SRIGAYATRI EDUCATIONAL INSTITUTIONS
INDIA

WORK ENERGY AND POWER (UT-05 QB)

1. A Body of mass 2 kg initially at rest moves under the action of an applied horizontal force of 8N on a table with coefficient of kinetic friction =0.1 compute the work done by friction in 10 S

2. A force acts on a 2kg object so that its position is given as a function of time as $x=3t^2+5$. What is the work done by this force in first 5 seconds---------J

3. A pump on the ground floor of a building can Pump up water to fill a tank of volume in $30m^3$ in 10m. If the tank 40 m above the ground, and the efficiency of the Bump is 30% how much elastic power is consumed by the pomp?

4. A body of mass 0.2 kg travels in a straight line with velocity $\upsilon = ax^{3/2}$ where $a = 5m^{-1/2}5^{-1}$? what is the work done by the net force during its displacement from x=0 to x=2 m.

5. A bullet of mass 0.012 kg and horizontal speed 8 om s^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 celling by means of this wires. Calculate the height of which the block rises. Also, estimate the amount of heat produced in the block.

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 $5\text{m}5^{-1}$ relative to the trolley in direction opposite to the its motion, and jumps out of the trolley. What is the final speed of the trolley? How much has the trolly moved from the time the child begins to run ?

7. Find the angle between force $\vec{F} = \left(3\hat{i} + 4j - 5k\right)$ unit and displacement $d = (5\hat{i} + 4j + 3k)$ unit . Also find the projection of F and d.

8. m a ballistics demonstration a police officer fires a bullet of mass 50.0g with speed $200ms^{-1}$ on soft polywood of thickness 4.00cm. The bullet emerges with only 10% of its initial kinetic energy. what is the emergent speed of the bullet ?

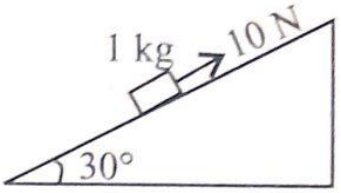
9. A women pushed a trunk on a Railway platform which as a rough surface. She applies a force of 150 N over a distance of 10 M. Thereafter she gets progressively tired and her applied force reduces linearly with distance to 50N. The total distance through which the trunk has been moved is 20m. Frictional force 50 N. Calculate the work done by the two forces over 20 m.

10. An elevator can carry a maximum load of 16 kg celevator + passengers is moving up with a constant speed of $2ms^{-1}$. The frictional force opposing the motion is 4000N. Determine the minimum power delivered by the motor to all elevator in watts as well as in horse power .

11. A body of mass 4 kg is moving of $8kg\,ms^{-1}$. A force 0.2 N acts on it in the direction of motion of the body for 10 s. The increase in kinetic energy is
a) 10 J b) 8.5 J c) 4.5 J d) 4 J

12. A particle acted upon by constant forces $4\hat{i}+\hat{j}-3\hat{k}$ and $3\hat{i}+\hat{j}-\hat{k}$ is displacement from the point $\hat{i}+2\hat{j}+3\hat{k}$ to point $5\hat{i}+4\hat{j}+\hat{k}$. The total work done by the forces in SI unis is
a) 20 b) 40 c) 50 d) 30

13. A block of mass 1 kg is pushed up a surface inclined to horizontal at an angle of 30^0 by a force of 10 N parallel to the inclined surface as shown in the figure. The coefficient of friction between block and the incline is 0.1 . If the block is pushed up by 10 m along the incline, then the work against gravity is $\left(Take\ g=10ms^{-2}\right)$



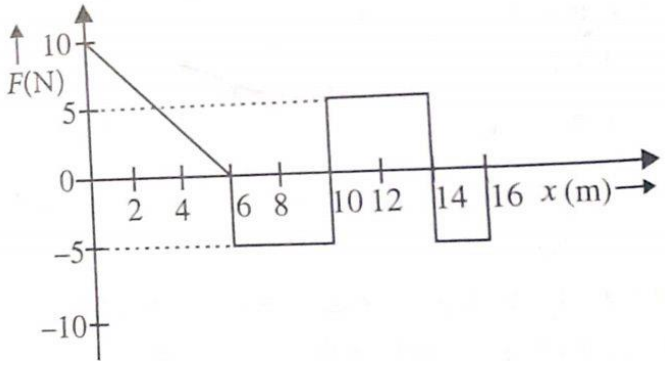
a) 10 J b) 50 J c) 100 J d) 150 J

14. A truck and a car moving with the same kinetic energy are brought to rest by the application of brakes which provide equal retarding forces. Which of them will come to rest in a shorter distance?
(a) The truck (b) The car
(c) Both will travel the same distance before coming to rest
(d) Cannot be predicted

15. In a ballistics demonstration a police officer fires a bullet of 50g with speed $200\,ms^{-1}$ on soft plywood of thickness 2 cm. The bullet emerges with only 10% of its initial kinetic energy. The emergent speed of the bullet is
a) $2\sqrt{10}\text{ms}^{-1}$ b) $20\sqrt{10}\text{ms}^{-1}$ c) $10\sqrt{2}\,\text{ms}^{-1}$ d) $10\sqrt{20}\,\text{ms}^{-1}$

16. A running man has half the kinetic energy than a boy of half his mass has . The man speed up by a $1.0\,\text{ms}^{-1}$ and then he has same energy as the boy. The original speed of the man and boy respectively are
a) $2.4\text{ms}^{-1}, 1.2\text{ms}^{-1}$ b) $1.2\text{ms}^{-1}, 4.4\text{ms}^{-1}$
c) $2.4\text{ms}^{-1}, 4.8\text{ms}^{-1}$ d) $4.8\text{ms}^{-1}, 2.4\text{ms}^{-1}$

17. A particle is acted upon by a force F which varies with position x as shown in figure. If the particle x = 0 has kinetic energy energy of 25J , then the particle at x=16 m is.



a) 45 J b) 30 J c) 70 J d) 20 J

18. A particle in a certain conservative force field has a potential energy given by $V=\frac{20xy}{z}$. The force exerted on it is
(a) $\left(\frac{20y}{z}\right)\hat{i}+\left(\frac{20x}{z}\right)\hat{j}+\left(\frac{20xy}{z^2}\right)\hat{k}$

$(b)-\left(\frac{20y}{z}\right)\hat{i}-\left(\frac{20x}{z}\right)\hat{j}+\left(\frac{20xy}{z^2}\right)\hat{k}$

(c) $-\left(\frac{20y}{z}\right)\hat{i}-\left(\frac{20x}{z}\right)\hat{j}-\left(\frac{20xy}{z^2}\right)\hat{k}$

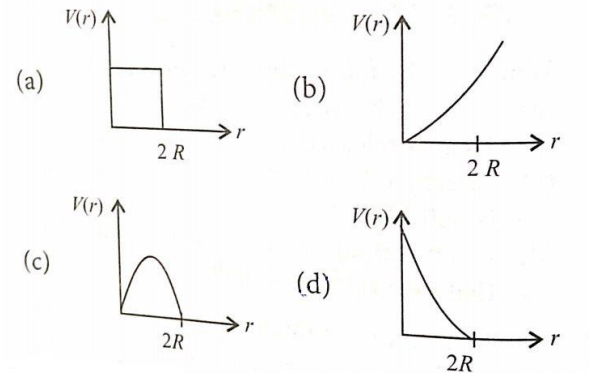
(d) $\left(\frac{20y}{z}\right)\hat{i}+\left(\frac{20x}{z}\right)\hat{j}-\left(\frac{20xy}{z^2}\right)\hat{k}$

19. In a shotput event an athlete throws the shotput of mass 20 kg with an initial speed of $2ms^{-1}$ at 45° from a height 3 m above ground. Assuming air resistance to be negligible and acceleration due to gravity to be $10ms^{-2}$ the kinetic energy of the shotput when it just reaches the ground will be
(a) 2.5 J (b) 5 J (c) 525 J (d) 640 J

20. The bob of a pendulum is released from a horizontal position. If the length of pendulum is 2 m, what is the speed with which the bob arrives at the lower most point. Assume that 10% of its energy is dissipated against air resistance. $\left(Take\, g = 10\, ms^{-2}\right)$

a) $4ms^{-1}$ b) $6ms^{-1}$ c) $8ms^{-1}$ d) $10ms^{-1}$

21. Which of the following potential energy curves possibly describe the elastic collision of two billiard balls each of radius R. Here r is the distance between centres of the balls.



22. A ball falls under gravity from a height of 10 m with an initial downward velocity u. It collides with the around. losses 50% of its energy in collision and then rises back to the same height. The initial velocity u is

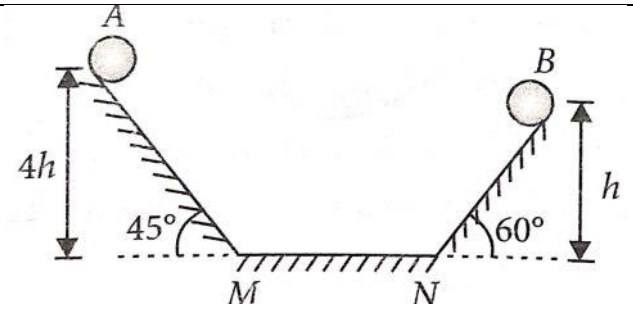
a) $7ms^{-1}$ b) $25ms^{-1}$ c) $14ms^{-1}$ d) $28ms^{-1}$

23. A neutron collides, head-on with a deuterium at rest. What fraction of the neutron's energy would be transferred to the deuterium?
(a) 89% (b) 11% (c) 79% (d) 21%

24. A bicyclist comes to a skidding stop in 10m. During the force on the bicycle due to the road is 200 N and is directly opposed to the motion. The work done by the cycle on the road is
(a) +2000 J (b) -200 J (c) zero (d) -20000J

25. In a shotput event an athlete throws the shotput of mass 10kg with an initial speed of 1 m/s at 45^0 from a height 1.5 m above ground. Assuming air resistance to be negligible and acceleration due to gravity to be $10m/s^2$, the kinetic energy of the shotput when it just reaches the ground will be
(a) 2.5 J (b) 5.0 J (c) 52.5 J (d) 155.0 J

26. Two identical balls A and B are released from the positions shown in the figure. They collide elastically on horizontal portion MN. The ratio of heights attained by A and B after collision will be (neglect friction)



a) 1 : b) 2: 1 c) 4: 13 d) 2 :11

27. A force F=20 +10 y acts on a particle in y –direction where F is in newton and y metre .Work done by this force to move the particle from y = 0 to y=1 m is
a) 20 J b) 30 J c) 5 J d) 25 J

28. A body of mass m starts moving from rest along x -axis so that its velocity varies as $v = a\sqrt{s}$ where a is a constant and s is the distance covered by the body. The total work done by all the forces acting on the body in the first t seconds after the start of the motion is
a) $\frac{1}{4}ma^4t^2$ b) $4ma^4t^2$ c) $\frac{1}{8}ma^4t^2$ d) $8ma^4t^2$

29. A body of mass 1 kg begins to move under the action of a time dependent force $\vec{F} = \left(2t\hat{i} + 3t^2\hat{j}\right)\text{N}$, where $\hat{i}$ & j are unit vectors along x and y axis. What power will be developed by the force at the time t ?
a) $\left(2t^3 + 3t^4\right)W$ b) $\left(2t^3 + 3t^5\right)W$ c) $\left(2t^3 + 3t^3\right)W$ d) $\left(2t^2 + 3t^4\right)W$

30. A body of mass m_1 moving with an unknown velocity of $v_1\hat{i}$ undergoes a collinear collision with a body of mass m_2 moving with a velocity $v_2\hat{i}$. After collision, m_1 *and* m_2 move with velocities of $v_3\hat{i}$ and $v_4\hat{i}$, respectively. If $m_2 = 0.5m_1$ and $v_3 = 0.5v_1$, then v, is
a) $v_4 - v_2$ b) $v_4 - \frac{v_2}{2}$ c) $v_4 - \frac{v_2}{4}$ d) $v_4 + v_2$

KEY SHEET

1) 300	**2) 900**	**3) 65**	**4) 20**	**5) 0.27**	**6) 38**	**7) 16/50**	**8) 63**	**9) 2000**	**10) 8000**
11) C	**12) B**	**13) B**	**14) C**	**15) B**	**16) C**	**17) A**	**18) B**	**19) D**	**20) B**
21) D	**22) C**	**23) A**	**24) C**	**25) D**	**26) C**	**27) D**	**28) C**	**29) B**	**30) A**

HINTS & SOLUTIONS

1. $w_f = -\mu mgs$

$s = \frac{1}{2}at^2$

Ans: 300J

2. $x=3t^2+5$

$v = \frac{dx}{dt} = 6t$

$KE = \frac{1}{2}m(v_f^2 - v_i^2)$

3. $\eta = \frac{p_{out}}{p_{in}}$

$p_{in} = \frac{p_{out}}{\eta}$

Ans: 65kw

4. $V = ax^{3/2}$

$V = 5x^{3/2}$

If x=0, $v_1=5(0)=0$

If x=2, $v_2=5(2)^{3/2}$

$W=k_f-k_i$

W=20J

5. $h = \frac{v^2}{2g}$

$v = \frac{mu}{M+m}$

H=0.27m

6. $p_1=(200+20)v$

$P_2=200v^1+20(v^1-5)$

$P_1=P_2$

$V = \frac{d}{t}$

$t = \frac{d}{v} = \frac{10}{5} = 2$

$d=v^1t$

d=38m

7. $\cos\theta = \frac{\vec{F}.\vec{S}}{FS}$

$\cos\theta = \frac{16}{50}$

8. m=50

$K_f = \frac{10}{100}ki$

V=63m/s

9. $w=w_1+w_2$

w=(F-f)s

w=2000J

10. P=F.V

P=8000watt

11. p=mu
u=2
$a = \frac{F}{m} = 0.05 m/s^2$
$s = ut + \frac{1}{2}at^2$
S=22.5m
W=F.d
=4.5J

12. $r = r_2 - r_1$
$w = (F_1 + F_2).r$

13. $w_g = mgd \sin\theta$

14. work done=force x distance= $\Delta K.E$

15. $K.E_i = \frac{1}{2}mv_i^2$
$k_f = 10\%$
$\frac{1}{2}mvf^2 = k_f$

16. $\frac{1}{2}mv^2 = \frac{1}{2}(\frac{1}{2}mv^2)$
$\frac{1}{2}m(v+1)^2 = \frac{1}{2}(\frac{m}{2})v^2$

17. w= Area under F-x graph with proper singh
W= Area of triangle+ Area of rectangle+ Area of rectangle + Area of rectangle
W=20J
W= $K_f - K_i$
$K_f = 45J$

18. $F = -\nabla V$

19. $U_i + K_i = U_f + U_f$

20. $\frac{1}{2}mv^2 = \frac{90}{100}$ of mgh

21. P.E of a system of two masses exist only during collision. The P.E is due to deformation

22. If m is the mass of the ball, then its total initial energy at height h = $\frac{1}{2}mu^2 + mgh$
Energy after collision=50% of $(\frac{1}{2}mu^2 + mgh)$
After ball rebounds to height
$\frac{1}{2}(\frac{1}{2}mu^2 + mgh) = mgh$
$u = \sqrt{2gh}$ =14 m/s

23. $f = \frac{4(m_n)(2m_n)}{(m_n + 2m_n)^2}$
$= \frac{8}{9} = 89\%$

24. As the road does not move at all, therefore work done by the cycle on the road must be zero.

25. Intial KE of the shot put

$= \frac{1}{2}(10kg)(1m/s^2) = 5J$

Mgh=150J

E_{Intial} =155J

(h=0)

K.E of the shotput on hitting the ground=155J

26. $V_A = \sqrt{2gh}$

$V_B = 2\sqrt{2gh}$

$h_A = h$

$\frac{1}{2}mv_B^2 = \frac{1}{2}mv^2 + mgh$

$v = \sqrt{6gh}$

$\frac{h_A}{h_B} = \frac{4}{13}$

27. $w = \int F.dy$

28. $v = a\sqrt{s}$

$\frac{ds}{dt} = a\sqrt{s}$

$\int_0^s \frac{ds}{dt} = \int_0^t adt$

29. $a = \frac{F}{m}$

V= $\int adt$

P = F.V

30. $m_1\bar{v}_1 + m_2\bar{v}_2 = m_1\bar{v}_1^{-1} + m_2\bar{v}_2^{-1}$