OBJECTIVE - I

1. A heavy stone is thrown from a cliff of height h with a speed v. The stone will hit the ground with maximum speed if it is thrown

(A) vertically downward (B) vertically upward

(C) horizontally (D*) the speed does not depend on the initial direction.

D

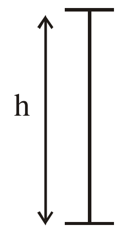
By energy canservation Þ

initial energy = final energy

$K.B_i + P.B_i = K.B_f + P.B_f$

$1/2\ mu^2 + mgh = 1/2\ mv^2 + 0$

$$v = \sqrt{u^2 + 2gh}$$



So we can concluet that the speed does not depend on the initial direction.

2. Two springs A and B ($k_A = 2k_B$) are strettched by applying forces of equal magnitudes at the four ends. If the energy stored in A is E, that in B is -

(A) E/2 (B*) 2E (C) E (D) E/4

Sol. B

Energy store in A = $1/2\ k_A x_A^2 = E$ .... (1)

Spring A and B stretched by applying equal magnitudes of force.

For spring A Þ $k_A x_A = F$ .... (2)

For spring B Þ $k_B x_B = F$ .... (3)

From equation (2) & (3)

$k_A x_A = k_B x_B$ .... (4)

Given $k_A = 2\ k_B$ Þ $x_B = 2x_A$

Energy store in B = $1/2\ k_B x_B^2$

$$= \frac{1}{2}\left(\frac{k_A}{2}\right)(2x_A)^2 = k_A x_A^2$$

= 2E (from equation (1)).

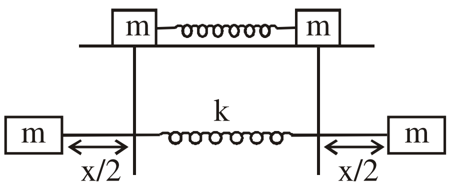
3. Two equal masses are attached to the two ends of a spring of spring constant k. The masses are pulled out symmetrically to stretch the spring by a length x over its natrual length. The work done by the spring on each mass is -

(A) $\frac{1}{2}kx^2$ (B) $-\frac{1}{2}kx^2$ (C) $\frac{1}{4}kx^2$ (D*) $-\frac{1}{4}kx^2$

Sol. D

Potential energy = $\frac{1}{2}k\left(\frac{x}{2}\right)^2 + \frac{1}{2}k\left(\frac{x}{2}\right)^2$

$$= \frac{1}{4}\ kx^2$$



4. The negative of the work done by the conservative internal forces on a system equals the change in

(A) total energy (B) kinetic energy (C*) potential energy (D) none of these

Sol. C

W = – Dv (Change in potential energy)

5. The work done by the external forces on a system equals the change in

(A*) total energy (B) kinetic energy (C) potential energy (D) none of these

Sol. A

$W_{external\ force}$ = DE (Change in toatl energy)

By work energy theorem

$W_{ext} + W_{int} + W_{preudo} + W_{friction} + ... = D$ K.E.

Þ $W_{int} = -$ D v

Þ W_{ext} = D K.B. + D u

Þ W_{ext} = T.E.

6. The work done by all the forces (external and internal) on a system equals the change in

(A) total energy (B*) kinetic energy (C) potential energy (D) none of these

Sol. B

By work energy theorem

7. ______________ of a two particle system depends only on the separation between the two particles. The most appropriate choice for the blank space in the above sentence is

(A) kinetic energy (B) total mechanical energy

(C*) potential energy (D) total energy

Sol. C

8. A small block of mass m is kept on a rough inclined surface of inclination q fixed in a elevator. The elevator goes up with a uniform velocity v and the block does not slide on the wedge. The work done by the force of friction on the block in time t will be -

(A) zero (B) mgvt cos^2q (C*) mgvt sin^2q (D) mgvt sin2q

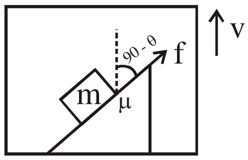
Sol. C

Distance travelled by the elevator in 't' time is = vt

Block don't slide on the wedge.

So friction force = mg sinq

Work done by the force friction on the block in time t will be



= $\vec{F}.\vec{d}$

= Fd cos (90 - q)

= mg sin q . vt sin q

= mg vt sin q

9. A block of mass m slides down a smooth vertical circular track. During the motion, the block is in

(A) vertical equilibrium (B) horizontal equilibrium (C) radial equilibrium (D*) none of these

Sol. D

10. A particle is rotated in a vertical circle by connecting it to a string of length l and keeping the other end of the string fixed. The minimum speed of the particle when the string is horizontal for which the particle will complete the circle is -

(A) $\sqrt{g\ell}$ (B) $\sqrt{2g\ell}$ (C*) $\sqrt{3g\ell}$ (D) $\sqrt{5g\ell}$

Sol. D

Energy conservation A to B is

$T.B_i = T.B_f$

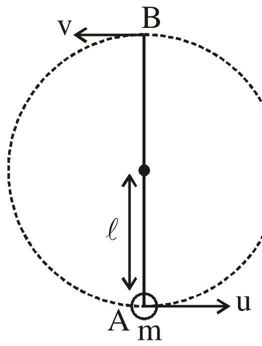
$P.B_i + K.B_i = P.E_f + K.B_f$

$0 + 1/2\ mu^2 = mg\ (2l) + 1/2\ mv^2$

$mu^2 = 4mgl + mv^2$ .... (1)

For minimum velocity 'u' that causes particle will complete the circle formation velocity tension at point 'B' is zero.

F.B>D. of point 'B'



$T_B = 0$ Þ $\frac{mv^2}{\ell} = mg$ .... (2)

From equation (1) & (2)

$mu^2 = 4\,mgl + mgl$

$u = \sqrt{5g\ell}$

OBJECTIVE - II

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

Sol. AB

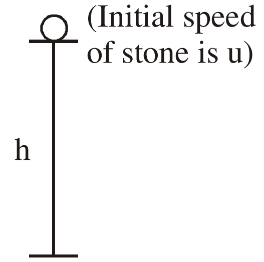
By apply the energy conservation

$T.E_i = T.E_f$

$P.B_i + K.B_i = P.B_f + K.B_f$

$mgh + 1/2\ mu^2 = 0 + 1/2\ mv^2$

$v = \sqrt{u + 2gh}$



Hitting velocity 'v' is depend on the speed of projection
& large than the speed of projection.

2. The total work done on a particle is equal to the change in its kinetic energy
(A*) always (B) only if the forces acting on it are conservative
(C) only if gravitational force alone acts on it (D) only if elastic force alone acts on it.

Sol. A

By work energy theorem
The total work done an a particle is equal to the change in its kinetic energy.

3. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion of the particle takes place in a plane. If follows that
(A) its velocity is constant (B) its acceleration is constant
(C*) its kinetic energy is constant (D*) it moves in a circular path

Sol. CD

Force of constant magnitude which is always pependicular to the to the velocity of the particle. That causes magnitude of velocity of the particle remain constant. So we can say that its kinetic energy is constant & this force is povide the centripetal acceleration that causes particle moves in a circular path.

4. Consider two observers moving with respect to each other at a speed v along a straight line.They observe a block of mass m moving a distance l on a rough surface. The following quantities will be same as observed by the two observers
(A) kinetic energy of the block at time t (B) work done by friction
(C) total work done on the block (D*) acceleration of the block.

Sol. D

Two observers moving with respect to each other at a speed v along a straight line mean with respect to each other change in kinetic energy is always same.
By the work energy theorem we can say that work done by the friction force is same with respect to block is same & also say that acceleration will be same of the block.

5. You lift a suitcase from the floor and keep it on a table. The work done by you on the suitcase does not depen on -
(A*) the path taken by the suitcase (B*) the time taken by you in doing so
(C) the weight of the suitcase (D*) your weight.

Sol. ABD

Work done by you on the suit case is change in
Potential energy = mgh
Here mg is the weight of the suit case & h is height of floor ro table.

6. No work is done by a force on an object if

(A*) the force is always perpendicular to its velocity

(B) the force is always perpendicular to its acceleration

(C*) the object is stationary but the point of application of the force moves on the object

(D*) the object moves in such a way that the point of application of the force remains fixed.

Sol. ACD

Work done by a force on an object = $\vec{F}.\vec{d}$

= Fd cos q

Displacement always in the direction of velocity.

(a) F ^ v mean q = 90°, cos 90° = 0

Work done by a force in an object = 0

(b) Always acceleration not provide the direction of motion.

(c) Object is stationary mean s d = 0

(d) It is the condition of the circular motion, here force provide the centripetal acceleration. Angle between this force & displacement is 90°. So work done by a force on an object is zero.

7. A particle of mass m is attached to a light string of length l, the other end of which is fixed. Initially the string is kept horizontal and the particle is given an upward velocity v. The particle is just able to complete a circle

(A*) the string becomes slack when the particle reaches its highest point

(B) the velocity of the particle becomes zero at the highest point

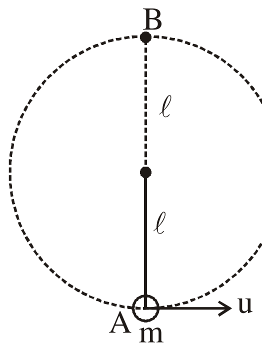
(C) the kinetic energy of the ball in initial position was $\frac{1}{2}mv^2 = mgl$.

(D*) the particle again passes through the initial position.

Sol. AD

The minimum velocity gives to the particle is

just able to complete a circle is Þ $\sqrt{5g\ell}$



So initial K.E. of the particle = 1/2 mu^2

= 1/2 m (5gl)

Apply energy conservation A to B

$T.B_A = T.B_B$

$K.B_A + P.B_A = K.B_A + P.B_A$

1/2 m (5gl) + 0 = K.BB + 2mgl

$K.B_B$ = 1/2 mgl

1/2 mv^2 = 1/2 mgl

$v_B = \sqrt{g\ell}$

End of complete one circle particle again passes through the initial position.

8. The kinetic energy of a particle continuously increases with time

(A) the resultant force on the particle must be parallel to the velocity at all instants.

(B*) the resultant force on the particle must be at an angle less than 90° with the velocity all the time

(C) its height above the ground level must continuously decrease

(D*) the magnitude of its linear momentum is increasing continuously

Sol. BD

Work done by the particle = D K

$\vec{F}.\vec{d}$ = D K Þ D K = Fd cos q

The resultant force on the particle must be at an angle less than 90° all the time.

Linear momentum Þ P = $\sqrt{2mK.E}$

9. 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 -

(A*) the spring was initially compressed by a distance x and was finally in its natural length

(B*) it was initially stretched by a distance x and finally was in its natural length

(C) it was initially in its natural length and finally in a compressed position

(D) it was initially in its natural length and finally in a stretched position

Sol. AB

$w = -\Delta u$

$w = u_i - u_f$

The spring was initially conpress or streched by a distance x than

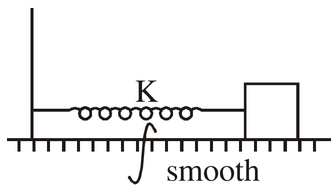
$u_i = 1/2\, kx^2$

Finally in its natural length

$x = 0$

$w = u_i - u_f$

$= 1/2\, kx^2$



10. A block of mass M is hanging over a smooth and light pulley through a light string. The other end of the string is pulled by a constant force F. The kinetic energy of the block increases by 20 J in 1s.

(A) the tension in the string is Mg

(B*) the tension in the string is F

(C) the work done by the tension on the block is 20 J in the above 1 s.

(D) the work done by the force of gravity is – 20 J in the above 1s.

Sol. B

Tension in the spring is equal to F'

$T - mg = ma \quad \Rightarrow \quad T = mg + ma$

Change in ΔK = work done by the gravity

Work done by the gravity = 20 J in 1 see

Work done by the tension force = 0