Q1. A body moves with simple harmonic motion of amplitude A and frequency $\frac{b}{2\pi}$.
What is the magnitude of the acceleration when the body is at maximum displacement?

A zero

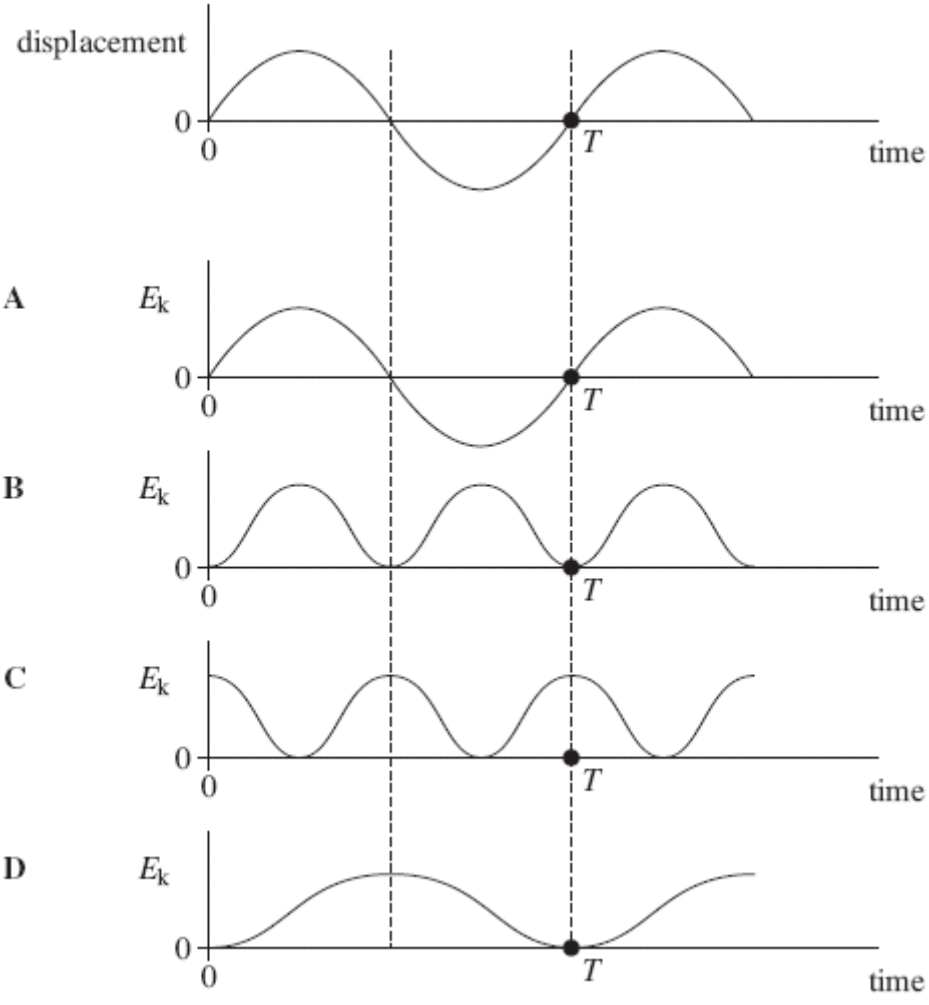
B $4\pi^2 Ab^2$

C Ab^2

D $\frac{4\pi^2 A}{b^2}$

(Total 1 mark)

Q2. An object oscillating in simple harmonic motion has a time period T. The first graph shows how its displacement varies with time. Which of the subsequent graphs, **A** to **D**, show how the kinetic energy, E_k, of the object varies with time?



(Total 1 mark)

Q3. The period of vertical oscillation of a mass-spring system is T when the spring carries a mass of 1.00 kg. What mass should be added to the 1.00 kg if the period is to be increased to 1.50 T?

A 0.25 kg

B 1.00 kg

C 1.25 kg

D 2.00 kg

(Total 1 mark)

Q4. The diagram shows two positions, **X** and **Y**, on the Earth's surface.

Which line, **A** to **D**, in the table gives correct comparisons at **X** and **Y** for gravitational potential and angular velocity?

	gravitational potential at X compared with Y	**angular velocity at X compared with Y**
A	greater	greater
B	greater	same
C	greater	smaller
D	same	same

(Total 1 mark)

Q5. What would the period of rotation of the Earth need to be if objects at the equator were to appear weightless?

radius of Earth = 6.4×10^{6} m

A 4.5×10^{-2} hours

B 1.4 hours

C 24 hours

D 160 hours

(Total 1 mark)

Q6. A mass on the end of a string is whirled round in a horizontal circle at increasing speed until the string breaks. The subsequent path taken by the mass is

A a straight line along a radius of the circle.

B a horizontal circle.

C a parabola in a horizontal plane.

D a parabola in a vertical plane.

(Total 1 mark)

Q7. A particle of mass *m* moves in a circle of radius *r* at uniform speed, taking time ***T*** for each revolution. What is the kinetic energy of the particle?

A $\frac{\pi^2 mr}{T^2}$

B $\frac{\pi^2 mr^2}{T^2}$

C $\frac{2\pi^2 mr^2}{T}$

D $\frac{2\pi^2 mr^2}{T^2}$

(Total 1 mark)

Q8. A body moves with simple harmonic motion of amplitude 0.90 m and period 8.9 s. What is the speed of the body when its displacement is 0.70 m?

A 0.11 m s^{-1}

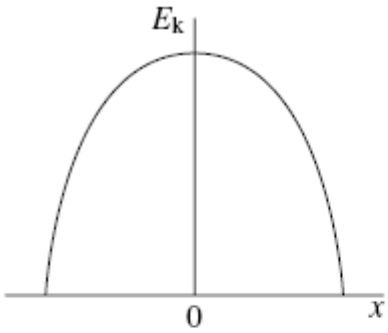
B 0.22 m s^{-1}

C 0.40 m s^{-1}

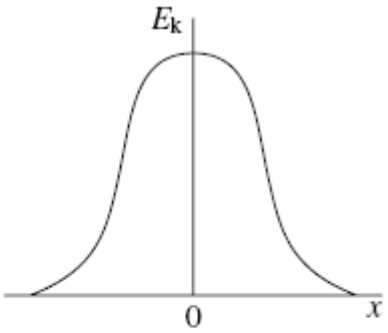
D 0.80 m s^{-1}

(Total 1 mark)

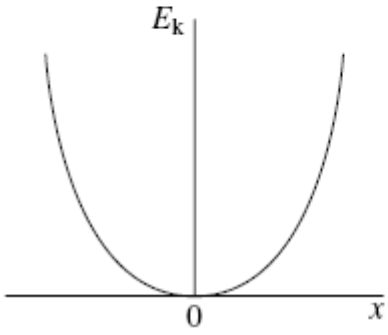
Q9. Which graph, **A** to **D**, shows the variation of the kinetic energy, E_k, with displacement x for a particle performing simple harmonic motion?



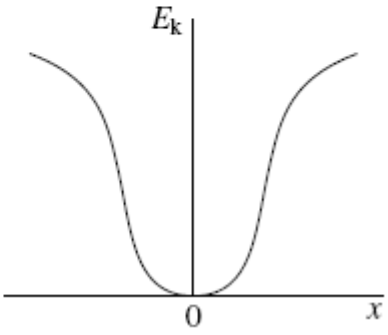
A



B



C



D

(Total 1 mark)

Q10. The time period of oscillation of a simple pendulum of length *l* is the same as the time period of oscillation of a mass *M* attached to a vertical spring. The length and mass are then changed. Which row, **A** to **D**, in the table would give a simple pendulum with a time period twice that of the spring oscillations?

	new pendulum length	**new mass on spring**
A	$2l$	$2M$
B	$2l$	$\frac{M}{2}$
C	$\frac{l}{2}$	$2M$
D	$\frac{l}{2}$	$\frac{M}{2}$

(Total 1 mark)

Q11. What is the angular speed of a point on the Earth's equator?

A 7.3×10^{-5} rad s^{-1}

B 4.2×10^{-3} rad s^{-1}

C 2.6×10^{-1} rad s^{-1}

D 15 rad s^{-1}

(Total 1 mark)

Q12. Which one of the following does **not** involve a centripetal force?

A an electron in orbit around a nucleus

B a car going round a bend

C an α particle in a magnetic field, travelling at right angles to the field

D an α particle in a electric field, travelling at right angles to the field

(Total 1 mark)

Q13. Which one of the following gives the phase difference between the particle velocity and the particle displacement in simple harmonic motion?

A $\frac{\pi}{4}$ rad

B $\frac{\pi}{2}$ rad

C $\frac{3\pi}{4}$ rad

D 2π rad

(Total 1 mark)

Q14. A mass *M* hangs in equilibrium on a spring. *M* is made to oscillate about the equilibrium position by pulling it down 10 cm and releasing it. The time for *M* to travel back to the equilibrium position for the first time is 0.50 s. Which row, **A** to **D**, in the table is correct for these oscillations?

	amplitude / cm	**period / s**
A	10	1.0
B	10	2.0
C	20	2.0
D	20	1.0

(Total 1 mark)

Q15. Which one of the following statements concerning forced vibrations and resonance is correct?

A An oscillating body that is not resonating will return to its natural frequency when the forcing vibration is removed.

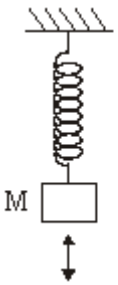
B At resonance, the displacement of the oscillating body is 180° out of phase with the forcing vibration.

C A pendulum with a dense bob is more heavily damped than one with a less dense bob of the same size.

D Resonance can only occur in mechanical systems.

(Total 1 mark)

Q16. A mass M on a spring oscillates along a vertical line with the same period *T* as an object O in uniform circular motion in a vertical plane. When M is at its highest point, O is at its lowest point.



What is the least time interval between successive instants when the acceleration of M is exactly in the opposite direction to the acceleration of O?

A $\frac{T}{4}$

B $\frac{T}{2}$

C $\frac{3T}{4}$

D T

(Total 1 mark)

Q17. A particle of mass *m* oscillates with amplitude *A* at frequency *f*. What is the maximum kinetic energy of the particle?

A $\frac{1}{2}\pi^2 mf^2A^2$

B $\pi^2 mf^2A^2$

C $2\pi^2 mf^2A^2$

D $4\pi^2 mf^2A^2$

(Total 1 mark)

Q18. For a particle moving in a circle with uniform speed, which **one** of the following statements is correct?

A The displacement of the particle is in the direction of the force.

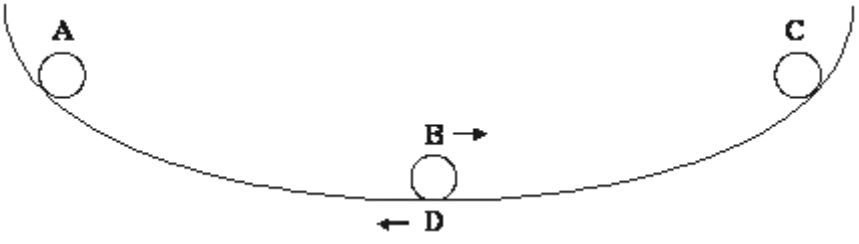
B The force on the particle is in the same direction as the direction of motion of the particle.

C The momentum of the particle is constant.

D The kinetic energy of the particle is constant.

(Total 1 mark)

Q19. A ball bearing rolls on a concave surface, as shown in the diagram, in approximate simple harmonic motion. It is released from **A** and passes through the lowest point **B** before reaching **C**. It then returns through the lowest point **D**. At which stage, **A**, **B**, **C** or **D**, does the ball bearing experience maximum acceleration to the left?



(Total 1 mark)

Q20. A body moves with simple harmonic motion of amplitude *A* and frequency $\frac{b}{2\pi}$. What is the magnitude of the acceleration when the body is at maximum displacement?

A zero

B $4\pi^2 Ab^2$

C Ab^2

D $\frac{4\pi^2 A}{b^2}$

(Total 1 mark)

Q21. What is the value of the angular velocity of a point on the surface of the Earth?

A 1.2×10^{-5} rad s^{-1}

B 7.3×10^{-5} rad s^{-1}

C 2.6×10^{-1} rad s^{-1}

D 4.6×10^{2} rad s^{-1}

(Total 1 mark)

Q22. The diagram shows two positions, **X** and **Y**, at different heights on the surface of the Earth.

Which line, **A** to **D**, in the table gives correct comparisons at **X** and **Y** for gravitational potential and angular velocity?

	gravitational potential at X compared with Y	**angular velocity at X compared with Y**
A	greater	greater
B	greater	same
C	greater	smaller
D	same	same

(Total 1 mark)

Q23. Protons, each of mass *m* and charge *e*, follow a circular path when travelling perpendicular to a magnetic field of uniform flux density *B*. What is the time taken for one complete orbit?

A $\frac{2\pi eB}{m}$

B $\frac{m}{2\pi eB}$

C $\frac{eB}{2\pi m}$

D $\frac{2\pi m}{eB}$

(Total 1 mark)

Q24. A spring is suspended from a fixed point. A mass attached to the spring is set into vertical undamped simple harmonic motion. When the mass is at its lowest position, which one of the following has its minimum value?

A the potential energy of the system

B the kinetic energy of the mass

C the acceleration of the mass

D the tension in the spring

(Total 1 mark)

Q25. The time period of a simple pendulum is doubled when the length of the pendulum is increased by 3.0 m. What is the original length of the pendulum?

A 1.0 m

B 1.5 m

C 3.0 m

D 6.0 m

(Total 1 mark)

Q26. A particle of mass *m* moves in a circle of radius *r* at uniform speed, taking time *T* for each revolution. What is the kinetic energy of the particle?

A $\frac{\pi^2 m r}{T^2}$

B $\frac{\pi^2 m r^2}{T^2}$

C $\frac{2\pi^2 m r^2}{T}$

D $\frac{2\pi^2 m r^2}{T^2}$

(Total 1 mark)

Q27. Which one of the following statements always applies to a damping force acting on a vibrating system?

A It is in the same direction as the acceleration.

B It is in the opposite direction to the velocity.

C It is in the same direction as the displacement.

D It is proportional to the displacement.

(Total 1 mark)

Q28. A mass on the end of a string is whirled round in a horizontal circle at increasing speed until the string breaks. The subsequent path taken by the mass is

A a straight line along a radius of the circle.

B a horizontal circle.

C a parabola in a horizontal plane.

D a parabola in a vertical plane.

(Total 1 mark)

Q29. A particle of mass m moves in a circle of radius r at a uniform speed with frequency f.
What is the kinetic energy of the particle?

A $\frac{mf^2r^2}{4\pi^2}$

B $\frac{mf^2r}{2}$

C $2\pi^2mf^2r^2$

D $4\pi^2mf^2r^2$

(Total 1 mark)

Q30. A body is in simple harmonic motion of amplitude 0.50 m and period 4π seconds. What is the speed of the body when the displacement of the body is 0.30 m?

A 0.10 m s^{-1}

B 0.15 m s^{-1}

C 0.20 m s^{-1}

D 0.40 m s^{-1}

(Total 1 mark)

Q31. Which one of the following statements about an oscillating mechanical system at resonance, when it oscillates with a constant amplitude, is **not** correct?

A The amplitude of oscillations depends on the amount of damping.

B The frequency of the applied force is the same as the natural frequency of oscillation of the system.

C The total energy of the system is constant.

D The applied force prevents the amplitude from becoming too large.

(Total 1 mark)

Q32. What is the angular speed of a point on the Earth's equator?

A 7.3×10^{-5} rad s^{-1}

B 4.2×10^{-3} rad s^{-1}

C 2.6×10^{-1} rad s^{-1}

D 15 rad s^{-1}

(Total 1 mark)

Q33. A body moves in simple harmonic motion of amplitude 0.90 m and period 8.9 s. What is the speed of the body when its displacement is 0.70 m?

A 0.11 m s^{-1}

B 0.22 m s^{-1}

C 0.40 m s^{-1}

D 0.80 m s^{-1}

(Total 1 mark)

Q34. To find a value for the acceleration of free fall, *g*, a student measured the time of oscillation, *T*, of a simple pendulum whose length, *l*, is changed. The student used the results to plot a graph of T^2 (*y* axis) against *l* (*x* axis) and found the slope of the line to be *S*. It follows that *g* is

A $\frac{4\pi^2}{S}$.

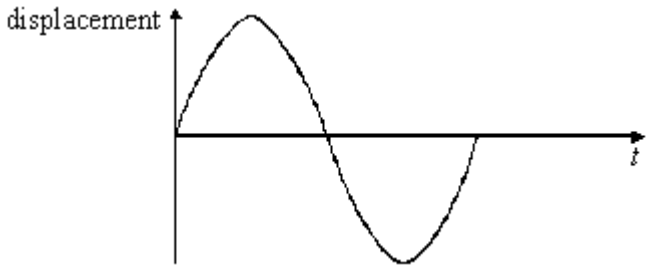
B $4\pi^2 S$.

C $\frac{2\pi}{S}$.

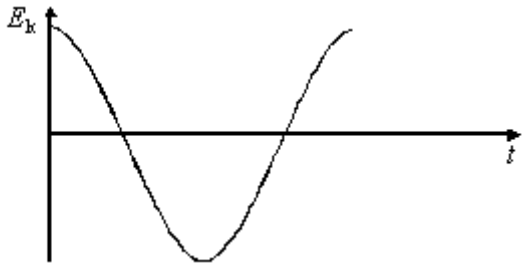
D $2\pi S$.

(Total 1 mark)

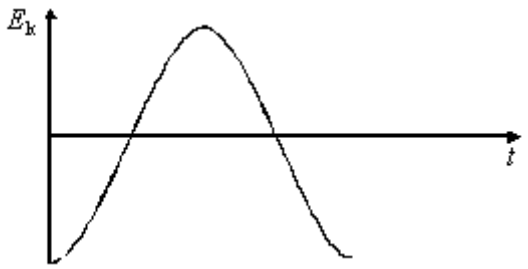
Q35. The top graph is a displacement/time graph for a particle executing simple harmonic motion. Which one of the other graphs shows correctly how the kinetic energy, E_k, of the particle varies with time?



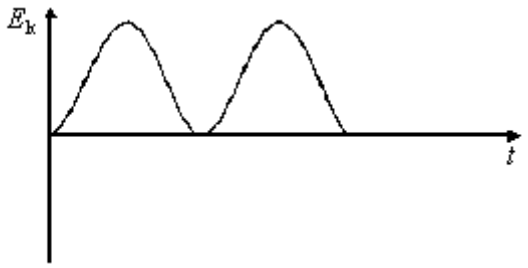
A



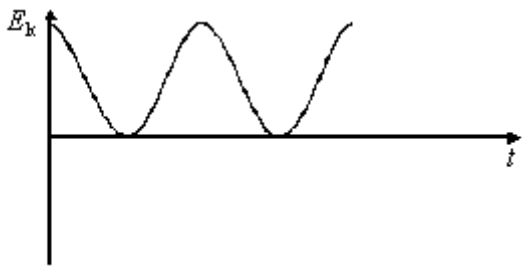
B



C



D



(Total 1 mark)

Q36. An object moving at constant speed in a circle experiences a force that is

A in the direction of motion.

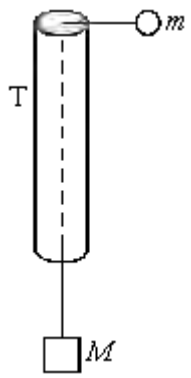
B outwards and at right angles to the direction of motion.

C inwards and at right angles to the direction of motion.

D opposite to the direction of motion.

(Total 1 mark)

Q37.



The figure shows a smooth thin tube T through which passes a string with masses *m* and *M* attached to its ends. Initially the tube is moved so that the mass, *m*, travels in a horizontal circle of constant radius *r*, at constant speed, *v*. Which one of the following expressions is equal to *M*?

A $\frac{mv^2}{2r}$

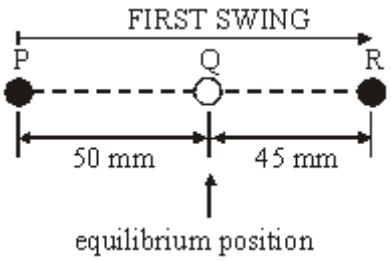
B mv^2rg

C $\frac{mv^2g}{r}$

D $\frac{mv^2}{rg}$

(Total 1 mark)

Q38. A particle, whose equilibrium position is at Q, is set into oscillation by being displaced to P, 50 mm from Q, and then released from rest. Its subsequent motion is simple harmonic, but subject to damping. On the first swing, the particle comes to rest momentarily at R, 45 mm from Q.



During this first swing, the greatest value of the acceleration of the particle is when it is at

A P.

B Q.

C R.

D P and R.

(Total 1 mark)

Q39. A particle of mass 5.0×10^{-3} kg performing simple harmonic motion of amplitude 150 mm takes 47 s to make 50 oscillations. What is the maximum kinetic energy of the particle?

A 2.0×10^{-3} J

B 2.5×10^{-3} J

C 3.9×10^{-3} J

D 5.0×10^{-3} J

(Total 1 mark)

Q40. When the length of a simple pendulum is decreased by 600 mm, the period of oscillation is halved. What is the original length of the pendulum?

A 800 mm

B 1000 mm

C 1200 mm

D 1400 mm

(Total 1 mark)

Q41. A fairground roundabout makes nine revolutions in one minute. What is the angular speed of the roundabout?

A 0.15 rad s^{-1}

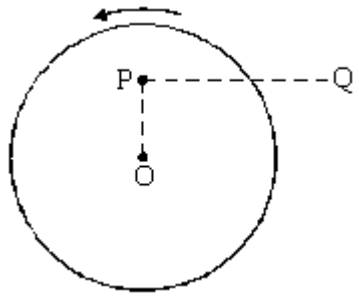
B 0.34 rad s^{-1}

C 0.94 rad s^{-1}

D 2.1 rad s^{-1}

(Total 1 mark)

Q42.



A small mass is placed at P on a horizontal disc which has centre O. The disc rotates anti-clockwise about a vertical axis through O with constant angular speed. Which one of the following describes the force which keeps the mass at rest relative to the disc?

A the weight of the mass

B a frictional force directed away from O

C a frictional force directed towards O

D a frictional force directed from P to Q

(Total 1 mark)

Q43. Which one of the following gives the phase difference between the particle velocity and the particle displacement in simple harmonic motion?

A $\frac{\pi}{4}$ rad

B $\frac{\pi}{2}$ rad

C $\frac{3\pi}{4}$ rad

D 2π rad

(Total 1 mark)

Q44. A particle oscillates with undamped simple harmonic motion. Which one of the following statements about the acceleration of the oscillating particle is true?

A It is least when the speed is greatest.

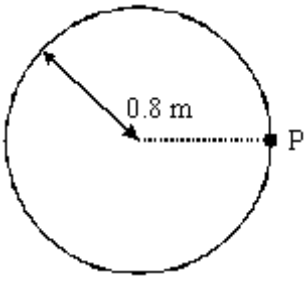
B It is always in the opposite direction to its velocity.

C It is proportional to the frequency.

D It decreases as the potential energy increases.

(Total 1 mark)

Q45.



A model car moves in a circular path of radius 0.8 m at an angular speed of $\frac{\pi}{2}$ rad s^{-1}.

What is its displacement from point P, 6 s after passing P?

A zero

B 1.6 m

C 0.4π m

D 1.6π m

(Total 1 mark)

Q46. A planet of mass M and radius R rotates so rapidly that loose material at the equator just remains on the surface. What is the period of rotation of the planet?

G is the universal gravitational constant.

A $2\pi\sqrt{\frac{R}{GM}}$

B $2\pi\sqrt{\frac{R^2}{GM}}$

C $2\pi\sqrt{\frac{GM}{R^3}}$

D $2\pi\sqrt{\frac{R^3}{GM}}$

(Total 1 mark)