CBSE

WORK ENERGY AND POWER WS 9

Class 11 - Physics

Section A

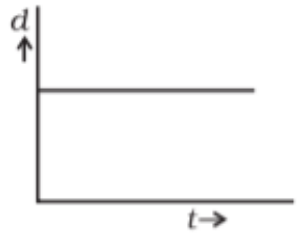
1. A particle is acted by a constant power. Then, which of the following physical quantity remains constant? **[1]**

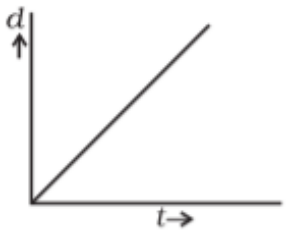
   a) Rate of change of acceleration
   b) Rate of change of kinetic energy
   c) Kinetic energy
   d) Speed

2. A constant force F is pushing a 5 kg mass on a horizontal surface at a constant velocity of 2 m/s. The coefficient of friction between the surface and the mass is 0.3 (Take g = 10 $\frac{m}{s^2}$). If F acts along the direction of motion, the rate at which F is doing work (in watt) **[1]**

   a) 6
   b) 30
   c) 10
   d) 3

3. A body is moving unidirectionally under the influence of a source of constant power supplying energy. Which of the diagrams shown in Fig. correctly shows the displacement-time curve for its motion? **[1]**

   a) 

   b) 

   c)

   d)

4. An electric pump is used to fill an overhead tank of capacity $9m^3$ kept at a height of 10 m above the ground. If the pump takes 5 min to fill the tank by consuming 10 kW power, the efficiency of the pump should be **[1]**

   a) 40%
   b) 60%
   c) 30%
   d) 20%

5. A pump on the ground floor of a building can pump up water to fill a tank of volume $30m^3$ in 15 min. If the tank is 40 m above the ground, and the efficiency of the pump is 30%, how much electric power is consumed by the pump? **[1]**

   a) 33.6 kW
   b) 45.2 kW
   c) 38.3 kW
   d) 43.3 kW

6. If $\vec{F}$ = (60$\hat{i}$ + 15$\hat{j}$ - 3$\hat{k}$) N and $\vec{v}$ = (2$\hat{i}$ - 4$\hat{j}$ + 5$\hat{k}$) $\frac{m}{s}$, then instantaneous power is **[1]**

a) 45 watt

b) 195 watt

c) 100 watt

d) 75 watt

7. A 50.0-kg marathon runner runs up the stairs to the top of a 443-m-tall Tower. To lift herself to the top in 15.0 minutes, what must be her average power output? **[1]**

a) 261 W

b) 221 W

c) 201 W

d) 241 W

8. 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

9. The power (P) of an engine lifting a mass of 100 kg upto a height of 10 m in 1 min is **[1]**

a) 165 W

b) 162.3 W

c) 163.3 W

d) 164.3 W

10. A pump is required to lift 800 kg of water per minute from a well 14.0 m deep and eject it with a speed of 18.0 m/s. How much work is done per minute in lifting the water? **[1]**

a) 1.10×10^5 J

b) 1.40×10^5 J

c) 1.30×10^5 J

d) 1.20×10^5 J

11. A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to **[1]**

a) t^2

b) $t^{1/2}$

c) $t^{3/2}$

d) t

12. A particle moves with a velocity ($5\hat{i}$ - $3\hat{j}$ + $6\hat{k}$) $\frac{m}{s}$ under the influence of a constant force $\vec{F}$ = ($10\hat{i}$ + $10\hat{j}$ + 20 $\hat{k}$) N. The instantaneous power applied to the particle is **[1]**

a) 140 Js^{-1}

b) 170 Js^{-1}

c) 40 Js^{-1}

d) 200 Js^{-1}

13. The Sun converts an enormous amount of matter to energy. Each second, 4.19×10^9 kg-approximately the capacity of 400 average-sized cargo ships-is changed to energy. What is the power output of the Sun? **[1]**

a) 1.57×10^{26} W

b) 3.77×10^{26} W

c) 2.62×10^{26} W

d) 0.72×10^{26} W

14. An engine pumps water through a hosepipe. Water passes through the pipe and leaves it with a velocity of 2 $\frac{m}{s}$. The mass per unit length of water in the pipe is 100 $\frac{kg}{m}$. What is the power of the engine? **[1]**

a) 400 W

b) 800 W

c) 100 W

d) 200 W

15. An electric motor exerts a force of 40 N on a cable and pulls it by distance of 30 m in one minute. The power supplied by the motor (in watt) is **[1]**

a) 2

b) 200

c) 20

d) 10

16. A particle of mass m is driven by a machine that delivers a constant power of k watts. If the particle starts from rest the force on the particle at time t is **[1]**

a) $\sqrt{2mk}t^{\frac{-1}{2}}$

b) $\sqrt{\frac{mk}{2}}t^{\frac{-1}{2}}$

c) $\sqrt{mk}t^{\frac{-1}{2}}$

d) $\frac{1}{2}\sqrt{mk}t^{\frac{-1}{2}}$

17. Power can be expressed as **[1]**

a) $\vec{F} \times \vec{v}$

b) $\vec{F}$·t

c) $\vec{F} \cdot \vec{v}$

d) $\frac{1}{2}\vec{F} \cdot v^2$

18. 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

19. Waterfalls from a height of 60 m at the rate 15 $\frac{kg}{s}$ to operate a turbine. The losses due to frictional forces are 10% of energy. How much power is generated by the turbine? Take g = 10 m/s^2. **[1]**

a) 10.2 kW

b) 7.0 kW

c) 8.1 kW

d) 12.3 kW

20. 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) $t^{1/2}$

21. A car of mass 1000 kg accelerates uniformly from rest to a velocity of 54 $\frac{km}{h}$ in 5 s. The average power of the engine during this period in watt is (neglect friction) **[1]**

a) 2250 W

b) 2000 W

c) 22500 W

d) 5000 W

22. **Assertion:** Power delivered by all forces acting on a particle moving in a uniform circular motion is always zero. **[1]**

Reason: Work done by all forces acting on a particle moving in a uniform circular motion is zero.

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.

23. **Assertion (A):** Power of machine gun is determined by both, the number of bullets fired per second and kinetic energy of bullets. **[1]**

Reason (R): Power of any machine is defined as work done (by it) per unit time.

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.

24. **Assertion:** A particle is rotated in a vertical circle with help of a string. Power delivered by the tension in the string to the particle is zero. **[1]**

Reason: In vertical circular motion, tension is always perpendicular to instantaneous velocity.

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.

25. **Assertion (A):** The instantaneous power of an agent is measured as the dot product of instantaneous velocity and the force acting on it at that instant. **[1]**

Reason (R): The unit of instantaneous power is watt.

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.

26. **Assertion (A):** The power of a pump which raises 100 kg of water in 10 sec to a height of 100 m is 10 kW. **[1]**

Reason (R): The practical unit of power is horsepower.

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.

27. **Assertion (A):** Power developed in a circular motion is always zero. **[1]**

Reason (R): Work done in circular motion is zero.

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.

28. A car of mass m is driven with an acceleration a along a straight level road against a constant external resistive force R. When the velocity of the car is v, the rate at which engine of the car is doing work, will be **[1]**

a) $(R + ma)\cdot v$

b) $(ma - R)\cdot v$

c) $ma\cdot v$

d) $R\cdot v$

29. A machine can take out 1000 kg of mud per hour from a depth of 100 m. If the efficiency of the machine is 0.9, calculate its power. **[1]**

30. Define power and its SI unit. **[1]**

31. A lift is designed to carry a load of 4000 kg through 10 floors of a building averaging 6 m per floor in 10 seconds. Calculate the horsepower of the lift. **[1]**

32. Why is electrical power required at all when the elevator is descending? Why should there be a limit on the number of passengers in this case? **[1]**

33. When a constant force is applied to a body moving with constant acceleration, is the power of the force **[1]**

constant? If not, how would force have to vary with speed for power to be constant?

34. An engine of 4.9 kW power is used to pump water from a well 50 m deep. Calculate the quantity of water in kilolitres which it can pump out in one hour. **[1]**

35. Calculate the power of an electric engine which can lift 20 tonnes of coal per hour from a mine 180 m deep. **[1]**

36. Name the physical quantity which is expressed as force times velocity. Is it a scalar or a vector quantity? **[1]**

37. What are the dimensions of power? Is it scalar or vector? **[1]**

38. A man weighing 60 kg climbs up a staircase carrying a load of 20 kg on his head. The staircase has 20 steps each of height 0.2 m If he takes 10 s to climb, find his power. **[1]**

39. How many watts are there in one horsepower? **[1]**

40. A 30 m deep well is having water upto 15 m. An engine evacuates it in one hour. Calculate the power of the engine if the diameter of the well is 4 m. **[1]**

41. One coolie takes 1 min to raise a box through a height 2 m. Another takes 30 s for the same job and does the same amount of work. Which one of these two has greater power and which one uses greater energy? **[1]**

42. A machine gun fires 60 bullets per minute with a velocity of 700 ms^{-1}. If each bullet has a mass of 50 g, find the power developed by the gun. **[1]**

43. Water is pumped out of a well 10 m deep by means of a pump rated at 10 kW. Find the efficiency of the motor if 4200 kg of water is pumped out every minute. Take g = 10 ms^{-2}. **[1]**

44. A body of mass m accelerates uniformly from rest to velocity v_1 in time t_1. Find the expression for the instantaneous power delivered to the body as a function of time. **[1]**

45. A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to **[1]**

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

    ii. t

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

    iv. t^2

46. About 4×10^9 kg of the matter is converted into energy in the sun each second. What is the power output of the sun? **[1]**

Section B

47. 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.

48. 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]**

49. Calculate the horsepower of a man who can chew ice at the rate of 30 g per minute. Given 1 hp = 746 W and J = 4.2 J cal^{-1}. **[2]**

50. Calculate the power of a motor which is capable of raising 2000 liters of water in 5 min from a well 120 m deep. **[2]**

51. A car of mass 2000 kg is lifted up a distance of 30 m by a crane in 1 min. A second crane does the same job in 2 min. Do the cranes consume the same or different amounts of fuel? What is the power supplied by each crane? Neglect power dissipation against friction. **[2]**

52. The average work done by a human heart while it beats once is 0.5 J. Calculate the power used by heart if it **[2]**

beats 72 times in a minute.

53. 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]**

54. Define power. Prove that P = $\vec{F} \cdot \vec{v}$, where the symbols have their usual meanings. **[2]**

55. The human heart discharges 75 mL of blood at each beat against a pressure of 0.1 m of Hg. Calculate the power of the heart assuming that pulse frequency is 80 beats per minute. The density of Hg = 13.6 $\times$ 10^3 kgm^{-3}. **[2]**

56. Calculate the power of a crane in watts, which lifts a mass of 100 kg to a height of 10 m in 20s. **[2]**

57. 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

58. A boy of mass 40 kg walks up a flight of stairs to a vertical distance of 12 m, in a time interval of 40 s. **[2]**

i. At what rate is the boy doing work against the force of gravity?

ii. If energy is transformed by the leg muscles of the students at the rate of 30 kJ every minute, what is the students power output?

Section C

59. A bullet of mass 0.01 kg and travelling at a speed of 500 ms^{-1} strikes a block of mass 2 kg which is suspended by a string of length 5 m. The centre of gravity of the block is found to rise a vertical distance of 0.1 m. What is the speed of the bullet after it emerges from the block? Take g = 9.8 ms^{-2}. **[3]**

60. A car of mass 1000 kg accelerates uniformly from rest to a velocity of 54 km h^{-1} in 5 s. Calculate **[3]**

i. its acceleration,

ii. its gain in kinetic energy,

iii. average power of the engine during this period. Neglect friction.

61. An electric motor is used to lift an elevator and its load (total mass = 1500 kg) to a height of 20 m. The time taken for the job is 20 s. What is the work done? What is the rate at which work is done? If the efficiency of the motor is 75%, at which rate is the energy supplied to the motor? **[3]**

62. A man cycles up a hill, whose slope is 1 in 20 with a velocity of 6 A kmh-x along the hill. The weight of the man and the cycle is 98 kg. What work per minute is he doing? What is his horsepower? **[3]**

Section D

Question No. 63 to 66 are based on the given text. Read the text carefully and answer the questions: **[4]**

Power is defined as the time rate at which work is done or energy is transferred. The average power of a force is defined as the ratio of the work, W, to the total time t taken

$P_{av} = \frac{W}{t}$

The instantaneous power is defined as the limiting value of the average power as time interval approaches zero.

$P = \frac{dw}{dt}$

The work dW done by a force F for a displacement dr is dW = F·dr. The instantaneous power can also be expressed as

$P = \frac{F.dr}{dt}$

P = F·v

Where v is the instantaneous velocity when the force is F. Power, like work and energy, is a scalar quantity. Its dimensions are $[ML^2 T^{-3}]$. In the SI, its unit is called a watt (W). The watt is 1 J s^{-1}. The unit of power is named after James Watt, one of the innovators of the steam engine in the eighteenth century. There is another unit of power, namely the horse-power (hp)

1 hp = 746 W

This unit is still used to describe the output of automobiles, motorbikes.

63. What is the term used for the time rate at which work is done or energy is transferred?
64. What is the term used for the limiting value of power as the time interval approaches zero?
65. Define instantaneous power. Give its SI unit and dimensions.
66. 1 horse power is equal to how many watt?

Section E

67. **Fill in the blanks:** **[5]**

(a) A motorboat is moving at a steady speed of 20 ms^{-1}. If the water resistance on the boat is 6000 N, the power of the engine is _____ kW. **[1]**

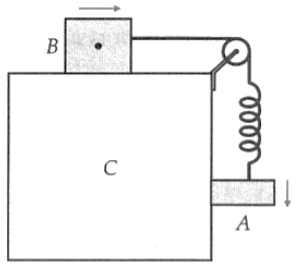
(b) The power of a pump which raises 100 kg of water in 10 s to a height of 100 m is _____ kW. Take g = 10 ms^{-2}. **[1]**

(c) Average power is the ratio of the work to the _____. **[1]**

(d) _____ is defined as the rate at which work is done or energy is transferred. **[1]**

(e) The power of an agent at any instant is equal to the dot product of its _____ and _____ vectors at that instant. **[1]**

68. Two blocks A and B are connected to each other as shown in Fig. The string and spring is massless and the pulley frictionless. Block B slides over the horizontal top surface of stationary block C and block A slides along the vertical side of C both with the same uniform speed. The coefficient of friction between the blocks is 0.2 and the spring constant of spring is 1960 Nm^{-1}. If mass of block A is 2 kg, calculate **[5]**

i. the mass of block B and

ii. energy stored in spring.