विघ्न विचारत भीरु जन, नहीं आरम्भे काम,
विपति देख छोड़े तुरंत मध्यम मन कर श्याम।
पुरुष सिंह संकल्प कर, सहते विपति अनेक,
'बना' न छोड़े ध्येय को, रघुबर राखे टेक।।

रचितः मानव धर्म प्रणेता
सद्गुरु श्री रणछोड़दासजी महाराज

WORK POWER AND ENERGY

Some questions (Assertion–Reason type) are given below. Each question contains STATEMENT – 1 (Assertion) and STATEMENT – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. So select the correct choice :

Choices are :

(A) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is** a correct explanation for Statement – 1.
(B) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is NOT** a correct explanation for Statement – 1.
(C) Statement – 1 is True, Statement – 2 is False.
(D) Statement – 1 is False, Statement – 2 is True.

80. **STATEMENT – 1**
A body is connected to a string and if it just completes a circle, it must have zero velocity at the top.

STATEMENT – 2
A body is projected in vertically upward direction, at the highest point the acceleration of particle is non–zero.

81. **STATEMENT – 1**
A man of mass m, standing on a frictionless surface pushes a wall and acquires a velocity v_0. The work done by the wall on the man is zero.

STATEMENT – 2
Work done by all the forces is equal to the change in the kinetic energy.

82. **STATEMENT – 1**
A bomb at rest explodes into two fragments of different masses. The kinetic energies of the two fragments will be in inverse ratio of their masses.

STATEMENT – 2
Kinetic energy of a body is inversely proportional to its momentum.

83. **STATEMENT – 1**
When a man raises himself up by pulling down on a horizontal bar as in a gymnasium, it is work done by the normal reaction from the bar that goes on to increase his potential energy.

STATEMENT – 2
Normal force applied by the bar on the man is responsible for lifting the centre of mass of the man.

84. **STATEMENT – 1**
The potential energy of a certain amount of liquid when spread out in a thin layer is more than that of the some amount of liquid in the shape of a sphere.

STATEMENT – 2
The potential energy decreases on account of decreased intermolecular distance.

85. **STATEMENT – 1**
Mechanical energy of a particle is conserved if it is acted upon by a conservative force only.

STATEMENT – 2
Work done by a conservative force in a closed path is zero.

86. **STATEMENT – 1**
When a charged particle is moved in an equipotential plane work done by electric field is zero.

STATEMENT – 2
Electric field is perpendicular to equipotential plane.

87. **STATEMENT – 1**
Under the action of a force of constant magnitude, work done is path independent.

STATEMENT – 2
Work done by force of gravity is path independent only near the surface of Earth.

88. **STATEMENT – 1**
For work to be done, the force must act for a distance.

STATEMENT – 2
Work does not depend on frame of reference.

89. **STATEMENT – 1**
If a particle of mass m is connected to a light rod and whirled in a vertical circle of radius R, then to complete the circles, the minimum velocity of the particle at the bottom point is $\sqrt{5gR}$.

STATEMENT – 2
Mechanical energy is conserved and in case of the minimum velocity at the bottom point, the velocity at the top point will be zero.

90. **STATEMENT – 1**
The work done by the radial force acting on a particle when is doing uniform circular motion is zero.

STATEMENT – 2
No work is done by a force if force is perpendicular to the elementary displacement.

91. **STATEMENT – 1**
The work done by the net force on a particle during non–uniform circular motion is not equals to zero.

STATEMENT – 2
As in case of non–uniform circular motion net force and elementary displacement are not perpendicular to each other.

92. **STATEMENT – 1**
A body is sliding down with constant speed on an inclined plane. Its total energy remains constant.

STATEMENT – 2
Work done by friction on the body will get converted into heat.

93. **STATEMENT – 1**
Two cars of unequal mass are moving with equal velocity in straight line. On applying equal resistive force on both the cars, work done to stop them are equal.

STATEMENT – 2
Work done is equal to change in its kinetic energy.

94. **STATEMENT – 1 :** A heavy weight is suspended from the spring. A person raises the weight slowly till the spring become slack. The work done by person is W. The energy stored on the stretched spring was E. The gain in gravitational potential energy is (W + E)

STATEMENT – 2 : Work done by the spring force is always negative.

95. **STATEMENT – 1 :** Kinetic energy of a system can be increased without applying any external force on the system.

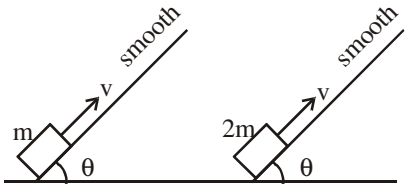
STATEMENT – 2 : Single external force acting on a particle necessarily changes its kinetic energy.

96. **STATEMENT – 1 :** A particle is rotated in a vertical circle with the help of a string. Power produced by tension in the string on particle is zero.

STATEMENT – 2 : Tension is always perpendicular to instantaneous velocity.

97. **STATEMENT – 1 :** Consider the two situation shown in the figure. In first case height attained by particle above ground is same as the height attained by particle in case II.

STATEMENT – 2 : As planes are smooth so initial kinetic energy is converted into potential energy. Initial kinetic energy in two cases is different.



98. **STATEMENT – 1 :** If we lift a block from the floor and keep it on a table. The work done by us on the block does not depend on the path taken by the block.

STATEMENT – 2 : Work done by a conservative force depends only on the initial and final states.

99. **STATEMENT – 1 :** Power developed in a uniform circular motion is always zero.

STATEMENT – 2 : Work done in case of a uniform circular motion is zero.

100. **STATEMENT – 1 :** Work is always same in all the reference frame as it is invariant physical quantity.

STATEMENT – 2 : Work is dot product of force and displacement and therefore work is variant as force and displacement are dependent on frame of reference.

101 **STATEMENT – 1 :** If a spring is compressed, energy is stored in spring and when it is elongated, energy is released.

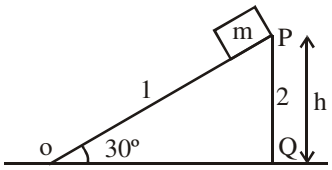
STATEMENT – 2 : The energy is stored in a spring is proportional to square of linear deformation of spring.

102. **STATEMENT – 1 :** A car and heavy lorry have the same speed; moving on a road. Same back force is applied and both stop in same distance.

STATEMENT – 2 : Same force will cause the different retardation in the two vehicles.

103. **STATEMENT – 1 :** Work done by gravitation force in reaching the block at O and Q is same.

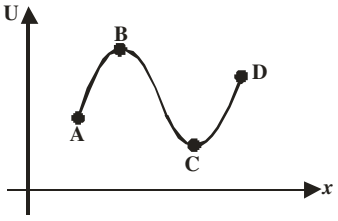
STATEMENT – 2 : Gravitational force is conservative in nature.



104. **STATEMENT – 1 :** The change in kinetic energy of a particle is equal to the work done on it by the net force.

STATEMENT – 2 : Change in kinetic energy is equal to the work done only in case of a system of one particle.

105. **STATEMENT – 1 :** The potential energy of a particle varies with distance x as shown in the graph.



The force acting on the particle is zero at point B and C.

STATEMENT – 2 : The slope of U-x curve is zero at point B and C.

106. **STATEMENT – 1 :**In an elastic collision of two bodies, the momentum and energy of each body is conserved.

STATEMENT – 2 : If two bodies stick to each other after colliding, the collision is said to be perfectly inelastic.

107. **STATEMENT – 1 :** Work done by internal force on the system is always zero.

STATEMENT – 2 : Kinetic energy remains unchanged if work done by net force is zero.

108. **STATEMENT – 1 :** A block placed on smooth inclined plane. Its kinetic energy increases.

STATEMENT – 2 : In above case change in kinetic energy is equal to sum of work done by normal reaction and gravitational force.

109. **STATEMENT – 1 :** Work done by friction depends upon displacement of the body.

STATEMENT – 2 : Frictional force is non–conservative.

110. **STATEMENT – 1 :** In uniform circular motion of a particle, sum of power delivered to it by all the forces acting on the particle is zero.

STATEMENT – 2 : Dot product of two perpendicular vector is always zero.

111. **STATEMENT – 1 :** If $W_{net} > 0$ then Δ KE > 0 and $KE_{final} >$ KE.

STATEMENT – 2 : If net force acting on the particle does positive work on it, then kinetic energy of the particle increases.

112. **STATEMENT – 1 :** A body may gain kinetic energy and potential energy simultaneously.

STATEMENT – 2 : Principle of conservation of mechanical energy may not be valid every time.

113. **STATEMENT – 1 :** The work done by a conservative force during a round trip is always zero.

STATEMENT – 2 : No force is required to move a body in its round trip.

114. **STATEMENT – 1 :** A race car traveling around a circular track have a non-zero impulse.
because
STATEMENT – 2 : The impulse is zero only when there is no net change in momentum.

ANSWER

80.	(D)						
81.	(B)	82.	(C)	83.	(D)	84.	(B)
85.	(D)	86.	(A)	87.	(D)	88.	(C)
89.	(D)	90.	(A)	91.	(A)	92.	(D)
93.	(D)	94.	(C)	95.	(C)	96.	(A)
97.	(A)	98.	(A)	99.	(A)	100.	(D)
101.	(D)	102.	(D)	103.	(A)	104.	(C)
105.	(A)	106.	(D)	107.	(D)	108.	(A)
109.	(D)	110.	(A)	111.	(A)	112.	(B)
113.	(C)	114.	(D)				

SOLUTION

80. At the highest point of vertical circle tension is zero not velocity.

82. $\because$ $O = m_1v_1 - m_2v_2$
and $K_1 + K_2 = E$ the energy released in explosion.

$\therefore \quad \frac{K_1}{K_2} = \frac{m_2}{m_1}$

and $P = \sqrt{2mE}$.

83. The assertion is false because normal force cannot do any work in the absence of any displacement. The statement of Reason is correct because an external force alone can shift the position of centre of mass.

84. The potential energy of two identical molecules increase when the distance between them is increased.

87. Work done by force of gravity is path independent near the surface of Earth, for one reason that the force of gravity is constant near the surface of Earth. Also work done by force of gravity is path independent at greater height as the force of gravity is a conservative force.

88. Work depends on frame of reference. With change of frame of reference, inertial force does not change, but displacement may change.

89. Using conservation of mechanical energy and taking zero velocity at the top point, the minimum velocity at the bottom point is $2\sqrt{gR}$.

94. W(mg) + W (sp) + W (Man) = 0
$-\Delta U + E + W = 0$
$\Delta U = E + W.$
Work done by spring force is positive when a compressed spring is released or stretched spring released.

95. Work done by internal force = change in kinetic energy
If $F_{ext} = 0$ $F_{n.C} = 0$
During motion of circular path work done by the centripetal force is zero.

96. $P = \vec{F}.\vec{V}$
$= F V \cos\theta$
if $\theta = 90$
then P = 0.

97. $\frac{1}{2}mv^2 = mgh_1 \Rightarrow \quad h_1 = \frac{v^2}{2g}$

$\frac{1}{2}(2m)v^2 = (2m)gh_2 \quad \Rightarrow \quad h_2 = \frac{v^2}{2g}$.

98. There is no loss of energy by conservative forces hence they are all path independent.

99. Work done and power developed is zero in uniform circular motion.
$P = \frac{W}{t}$ hence reason is the correct explanation of assertion.

100. $W = \vec{F}.\vec{S}$
As $\vec{F}$ and $\vec{S}$ are dependent on reference frame hence, W is not an invariant physical quantity.

101. $U = \frac{1}{2}K(\Delta x)^2$; Δx may be compression or elongation.

102. Since mass of car < mass of lorry. Retardation on car is more than lorry. And car will stop earlier; is lesser distance.

103. $\omega_{op} = (mg\sin\theta)\dfrac{h}{\sin\theta} = mgh$ …(i)

$\omega_{oa} = mg.h$ …(ii)

104. $\Delta KE = W_{\text{by net force}}$
This relation is valid for particle as well as system of particles.

105. $f = -\dfrac{dv}{dx} \therefore F = 0 \text{ at point B and C}.$

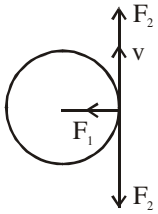
106. In an elastic collision both the momentum and kinetic energy remains conserved. This rule is not for individual bodies but for the centre of mass of the system of bodies before and after the collision.
The collision is perfectly is elastic, if two bodies stick to each other.

107. Work done by all the forces is equal to change in its kinetic energy.

108. Work done by all the forces is equal to change in kinetic energy.

109. Work done by non–conservative force depends upon entire path i.e., distance.

110.



For uniform circular motion

$\vec{F}_2 = -\vec{F}_3$

$\therefore \quad \vec{F}_2.\vec{v} + \vec{F}_3.\vec{v} = 0$

$\vec{F}_1.\vec{v} = 0$

$\because \quad \vec{F}_1 \perp \vec{v}.$

111. For example in an air filled balloon, the upthrust is more than the weight of a balloon i.e., the resultant force does work in lifting. This gives gain in kinetic energy besides potential energy at the expense of chemical energy of the fuel.

113. During a round trip, the body finally comes at its initial position i.e., the displacement of body is equal to zero. Therefore work done is equal to zero. So $w = \vec{F}.\vec{S} = 0$. Statement – I is correct and statement – II is wrong.

114. The force on the car causing the circular motion is the friction between the tires and the roadway and this force is always directed towards the centre of the circle. So total impulse is zero.