QUIZ: WORK & ENERGY-I

1. In which one of the following cases, work is done?
(a) Sheela pushes a rock but the rock does not move at all.
(b) Mohan stands still for a few minutes with a heavy load on his head.
(c) Radha pushes a box lying on a floor, through 1 m.
(d) Shyam pushes a wall but the wall does not move at all.

2. Consider the following situations. In which case, the work done is negative?
(a) Work done by Ramesh who pushes a box through 2m which is lying on a horizontal surface.
(b) Work done by the force of gravity when a ball is dropped from a height and it moves down.
(c) Work is done by Narendra in lifting a 10 kg box from the ground and puts it on his head.
(d) In case (c), work done by force of gravity.

3. A ball of 100g is dropped from a height of 10m and reaches the ground. The work done by force of gravity in bringing the ball to the ground is (take $g = 9.8\ m/s^2$)
(a) 98 J
(b) 9.8 J
(c) -98 J
(d) -9.8 J

4. Mohan lifts a box of 10 kg from the ground and puts it on his head 2.0 m above the ground. In this process, the work done by Mohan and the force of gravity, respectively are (take $g = 9.8\ m/s^2$)
(a) 196 J, 196 J
(b) 196 J, -196 J
(c) -196 J, -196 J
(d) -196 J, 196 J

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5. An object of 5 kg is lying on a horizontal table. A constant horizontal force of 10 N is applied to the object. The kinetic energy of the object, after it has moved through a distance of 100 m is

(a) 200 J
(b) 500 J
(c) 600 J
(d) 1000 J

6. A cricket ball of 160g is dropped from a height of 25 m. The kinetic energy of the ball just before it strikes the ground is (take g = 9.8 m/s^2, negligible air resistance)

(a) 19.6 J
(b) 39.2 J
(c) 196 J
(d) 392 J

7. An object of mass 1.5 kg, initially at rest, is set in motion under the action of a constant force. In which one of the following cases, work done is maximum?

The velocity of the object increase from

(a) 0 to 5 m/s
(b) 5 m/s to 10 m/s
(c) 10 m/s to 15 m/s
(d) 15 m/s to 20 m/s

Answers:

1. (c)

Options:

(a) Work done = Force × displacement. Since the rock does not move at all hence displacement is zero. Thus Work done is zero. Hence this option is wrong.

(b) The load does not move or is displaced, thus work done is zero (work done = force × displacement). Hence this option is wrong.

(c) Radha applies force to push the box. So there is a force and this forces cause the box to displace by 1 m. Thus work is done in this case. Hence this option is correct.

(d) Work done = Force × displacement and since displacement of the wall is zero. Therefore work done is zero. Hence this option is wrong.

2. (d)

Options:

(a) Displacement of the box is in the direction of force applied by Ramesh. Thus work done is positive in this case. Hence this option is wrong.

(b) For a ball (mass *m*) falling down, force of gravity (= mg) is downward and thus the direction of displacement is also downward. Therefore work done by the force of gravity is positive. Hence this option is wrong.

(c) When Narendra lifts a box, he applies an upward force. Thus box moves upward or displacement is in upward direction. Therefore work done by Narendra is positive. Hence this option is wrong.

(d) The force of gravity on the box is mg and is downward. Narendra lifts the ball upward. Thus displacement of the box is upward. Thus work done by the force of gravity in this case is negative. Hence this option is correct.

3. (b)

Options:

(a) m = 100g = 0.1kg, force of gravity = mg = 0.1kg × 9.8 m/s^2 =0.98 N

Therefore W = 0.98 N × 10 m = +9.8 J

Hence this option is wrong.

(b) *Work done* = force ×displacement

=mgh

=0.1 × 9.8 × 10

= +9.8 J

As the force and the displacement are in the same direction, thus this work done is positive. Hence this option is correct.

(c) Since displacement and force are is the same direction, thus the work done is positive which is contrary to the given option i.e. -98J. Hence this option is wrong.

(d) Displacement and force of gravity are in the same direction, thus work done is positive which is contrary to the given option i.e. -9.8J. Hence this option is wrong.

4. (b)

Options:

(a) m= 10kg, s= 2.0m,

Work done by Mohan = Force applies by him × 2.0 m.

$= (10kg \times 9.8\ m/s^2) \times 2.0\ m$
$= +196J$

Force of gravity is downward while the box is displaced upward. So work done by force of gravity is negative. Hence this option is wrong.

(b) Work done by Mohan = $10 \times 9.8 \times 2.0m$
$= +196J$

Direction of applied force and displacement is in the same direction, thus the work done by Mohan is positive.

But force of gravity is downward. Hence work done by force of gravity is negative i.e. -196 J.

Hence this option is correct.

(c) Work done by Mohan = $10 \times 9.8 \times 2.0m$
$= +196J$

Direction of applied force and displacement is in the same direction, thus the work done by Mohan is positive which contrary to the value given in this option i.e -196J.

Hence this option is wrong.

(d) Work done by Mohan = $10 \times 9.8 \times 2.0m$
$= +196J$

Direction of applied force and displacement is in the same direction, thus the work done by Mohan is positive which contrary to the value given in this option i.e., -196J.

Furthermore, force of gravity and displacement are in opposite direction, thus work done by gravity is negative which is again contrary to the value given in this option i.e. +196J.

Hence this option is wrong.

Explanation: In case of Mohan, displacement of the box and the force applied by Mohan are in the same direction. So $W = F \times S = mgs = 10\ kg \times 9.8\ m/s^2 \times 2m = 196J$

The force of gravity is directed downward while the displacement of the object is upward. Hence work done by force of gravity is negative but of the same magnitude.

5. (d)

Options:

(a) Work done = Force × Displacement
= 10N × 100m
= 1000J.

Applying Work-Energy Theorem, i.e. Work done = change in K.E
= final K.E – Initial K.E.
=1000 J

Since initial K.E = 0, therefore after moving a distance of 100m under 10N force, final kinetic energy = 1000J. Hence this option is wrong.

(b) According to work – Energy theorem, Change in K.E = work done = 10 × 100 = 1000 J

Since initial K.E = 0, therefore after moving a distance of 100m under 10N force, final kinetic energy must be 1000J.Hence this option is wrong.

(c) According to work – Energy theorem, Change in K.E = work done = 10 × 100 = 1000 J

Since initial K.E = 0, therefore after moving a distance of 100m under 10N force, final kinetic energy must be 1000J. Hence this option is wrong.

(d) Work done = Force × Displacement

= 10N × 100m

= 1000J.

Applying Work-Energy Theorem, i.e Work done = change in K.E

= final K.E – Initial K.E.

=1000 J

Since initial K.E = 0, therefore after moving a distance of 100m under 10N force, final kinetic energy must be 1000J. Hence this option is wrong.

Alternative solution: This problem can also be solved using equation of motion. Here $a = \frac{F}{m} = 10N/5kg$ = 2m/s^2. Final velocity $v^2 = u^2 + 2as = 0 + 2 \times (2m/s^2) \times 100\ m = 400m^2/s^2$

Hence final K.E. = (1/2) mv^2 = (1/2)x5 kg x 400m^2/s^2 =1000J

6. (b)

Options:

(a) m = 160 g = 0.16 kg

Using $v^2 = u^2 + 2gs = 0+2\times9.8\times25$

K.E of the ball = $\frac{1}{2}mv^2 = \frac{1}{2} \times 0.16 \times 2\times9.8 \times 25$

= 39.2 J

Hence this option is wrong.

(b) m = 160 g = 0.16 kg

Using $v^2 = u^2 + 2gs = 0+ 2 \times9.8\times25 = 2 \times 9.8 \times 25$

K.E. = $\frac{1}{2}mv^2 = \frac{1}{2} \times 0.16 \times 2x9.8 \times 25$

= 39.2 J

Hence this option is correct.

Also see second method.

(c) m = 160 g = 0.16 kg

Using $v^2 = u^2+2gs = 0+2×9.8×25$

K.E. $= \frac{1}{2}mv^2 = \frac{1}{2} × 0.16 × (0+9.8 × 2 × 25)$

$= 39.2$ J

Hence this option is wrong.

(d) $m = 160$ $g = 0.16$ kg

Using $v^2 = u^2+2gs = 0+2×9.8×25$

K.E. $= \frac{1}{2}mv^2 = \frac{1}{2} × 0.16 × (0+9.8 × 2 × 25)$

$= 39.2$ J

The value given in this option (392 J) is ten times the correct value. Hence this option is wrong.

Explanation: First method: One can solve it using equation of motion and formula for kinetic energy.

Using $v^2 = u^2 + 2as$, $= 0 + 2 × 9.8$ m/s^2 ×25 m = 50× 9.8 (m/s)^2

K.E. $= \frac{1}{2}mv^2 = \frac{1}{2} × 0.16 × (0+9.8 × 2 × 25)$

$= 39.2$ J

Second method: One can invoke relation between work and change in kinetic energy. Force acting on the object = mg, work done = mgh

Work done = 0.16 kg × 9.8 m/s^2 × 25m = 39.2 J.

The work done = change in kinetic energy = Final kinetic energy as initial kinetic energy is zero.

7. (d)

Options:

(a) From Work Energy Theorem, Work done = Change in kinetic energy.

Therefore Work done $\propto$ (v^2-u^2), which imply maximum change in (v^2-u^2) corresponds to maximum change in kinetic energy.

(v^2-u^2) for four options are 25, 75, 125 and 175. Thus maximum change in (v^2-u^2) is 175.

Since change in (v^2-u^2) for the given option is 25 (5^2-0^2) and is less than 175. Hence this option is wrong.

(b) From Work Energy Theorem, Work done = Change in kinetic energy.

Therefore Work done $\propto$ (v^2-u^2), which imply maximum change in (v^2-u^2) corresponds to maximum change in kinetic energy.

(v^2-u^2) for four options are 25, 75, 125 and 175. Thus maximum change in (v^2-u^2) is 175.

Since change in (v^2-u^2) for the given option is 75 (10^2-5^2) and is less than 175. Hence this option is wrong.

(c) From Work Energy Theorem, Work done = Change in kinetic energy. Therefore Work done ∝ (v^2-u^2), which imply maximum change in (v^2-u^2) corresponds to maximum change in kinetic energy.

(v^2-u^2) for four options are 25, 75, 125 and 175. Thus maximum change in (v^2-u^2) is 175.
Since change in (v^2-u^2) for the given option is 125 (15^2-10^2) and is less than 175. Hence this option is wrong.

(d) From Work Energy Theorem, Work done = Change in kinetic energy. Therefore Work done ∝ (v^2-u^2), which imply maximum change in (v^2-u^2) corresponds to maximum change in kinetic energy.

(v^2-u^2) for four options are 25, 75, 125 and 175. Thus maximum change in (v^2-u^2) is 175.
Since change in (v^2-u^2) for the given option is 175 (20^2-15^2) and matches with the maximum value i.e. 175. Hence this option is correct.

Explanation: Work done is equal to the change in kinetic energy. This change is maximum in case (d) [$20^2 - 15^2$] > [$15^2 - 10^2$] > [$10^2 - 5^2$] > [$5^2 - 0^2$]. Hence work done is maximum in case (d).