Module-Test-10
(Physics-JEE)

January 18, 2023

Section-A
(One Options Correct Type)

This section contains 20 multiple choice questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE option is correct.

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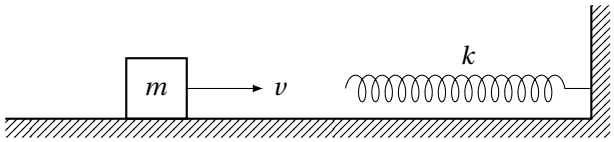
1. A 2 kg block slides on a horizontal floor with a speed of $4\,\mathrm{m\,s^{-1}}$. It strikes a uncompressed spring and compresses it till the block is motionless. The kinetic friction force is 15 N and spring constant is 10000 N/m. The spring compresses by

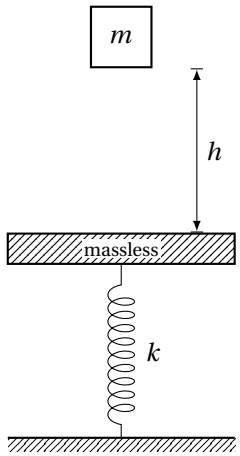


a) 5.5 cm *Ans.*
b) 2.5 cm
c) 11.0 cm
d) 8.5 cm

2. An open knife of mass m is dropped from a height h on a wooden floor. If the blade penetrates up to the depth d into the wood, the average resistance offered by the wood to the knife edge is

a) $mg\left(1+\frac{h}{d}\right)$ *Ans.*
b) $mg\left(1+\frac{h}{d}\right)^2$
c) $mg\left(1-\frac{h}{d}\right)$
d) $mg\left(1+\frac{d}{h}\right)$

3. A vertical spring is fixed to one of its end and a massless plank fitted to the other end. A block is released from a height h as shown. Spring is in relaxed position. Then choose the correct statement.

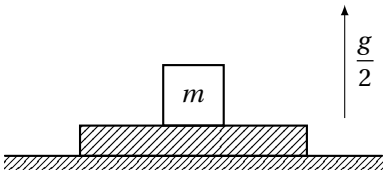


a) The maximum compression of the spring does not depend on h
b) The maximum kinetic energy of the block does not depend on h
c) The compression of the spring at maximum $K.E.$ of the block does not depend on h *Ans.*
d) The maximum compression of the spring does not depend on k

4. A spring of force constant 800 N/m has an extension of 5 cm. The work done in extending it from 5 cm to 15 cm is

   a) 16 J
   b) 8 J *Ans.*
   c) 32 J
   d) 24 J

5. A block of mass m is kept on a platform which starts from rest with constant acceleration $\frac{g}{2}$ upwards as shown in figure. Work done by normal reaction on block in time t is

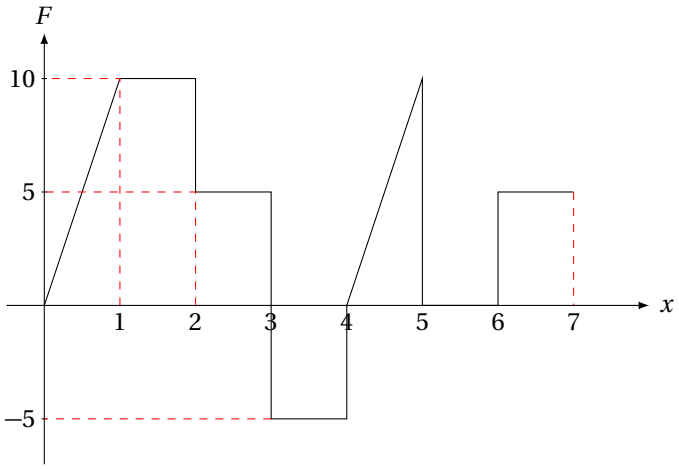


   a) $\frac{mg^2t^2}{8}$
   b) $\frac{3mg^2t^2}{8}$ *Ans.*
   c) 0
   d) $-\frac{mg^2t^2}{8}$

6. A force $F = -k(y\,i + x\,j)$ (where, k is a positive constant) acts on a particle moving in the x-y plane. Starting from the origin, the particle is taken along the positive X-axis to the point $(a,0)$ and then parallel to the Y-axis to the point (a,a). The total work done by the force F on the particle is

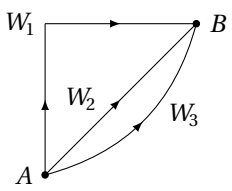
   a) $-2ka^2$
   b) $2ka^2$
   c) $-ka^2$ *Ans.*
   d) ka^2

7. The relationship between the force F and position x of a body is as shown in figure. The work done in displacing the body from $x = 1$ m to $x = 5$ m will be



   a) 30 J
   b) 15 J *Ans.*
   c) 25 J
   d) 20 J

8. If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 respectively (as shown) in the gravitational field of a point mass m. Find the correct relation between W_1, W_2 and W_3.

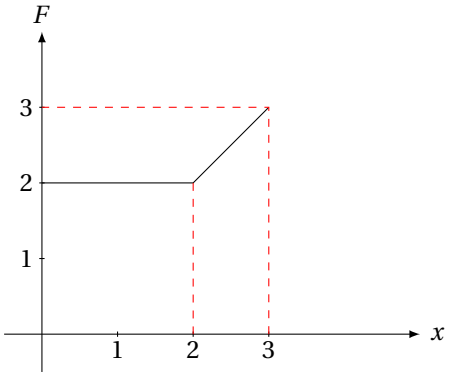


   a) $W_1 > W_2 > W_3$
   b) $W_1 = W_2 = W_3$ *Ans.*
   c) $W_1 < W_2 < W_3$
   d) $W_2 > W_1 > W_3$

9. A force acts on a 2 kg 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?

   a) 850 J
   b) 900 J *Ans.*
   c) 950 J
   d) 875 J

10. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled 3 m is



   a) 4 J
   b) 2.5 J
   c) 6.5 J *Ans.*
   d) 5 J

11. A time dependent force $F = 6t$ acts on a particle of mass 1 kg. If the particle starts from rest, the work done by the force during the first 1 s will be

   a) 22 J
   b) 9 J
   c) 18 J
   d) 4.5 J *Ans.*

12. A particle which is experiencing a force, is given by $\vec{F} = 3\hat{i} - 12\hat{j}$, undergoes a displacement of $\vec{d} = 4\hat{i}$. If the particle had a kinetic energy of 3 J at the beginning of the displacement, what is its kinetic energy at the end of the displacement ?

   a) 9 J
   b) 15 J *Ans.*
   c) 12 J
   d) 10 J

13. Two masses of 1 g and 4 g are moving with equal kinetic energies. The ratio of the magnitudes of their momenta is

   a) 4 : 1
   b) $\sqrt{2}$: 1
   c) 1 : 2 *Ans.*
   d) 1 : 16

14. A body of mass $m = 10^{-2}$ kg is moving in a medium and experiences a frictional force $F = -kv^2$. Its initial speed is $v_0 = 10\,\mathrm{m\,s^{-1}}$. If, after 10 s, its energy is $\frac{1}{8}mv_0^2$, the value of k will be

   a) 10^{-3} kg/s
   b) 10^{-4} kg/m *Ans.*
   c) 10^{-1} kg/ms
   d) 10^{-3} kg/m

15. A projectile is fired from the origin with a velocity v_0 at an angle θ with the x-axis. The speed of the projectile at an altitude h is

   a) $v_0 \cos\theta$
   b) $\sqrt{v_0^2 - 2gh}$ *Ans.*
   c) $\sqrt{v_0^2 \sin^2\theta - 2gh}$
   d) None of these

16. A particle moves under the action of a force $F = 20\hat{i} + 15\hat{j}$ along a straight line $3y + \alpha x = 5$, where, α is a constant. If the work done by the force F is zero, then the value of α is

   a) $\frac{4}{9}$
   b) $\frac{9}{4}$
   c) 3
   d) 4 *Ans.*

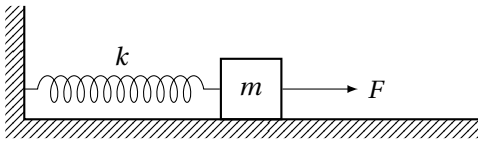
17. A mass of 0.5 kg moving with a speed of $1.5\,\text{m s}^{-1}$ on a horizontal smooth surface, collides with a nearly weightless spring of force constant $k = 50\,\text{N/m}$. The maximum compression of the spring would be

a) 0.15 m *Ans.*
b) 0.12 m
c) 0.5 m
d) 0.25 m

18. At time $t = 0$, particle starts moving along the x-axis. If its kinetic energy increases uniformly with time t , the net force acting on it must be proportional to

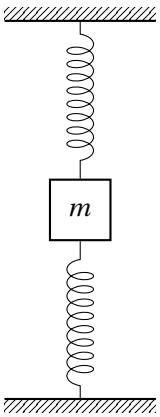
a) $\sqrt{t}$
b) constant
c) t
d) $\frac{1}{\sqrt{t}}$ *Ans.*

19. A block of mass m is connected to a spring of force constant k. Initially the block is at rest and the spring has natural length. A constant force F is applied horizontally towards right. The maximum speed of the block will be (there is no friction between block and the surface)



a) $\frac{F}{\sqrt{2mk}}$
b) $\frac{F}{\sqrt{mk}}$ *Ans.*
c) $\frac{\sqrt{2}F}{\sqrt{mk}}$
d) $\frac{2F}{\sqrt{mk}}$

20. A block tied between two identical springs is in equilibrium. If upper spring is cut, then the acceleration of the block just after cut is $5\,\text{m s}^{-2}$. Now if instead of upper string lower spring is cut, then the acceleration of the block just after the cut will be (Take $g = 10\,\text{m s}^{-2}$)



a) $1.25\,\text{m s}^{-2}$
b) $5\,\text{m s}^{-2}$ *Ans.*
c) $10\,\text{m s}^{-2}$
d) $2.5\,\text{m s}^{-2}$

Section-B
(Numerical Answer Type)

This section contains 10 questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place).
Do any 5 questions out of 10 Questions.

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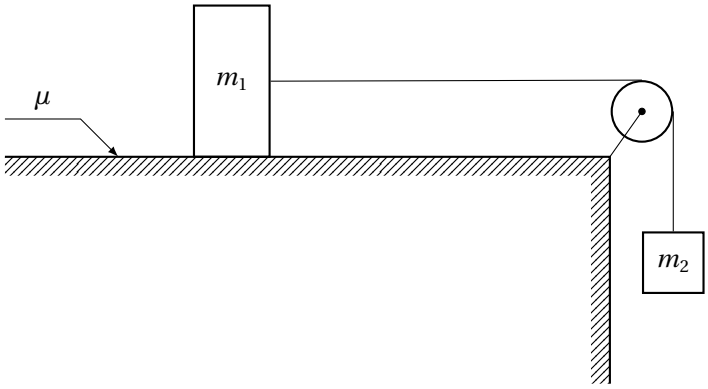
21. A ball of mass 1 kg is dropped from a tower. Find power of gravitational force at time $t = 2\,\text{s}$. Take $g = 10\,\text{m s}^{-2}$. [200]

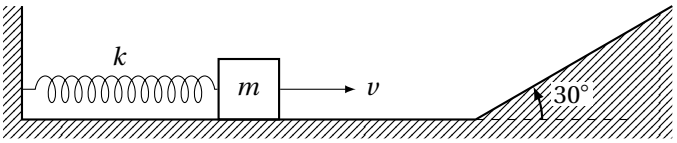
22. A block of mass 5 kg is raised from the bottom of the lake to a height of 3 m without change in kinetic energy. If the density of the block is $3000\,\text{kg/m}^3$, then the work done is equal to [100]

23. A body is displaced from origin to (1 m, 1 m) by a force $\vec{F} = 2y\,\hat{i} + 3x^2\,\hat{j}$ along the path $y = x^2$, if the work done along the path is W then $[W]$ is (where [ ] is greatest integer function) [2]

24. Two masses $m_1 = 10\,\text{kg}$ and $m_2 = 5\,\text{kg}$ are connected by an ideal string as shown in the figure. The coefficient of friction between m_1 and the surface is $\mu = 0.2$. Assuming that the system is released from rest. Calculate the velocity of blocks when m_2 has descended by 4 m. ($g = 10\,\text{m s}^{-2}$) [4]

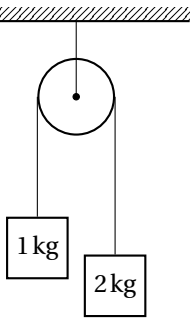


25. In the figure shown, all surfaces are smooth and force constant of spring is 10 N/m. Block of mass 2 kg is not attached with the spring. The spring is compressed by 2 m and then released. Find the maximum distance d travelled by the block over the inclined plane. Take ($g = 10\,\text{m s}^{-2}$) . [2]

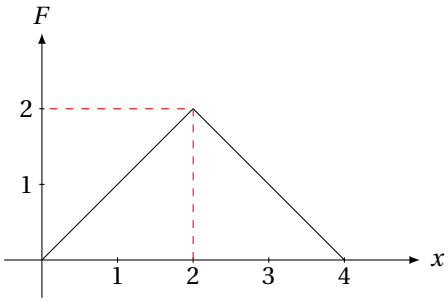


26. A rod of length 1.0 m and mass 1 kg fixed at one end is initially hanging vertical. The other end is now raised until it makes an angle 90° with the vertical. How much work is required ? ($g = 10\,\text{m s}^{-2}$) [5]

27. In the given figure, system is released from rest. Friction is absent and string is massless. In time $t = 0.3\,\text{s}$, work done by gravity on 2 kg block is ($g = 10\,\text{m s}^{-2}$) [3]



28. For the given graph find the work done by the force. [4]



29. Suppose you drag a block slowly of mass 1 kg on a horizontal rough plane for 2 m by applying a force of 5 N, then find the magnitude of work done by the friction force. [10]

30. A force $F = (2 + 2x)$ acts on a particle in x-direction where F is in newton and x in metre. Find the work done by this force during a displacement from $x = 1.0\,\text{m}$ to $x = 2.0\,\text{m}$. [5]