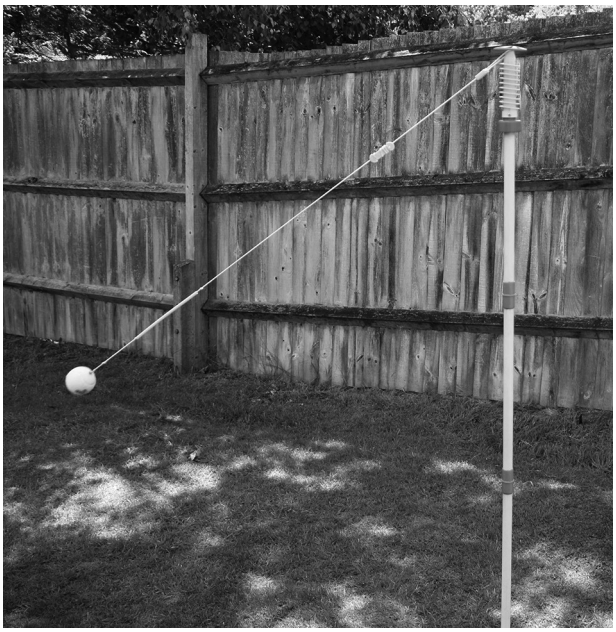
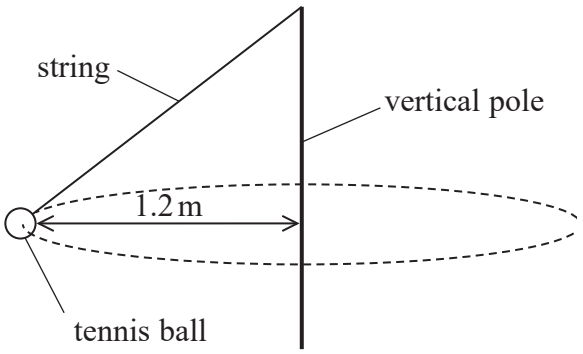
13 A 'tennis trainer' consists of a tennis ball suspended by a string from the top of a vertical pole. When the ball is hit it travels in a horizontal circle around the pole, as shown in both the photograph and the diagram.





The radius of the path of the ball is 1.2 m and the speed of the ball is 3.8 m s^{-1}.

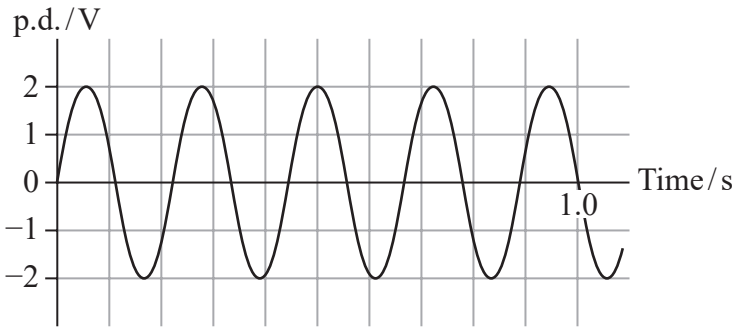
Deduce whether these values are consistent with the angle between the string and the vertical pole shown in the photograph.

(Total for Question 13 = 5 marks)

Answer ALL questions.

All multiple choice questions must be answered with a cross ☒ in the box for the correct answer from A to D. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The graph shows how a potential difference (p.d.) varies with time.



Which of the following is correct?

☒ **A** The frequency is 4.5 Hz.

☒ **B** The peak value is 4.0 V.

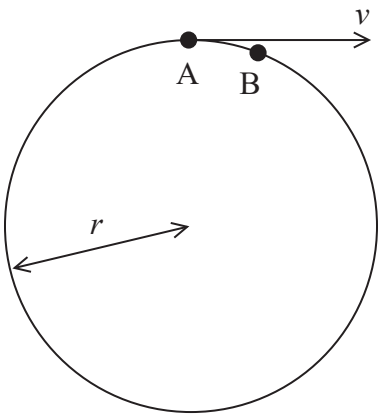
☒ **C** The period is 0.20 s.

☒ **D** The root mean square value of p.d. is 1.0 V.

(Total for Question 1 = 1 mark)

11 The International Space Station (ISS) orbits the Earth with a constant speed v. The orbit is circular and of radius r.

(a) The diagram represents two positions, A and B, of ISS during its orbit.



Draw a labelled vector diagram, in the space below, of the velocities at the two positions that shows the acceleration is directed towards the centre of the orbit.

(2)

(b) (i) The ISS completes one orbit in 92 minutes.

Calculate the centripetal acceleration of the ISS.

$r = 6800\,\text{km}$

(3)

Centripetal acceleration = ...

(ii) Astronauts in the ISS are often described as being "weightless".

Discuss whether the astronauts are "weightless" when they are orbiting the Earth in the ISS.

(4)

(Total for Question 11 = 9 marks)

7 The intensity of light incident on a light dependent resistor (LDR) can vary both its

(Total for Question 8 = 1 mark)

9 The blade of a lawnmower rotates at a speed of 50 revolutions per second.

Which of the following is the angular speed of the blade in rads s^{-1}?

☒ **A** 7.96

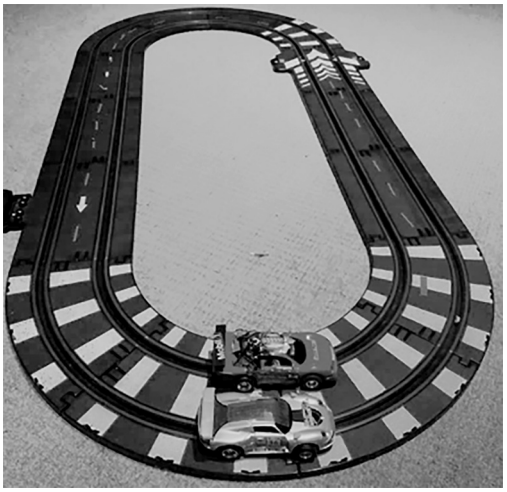
☒ **B** 15.9

☒ **C** 157

☒ **D** 314

(Total for Question 9 = 1 mark)

13 The photograph shows a model racing car set. The curved parts of the track are semicircular. The car makes electrical contact with the track using metal brushes underneath the car.



(a) There is a maximum speed for the car to stay on the curved part of the track. Explain why the car will slip off the curved part of the track if the car exceeds the maximum speed.

(3)

(b) The following measurements are made for a car starting at rest on a straight piece of track.

distance travelled = 1.2 m

time taken = 0.77 s

(i) Show that the final velocity of the car is about $3\,m\,s^{-1}$.

Assume the acceleration is constant.

(2)

(ii) The final velocity calculated in (b)(i) is the maximum velocity before the car slips off the track.

Calculate the maximum horizontal force between the curved part of the track and the car.

mass of car = 0.050 kg

radius of curved part of track = 0.042 m

(2)

Maximum horizontal force = ...

(c) The cars are controlled separately and so can be raced, with one car on the inner lane and the other on the outer lane. The cars are identical. Each car is raced at its highest speed for that lane.

Explain why the outcome of the race is difficult to predict.

(3)

(Total for Question 13 = 10 marks)