**CBSE Test Paper 02**

**Chapter 6 Work Energy & Power**

1. The scalar product of vectors is **1**
   a. non commutative and not distributive
   b. non commutative and distributive
   c. commutative and not distributive
   d. commutative and distributive
2. Power is defined as **1**
   a. ability to do work
   b. energy due to motion
   c. the time rate at which work is done or energy is transferred
   d. stored energy
3. A weight of 20kg falls from a height of 10 m. The work done by the gravitational force is (Take g = 10 m $s^{-2}$) **1**
   a. 3000 J
   b. 2500 J
   c. 1500 J
   d. 2000 J
4. mass and energy are equivalent and are related by **1**
   a. $E = mc^3$
   b. $E = 2mc^2$
   c. $E = mc^2/2$
   d. $E = mc^2$
5. S.I unit of power is **1**
   a. Joule
   b. Newton
   c. Angstrom
   d. Watt
6. 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**
7. Which physical terms remain conserved in an inelastic collision? **1**

8. What is the loss in kinetic energy after a collision, if the target body is initially at rest? **1**

9. Write the advantages and disadvantages of platinum resistance thermometer. **2**

10. 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? **2**

11. On complete combustion a litre of petrol gives off heat equivalent to $3 \times 10^7$ J. In a test drive a car weighing 1200 kg including the mass of driver, runs 15 km per litre while moving with a uniform speed on a straight track. Assuming that friction offered by the road surface and air to be uniform, calculate the force of friction acting on the car during the test drive, if the efficiency of the car engine were = 0.5. **2**

12. Develop a relation between the co-efficient of linear expansion, co-efficient superficial expansion and coefficient of cubical expansion of a solid. **3**

13. An adult weighing 600 N raises the centre of gravity of his body by 0.25 m while taking each step of 1 m length in jogging. If he jogs for 6 km, calculate the energy utilized by him in jogging assuming that there is no energy loss due to friction of ground and air. Assuming that the body of the adult is capable of converting 10% of energy intake in the form of food, calculate the energy equivalents of food that would be required to compensate energy utilised for jogging. **3**

14. The blades of a windmill sweep out a circle of area A. **3**
    i. If the wind flows at a velocity v perpendicular to the circle, what is the mass of the air passing through it in time t?
    ii. What is the kinetic energy of the air?
    iii. Assume that the windmill converts 25% of the wind's energy into electrical energy, and that A = 30 $m^2$, v = 36 km/h and the density of the air is 1.2$kgm^{-3}$. What is the electrical power produced?

15. A body of mass M at rest is struck by a moving body of mass m. Prove that fraction of the initial KE of the mass m transferred to the struck body is $4mM/(m + M)^2$ in an elastic collision. **5**

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**Answer**

1. d. commutative and distributive

   **Explanation:** Scalar product is

   a. Commutative:

   $\vec{A}.\vec{B} = \vec{B}.\vec{A}$

   $|A||B|\cos\theta = |B||A|\cos\theta$

   b. Distributive

   $\vec{A}.(\vec{B}+\vec{C}) = \vec{A}.\vec{B} + \vec{A}.\vec{C}$

2. c. the time rate at which work is done or energy is transferred

   **Explanation:** Power is the rate of doing work. It is the amount of energy consumed per unit time. Having no direction, it is a scalar quantity. In the SI system, the unit of power is the joule per second (J/s), known as the watt. The integral of power over time defines the work performed.

   $P = \frac{dW}{dt} = \frac{d(\vec{F}.\vec{s})}{dt}$

   if force is constant

   $P = \vec{F}\frac{d\vec{s}}{dt} = \vec{F}.\vec{v}$

3. d. 2000 J

   **Explanation:** $W = Fs\cos\theta = mgh\cos 0^{\circ}$

   $W = 20 \times 10 \times 10 \times 1 = 2000J$

4. d. $E = mc^2$

   **Explanation:** Mass–Energy equivalence states that anything having mass has an equivalent amount of energy and vice versa, with these fundamental quantities directly relating to one another by Einstein's theory of special relativity. It shows that matter (as mass) and energy can be converted into each other according to the famous equation $E = mc^2$

5. d. Watt

   **Explanation:** The SI unit of power, equivalent to one joule per second,

corresponding to the rate of consumption of energy (Work done).

6. When elevator is descending then it is not its free fall under gravity it descends with uniform speed. Power is required to decrease the velocity due to free fall.
   Power of motor or system of an elevator is constant and a limited or specified power can stop the speed of freely falling of passenger along with elevator.

7. In an inelastic collision, total linear momentum of the system, as well as total energy, remain conserved. Though kinetic energy of the system changes.

8. The loss in K.E (kinetic energy) after the collision is given by:
   $\frac{1}{2}\left(\frac{m_1 m_2}{m_1+m_2}\right)u^2$
   Where 'u' is the initial velocity.

9. **Advantages of Platinum Resistance thermometer:-**

   i. High accuracy of measurement
   ii. Measurements of temperature can be made over a wide range of temperature i.e. from - $260^0$C to $1200^0$C.

   **Disadvantages of Platinum Resistance thermometer:-**

   i. High Cost
   ii. Requires additional equipment such as bridge circuit, Power supply etc.

10. Mass of the bolt, m = 0.3 kg
    Speed of the elevator = 7 m/s
    Height, h = 3 m
    Since the relative velocity of the bolt with respect to the lift is zero, at the time of impact, potential energy gets converted into heat energy.
    Heat produced = Loss of potential energy
    = mgh = $0.3 \times 9.8 \times 3$ = 8.82 J
    The heat produced will remain the same even if the lift is stationary. This is because of the fact that the relative velocity of the bolt with respect to the lift will remain zero.

11. Efficiency of car engine = 0.5
    $\therefore$ Energy given by car by 1 litre of petrol = $0.5 \times 3 \times 10^7$

$= 1.5 \times 10^7$

Work done by car in 15 km = F.s

$= f \times 15000 J \{s = 15km = 15000m/s\}$

This work done by car is only against force of friction $f$ as car is going horizontally only.

$\therefore f \times 15000 = 1.5 \times 10^7$

$f = \frac{1.5 \times 10^7}{15000} = 10^3 N$

12. Since, co-efficient of linear expansion , α = $\frac{\Delta L}{L \Delta T}$

ΔL = change in length

L = length

ΔT = change in temperature , for an infinitesimally small change in temperature

$\alpha = \frac{dL}{LdT}$

Similarly, co-efficient of superficial expansion , β = $\frac{dS}{SdT}$

dS = infinitesimal change in area

S = original area

dT = infintesimaly change in temperature

S = $L^2$

, $\beta = \frac{1}{L^2} \frac{dL^2}{dT} = 2L \frac{dL}{dT}$

$\beta = 2\alpha$

similarly , Co-efficient of cubical expansion, $\gamma = \frac{dV}{VdT}$

dV = infinitesimal change in volume

V = original volume

dT = infinitesimal change in temperature

$\gamma = \frac{1}{L^3} \frac{dL^3}{dT} = 3 \frac{1}{L} \frac{dL}{dT} = 3\alpha$

$\alpha = \frac{\beta}{2} = \frac{\gamma}{3}$

13. According to question the weight of the Jogger = 600 N

Work done in raising the center of gravity = mgh

work Done = 600 x 0.25 = 150 J

$\therefore$ Number of steps in 6 Km= $\frac{6000m}{1m} = 6000 steps$

Energy utilised in 6000 m = $6000 \times 150 = 900000 J$

Since 10% of energy utilised in jogging.

∴ Energy utilised in jogging = 900000 × 0.1 = 90000 J

14. i. Area swept by blades of windmill = A, and velocity of wind = v
Therefore, Volume of air passing per unit time = A × v
Also, Mass of air passing per unit time = Av$\rho$
and mass of air passing in time t, M = A × v$\rho$t

ii. Kinetic Energy of said quantity of air, K = $\frac{1}{2}Mv^2 = \frac{1}{2}A\rho tv^3$

iii. If it is assumed that the efficiency of the windmill is 25%, then we have
Output electrical power = 25% of input power = $\frac{25}{100} \times \frac{1}{2}A\rho v^3$
As A = 30 $m^2$, v = 36 m / h = $36 \times \frac{5}{18} m/s$ = 10 m/s and $\rho$ =1.2 $kgm^{-3}$
Therefore, Output electrical power = $\frac{25}{100} \times \frac{1}{2} \times 30 \times 1.2 \times (10)^3$= 4500 W= 4.5 kW [ because 1 kiloWatt = 1000 Watt]
Hence, electrical power produced = 4.5 kW

15. Here we have, $m_1$ = mass of neutron = m
$m_2$ = mass of target nucleus = M
$u_1$ = u and $u_2$ = 0 ( M is at rest)
Now from the collision theory we know that, $v_2 = \frac{2m_1}{m_1+m_2} \cdot u_1 + \frac{m_2-m_2}{m_1+m_2} \cdot u_2$
$= \frac{2m}{m+M} \cdot u + 0 = \frac{2mu}{m+M}$
Initial kinetic energy of mass m, $K_1 = \frac{1}{2}m_1u_1^2 = \frac{1}{2}mu^2$
Final Kinetic Energy of mass M,e
$K_2 = \frac{1}{2}m_2v_2^2 = \frac{1}{2}M\left(\frac{2mu}{m+M}\right)^2 = \frac{2Mm^2u^2}{(m+M)^2}$
A fraction of the kinetic energy transferred is given by:
$f = \frac{K_2}{K_1} = \frac{2Mm^2u^2}{(m+M)^2} \times \frac{2}{mu^2} = \frac{4mM}{(m+M)^2}$

i. For deuterium, M = 2m, therefore
$f = \frac{4m \times 2m}{(m+2m)^2} = \frac{8}{9} \simeq 0.9$
that is about 90% of the neutron's energy is transferred to deuterium.

ii. For carbon, M =12m, therefore
$f = \frac{4m \times 12m}{(m+12m)^2} = 0.284$
that is about 28.4% of the neutron's energy is transferred to carbon.