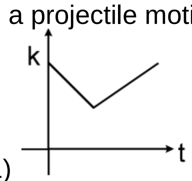
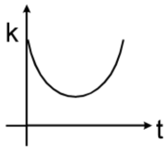
Self Practice Paper (SPP)

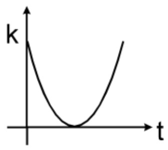
1. A car of mass m starts moving so that its velocity varies according to the law $v = \beta\sqrt{s}$, where β is a constant, and s is the distance covered. The total work performed by all the forces which are acting on the car during the first t seconds after the beginning of motion is
(1) $m\beta^4 t^2/8$ (2) $m\beta^2 t^4/8$ (3) $m\beta^4 t^2/4$ (4) $m\beta^2 t^4/4$

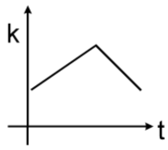
2. A block of mass 250 g is kept on a vertical spring of spring constant 100 N/m fixed from below. The srping is now compressed to have a length 10 cm shorter than its natural length and the system is released from this position. How high does the block rise? Take $g = 10\ m/s^2$.
(1) 20 cm (2) 30 cm (3) 40 cm (4) 50 cm

3. In a projectile motion, KE varies with time as in graph :

(1) 

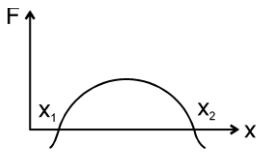
(2) 

(3) 

(4) 

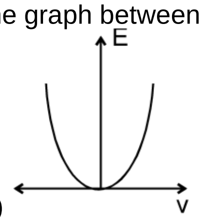
4. A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to (u = 0) -
(1) $t^{1/2}$ (2) $t^{3/4}$ (3) $t^{3/2}$ (4) t^2

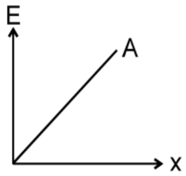
5. The force acting on a body moving along x-axis varies with the position of the particle as shown in the figure.

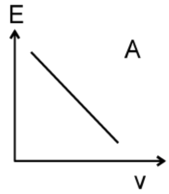


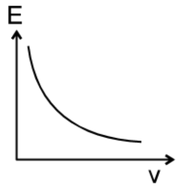
The body is in stable equilibrium at
(1) $x = x_1$ (2) $x = x_2$ (3) both x_1 and x_2 (4) neither x_1 nor x_2

6. The graph between kinetic energy E and velocity v is :

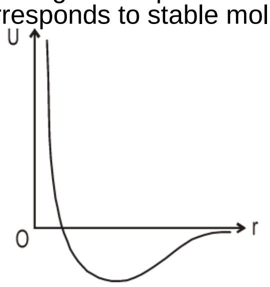
(1) 

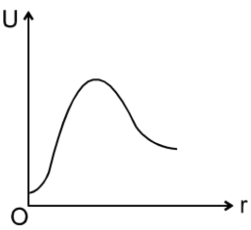
(2) 

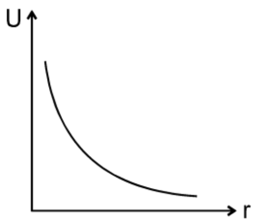
(3) 

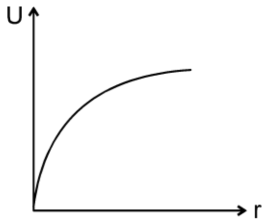
(4) 

7. The diagrams represent the potential energy U of a function of the inter-atomic distance r. Which diagram corresponds to stable molecules found in nature.

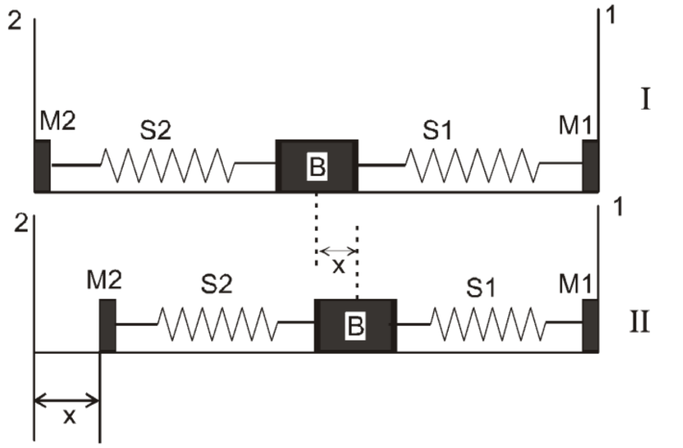
(1) 

(2) 

(3) 

(4) 

8. A block (B) is attached to two unstretched springs S1 and S2 with spring constants k and 4 k, respectively (see figure I). The other ends are attached to identical supports M1 and M2 not attached to the walls. The springs and supports have negligible mass. There is no friction anywhere. The block B is displaced towards wall 1 by a small distance x (figure II) and released. The block returns and moves a maximum distance y towards wall 2. Displacements x and y are measured with respect to the equilibrium position of the block B. The ratio $\frac{y}{x}$ is **(JEE 2008, 3/163)**



(1) 4 (2) 2 (3) $\frac{1}{2}$ (4) $\frac{1}{4}$

9. The work done on a particle of mass m by a force, $K\left[\frac{x}{(x^2+y^2)^{3/2}}\hat{i}+\frac{y}{(x^2+y^2)^{3/2}}\hat{j}\right]$ (K being a constant of appropriate dimensions), when the particle is taken from the point (a, 0) to the point (0, a) along a circular path of radius a about the origin in the x-y plane is : **[JEE-2013][WPE]**

(1) $\frac{2K\pi}{a}$ (2) $\frac{K\pi}{a}$ (3) $\frac{K\pi}{2a}$ (4) 0

10. The kinetic energy acquired by a body of mass m is travelling some distance s, starting from rest under the actions of a constant force, is directly proportional to **[Pb. PET 2000]**

(1) m^0 (2) m (3) m^2 (4) $\sqrt{m}$

11. A particle moves under the effect of a force F = Cx from x = 0 to x = x_1. The work done in the process is **[CPMT 1982; DCE 2002;Orissa JEE 2005]**

(1) Cx_1^2 (2) $\frac{1}{2}Cx_1^2$ (3) Cx_1 (4) Zero

12. A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement x is proportional to **[AIEEE 2004]**

(1) x^2 (2) e^x (3) x (4) $\log_e x$

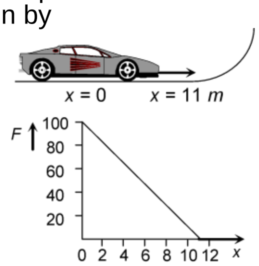
13. A rifle bullet loses 1/20th of its velocity in passing through a plank. The least number of such planks required just to stop the bullet is **[EAMCET 1987; AFMC 2004]**

(1) 5 (2) 10 (3) 11 (4) 20

14. A 12 HP motor has to be operated 8 hours/day. How much will it cost at the rate of 50 paisa/kWh in 10 days

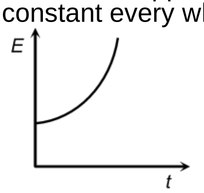
(1) Rs. 350/- (2) Rs. 358/- (3) Rs. 375/- (4) Rs. 397/-

15. A toy car of mass 5 kg moves up a ramp under the influence of force F plotted against displacement x. The maximum height attained is given by



(1) y_{max} = 20 m (2) y_{max} = 15 m (3) y_{max} = 11 m (4) y_{max} = 5 m

16. A particle is dropped from a height h. A constant horizontal velocity is given to the particle. Taking g to be constant every where, kinetic energy E of the particle w. r. t. time t is correctly shown in



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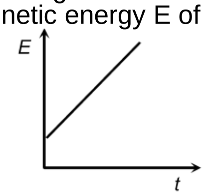

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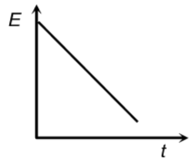

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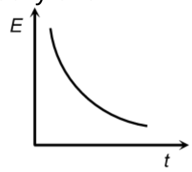
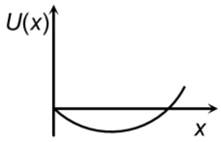


(4)

17. A particle which is constrained to move along the x-axis, is subjected to a force in the same direction which varies with the distance x of the particle from the origin as $F(x) = -kx + ax^3$. Here k and a are positive constants. For $x \geq 0$, the functional from of the potential energy U(x) of the particle is **[IIT-JEE (Screening) 2002]**



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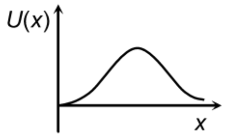

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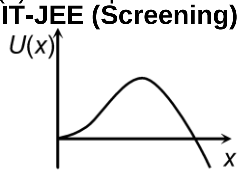

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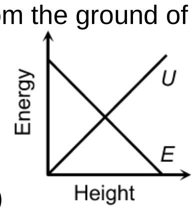
18. Which of the following graphs is correct between kinetic energy (E), potential energy (U) and height (h) from the ground of the particle



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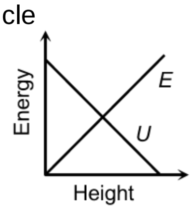

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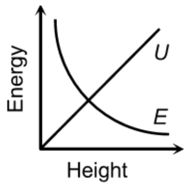

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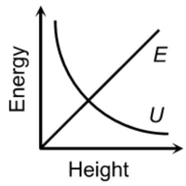


(4)

Multiple Choice Questions

19.* A heavy stone is thrown from a cliff of height h in a given direction. The speed with which it hits the ground
(1) must depend on the speed of projection (2) must be larger than the speed of projection
(3) must be independent of the speed of projection (4) may be smaller than the speed of projection

20.* One end of a light spring of spring constant k is fixed to a wall and the other end is tied to a block placed on a smooth horizontal surface. In a displacement, the work done by the spring is $\frac{1}{2}kx^2$. The possible cases are
(1) the spring was initially compressed by a distance x and was finally in its natural length
(2) it was initially stretched by a distance x and finally was in its natural length
(3) it was initially in its natural length and finally in a compressed position
(4) it was initially in its natural length and finally in a stretched position

21.* If force is always perpendicular to motion
(1) KE remains constant (2) work done = 0 (3) speed is constant (4) velocity is constant

22.* Work done by force of friction
(1) can be zero (2) can be positive (3) can be negative (4) information insufficient

23.* A particle is taken from point A to point B under the influence of a force field. Now it is taken back from B to A and it is observed that the work done in taking the particle from A to B is not equal to the work done in taking it from B to A. If W_{nc} and W_c is the work done by non-conservative forces and conservative forces present in the system respectively, ΔU is the change in potential energy, Δk is the change in kinetic energy, then
(1) $W_{nc} - \Delta U = \Delta k$ (2) $W_c = -\Delta U$ (3) $W_{nc} + W_c = \Delta k$ (4) $W_{nc} - \Delta U = -\Delta k$

SPP Answers

1.	(1)	**2.**	(1)	**3.**	(2)	**4.**	(3)	**5.**	(2)	**6.**	(1)	**7.**	(1)
8.	(3)	**9.**	(4)	**10.**	(1)	**11.**	(2)	**12.**	(1)	**13.**	(3)	**14.**	(2)
15.	(3)	**16.**	(1)	**17.**	(4)	**18.**	(1)	**19.***	(1,2)	**20.***	(1,2)	**21.***	(1,2,3)
22.*	(1,2,3)		**23.***	(1,2,3)									

SPP Solutions

1. $v = \beta\sqrt{s}$

$\frac{ds}{dt} = \beta\sqrt{s}$,

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

$2\sqrt{s} = \beta t$

$\sqrt{s} = \beta t/2$ ....(1)

W = workdone by all the forces = ΔK

$= \frac{1}{2} mv^2 = \frac{1}{2} m \beta^2 s = \frac{1}{2} m\beta^2 \left(\frac{\beta^2 t^2}{4}\right)$

2. $\frac{1}{2}(100)\left(\frac{10}{100}\right)^2 = \left(\frac{250}{1000}\right)(10)\left(\frac{H}{100}\right)$, H = 20 cm.

3. K.E. + P.E. = constant = C (say)

$K - mg\,(tu \sin\theta - \frac{1}{2} gt^2) = C$

$K = mg\,[tu \sin\theta - \frac{1}{2} gt^2] + C$ [= parabolic]

C ≠ 0 so answer is (2)

4. $P = FV = m\left(\frac{dv}{dt}\right)v$

$P\int_0^t dt = m\left[\frac{v^2}{2}\right]_0^v$

$Pt = \frac{mv^2}{2}$, $v^2 = \frac{2Pt}{m}$, $v = \frac{ds}{dt} = \sqrt{\frac{2P}{m}}\sqrt{t}$

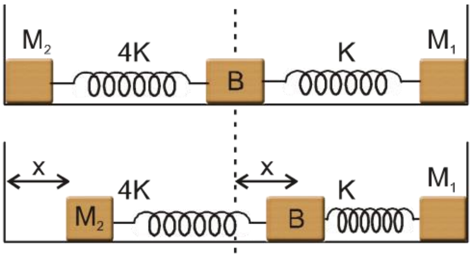
$\int_0^t ds = \sqrt{\frac{2P}{m}}\int_0^t \sqrt{t}\,dt$; $s \propto t^{3/2}$

5. At $x = x_2$, as x increases, F acts along negative x-direction.

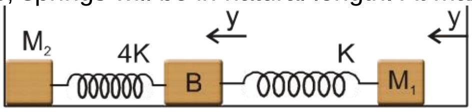
6. $E = \frac{1}{2}mv^2$ (parabola)

7. Only is (A), U is minimum for some value of r

8.



As springs and supports (m_1 and m_2) are having negligible mass. Whenever springs pull the massless supports, springs will be in natural length. At maximum compression, velocity of B will be zero.



And by energy conservation

$\frac{1}{2}(4K)y^2 = \frac{1}{2}Kx^2$ $\qquad \frac{y}{x} = \frac{1}{2}$

9. suppose $x = r\cos\theta$

$y = r\sin\theta$

force on particle is $\frac{K}{r^3}\left(r\cos\theta\hat{i} + r\sin\theta\hat{j}\right)$

force is in radial direction so work done by this force along given path (circle) is zero.

10. K.E. acquired by the body = work done on the body

$K.E. = \frac{1}{2}mv^2 = Fs$ i.e. it does not depend upon the mass of the body although velocity depends upon the mass

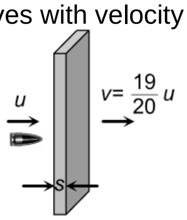
$v^2 \propto \frac{1}{m}$ [If F and s are constant]

11. $W\int_0^{x_1} F.dx = \int_0^{x_1} Cx\,dx = C\left[\frac{x^2}{2}\right]_0^{x_1} = \frac{1}{2}Cx_1^2$

12. This condition is applicable for simple harmonic motion. As particle moves from mean position to extreme position its potential energy increases according to expression $U = \frac{1}{2}kx^2$ and accordingly kinetic energy decreases.

13. Let the thickness of one plank is s

if bullet enters with velocity u then it leaves with velocity

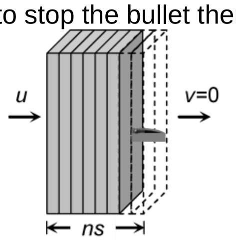


$v = \left(u - \frac{u}{20}\right) = \frac{19}{20}u$

from $v^2 = u^2 - 2as$

$\Rightarrow \left(\frac{19}{20}u\right)^2 = u^2 - 2as$ $\quad \Rightarrow \frac{400}{39} = \frac{u^2}{2as}$

Now if the n planks are arranged just to stop the bullet then again from $v^2 = u^2 - 2as$



$0 = u^2 - 2ans$ $\quad \Rightarrow n = \frac{u^2}{2as} = \frac{400}{39}$ $\quad \Rightarrow n = 10.25$

As the planks are more than 10 so we can consider n = 11

14. If a motor of 12 HP works for 10 days at the rate of 8 hr/day then energy consumption = power × time

$= 12 \times 746 \frac{J}{sec} \times (80 \times 60 \times 60)$ sec

$= 12 \times 746 \times 80 \times 60 \times 60$ J = 2.5 × 10^9 J

Rate of energy = $50 \frac{paisa}{kWh}$

i.e. 3.6×10^6 J energy cost 0.5 Rs

So 2.5 × 10^9 J energy cost = $\frac{2.5 \times 10^9}{2 \times 3.6 \times 10^6} = 358$ Rs

$= 12 \times 746 \frac{J}{sec} \times (80 \times 60 \times 60)$ sec

$= 12 \times 746 \times 80 \times 60 \times 60 J$ = 2.5 × 10^9 J

$= \frac{2.5 \times 10^9}{2 \times 3.6 \times 10^6} = 358$ Rs

15. Work done = Gain in potential energy
Area under curve = mgh

$\Rightarrow \frac{1}{2} \times 11 \times 100 = 5 \times 10 \times h$ $\Rightarrow h = 11m$

16. As particle is projected with some velocity therefore its initial kinetic energy will not be zero.
As it moves downward under gravity then its velocity increases with time K.E. ∝ v^2 ∝ t^2 (As v ∝ t)
So the graph between kinetic energy and time will be parabolic in nature.

17. $F = \frac{-dU}{dx} \Rightarrow dU = -F\,dx \Rightarrow U = -\int_0^x (-Kx + ax^3)dx = \frac{kx^2}{2} - \frac{ax^4}{4}$

∴ We get U = 0 at x = 0 and x = $\sqrt{2k/a}$ and also U = negative for $x > \sqrt{2k/a}$.
So F = 0 at x = 0
i.e. slope of U – x graph is zero at x = 0.

$F = \frac{-dU}{dx} \Rightarrow dU = -F\,dx \Rightarrow U = -\int_0^x (-Kx + ax^3)dx = \frac{kx^2}{2} - \frac{ax^4}{4}$

18. Potential energy increases and kinetic energy decreases when the height of the particle increases it is clear from the graph (1).

19.* $W_G = \Delta K$, $mgh = \frac{1}{2} mv^2 - \frac{1}{2} mu^2$, $\frac{1}{2} mu^2 + mgh = \frac{1}{2} mv^2$
so v > u and v depends upon u.

20.* $W_S = U_i - U_f$, $\frac{1}{2} kx^2 = U_i - U_f$

$U_f = 0 \Rightarrow U_i = \frac{1}{2} kx^2 = \frac{1}{2} k(-x)^2$
⇒ spring was either compressed or stratched initially by a distance x.

21.* W = ΔK, 0 = ΔK, k remains constant, speed remains constant.

22.* This can be explained by two blocks problem.

23.* From work energy theorem $W_C + W_{nC} = \Delta K$, $W_C = -\Delta U$, $W_{nC} - \Delta U = \Delta K$