1. A spring with $k = 20$ N/m is stretched $x = 0.15$ m. The magnitude of the restoring force (in N)?

   _____ N

2. An oscillator has a period of 0.25 s. Its frequency (in Hz)?

   _____ Hz

3. An oscillator has $A = 0.2$ m and $\omega = 4$ rad/s. Its maximum speed (in m/s)?

   _____ m/s

4. A spring with $k = 100$ N/m oscillates with amplitude $A = 0.2$ m. Its total energy (in J)?

   _____ J

5. A simple pendulum swings through small angles with $L = 0.25$ m and $g = 9.8\ \frac{\text{m}}{\text{s}^2}$. Find its period (in s, to 1 decimal).

   _____ s

6. A motion is simple harmonic when the restoring force is...

   ☐ proportional to displacement and opposite in direction

   ☐ constant in size and direction

   ☐ proportional to speed

7. You replace a mass-spring oscillator's mass with a heavier one. The period...

   ☐ stays the same

   ☐ increases

   ☐ decreases

8. Where in the motion is the speed greatest?

   ☐ it is constant

   ☐ at the equilibrium position

   ☐ at the two extremes

9. At which point is the oscillator's energy entirely kinetic?

   ☐ at the equilibrium position

   ☐ nowhere – it is always shared

   ☐ at the extremes

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   ☐ the radius of the pivot

   ☐ the distance from the pivot to the centre of mass

   ☐ the full length of the body

1. **3 N**

   $|F| = kx = 20 \times 0.15 = 3$ N.

2. **4 Hz**

   $f = 1/T = 1/0.25 = 4$ Hz.

3. **0.8 m/s**

   $v_{max} = A\omega = 0.2 \times 4 = 0.8$ m/s.

4. **2 J**

   $E = \frac{1}{2}kA^2 = \frac{1}{2}(100)(0.2)^2 = 2$ J.

5. **1.0 s**

   $T = 2\pi\sqrt{L/g} = 2\pi\sqrt{0.25/9.8} \approx 1.0$ s.

6. **proportional to displacement and opposite in direction**

   $F = -kx$ – proportional to x and pointing back toward equilibrium.

7. **increases**

   $T = 2\pi\sqrt{m/k}$, so a bigger m gives a longer T.

8. **at the equilibrium position**

   Speed peaks where $x = 0$ (the middle) and is zero at the ends.

9. **at the equilibrium position**

   At equilibrium $x = 0$ so $U = 0$ and all the energy is kinetic.

10. **the distance from the pivot to the centre of mass**

    d is the fixed pivot-to-center-of-mass distance. At angular displacement theta from the downward vertical, gravity's perpendicular lever arm is d sin theta and its restoring torque is -mgd sin theta.

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