

SHM [33 marks]

1. An object undergoing simple harmonic motion (SHM) has a period T and total energy E . The amplitude of oscillations is halved. What are the new period and total energy of the system? [1 mark]

	Period	Total energy
A.	$\frac{T}{2}$	$\frac{E}{4}$
B.	$\frac{T}{2}$	$\frac{E}{2}$
C.	T	$\frac{E}{4}$
D.	T	$\frac{E}{2}$

Markscheme

C

2. A mass at the end of a vertical spring and a simple pendulum perform oscillations on Earth that are simple harmonic with time period T . Both the pendulum and the mass-spring system are taken to the Moon. The acceleration of free fall on the Moon is smaller than that on Earth. What is correct about the time periods of the pendulum and the mass-spring system on the Moon? [1 mark]

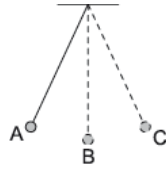
	Simple pendulum	Mass-spring system
A.	T	T
B.	greater than T	T
C.	greater than T	greater than T
D.	T	greater than T

Markscheme

B

3. A simple pendulum bob oscillates as shown.

[1 mark]



At which position is the resultant force on the pendulum bob zero?

- A. At position A
- B. At position B
- C. At position C
- D. Resultant force is never zero during the oscillation

Markscheme

D

4. A spring loaded with mass m oscillates with simple harmonic motion. The amplitude of [1 mark] the motion is A and the spring has total energy E . What is the total energy of the spring when the mass is increased to $3m$ and the amplitude is increased to $2A$?

- A. $2E$
- B. $4E$
- C. $12E$
- D. $18E$

Markscheme

B

5. A pendulum oscillating near the surface of the Earth swings with a time period T . What [1 mark] is the time period of the same pendulum near the surface of the planet Mercury where the gravitational field strength is $0.4g$?

- A. $0.4T$
- B. $0.6T$
- C. $1.6T$
- D. $2.5T$

Markscheme

C

6. A mass oscillates with simple harmonic motion (SHM) of amplitude x_0 . Its total energy is 16 J . [1 mark]

What is the kinetic energy of the mass when its displacement is $\frac{x_0}{2}$?

- A. 4 J
- B. 8 J
- C. 12 J
- D. 16 J

Markscheme

C

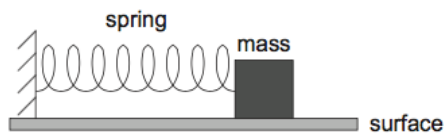
7. A particle is oscillating with simple harmonic motion (shm) of amplitude x_0 and maximum kinetic energy E_k . What is the potential energy of the system when the particle is a distance $0.20x_0$ from its maximum displacement? [1 mark]

- A. $0.20E_k$
- B. $0.36E_k$
- C. $0.64E_k$
- D. $0.80E_k$

Markscheme

C

8. A mass is connected to a spring on a frictionless horizontal surface as shown. [1 mark]



The spring is extended beyond its equilibrium length and the mass executes simple harmonic motion (SHM). Which of the following is independent of the initial displacement of the spring?

- A. The angular frequency of the oscillation
- B. The total energy of the mass
- C. The average speed of the mass
- D. The maximum kinetic energy of the mass

Markscheme

A

9. A simple pendulum has mass M and length l . The period of oscillation of the pendulum is T . What is the period of oscillation of a pendulum with mass $4M$ and length $0.25l$? [1 mark]
- A. $0.5T$
 - B. T
 - C. $2T$
 - D. $4T$

Markscheme

A

10. Which of the following experiments provides evidence for the existence of matter waves? [1 mark]
- A. Scattering of alpha particles
 - B. Electron diffraction
 - C. Gamma decay
 - D. Photoelectric effect

Markscheme

B

11. The period of a particle undergoing simple harmonic motion (SHM) is T . [1 mark]
- The ratio $\frac{\text{acceleration of the particle}}{\text{displacement of the particle from its equilibrium position}}$ is proportional to
- A. T^{-2} .
 - B. T^{-1} .
 - C. T .
 - D. T^2

Markscheme

A

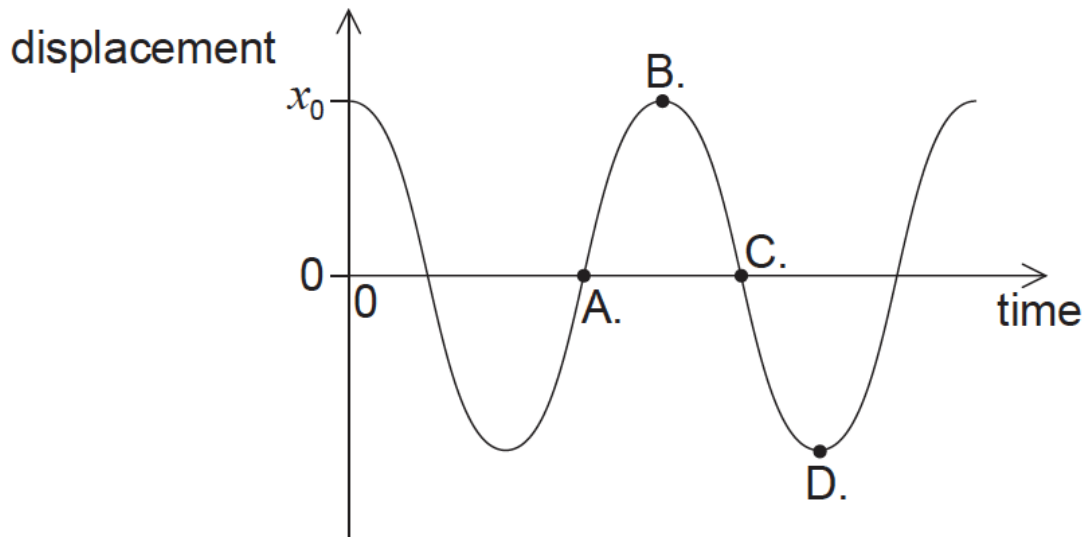
12. A particle of mass m oscillates with simple harmonic motion (SHM) of angular frequency ω . The amplitude of the SHM is A . What is the kinetic energy of the particle when it is half way between the equilibrium position and one extreme of the motion? [1 mark]

- A. $\frac{mA^2\omega^2}{4}$
B. $\frac{3mA^2\omega^2}{8}$
C. $\frac{9mA^2\omega^2}{32}$
D. $\frac{15mA^2\omega^2}{32}$

Markscheme

B

13. The bob of a pendulum has an initial displacement x_0 to the right. The bob is released and allowed to oscillate. The graph shows how the displacement varies with time. At which point is the velocity of the bob at maximum towards the right? [1 mark]



Markscheme

A

14. A particle undergoes simple harmonic motion (SHM) of maximum kinetic energy E_{\max} [1 mark] and amplitude x_0 . The particle is released from rest at its maximum displacement amplitude.

What is the change in the kinetic energy when the particle has travelled a distance of $\frac{x_0}{3}$?

- A. $\frac{E_{\max}}{9}$
- B. $\frac{4E_{\max}}{9}$
- C. $\frac{5E_{\max}}{9}$
- D. $\frac{8E_{\max}}{9}$

Markscheme

C

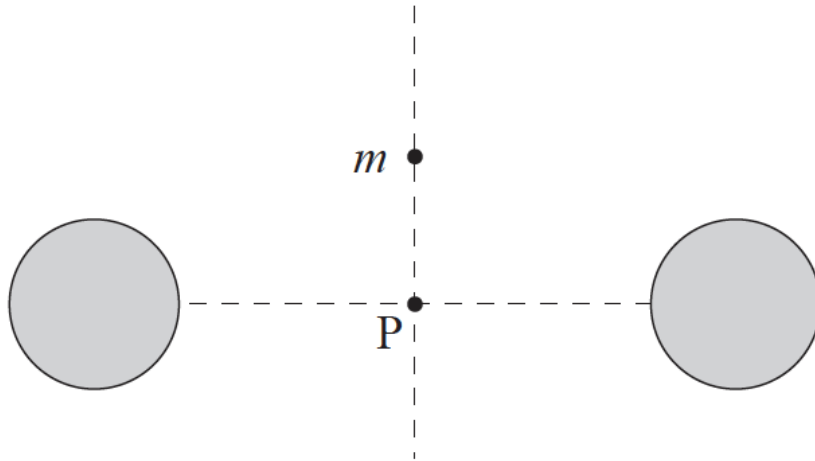
15. A body moves with simple harmonic motion (SHM) with period T and total energy E_T . [1 mark] What is the total energy when the period of the motion is changed to $5T$ and the amplitude of the motion remains constant?

- A. $0.04 E_T$
- B. $0.2 E_T$
- C. $5 E_T$
- D. $25 E_T$

Markscheme

A

16. A small point mass m is placed at the same distance from two identical fixed spherical masses far from any other masses. [1 mark]



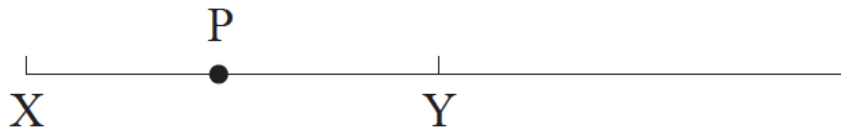
The point mass is released from rest. The point mass will

- A. move upwards.
- B. stay where it is.
- C. move towards P and stop there.
- D. oscillate about point P.

Markscheme

D

17. A particle P executes simple harmonic motion (SHM) about its equilibrium position Y. [1 mark]



The amplitude of the motion is XY.

At which of the positions shown on the diagram is the acceleration of P equal to zero and the kinetic energy of P equal to zero?

	Acceleration	Kinetic energy
A.	Y	X
B.	X	X
C.	Y	Y
D.	X	Y

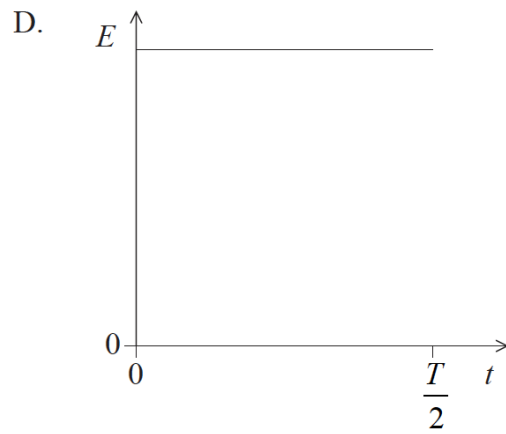
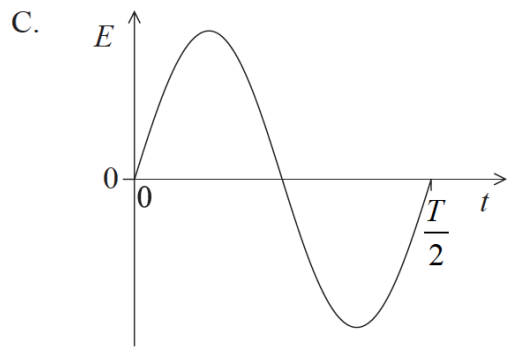
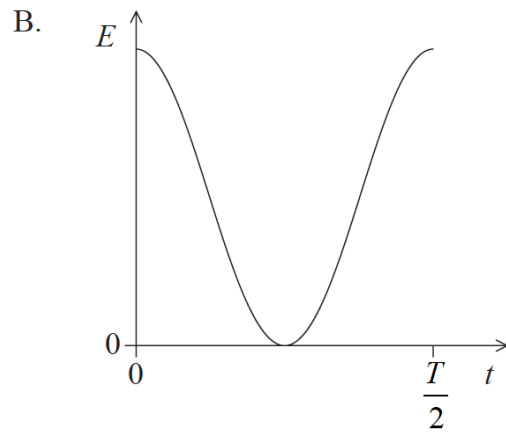
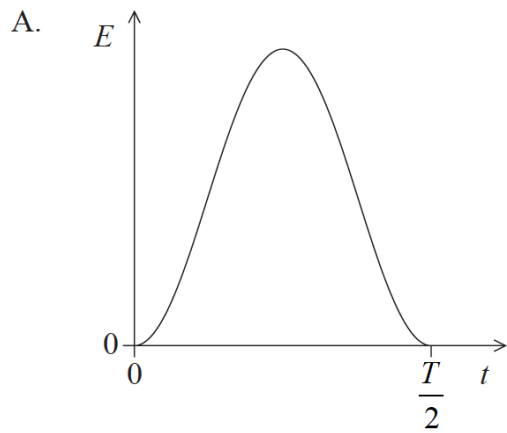
Markscheme

A

18. A particle executes simple harmonic motion (SHM) with period T .

[1 mark]

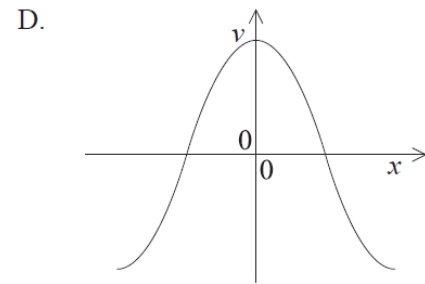
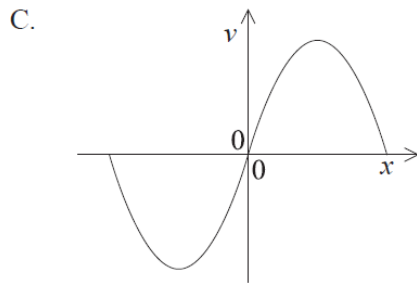
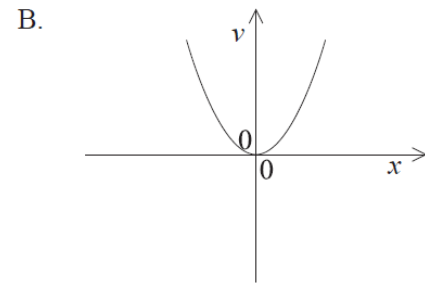
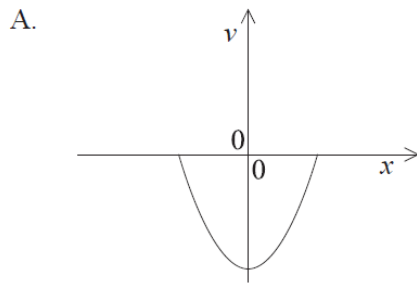
Which sketch graph correctly shows how the total energy E of the particle varies with time t from $t = 0$ to $t = \frac{T}{2}$?



Markscheme

D

19. Which graph shows how velocity v varies with displacement x of a system moving with [1 mark] simple harmonic motion?



Markscheme

A

20. An object undergoes simple harmonic motion with time period T and amplitude 0.5 m. [1 mark] At time $t = 0$ s the displacement of the object is a maximum.

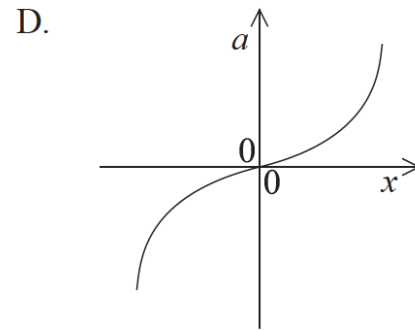
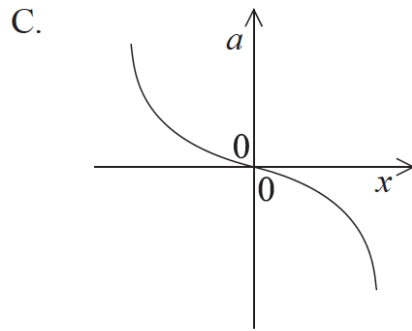
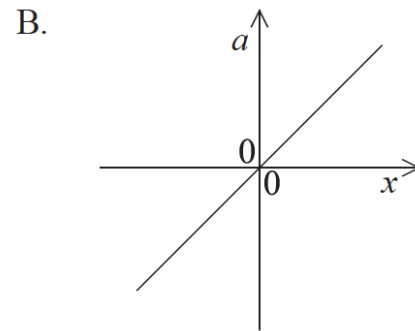
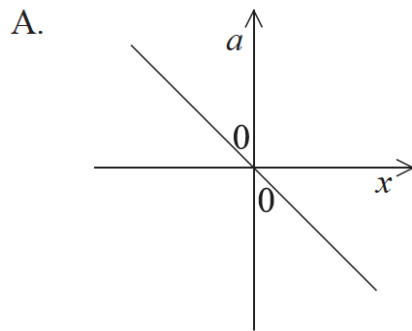
What is the displacement of the object at time $t = \frac{3T}{4}$?

- A. -0.50 m
- B. 0.50 m
- C. 0.25 m
- D. 0 m

Markscheme

D

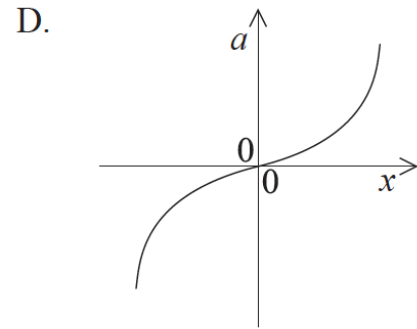
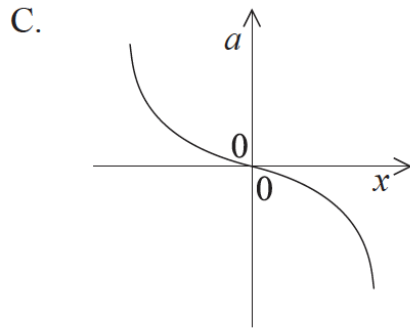
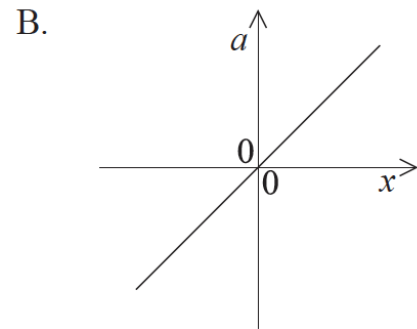
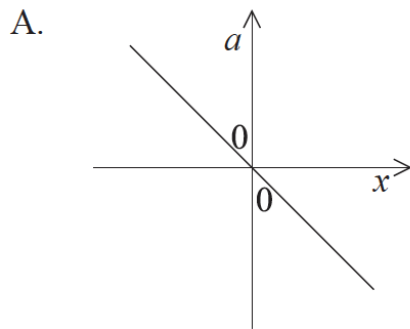
21. An object undergoes simple harmonic motion. Which graph shows the relationship between the acceleration a and the displacement x from the equilibrium position? [1 mark]



Markscheme

A

22. An object undergoes simple harmonic motion. Which graph shows the relationship between the acceleration a and the displacement x from the equilibrium position? [1 mark]



Markscheme

A

23. An object is undergoing simple harmonic motion (SHM) about a fixed point P. The magnitude of its displacement from P is x . Which of the following is correct? [1 mark]

	Magnitude of resultant force	Direction of resultant force
A.	proportional to x	towards P
B.	inversely proportional to x	towards P
C.	proportional to x	away from P
D.	inversely proportional to x	away from P

Markscheme

A

24. An object undergoes simple harmonic motion (SHM). The total energy of the object is proportional to [1 mark]
- A. the amplitude of the oscillations.
 - B. the time period of the oscillations.
 - C. the frequency of the oscillations.
 - D. the mass of the object.

Markscheme

D

25. A particle undergoing simple harmonic motion (SHM) oscillates with time period T and angular frequency ω . The time period of the SHM changes to $2T$. Which of the following gives the new value of ω ? [1 mark]
- A. $\frac{\omega}{4}$
 - B. $\frac{\omega}{2}$
 - C. 2ω
 - D. 4ω

Markscheme

B

26. A particle is undergoing simple harmonic motion (SHM) in a horizontal plane. The total mechanical energy of the system is E . Which of the following correctly gives the kinetic energy of the particle at the positions of maximum displacement and equilibrium? [1 mark]

	Maximum displacement	Equilibrium
A.	$\frac{1}{2}E$	$\frac{1}{2}E$
B.	0	E
C.	$\frac{1}{2}E$	0
D.	E	0

Markscheme

B

27. The equation for the velocity of an object performing simple harmonic motion is $v = v_0 \sin \omega t$. Which of the following is a correct alternative form of the equation? [1 mark]

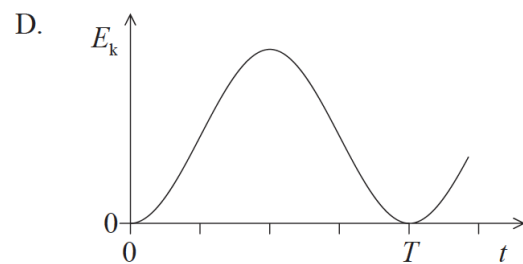
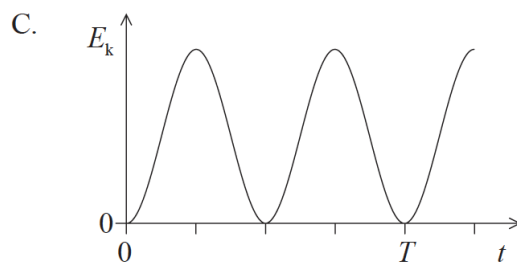
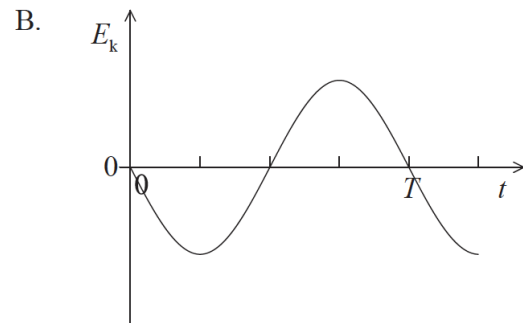
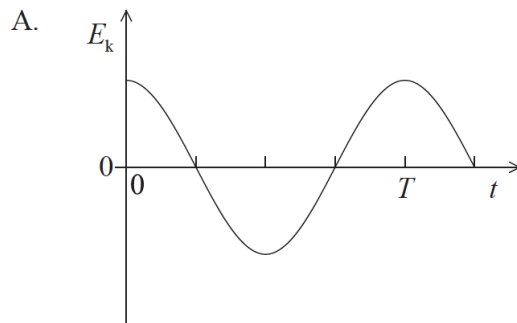
- A. $v = v_0 \sin\left(\frac{2\pi}{T}\right)t$
- B. $v = v_0 \sin\left(\frac{t}{T}\right)$
- C. $v = v_0 \sin \pi T t$
- D. $v = v_0 \sin\left(\frac{T}{2\pi}\right)t$

Markscheme

A

28. A particle oscillates with simple harmonic motion with period T . [1 mark]

At time $t=0$, the particle has its maximum displacement. Which graph shows the variation with time t of the kinetic energy E_k of the particle?



Markscheme

C

29. Two waves meet at a point. The waves have a path difference of $\frac{\lambda}{4}$. The phase difference between the waves is [1 mark]

1. $\frac{\pi}{8}$ rad.
2. $\frac{\pi}{4}$ rad.
3. $\frac{\pi}{2}$ rad.
4. π rad.

Markscheme

C

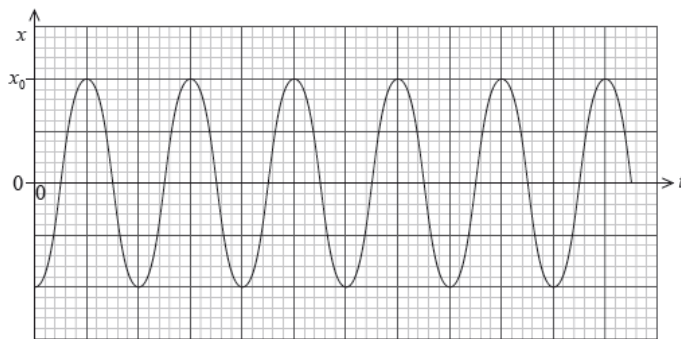
30. Two waves meet at a point. The waves have a path difference of $\frac{\lambda}{4}$. The phase difference between the waves is [1 mark]

1. $\frac{\pi}{8}$ rad.
2. $\frac{\pi}{4}$ rad.
3. $\frac{\pi}{2}$ rad.
4. π rad.

Markscheme

C

An object at the end of a spring oscillates vertically with simple harmonic motion. The graph shows the variation with time t of the displacement x . The amplitude is x_0 and the period of oscillation is T .



Markscheme

A

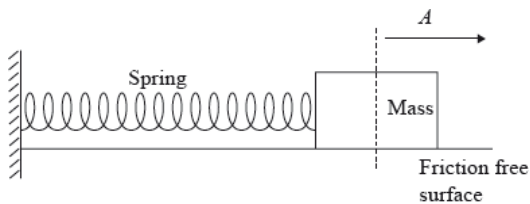
32. Which of the following is the correct expression for the maximum acceleration of the object? [1 mark]

- A. $\frac{2\pi}{T} x_0$
- B. $\frac{2\pi}{T^2} x_0$
- C. $\frac{4\pi^2}{T^2} x_0$
- D. $\frac{4\pi^2}{T} x_0$

Markscheme

C

33. A mass on the end of a horizontal spring is displaced from its equilibrium position by a distance A and released. Its subsequent oscillations have total energy E and time period T . [1 mark]



An identical mass is attached to an identical spring. The maximum displacement is $2A$. Assuming this spring obeys Hooke's law, which of the following gives the correct time period and total energy?

	New time period	New energy
A.	T	$4E$
B.	T	$2E$
C.	$\sqrt{2}T$	$4E$
D.	$\sqrt{2}T$	$2E$

Markscheme

A

