTIONS

Class 11 - Physics

Section A

1. A tandem (two-person) bicycle team must overcome a force of 165 N to maintain a speed of 9.00 m/s. Find the power required per rider, assuming that each contributes equally? **[1]**

   a) 742.5 W
   b) 765 W
   c) 798 W
   d) 702 W

2. If momentum decreases by 20%, K.E. will decrease by **[1]**

   a) 18%
   b) 40%
   c) 36%
   d) 8%

3. A particle is projected making an angle of 45^o with horizontal having kinetic energy K. The kinetic energy at the highest point will be **[1]**

   a) K
   b) $\frac{K}{2}$
   c) $\frac{K}{\sqrt{2}}$
   d) 2K

4. A body of mass 1 kg begins to move under the action of a time dependent force F = $(2t\hat{i} + 3t^2\hat{j})$ N, where $\hat{i}$ and $\hat{j}$ are unit vectors along x and y axes. What power will be developed by the force at the time t? **[1]**

   a) $(2t^2 + 3t^2)$ W
   b) $(2t^3 + 3t^4)$ W
   c) $(2t^3 + 3t^5)$ W
   d) $(2t^2 + 4t^4)$ W

5. How many joules of energy does a 100-watt light bulb use per hour? How fast would a 70-kg person have to run to have that amount of kinetic energy? **[1]**

   a) 360000 J, 101 m/s
   b) 320000 J, 130 m/s
   c) 380000 J, 120 m/s
   d) 340000 J, 140 m/s

6. A trolley of mass 200 kg moves with a uniform speed of 36 km/h on a frictionless track. A child of mass 20 kg runs on the trolley from one end to the other (10 m away) with a speed of 4 ms^{-1} relatives to the trolley in a direction opposite to its motion, and jumps out of the trolley. What is the final speed of the trolley? **[1]**

   a) 11.36 m/s
   b) 8.13 m/s
   c) 10.36 m/s
   d) 9.36 m/s

7. Two particles of masses m_1, m_2 move with initial velocities u_1 and u_2. On collision, one of the particles gets excited to a higher level, after absorbing energy s. If the final velocities of particles be v_1 and v_2 respectively, then we must have **[1]**

a) $m_1^2u_1 + m_2^2u_2 - \varepsilon = m_1^2v_1 + m_2^2v_2$ b) $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 - \varepsilon$

c) $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 - \varepsilon = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$ d) $\frac{1}{2}m_1^2u_1^2 + \frac{1}{2}m_2^2u_2^2 + \varepsilon = \frac{1}{2}m_1^2v_1^2 + \frac{1}{2}m_2^2v_2^2$

8. In a graph of F(x) vs x, the area under the curve represents the **[1]**

a) energy of F(x) b) work done by F(x).

c) impulse of F(x) d) momentum of F(x)

9. A simple pendulum hanging freely and at rest is vertical because in that position **[1]**

a) potential energy is zero b) potential energy is minimum

c) kinetic energy is zero d) kinetic energy is minimum

10. A particle of mass m_1 is moving with a velocity v_1 and another particle of mass m_2 is moving with a velocity v_2. Both of them have the same momentum but their different kinetic energies are E_1 and E_2 respectively. If $m_1 > m_2$, then **[1]**

a) $E_1 = E_2$ b) $E_1 > E_2$

c) $E_1 < E_2$ d) $\frac{E_1}{E_2} = \frac{m_1}{m_2}$

11. A ball moves on a frictionless inclined table without slipping. The work done by the table surface on the ball is **[1]**

a) negative b) One

c) positive d) zero

12. A bomb of mass 9 kg explodes into 2 pieces of mass 3 kg and 6 kg. The velocity of mass 3 kg is 1.6 m/s, the KE of mass 6 kg is **[1]**

a) 9.6 J b) 1.92 J

c) 3.84 J d) 2.92 J

13. The work done by an applied variable force $F = x + x^3$ from x = 0 m to x = 2 m, where x is displacement, is **[1]**

a) 8 J b) 10 J

c) 6 J d) 12 J

14. A body moves a distance of 10 m under the action of force F = 10N. If the work done is 25 J, the angle which the force makes with the direction of motion is **[1]**

a) none of these b) 0^o

c) 30^0 d) 60^o

15. A particle of mass m_1 moving with velocity v collides with a mass m_2 at rest, then they get embedded. At the instant of collision, velocity of the system **[1]**

a) increases b) decreases

c) remains constant d) becomes zero

16. 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

17. Consider the collision of two cars. Car 1 is at rest and Car 2 is moving at a speed of 2 m /s in the negative x-direction. Both cars each have a mass of 500 kg. The cars collide inelastically and stick together. What is the resulting velocity of the resulting mass of metal? **[1]**

a) 1.4 m /s to the left b) 1 m/s to the left

c) 1.2 m /s to the left d) 1.5 m /s to the left

18. A bomb of mass 3.0 kg explodes in air into two pieces of masses 2.0 kg and 1.0 kg. The smaller mass goes at a speed of 80 ms^{-1}. The total energy imparted to the two fragments is **[1]**

a) 1.07 kJ b) 4.8 kJ

c) 2.14 kJ d) 2.4 kJ

19. 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 **[1]**

a) -20,000J b) -200J

c) +2000J d) Zero

20. A boy pulls a 5 kg block along a 20 m long horizontal surface at a constant velocity by applying a horizontal force F. If the coefficient of kinetic friction is 0.2, how much work does the boy do on the block? (g = 10 ms^{-2}) **[1]**

a) 300 J b) 200 J

c) 400 J d) 100 J

21. 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

22. A body is moving unidirectionally under the influence of a source of constant power. Its displacement in time t is proportional to **[1]**

a) t b) $t^{3/2}$

c) t^2 d) $t^{1/2}$

23. If a neutron collides with a stationary α-particle with velocity v, what is resultant velocity of neutron? **[1]**

a) $\frac{4}{5}$v b) $\frac{1}{5}$v

c) $\frac{3}{5}$v d) $\frac{2}{5}$v

24. In which case, work done will be zero **[1]**

i. a weight-lifter while holding a weight of 100 kg on his shoulders for 1 min

ii. a locomotive against gravity when it is running on a level plane with a speed of 60 kmh^{-1}

iii. a person holding a suitcase on his head and standing at a bus terminal

iv. All of these

a) Statement (iv) is correct. b) Statement (i) is correct.

c) Statement (iii) is correct.

d) Statement (ii) is correct.

25. In an inelastic collision, what is conserved? **[1]**

a) Kinetic energy

b) Momentum

c) Kinetic energy and Momentum

d) Neither Kinetic energy nor momentum

26. 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) $\frac{E_A}{4}$

27. A particle moves under a force F = CX from X = 0 to X = X_1. The work done is **[1]**

a) CX_1^3

b) $\frac{CX_1^2}{2}$

c) zero

d) CX_1^2

28. A 6.0-kg box moving at 3.0 m/s on a horizontal, frictionless surface runs into a light spring of force constant 75 N/cm Use the work–energy theorem to find the maximum compression of the spring. **[1]**

a) 7.5 cm

b) 8.5 cm

c) 9.5 cm

d) 6.5 cm

29. When a spring is stretched by 2 cm, it stores 100 J of energy. If it is stretched further by 2 cm, the stored energy will be increased by **[1]**

a) 200 J

b) 300 J

c) 400 J

d) 100 J

30. A force acts on a 3 g particle in such a way that the position of the particle as a function of time is given by x = $3t - 4t^2 + t^3$, where x is in metres and t is in seconds. The work done during the first 4 seconds is **[1]**

a) 450 mJ

b) 490 mJ

c) 530 mJ

d) 576 mJ

Section B

31. A body of mass M is moved along a straight line by a machine delivering a constant power P. Find the expression for the distance moved by the body in terms of M, P, and t. **[2]**

32. The human heart forces 4000 cm^3 of blood per minute through the arteries under the pressure of 130 mm. The density of blood is 1.03 g cm^{-3}. What is the horsepower of the heart? **[2]**

33. 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.

34. A large mass M moving with a velocity v collides head-on with a very small mass m at rest. If the collision is elastic, obtain an expression for the energy lost by the large mass M (Take M + m ≈ M). **[2]**

35. A body is moving unidirectionally under the influence of a source of constant power. Its displacement in time t is proportional to **[2]**

i. $t^{\frac{1}{2}}$

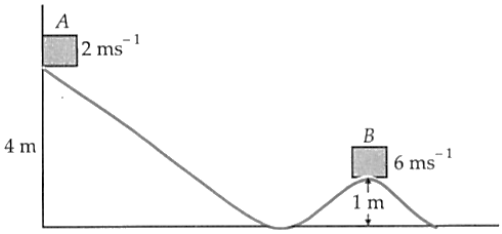
ii. t

iii. $t^{\frac{3}{2}}$

iv. t^2

36. A car of mass 1000 kg travelling at 32 ms^{-1} dashes into the rear of a truck of mass 8000 kg moving in the same direction with a velocity of 4 ms^{-1}. After the collision, the car bounces with a velocity of 8 ms^{-1}. What is the velocity of truck after the impact? **[2]**

37. A 3.0 kg block, as shown in Fig., has a speed of 2 ms^{-1} at A and 6 ms^{-1} at B. If the distance from A to B along the curve is 12 m, how large a frictional force acts on it? Assuming the same friction, how far from B will it stop? **[2]**



38. A vehicle of mass 30 quintals moving with a speed of 18 km h^{-1} collides with another vehicle of mass 90 quintals moving with a speed of 14.4 km h^{-1} in the opposite direction. What will be the velocity of each after the collision? **[2]**

39. A bolt of mass 0.3 kg falls from the ceiling of an elevator moving down with a uniform speed of 7 ms^{-1}. It hits the floor of the elevator (length of the elevator 3 m) and does not rebound. What is the heat produced by the impact? Would your answer be different, if the elevator were stationary? **[2]**

40. A simple pendulum of length 1 m has a wooden bob of mass 1 kg. It is struck by a bullet of mass 10^{-2} kg moving with a speed of 2×10^2 ms^{-1}. The bullet gets embedded into the bob. Obtain the height to which the bob rises before swinging back. **[2]**

41. Two ball bearings of mass m each, moving in opposite directions with equal speed collide head on with each other. Predict the outcome of the collision, assuming it to be perfectly elastic. **[2]**

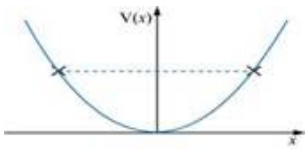
42. The velocity of an aeroplane is doubled. **[2]**

a. What will happen to its momentum? Will the momentum remain conserved?

b. What will happen to its K.E.? Will the energy remain conserved?

43. A particle moves along the x-axis from x = 0 to x = 5 m under the influence of a force given by $F = 7 - 2x + 3x^2$. Find the work done in the process. **[2]**

44. The potential energy function for a particle executing linear simple harmonic motion is given by $V(x) = \frac{kx^2}{2}$, where k is the force constant of the oscillator. For, k = 0.5 Nm^{-1}, the graph of V(x) versus x is shown in figure. Show that a particle of total energy 1 J moving under this potential must 'turn back' when it reaches x = ± 2 m. **[2]**



45. A 10 kg ball and 20 kg ball Approach each other with velocities 20 ms^{-1} and 10 ms^{-1} respectively. What are their velocities after a collision if the collision is perfectly elastic? **[2]**

46. A particle of mass m is moving in a horizontal circle of radius r, under a centripetal force equal to $-\left(\frac{K}{r^2}\right)$, where K is constant. What is the total energy of the particle? **[2]**

47. A stone of mass 0.4 kg is thrown vertically up with a speed of 9.8 ms^{-1}. Find the potential and kinetic energies after half a second. **[2]**

48. A body is being raised to a height *h* from the surface of earth. What is the sign of work done by: **[2]**

a. applied force

b. gravitational force?

49. Two bodies of masses 5 kg and 3 kg moving in the same direction along the same straight line with velocities 5 ms^{-1} and 3 ms^{-1} respectively suffer a one-dimensional elastic collision. Find their velocities after the collision. **[2]**

50. What is the amount of work done by **[2]**

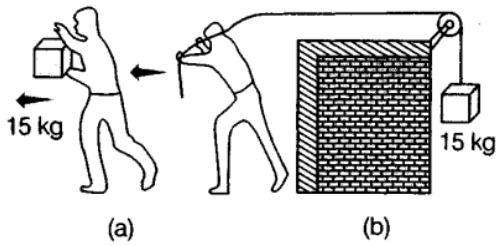
a. a weight-lifter in holding a weight of 120 kg on his shoulder for 30 s, and

b. a locomotive against gravity, if it is travelling on a level plane?

51. If the momentum of a body is increased by 50%, then what will be the percentage increase in the kinetic energy of the body? **[2]**

52. In Fig. (a) the man walks 2 m carrying a mass of 15 kg on his hands. In Fig. (b) he walks the same distance pulling the rope behind him. **[2]**

The rope goes over a pulley and a mass of 15 kg hangs at its other end. In which case is the work done greater?



53. A boy has a bag of sand of mass 20 kg. First of all, he keeps the bag on his head and moves 10 m. Second time, he drags the bag through 10 m on a frictionless surface with coefficient of friction μ = 0.1. In which case, he does more work? **[2]**

54. A neutron moving with a speed of 10^6 ms^{-1} suffers a head-on collision with a nucleus of mass number 80. What is the fraction of energy retained by the nucleus? **[2]**

55. An engine of mass 6.5 metric ton is going upon incline of 5 in 13 at the rate of 9 kmh^{-1}. Calculate the power of the engine if $\mu = \frac{1}{12}$ and g = 9.8 ms^{-2}. **[2]**

56. What is the work done by a person in carrying a suitcase weighing 10 kg f on his head when he travels a distance of 5 m in the **[2]**

i. vertical direction and

ii. horizontal direction?

Take g = 9.8 ms^{-2}.

57. A ball falls under gravity from a height of 10 m with an initial downward velocity u. It collides with the ground, loses 50% of its energy in the collision and then rises back to the same height. Find the initial velocity u. **[2]**

58. A chain is held on frictioness table with $\frac{1}{n}$th of its length hanging over the edge. If the chain has a length l and a mass m, how much work is required to pull the hanging part back on the table? **[2]**

59. A family uses 8 kW of power. **[2]**

a. Direct solar energy is incident on the horizontal surface at an average rate of 200 W per square meter. If 20% of this energy can be converted to useful electrical energy, how large an area is needed to supply 8 kw?

b. Compare this area to that of the roof of a typical house.

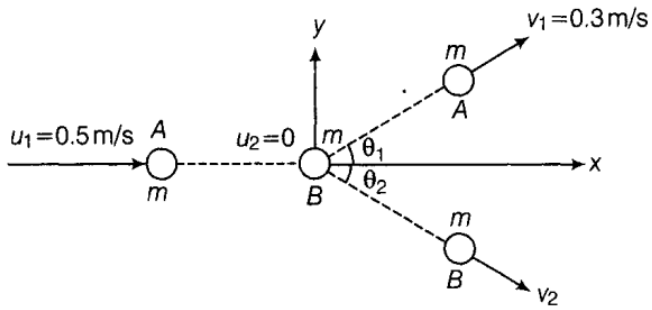
60. Two springs have force constants k_1 and k_2 ($k_1 > k_2$). On which spring is more work done, if **[2]**

i. they are stretched by the same force and

ii. they are stretched by the same amount?

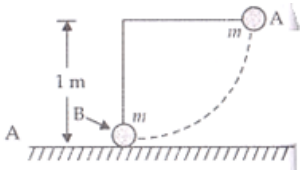
Section C

61. Consider the collision depicted in figure to be between two billiard balls with equal masses $m_1 = m_2$. The first ball is called the cue while the second ball is called the target. The billiard player wants to sink the target ball in a corner pocket, which is at an angle $\theta_2 = 37^0$. Assume that the collision is elastic and that friction and rotational motion are not important. Obtain θ_1. **[3]**



62. The bob A of a pendulum released from horizontal to the vertical hits another bob B of the same mass at rest on a table as shown in figure. **[3]**

If the length of the pendulum is 1m, calculate



i. the height to which bob A will rise after collision.

ii. the speed with which bob B starts moving. Neglect the size of the bobs and assume the collision to be elastic.

63. A person decides to use his bath-tub water to generate electric power to run a 40 W bulb. The bath-tub is located at a height of 10 m from the ground and it holds 200 litres of water. He installs a water-driven wheel generator on the ground. At what rate should the water drain from the bathtub to light the bulb? How long can he keep the bulb on, if the bath-tub was full initially? The efficiency of the generator = 90%. Take g = 9.8 ms^{-2}. **[3]**

64. 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]**

65. Answer carefully, with reasons: **[3]**

a. In an elastic collision of two billiard balls, is the total kinetic energy conserved during the short time of collision of the balls (i.e. when they are in contact)?

b. Is the total linear momentum conserved during the short time of an elastic collision of two balls?

c. What are the answers to (a) and (b) for an inelastic collision?

d. If the potential energy of two billiard balls depends only on the separation distance between their centres, is the collision elastic or inelastic?

(Note, we are talking here of potential energy corresponding to the force during collision, not gravitational potential energy)

66. If the linear momentum of a body increases by 20%, what will be the % increase in the kinetic energy of the **[3]**

body?

67. The turbine pits at the Niagra falls are 50 m deep. The average horsepower developed is 500. If the efficiency of the generator is 85%, how much water passes through the turbines per minute? Take g = 10 ms^{-2}. **[3]**

68. A large family uses 8 kW of power, **[3]**

a. Direct solar energy is incident on the horizontal surface at an average rate of 200 W per square meter. If 20% of this energy can be converted to useful electrical energy, how large an area is needed to supply 8 kW?

b. Compare this area to that of the roof of a house constructed on a plot of size 20 m $\times$ 15 m with a permission to cover upto 70%

69. Consider a one-dimensional motion of a particle with total energy E. There are four regions A, B, C and D in which the relation between potential energy *V,* kinetic energy *(K)* and total energy *E* is as given below: **[3]**

Region A : V > E

Region B : V < E

Region C : K > E

Region D : V > K

State with reason in each case whether a particle can be found in the given region or not.

70. A well 20 m deep and 3 m in diameter contains water to a depth of 14 metre. How long will a 5 hp engine take to empty it? **[3]**

71. Estimate the amount of energy released in the nuclear fusion reaction **[3]**

$_1H^2 + {}_1H^2 \longrightarrow {}_2He^3 + {}_0n^1$

Given that $M({}_1H^2) = 2.0141$ u,

$M({}_2He^3) = 3.0160$ u

Mn = 1.0087 u, where 1 u = 1.661 $\times$ 10^{-27} kg

Express your answer in units of MeV.

72. A curved surface is shown in figure. The portion BCD is free of friction. There are three spherical balls of identical radii and masses. Balls are released from rest one by one from A which is at a slightly greater height than C. With the surface AB, ball 1 has large enough friction to cause rolling down without slipping; ball 2 has a small friction and ball 3 has a negligible friction. **[3]**

i. For which ball is total mechanical energy conserved?

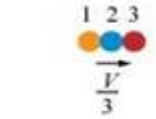
ii. Which ball (s) can reach D?

iii. For balls which do not reach D, which of the balls can reach back A?

73. Two identical ball bearings in contact with each other and resting on a frictionless table are hit head-on by another ball bearing of the same mass moving initially with a speed V. If the collision is elastic, which of the following figure is a possible result after collision? **[3]**

a. 

b. 

c. 

74. If the kinetic energy of a body increases by 300%, by what % will the linear momentum of the body increase? **[3]**

75. A railway carriage of mass 9000 kg moving with a speed of 36 kmh^{-1} collides with a stationary carriage of the same mass. After the collision, the carriages get coupled and move together. What is their common speed after collision? What type of collision is this? **[3]**