Q1. For a body performing simple harmonic motion, which one of the following statements is correct?

A The maximum kinetic energy is directly proportional to the frequency.

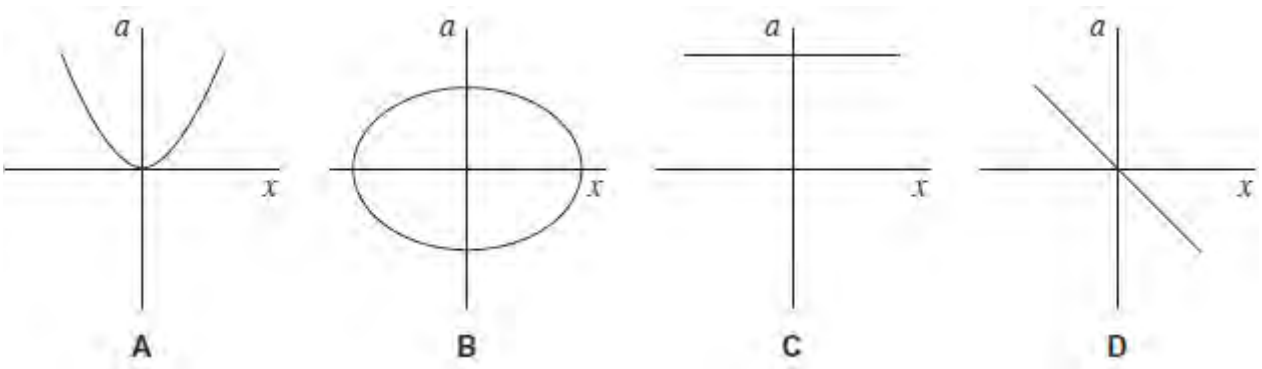
B The time for one oscillation is directly proportional to the frequency.

C The speed at any instant is directly proportional to the displacement.

D The maximum acceleration is directly proportional to the amplitude.

(Total 1 mark)

Q2. Which one of the following graphs shows how the acceleration, a, of a body moving with simple harmonic motion varies with its displacement, x?



(Total 1 mark)

Q3. A particle of mass 5.0×10^{-3} kg, moving with simple harmonic motion of amplitude 0.15 m, 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)

Q4. A simple pendulum has a time period of 1.42 s on Earth. The gravitational field strength at the surface of Mars is 0.37 times that at the surface of the Earth.
What is the time period of the pendulum on Mars?

A 0.53 s

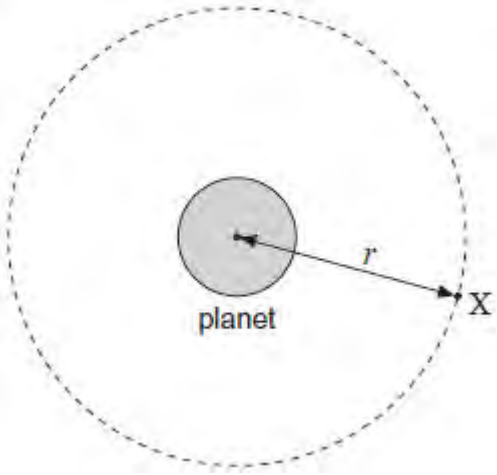
B 0.86 s

C 2.33 s

D 3.84 s

(Total 1 mark)

Q5.A satellite X is in a circular orbit of radius r about the centre of a spherical planet of mass M.

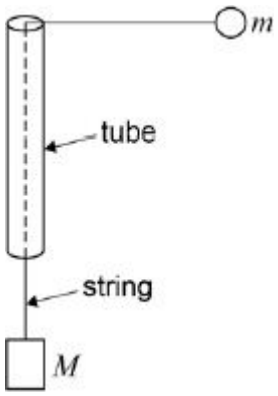


Which line, **A** to **D**, in the table gives correct expressions for the centripetal acceleration a and the speed v of the satellite?

	Centripetal acceleration a	**Speed v**
A	$\frac{GM}{2r}$	$\sqrt{\frac{GM}{2r}}$
B	$\frac{GM}{2r}$	$\sqrt{\frac{GM}{r}}$
C	$\frac{GM}{r^2}$	$\sqrt{\frac{GM}{2r}}$
D	$\frac{GM}{r^2}$	$\sqrt{\frac{GM}{r}}$

(Total 1 mark)

Q6. A string passes through a smooth thin tube. Masses m and M are attached to the ends of the string. The tube is moved so that the mass m travels in a horizontal circle of constant radius r and at constant speed v.



Which of the following expressions is equal to M ?

A $\frac{mv^2}{2r}$ ⬭

B mv^2rg ⬭

C $\frac{mv^2}{rg}$ ⬭

D $\frac{mv^2g}{r}$ ⬭

(Total 1 mark)

Q7. The frequency of a body moving with simple harmonic motion is doubled. If the amplitude remains the same which of the following is also doubled?

A The time period. ⬭

B The total energy. ⬭

C The maximum velocity. ⬭

D The maximum acceleration. ⬭

(Total 1 mark)

Q8. A particle oscillates with undamped simple harmonic motion.

The acceleration of the particle

A is always in the opposite direction to its velocity. ⬭

B decreases as the potential energy increases. ⬭

C is proportional to the frequency. ⬭

D is least when the speed is greatest. ⬭

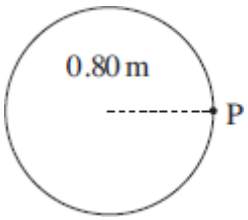
(Total 1 mark)

Q9. A simple pendulum and a mass-spring system have the same oscillation frequency f at the surface of the Earth. The pendulum and the mass-spring system are taken down a mine where the acceleration due to gravity is less than at the surface. What is the change in the frequency of the simple pendulum and the change in the frequency of the mass-spring system?

	simple pendulum	**mass-spring**	
A	f increases	f decreases	⬭
B	f decreases	f decreases	⬭
C	f increases	f stays unchanged	⬭
D	f decreases	f stays unchanged	⬭

(Total 1 mark)

Q10. A model car moves in a circular path of radius 0.80 m at an angular speed of $\frac{\pi}{2}$ rad s^{-1}.



What is its displacement from point P 6.0 s after passing P?

A zero

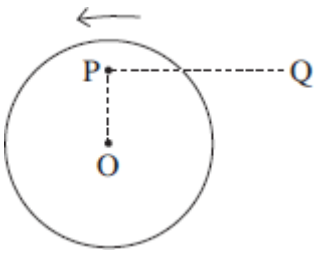
B 0.4π m

C 1.6 m

D 1.6π m

(Total 1 mark)

Q11. A small mass is placed at P on a horizontal disc which has its centre at 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 when in the position shown?

A the weight of the mass

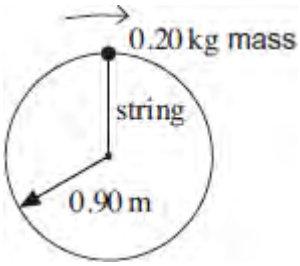
B a frictional force from P to Q

C a frictional force directed away from O

D a frictional force directed towards O

(Total 1 mark)

Q12. A 0.20 kg mass is whirled round in a vertical circle on the end of a light string of length 0.90 m.



At the top point of the circle the speed of the mass is 8.2 m s^{-1}. What is the tension in the string at this point?

A 10 N

B 13 N

C 17 N

D 20 N

(Total 1 mark)

Q13. Which line, **A** to **D**, in the table gives the amplitude and frequency of a body performing simple harmonic motion whose displacement x at time t is given by the equation $x = P\cos Qt$?

	Amplitude	**Frequency**
A	$\frac{P}{2}$	$\frac{Q}{2\pi}$
B	P	$2\pi Q$
C	P	$\frac{Q}{2\pi}$
D	$2P$	$\frac{Q}{2\pi}$

(Total 1 mark)

Q14. The tip of each prong of a tuning fork emitting a note of 320 Hz vibrates in simple harmonic motion with an amplitude of 0.50 mm.
What is the speed of each tip when its displacement is zero?

A zero

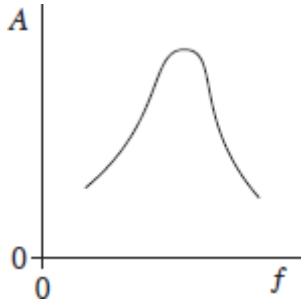
B 0.32π mm s^{-1}

C 160π mm s^{-1}

D 320π mm s^{-1}

(Total 1 mark)

Q15. A periodic force is applied to a lightly-damped object causing the object to oscillate.
The graph shows how the amplitude A of the oscillations varies with the frequency f of the periodic force.



Which one of the following statements best describes how the shape of the curve would differ if the damping had been greater?

A the curve would be lower at all frequencies

B the curve would be higher at all frequencies

C the curve would be unchanged except at frequencies above the resonant frequency where it would be lower

D the curve would be unchanged except at frequencies above the resonant frequency where it would be higher

(Total 1 mark)

Q16. The wheel of the London Eye has a diameter of 130 m and rotates at a steady speed, completing one rotation every 30 minutes. What is the centripetal acceleration of a person in a capsule at the rim of the wheel?

A 1.2×10^{-4} ms^{-2}

B 2.5×10^{-4} ms^{-2}

C 3.9×10^{-4} ms^{-2}

D 7.9×10^{-4} ms^{-2}

(Total 1 mark)

Q17. A small body of mass m rests on a horizontal turntable at a distance *r* from the centre. If the maximum frictional force between the body and the turntable is $\frac{mg}{2}$, what is the angular speed at which the body starts to slip?

A $\sqrt{\frac{gr}{2}}$

B $\frac{g}{r}$

C $\sqrt{\frac{g}{2r}}$

D $\frac{1}{2}\sqrt{\frac{g}{r}}$

(Total 1 mark)

Q18. A body of mass 0.50 kg, fixed to one end of a string, is rotated in a vertical circle of radius 1.5 m at an angular speed of 5.0 rad s^{-1}. What is the maximum tension in the string?

A 5.0 N

B 9.0 N

C 14 N

D 24 N

(Total 1 mark)

Q19. A particle of mass *m* oscillates in a straight line with simple harmonic motion of constant amplitude. The total energy of the particle is *E*. What is the total energy of another particle of mass 2*m*, oscillating with simple harmonic motion of the same amplitude but double the frequency?

A *E*

B 2*E*

C 4*E*

D 8*E*

(Total 1 mark)

Q20. When a mass suspended on a spring is displaced, the system oscillates with simple harmonic motion. Which one of the following statements regarding the energy of the system is **incorrect?**

A The potential energy has a minimum value when the spring is fully compressed or fully extended.

B The kinetic energy has a maximum value at the equilibrium position.

C The sum of the kinetic and potential energies at any time is constant.

D The potential energy has a maximum value when the mass is at rest.

(Total 1 mark)

Q21. When a mass M attached to a spring X, as shown in **Figure 1**, is displaced downwards and released it oscillates with time period *T*. An identical spring is connected in series and the same mass M is attached, as shown in **Figure 2**.

What is the new time period?

Figure 1

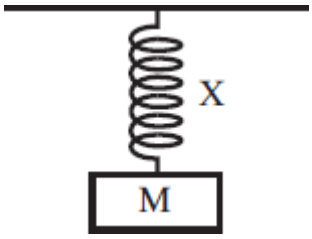
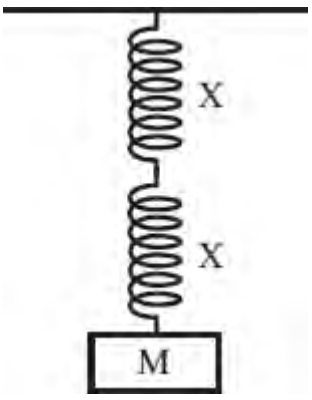


Figure 2



A $\frac{T}{2}$

B $\frac{T}{\sqrt{2}}$

C $\sqrt{2T}$

D $2T$

(Total 1 mark)

Q22. For a particle moving in a circle with uniform speed, which one of the following statements is **incorrect?**

A There is no displacement of the particle in the direction of the force.

B The force on the particle is always perpendicular to the velocity of the particle.

C The velocity of the particle is constant.

D The kinetic energy of the particle is constant.

(Total 1 mark)

Q23. A revolving mountain top restaurant turns slowly, completing a full rotation in 50 minutes. A man is sitting in the restaurant 15 m from the axis of rotation. What is the speed of the man relative to a stationary point outside the restaurant?

A $\frac{\pi}{100}$ m s^{-1}

B $\frac{3\pi}{5}$ m s^{-1}

C $\frac{\pi}{200}$ m s^{-1}

D $\frac{\pi}{1500}$ m s^{-1}

(Total 1 mark)

Q24. A particle of mass 0.20 kg moves with simple harmonic motion of amplitude 2.0×10^{-2} m. If the total energy of the particle is 4.0×10^{-5}J, what is the time period of the motion?

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

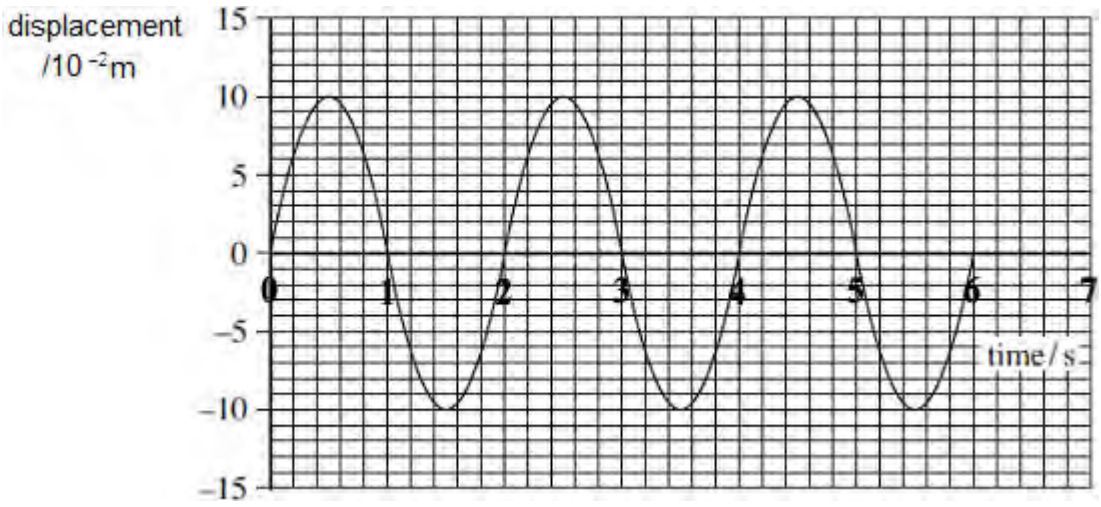
B $\frac{\pi}{2}$ seconds

C π seconds

D 2π seconds

(Total 1 mark)

Q25. The graph shows the variation in displacement with time for an object moving with simple harmonic motion.



What is the maximum acceleration of the object?

A 0.025 m s^{-2}

B 0.99 m s^{-2}

C 2.5 m s^{-2}

D 9.8 m s^{-2}

(Total 1 mark)

Q26. A simple pendulum and a mass-spring system are taken to the Moon, where the gravitational field strength is less than on Earth. Which line, **A** to **D**, in the table correctly describes the change, if any, in the period when compared with its value on Earth?

	period of pendulum	**period of mass-spring system**
A	increase	no change
B	increase	increase
C	no change	decrease
D	decrease	decrease

(Total 1 mark)

Q27. Two pendulums, P and Q, are set up alongside each other. The period of P is 1.90 s and the period of Q is 1.95 s.

How many oscillations are made by pendulum Q between two consecutive instants when P and Q move in phase with each other?

A 19

B 38

C 39

D 78

(Total 1 mark)

Q28. Which line, **A** to **D**, in the table correctly describes the trajectory of charged particles which enter separately, at right angles, a uniform electric field, and a uniform magnetic field?

	uniform electric field	**uniform magnetic field**
A	parabolic	circular
B	circular	parabolic
C	circular	circular
D	parabolic	parabolic

(Total 1 mark)

Q29. The Earth moves around the Sun in a circular orbit with a radius of 1.5×10^{8} km.
What is the Earth's approximate speed?

A $1.5 \times 10^{3} ms^{-1}$

B $5.0 \times 10^{3} ms^{-1}$

C $1.0 \times 10^{4} ms^{-1}$

D $3.0 \times 10^{4} ms^{-1}$

(Total 1 mark)

Q30. A particle moves in a circular path at constant speed. Which one of the following statements is correct?

A The velocity of the particle is directed towards the centre of the circle.

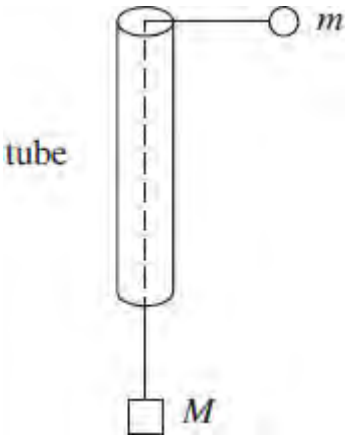
B There is no force acting on the particle.

C There is no change in the kinetic energy of the particle.

D The particle has an acceleration directed along a tangent to the circle.

(Total 1 mark)

Q31. The diagram shows a smooth thin tube through which passes a string with masses *m* and *M* attached to its ends. 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 $\frac{mv^2}{rg}$

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

(Total 1 mark)

Q32. A mass on the end of a spring undergoes vertical simple harmonic motion. At which point(s) is the magnitude of the resultant force on the mass a minimum?

A at the centre of the oscillation

B only at the top of the oscillation

C only at the bottom of the oscillation

D at both the top and bottom of the oscillation

(Total 1 mark)

Q33. A baby bouncer consisting of a harness and elastic ropes is suspended from a doorway. When a baby of mass 10 kg is placed in the harness, the ropes stretch by 0.25 m. When the baby bounces, she starts to move with vertical simple harmonic motion. What is the time period of her motion?

A 1.0 s

B 2.1 s

C 2.3 s

D 3.1 s

(Total 1 mark)

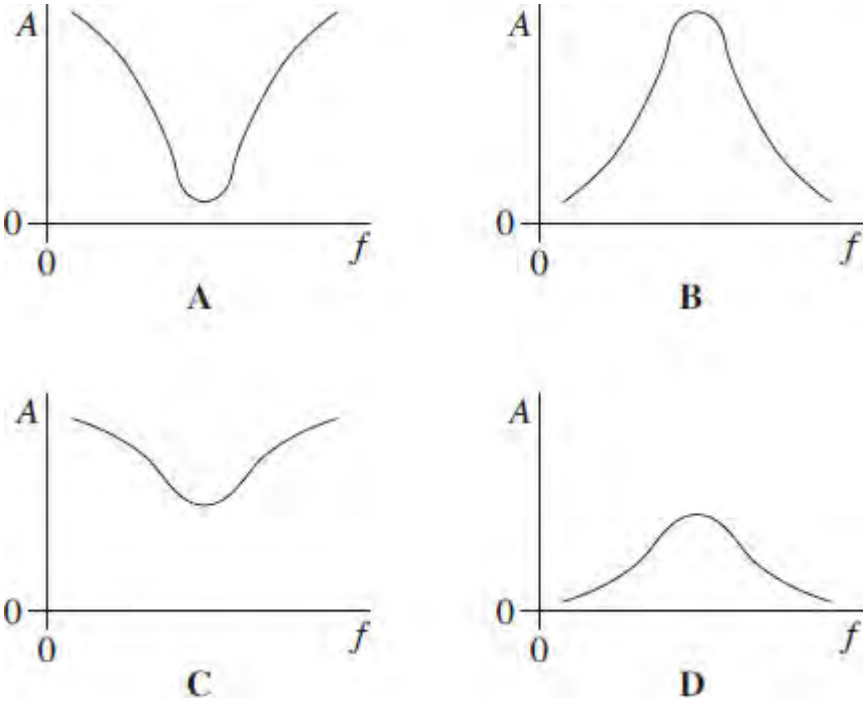
Q34. A simple pendulum and a mass-spring system both have the same time period *T* at the surface of the Earth. If taken to another planet where the acceleration due to gravity is twice that on Earth, which line, **A** to **D**, in the table gives the correct new time periods?

	simple pendulum	**mass-spring**
A	$T\sqrt{2}$	$\frac{T}{\sqrt{2}}$
B	$T\sqrt{2}$	T
C	$\frac{T}{\sqrt{2}}$	T
D	$\frac{T}{\sqrt{2}}$	$T\sqrt{2}$

(Total 1 mark)

Q35. An oscillatory system, subject to damping, is set into vibration by a periodic driving force of frequency *f*. The graphs, **A** to **D**, which are to the same scale, show how the amplitude of vibration *A* of the system might vary with *f*, for various degrees of damping.

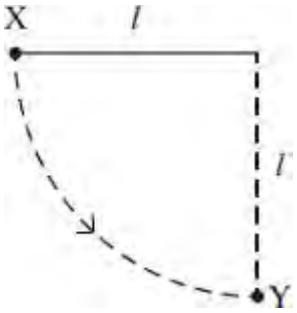
Which graph best shows the lightest damping?



(Total 1 mark)

Q36. A ball of mass m, which is fixed to the end of a light string of length l, is released from rest at X.

It swings in a circular path, passing through the lowest point Y at speed v.



If the tension in the string at Y is T, which one of the following equations represents a correct application of Newton's laws of motion to the ball at Y?

A $T = \frac{mv^2}{l} - mg$

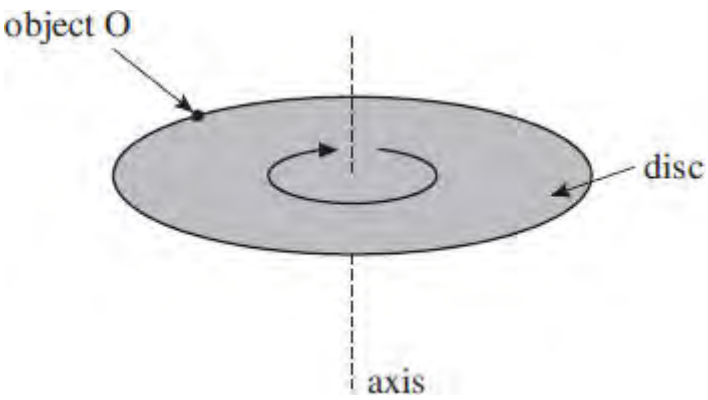
B $mg - T = \frac{mv^2}{l}$

C $T - mg = \frac{mv^2}{l}$

D $T + \frac{mv^2}{l} = mg$

(Total 1 mark)

Q37. A disc of diameter *D* is turning at a steady angular speed at frequency *f* about an axis through its centre.



What is the centripetal force on a small object O of mass *m* on the perimeter of the disc?

A $2\pi mfD$

B $2\pi mf^2D$

C $2\pi^2mf^2D$

D $2\pi mf^2D^2$

(Total 1 mark)

Q38. What is the angular speed of a car wheel of diameter 0.400 m when the speed of the car is 108 km h^{-1}?

A 75 rad s^{-1}

B 150 rad s^{-1}

C 270 rad s^{-1}

D 540 rad s^{-1}

(Total 1 mark)

Q39. Which one of the following statements is true when an object performs simple harmonic motion about a central point O?

A The acceleration is always directed away from O.

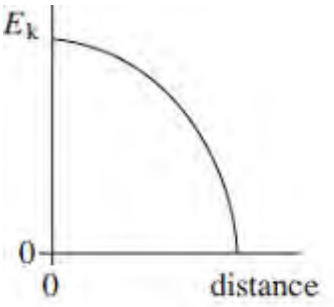
B The acceleration and velocity are always in opposite directions.

C The acceleration and the displacement from O are always in the same direction.

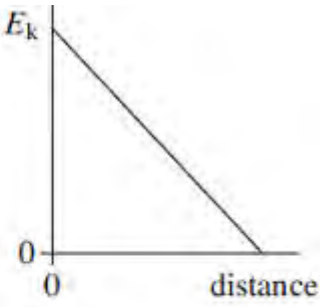
D The graph of acceleration against displacement is a straight line.

(Total 1 mark)

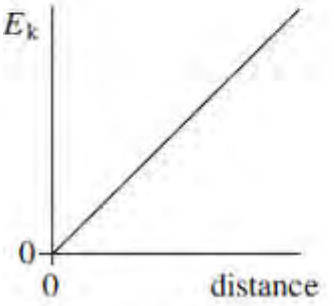
Q40. A body executes simple harmonic motion. Which one of the graphs, **A** to **D**, best shows the relationship between the kinetic energy, E_k, of the body and its distance from the centre of oscillation?



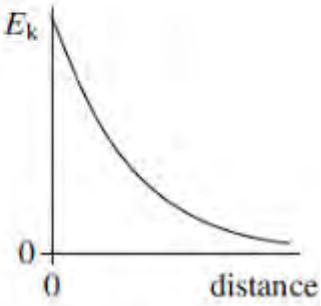
A



B



C



D

(Total 1 mark)

Q41. A mechanical system is oscillating at resonance with a constant amplitude. Which one of the following statements is **not** correct?

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

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 amplitude of oscillations depends on the amount of damping.

(Total 1 mark)

Q42. For a particle moving in a circle with uniform speed, which one of the following statements is correct?

A The kinetic energy of the particle is constant.

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

(Total 1 mark)

Q43. A young child of mass 20 kg stands at the centre of a uniform horizontal platform which rotates at a constant angular speed of 3.0 rad s^{-1}. The child begins to walk radially outwards towards the edge of the platform. The maximum frictional force between the child and the platform is 200 N. What is the maximum distance from the centre of the platform to which the child could walk without the risk of slipping?

A 1.1 m

B 1.3 m

C 1.5 m

D 1.7 m

(Total 1 mark)

Q44. A particle travels at a constant speed around a circle of radius *r* with centripetal acceleration *a*. What is the time taken for ten complete rotations?

A $\frac{\pi}{5}\sqrt{\frac{a}{r}}$

B $\frac{\pi}{5}\sqrt{\frac{r}{a}}$

C $20\pi\sqrt{\frac{a}{r}}$

D $20\pi\sqrt{\frac{r}{a}}$

(Total 1 mark)

Q45. The frequency of a body moving with simple harmonic motion is doubled. If the amplitude remains the same, which one of the following is also doubled?

A the time period

B the total energy

C the maximum velocity

D the maximum acceleration

(Total 1 mark)

Q46. The time period of a pendulum on Earth is 1.0 s. What would be the period of a pendulum of the same length on a planet with half the density but twice the radius of Earth?

A 0.5 s

B 1.0 s

C 1.4 s

D 2.0 s

(Total 1 mark)

Q47. 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 same direction as the displacement.

C It is in the opposite direction to the velocity.

D It is proportional to the displacement.

(Total 1 mark)

Q48. A satellite of mass *m* travels in a circular orbit of radius *r* around a planet of mass *M*. Which one of the following expressions gives the angular speed of the satellite?

A $\sqrt{GMr}$

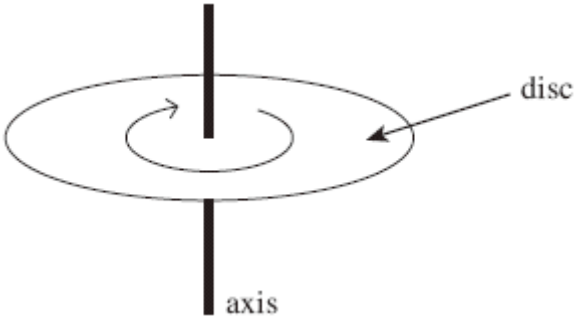
B $\sqrt{Gmr}$

C $\sqrt{\frac{Gm}{r^3}}$

D $\sqrt{\frac{GM}{r^3}}$

(Total 1 mark)

Q49. The diagram shows a disc of diameter 120 mm that can turn about an axis through its centre.



The disc is turned through an angle of 30° in 20 ms. What is the average speed of a point on the edge of the disc during this time?

A 0.5π m s^{-1}

B π m s^{-1}

C 1.5π m s^{-1}

D 2π m s^{-1}

(Total 1 mark)

Q50. 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 $\frac{mf^2r^2}{4\pi^2}$

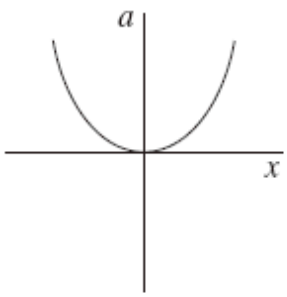
B $\frac{mf^2r}{2}$

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

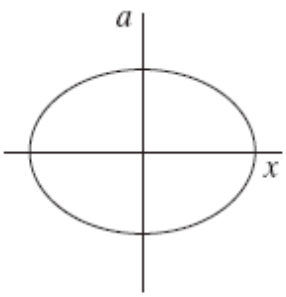
D $4\pi^2 mf^2r^2$

(Total 1 mark)

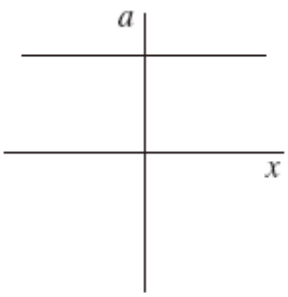
Q51. Which one of the following graphs shows how the acceleration, *a*, of a body moving with simple harmonic motion varies with its displacement, *x*?



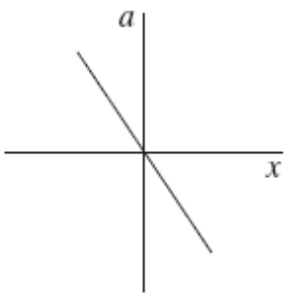
A



B



C



D

(Total 1 mark)