Work, Energy, And Power JEE Main PYQ - 3

Total Time: 25 Minute **Total Marks:** 40

Instructions

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1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Work, Energy, And Power

1. A person trying to lose weight by burning at lifts a mass of $10\,kg$ upto a height of $1\,m$ 1000 times. Assume that the potential energy lost each time he lowers the mass is dissipated. How much fat will he use up considering the work done only when the weight is lifted up ? Fat supplies $3.8 \times 10^7\,J$ of energy per kg which is converted to mechanical energy with a 20% efficiency rate. Take $g = 9.8\,ms^{-2}$: **(+4, -1)**

[2016]

a. $2.45 \times 10^{-3}\,kg$

b. $6.45 \times 10^{-3}\,kg$

c. $9.89 \times 10^{-3}\,kg$

d. $12.89 \times 10^{-3}\,kg$

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2. A piece of wood of mass $0.03\,kg$ is dropped from the top of a $100\,m$ height building. At the same time, a bullet of mass $0.02\,kg$ is fired vertically upward, with a velocity $100\,ms^{-1}$, from the ground. The bullet gets embedded in the wood. Then the maximum height to which the combined system reaches above the top of the building before falling below is : $(g = 10\,ms^{-2})$ **(+4, -1)**

[10 Jan. 2019 I]

a. 30 m

b. 10 m

c. 40 m

d. 20 m

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3. A point particle of mass m, moves along the uniformly rough track PQR as shown in the figure. The coefficient of friction, between the particle and the rough track equals μ. The particle is released, from rest, from the point P and it comes to rest at a point R. The energies, lost by the ball, over the parts, PQ and QR, of the track, are equal to each other, and no energy is lost when particle changes direction from PQ to QR. The values of the coefficient of friction μ and the distance $x(= QR)$, are, respectively close to : **(+4, -1)**

[2016]

a. 0.2 and 6.5 m

b. 0.2 and 3.5 m

c. 0.29 and 3.5 m

d. 0.29 and 6.5 m

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4. A projectile of mass M is fired so that the horizontal range is $4\,km$. At the highest point the projectile explodes in two parts of masses $M/4$ and $3M/4$ respectively and the heavier part starts falling down vertically with zero initial speed. The horizontal range (distance from point of firing) of the lighter part is : **(+4, -1)**

[Online April 23, 2013]

a. 16 km

b. 1 km

c. 10 km

d. 2 km

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5. A spring of unstretched length ℓ has a mass m with one end fixed to a rigid support. Assuming spring to be made of a uniform wire, the kinetic energy possessed by it if it's free end is pulled with uniform velocity v is : **(+4, -1)**

[Online April 12, 2014]

a. $\frac{1}{2}mv^2$

b. mv^2

c. $\frac{1}{3}mv^2$

d. $\frac{1}{6}mv^2$

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6. A spring whose unstretched length is l has a force constant k. The spring is cut into two pieces of unstretched lengths l_1 and l_2 where, $l_1 = nl_2$ and n is an integer. The ratio k_1/k_2 of the corresponding force constants, k_1 and k_2 will be : **(+4, -1)**

[12 April 2019 II]

a. $\frac{1}{n^2}$

b. n^2

c. $\frac{1}{n}$

d. n

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7. A uniform cable of mass $'M'$ and length $'L'$ is placed on a horizontal surface such that its $\left(\frac{1}{n}\right)^{th}$ part is hanging below the edge of the surface. To lift the hanging part of the cable upto the surface, the work done should be : **(+4, -1)**

[9 April 2019 I]

a. $\frac{MgL}{n^2}$

b. $\frac{MgL}{2n^2}$

c. $\frac{2MgL}{n^2}$

d. $nMgL$

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8. An alpha-particle of mass m suffers 1-dimensional elastic coolision with a nucleus at rest of unknown mass. It is scattered directly backwards losing, 64% of its initial kinetic energy. The mass of the nucleus is : **(+4, -1)**

[12 Jan. 2019 II]

a. 4 m

b. 3.5 m

c. 2 m

d. 1.5 m

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9. Vectors $a\hat{i}+b\hat{j}+\hat{k}$ and $2\hat{i}-3\hat{j}+4\hat{k}$ are perpendicular to each other when $3a+2b=7$, the ratio of a to b is $\frac{x}{2}$ The value of x is __ **(+4, -1)**

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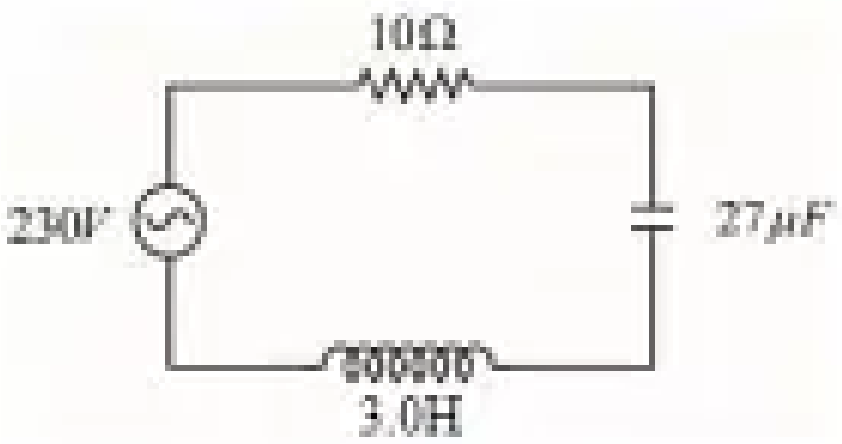
10. In the circuit shown in the figure, the ratio of the quality factor and the band width is__s **(+4, -1)**



Answers

1. **Answer: d**

Explanation:

$$0.2 \times 3.8 \times 10^7 \times m = 10 \times g \times 1 \times 1000$$
$$m = \frac{10 \times 9.8 \times 1000}{0.2 \times 3.8 \times 10^7} = 1.289 \times 10^{-2}\, kg = 12.89 \times 10^{-3}\, kg$$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.

- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

2. Answer: c

Explanation:

Time taken for the particles to collide,
$t = \frac{d}{V_{rel}} = \frac{100}{100} = 1\,\text{sec}$
Speed of wood just before collision = $gt = 10\,m/s$ & speed of bullet just before collision
$v - gt$
= $100 - 10 = 90\,m/s$
Now, conservation of linear momentum just before and after the collision -
$-(0.02)(1v) + (0.02)(9v) = (0.05)v$
$\Rightarrow\ 150\ = 5v$
$\Rightarrow\ v\ = 30\,m/s$
Max. height reached by body $h = \frac{v^2}{2g}$
$h = \frac{30\times30}{2\times10} = 45\,m$
$\therefore$ Height above tower = $40\,m$

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3. Answer: c

Explanation:

From work energy theorem and given condition

$mgh - 2\,\mu mg\,\cos\theta\frac{h}{\sin\theta} = 0$

$\therefore \mu = \frac{1}{2\cot 30} = \frac{1}{2\sqrt{3}} = 0.29$

again $\frac{mgh}{2} = \mu\, mg\, .QR$

$\therefore QR = \frac{h}{2\mu} = \frac{2}{2\times 0.29} = 3.5\, m$

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4. Answer: c

Explanation:

The correct option is(C): 10 km

$X_{COM} = \frac{m_1x_1+m_2x_2}{m_1+m_2}$
$R = \frac{\frac{M}{4}x+\frac{3M}{4}\times\frac{R}{2}}{M}$

Horizontal range is given as
$r_{\frac{M}{4}} = \frac{r}{2} + d = 2 + 8 = 10km$
$= 10Km$

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5. Answer: d

Explanation:

$$KE = \int \frac{1}{2} dm \left(\frac{v}{\ell} x\right)^2$$
$$= \frac{1}{2} \int \frac{m}{\ell} dx \frac{v^2}{\ell^2} x^2$$
$$= \frac{mv^2}{2\ell^2} \left(\frac{x^3}{3}\right)_0^{\ell}$$
$$= \frac{mv^2}{2\ell^3} \times \frac{\ell^3}{3}$$
$$= \frac{mv^2}{6}$$

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6. Answer: c

Explanation:

$$k_1 = \frac{C}{\ell_1}$$
$$k_2 = \frac{C}{\ell_2}$$
$$\frac{k_1}{k_2} = \frac{C\ell_2}{\ell_1 C}\ell_2 = \frac{\ell_2}{n\ell_2} = \frac{1}{n}$$

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7. Answer: b

Explanation:

Mass of the hanging part = $\frac{M}{n}$

$h_{COM} = \frac{L}{2n}$

work done W = mgh$_{COM} = \left(\frac{M}{n}\right) g \left(\frac{L}{2n}\right) = \frac{MgL}{2n^2}$

Option (2)

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8. Answer: a

Explanation:

$mv_0 = mv_2 - mv_1$
$\frac{1}{2}mV_1^2 = 0.36 \times \frac{1}{2}mV_0^2$
$v_1 = 0.6v_0$
$\frac{1}{2}MV_2^2 = 0.64 \times \frac{1}{2}mV_0^2$
$V_2 = \sqrt{\frac{m}{M}} \times 0.8V_0$
$mV_0 = \sqrt{mM} \times 0.8V_0 - m \times 0.6V_0$

$\Rightarrow 1.6m = 0.8\sqrt{mM}$

$4m^2 = mM$

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9. Answer: 1 - 1

Explanation:

The correct answer is 1.

For two perpendicular vectors

$(a\hat{i}+b\hat{j}+\hat{k})\cdot(2\hat{i}-3\hat{j}+4\hat{k})=0$

$2a-3b+4=0$

On solving, $2a-3b=-4$

Also given

$3a+2b=7$

We get $a=1, b=2$

$\frac{a}{b}=\frac{x}{2}\Rightarrow x=\frac{2a}{b}=\frac{2\times1}{2}$

$\Rightarrow x=1$

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10. Answer: 10 - 10

Explanation:

The correct answer is 10.

$\Delta\omega = \frac{R}{L}$

$Q = \frac{\omega_0}{\Delta\omega} = \omega_0 \frac{L}{R}$

$\omega_0 = \frac{1}{\sqrt{3\times27\times10^{-6}}} = \frac{1}{9\times10^{-3}}$

$\frac{Q}{\Delta\omega} = \frac{\omega_0 \frac{R}{R}}{\frac{R}{L}} = \omega_0 \frac{L^2}{R^2} = \sqrt{\frac{1}{LC}} \frac{L^2}{R^2}$

$= \frac{1}{9\times10^{-3}} \times \frac{9}{100} = 10\,s$

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called Refraction.

Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments