# PHYSICS

# BOOKS - JEEVITH PUBLICATIONS PHYSICS (KANNADA ENGLISH)

# WORK, POWER AND ENERGY

## One Marks Questions And Answers

**1.** When is work said to be done?

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**2.** Represent work in the form of an equation.

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**3.** When is work said to be minimum and maximum in terms of magnitude?

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**4.** Give the dimensional formula for work.

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**5.** What is the S.I. unit of work?

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**6.** Define the unit joule.

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**7.** Represent work done by a constant force graphically.

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**8.** Represent work done on a body by a variable force, graphically.

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**9.** Give an example for positive work.

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**10.** Give an example for negative work.

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**11.** Define dot product of two vectors.

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**12.** Represent component of one vector along the direction of the other vector pictorially.

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**13.** Represent the angle between two vectors in terms of the scalar product of those vectors.

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**14.** When is work said to be done?

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**15.** Express work done in terms of force and displacement.

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**16.** Express work in terms of energy.

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**17.** A cyclist stops by applying brakes on the road. What is the work done by the cycle on the road?

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**18.** Give the dimensional formula for work.

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**19.** Give the formula for the kinetic energy of a physical body.

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**20.** Write the SI unit of energy.

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**21.** Give the expression for work done by a variable force.

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**22.** Express K.E. of a body in terms of force mathematically.

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**23.** Express P.E. of a body in terms of force mathematically.

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**24.** What is meant by a conservative force?

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**25.** Say whether total mechanical energy is conserved for a conservative force or not.

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**26.** Give the expression for a spring force.

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**27.** If k is the force constant of the spring and $\mu$ is the coefficient of friction between the body of mass m and the floor, then write the total negative work done on the body tied to a spring at one end and the other end of the spring to a rigid support.

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**28.** What is meant by exothermic reaction?

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**29.** What is meant by endothermic reaction?

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**30.** Write the expression for energy equivalent of mass (Einstein's mass-energy equation).

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**31.** Define power.

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**32.** What is the source of energy of stars?

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**33.** Express average power in terms of work done.

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**34.** Express instantaneous power mathematically.

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**35.** Express instantaneous power in terms of $\overrightarrow{F}$ and $\overrightarrow{v}$.

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**36.** Express 1 HP in terms of watts.

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**37.** What is elastic collision?

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**38.** What is meant by inelastic collision?

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**39.** If $m_1$ collides another mass body $m_2$ at rest elastically, then what will be the fraction of kinetic energ lost by $m_1$ to the second body?

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**40.** If $m_1$ collides another mass body $m_2$ elastically, then what will be the fraction of kinetic energy retained by the body of mass $m_1$.

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**41.** If a body of mass $m_1$ moving with velocity $v_1$ collides inelastically with another mass $m_2$ at rest then give the expression for loss in the K.E. of the system.

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**42.** Define coefficient of resilience or restitution.

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**43.** What is the value of coefficient of restitution for a perfectly elastic collision?

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**44.** What is the value of coefficient of restitution for a perfectly inelastic collision?

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## Two Marks Questions And Answers

**1.** Deduce the work-energy theorem for a constant force.

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**2.** Represent work done on a body by a variable force, graphically.

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**3.** Calculate the amount of work done by the force on a body from the following graph

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**4.** What are the minimum and maximum speeds of a particle, describing a uniform circular motion?

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**5.** Give the expressions for work done by the spring and external pulling force.

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**6.** Represent KE and PE of a particle executing SHM graphically.

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**7.** Express $10^{-24}$ J in terms of eV.

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**8.** Express 5MeV in terms of J.

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**9.** Show that the power delivered to a body initially at rest and with a constant acceleration, is directly proportional to time.

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**10.** What are exothermic and endothermic chemical reactions?

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**11.** Write mass-energy equation and explain the symbols used.

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**12.** When a conservative force does a positive work an a body, the P.E of the body.....

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**13.** The work done by a body against friction always results in

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**14.** The rate of change of total momentum of a many particle system is proportional to the.....

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**15.** In an elastic collision of two bodies, the quantities which do not change after the collision are.....and.....

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## Three Marks Questions And Answers

**1.** Show that the displacement in time t is proportional to $t^{\frac{3}{2}}$ under the influence of a constant power.

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**2.** Distinguish between potential energy and kinetic energy.

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**3.** State and explain the law of conservation of mechanical energy.

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**4.** What is meant by a conservative force?

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**5.** Explain the work done by a varible force.

Watch Video Solution

**6.** Distinguish between elastic and inelastic collisions.

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## Five Marks Questions And Answers

**1.** Prove that change in kinetic energy of a paticle is equal to the work done on it by a variable force.

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**2.** What is the type of force that acts on a spring? Explain work energy theorem with respect to a spring.

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**3.** Obtain an expression for common velocity and loss in the kinetic energy for a moving body $m_1$ colliding against another at rest.

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**4.** Obtain an expression for final velocities of two colliding bodes initially in motion.

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**5.** Discuss different cases, to find final velocities for two bodies in the below expression for

$$v_{1f} = \frac{(m1 - m2)v1i}{m1 + m2} \text{ and } v_{2f} = \frac{2m1v1i}{m1 + m2}$$

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**6.** State the law of conservation of mechanical energy. Show that total mechanical energy of a body falling freely under gravity is conserved.

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## Numericals With Solutions

**1.** The K.E. of electron is 10 keV. Calculate its speed.

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**2.** A family uses 8 kW of power. Direct solar energy is incident on the horizontal surface at an average rate of 200W per sq. m. If 20% of this energy can be converted into useful electrical energy, how large an area is needed to supply 8 kW?

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**3.** What is the amount of energy released per atomic fission of U-235 by a stray neutron?

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**4.** What is the approximate energy released in the fusion of four protons under high pressure and a million kelvin of temperature?

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**5.** An electron and a proton are detected in a cosmic ray experiment, the first with kinetic energy 10 keV, and the second with 100 keV. Which is faster, the electron or the proton? Obtain the ratio of their speeds. (electron mass $= 9.11 \times 10^{-31} kg$, proton mass $= 1.67 \times 10^{-27} kg$, $1eV = 1.60 \times 10^{-19} J$).

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**6.** A rain drop of radius 2 mm falls from a height of 500 m above the ground. It falls with decreasing acceleration until at half its original height, it attains its maximum speed and moves with uniform speed thereafter. What is the work done by the gravitational force on the drop in the first and second half of its journey? What is the work done by the resistive force in the entire journey, if its speed on reaching the ground is $10ms^{-1}$?

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**7.** A body constrained to move along the z-axis of a coordinate system is subject to a constant force 'F' is given by $\overrightarrow{F} = -\hat{i} + 2\hat{j} + 3\hat{k}N$. What is the work done by this force in moving the body through a distance of 4 m along the z-axis?

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**8.** A molecule in a gas container hits a horizontal wall with a speed of $200ms^{-1}$ and

angle $30^\circ$ with the normal and rebounds with the same speed. Is momentum conserved in the collision? Is the collision elastic or inelastic.

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**9.** A force of $\vec{F} = \left(\hat{i} + 2\hat{j} + 3\hat{k}\right) N$ when acting on a particle propels it from a point $\left(\hat{i} + \hat{j} + \hat{k}\right)$ to a point $\left(\hat{i} - \hat{j} + 2\hat{k}\right)$. Calculate the amount of work done by the force.

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**10.** A pump is required to lift $800kg$ of water per minute from a 10 m deep well and eject it with speed of $20m/s$ . The required power in watts of the pump will be

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**11.** The potential energy of a particle in the X-Y plane is given by $U = k(x + y)$, where 'k' is a constant. Find the amount of work done by

the conservative force in moving a particle from (1, 1) to (2, 3).

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**12.** A fire engine can throw 400 gallons of water per minute to a height of 40 m. What H.P. does this represent? (1 gallon of water weights 4.536 kg).

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**13.** A car weighing 550 kg, ascends a hill with a gradient of 1 in 6 at a speed of 36 kmph. Find how much work is done per second, (a) in moving the car up the hill overcoming a total force of friction and air resistance equal to 350 kgwt.

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**14.** A turbine generates 1.64 MW. Assuming the efficiency to be 80% and head of water used

1663 m, calculate the rate of flow of water.

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**15.** A steam turbine shovel lifts $10^3$ kg of earth to a height of 3.75 m in 4s. If an engine working at $1.09 \times 10^4 W$ is used, then find how much work is wasted per second and the efficiency of the steam shovel.

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**16.** The makers of a certain motor car state that if the brakes are applied fully on a dry level road at 48 kmph, the vechicle will stop in 13m. A motorist while driving one of these cars on a level road was involved in an accident. However, if he claimed that he was proceeding at 32 kmph, and he had stopped in 3m after applying the brakes, then justify whether the claim was right or wrong.

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**17.** A machine gun fires 25 bullets of mass 0.1 kg each, per minute. If the speed of the bullet is $200ms^{-1}$, then calculate the power developed by the gun.

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**18.** A cloud of thickness 10 m and area $10^6m^2$ is formed at a height of 2 km above the ground. If the density of water is $10^3kgm^{-3}$, then calculate the potential energy of the cloud $\left(g = 9.8ms^{-2}\right)$.

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**19.** A body of mass 10 kg at a height 200 m falls freely. Calculate the kinetic energy with which it strikes the ground. What will be the linear momentum of the body? With what velocity will it strike the ground?

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**20.** A cart is used to lower vertically, a block of mass 10 kg over a distance of 0.30 m, at a

constant downward acceleration of $\left(\frac{g}{4}\right)$. Find the work done by the cart on the block.

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**21.** A body of mass 5 kg, initially at rest, moves under the action of an applied force of 15N on a horizontal surface with a coefficient of friction 0.25. Calculate

(a) Work done by the force (b) Work done by friction

(c ) Work done by net force (d) Change in kinetic energy in 5s.

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**22.** The blades of a windmill sweep out a circle of area $30m^2$. If the wind flows at a velocity $10ms^{-1}$ at right angles to the circle, what is the mass of the air passing through it in time t? What is the kinetic energy of the air? If the density of air is 1.2 $kgm^{-3}$, then calculate the electric power produced if the windmill

converts 25% of wind energy into electrical energy.

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**23.** A block of wood of mass 0.5 kg is suspended by means of a thin wire. A bullet of mass 0.020 kg is fired horizontally in the plane of the block with a velocity of $100ms^{-1}$. If the bullet gets stuck inside the block, then calculate the height by which the system rises

$\left(g = 9.8ms^{-2}\right)$. Calculate the amount of heat produced in the block.

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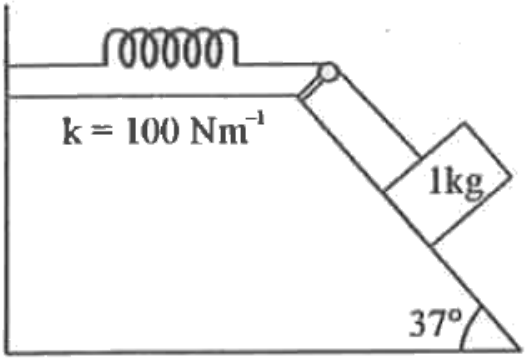
**24.** In the figure show below, calculate the coefficient of friction between the block and the inclined plane. Assume that the mass of the block s 1 kg. The block is released from rest and stops by covering the distance of 0.1 m on

the plane.

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**25.** A bullet of mass 0.012 kg and horizontal speed $70ms^{-1}$ strikes a block of wood of mass 0.4 kg and instantly comes to rest with respect to the block. The block is suspended from the ceiling by means of thin wires. Calculate the

height to which the block rises. Estimate the loss in kinetic energy.

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**26.** The bob of a pendulum is released from a horizontal position. If the length of the pendulum is 1.5m, what is the speed with which the bob arrive at the lower most point, given that, it dissipated 5% of its initial energy against air resistance?

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**27.** A person trying to lose weight lifts a 10 kg mass, one thousand times, to a height of 0.5m each time. Assume that the P.E. lost each time the person lowers the mass is dissipated.

How much work does the person do against the gravitational force?

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**28.** A person trying to lose weight lifts a 10 kg mass, one thousand times, to a height of 0.5m

each time. Assume that the P.E. lost each time the person lowers the mass is dissipated.

Fat supplies $3.8 \times 10^7$J of energy per kg which is converted to mechanical energy with a 20% efficiency rate. How much fat will the dieter use up?

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**29.** The blades of a windmill sweep out a circle of area $30m^2$. If the wind flows at a velocity $10ms^{-1}$ at right angles to the circle, what is

the mass of the air passing through it in time t? What is the kinetic energy of the air? If the density of air is 1.2 $kgm^{-3}$, then calculate the electric power produced if the windmill converts 25% of wind energy into electrical energy.

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**30.** The blades of a windmill sweep out a circle of area A.

If the wind flows at a velocity v perpendicular

to the circle, What is the kinetic energy of the air?

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**31.** The blades of a windmill sweep out a circle of area $30m^2$. If the wind flows at a velocity $10ms^{-1}$ at right angles to the circle, what is the mass of the air passing through it in time t? What is the kinetic energy of the air? If the density of air is 1.2 $kgm^{-3}$, then calculate the electric power produced if the windmill

converts 25% of wind energy into electrical energy.

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**32.** Two inclined frictionless tracks, one gradual and the other steep meet at A, from where two stones are allowed to slide down from rest, one on each track. Will the stones reach the bottom at the same time? Will they reach there with the same speed? Given

$\theta_1 = 30^\circ, \theta_2 = 60^\circ, h = 10m$. What are the speeds and time taken by the two stones?

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**33.** A particle moves along the x-axis from $x = 0$ to $x = 5m$ under the influence of a force given by $F = 7 - 2x + 3x^2$. Calculate the work done in doing so.

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