AQA Examination-style questions

1 **Figure 1** shows a cross-section of an automatic brake fitted to a rotating shaft. The brake pads are held on the shaft by springs.

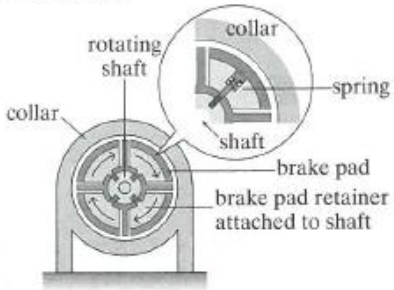

Figure 1

(a) Explain why the brake pads press against the inner surface of the stationary collar if the shaft rotates too fast. *(3 marks)*

(b) Each brake pad and its retainer has a mass of 0.30 kg and its centre of mass is 60 mm from the centre of the shaft. The tension in the spring attached to each pad is 250 N. Calculate the maximum frequency of rotation of the shaft for no braking. *(4 marks)*

(c) Automatic brakes of the type described above are used on ships to prevent lifeboats falling freely when they are lowered on cables onto the water. Discuss how the performance of the brake would be affected if the springs gradually became weaker. *(2 marks)*

2 (a) A particle that moves uniformly in a circular path is accelerating yet moving at a constant speed.

Explain this statement by reference to the physical principles involved. *(3 marks)*

(b) A 0.10 kg mass is to be placed on a horizontal turntable that is then rotated at a fixed rate of 78 revolutions per minute. The mass may be placed on the table at any distance, r, from the axis of rotation, as shown in **Figure 2**.

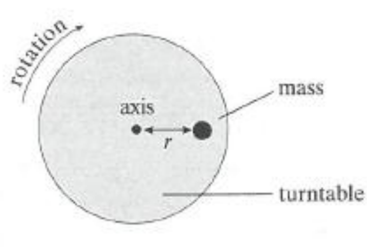

Figure 2

If the maximum frictional force between the mass and the turntable is 0.50 N, calculate the maximum value of the distance r at which the mass would stay on the turntable at this rate of rotation. *(4 marks)*

AQA, 2007

3 **Figure 3** shows a dust particle at position **D** on a rotating vinyl disc. A combination of electrostatic and frictional forces act on the dust particle to keep it in the same position.

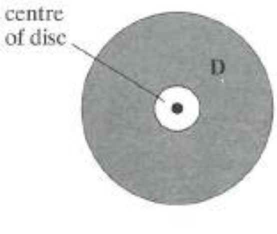

Figure 3

The dust particle is at a distance of 0.125 m from the centre of the disc. The disc rotates at 45 revolutions per minute.

(a) Calculate the linear speed of the dust particle at D. *(3 marks)*

(b) (i) Copy the diagram and mark an arrow to show the direction of the resultant horizontal force on the dust particle.

(ii) Calculate the centripetal acceleration at position D. *(3 marks)*

(c) On looking closely at the rotating disc it can be seen that there is more dust concentrated on the inner part of the disc than the outer part. Suggest why this should be so. *(3 marks)*

AQA, 2002

4 A strimmer is a tool for cutting long grass. A strimmer head such as that shown in **Figure 4a** is driven by a motor. This makes the plastic line rotate causing it to cut the grass. To simplify analysis, the strimmer line is modelled as the arrangement shown in **Figure 4b**. In this model the effective mass of the line is considered to rotate at the end of the line.

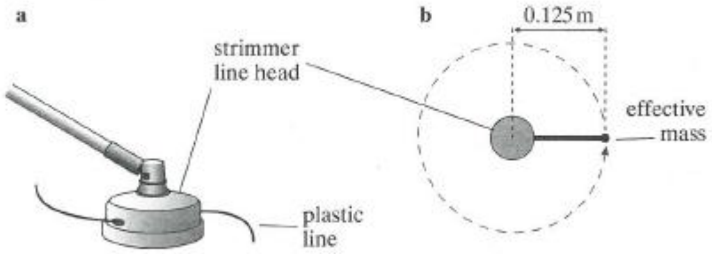

Figure 4

In one strimmer the effective mass of 0.80 g rotates in a circle of radius 0.125 m at 9000 revolutions per minute.

(a) Show that the angular speed of the line is approximately $9.4 \times 10^2 \, \text{rad s}^{-1}$. *(2 marks)*

(b) (i) Explain how the centripetal force is applied to the effective mass.

(ii) Calculate the centripetal force acting on the effective mass. *(4 marks)*

(c) The line strikes a pebble of mass 1.2 g, making contact for a time of 0.68 ms. This causes the pebble to fly off at a speed of $15 \, \text{m s}^{-1}$.

Calculate the average force applied to the pebble. *(3 marks)*

AQA, 2007

5 **Figure 5** shows a toy engine moving with a constant speed on a circular track of constant radius.

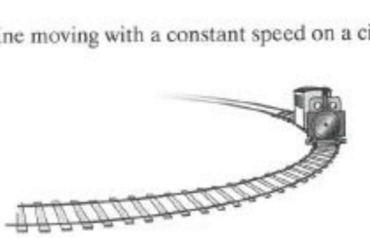

Figure 5

(a) (i) Explain why the engine is accelerating even though its speed remains constant.

(ii) Mark on a copy of **Figure 5** the direction of the centripetal force acting on the engine. *(3 marks)*

(b) The total mass of the toy engine is 0.14 kg and it travels with a speed of $0.17 m s^{-1}$. The radius of the track is 0.80 m. Calculate the centripetal force acting on the engine. *(2 marks)*

Figure 6 shows a close up of a pair of wheels as the engine moves towards you in the forward direction shown in **Figure 5**.

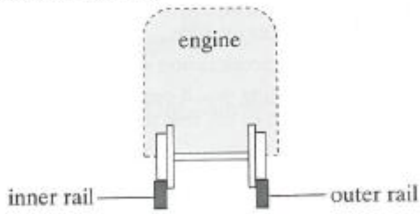

Figure 6

(c) (i) State and explain on which wheel the centripetal force acts at the instant shown. You may use **Figure 6** to help your explanation.

(ii) For the toy engine going round a curved track, state and explain the two factors which determine the stress on each wheel. *(5 marks)*

AQA, 2004

6 A mass of 30 g is attached to a thread and whirled in a circle of radius 45 cm. The circle is in a horizontal plane. The tension in the thread is 0.35 N.

(a) Calculate:

(i) the speed of the mass,

(ii) the period of rotation of the mass. *(4 marks)*

(b) The mass M is now whirled in a circle in a vertical plane as shown in **Figure 7**.

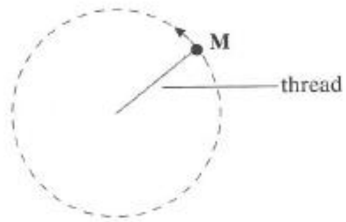

Figure 7

(i) On a copy of **Figure 7**, label the forces acting on the mass, and use arrows to show their direction.

(ii) Without performing calculations, state and explain the difference between the tension in the thread when M is at the top of the circle and when it is at the bottom. *(6 marks)*

AQA, 2007

7 **Figure 8** shows the initial path taken by an electron when it is produced as a result of a collision in a cloud chamber.

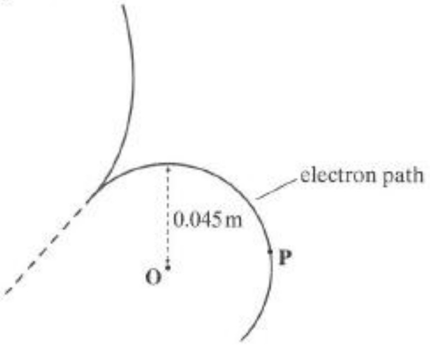

Figure 8

The path is the arc of a circle of radius 0.045 m with centre O.

The speed of the electron is $4.2 \times 10^7\,\text{m}\,\text{s}^{-1}$. The mass of an electron is 9.1×10^{-31} kg.

(a) Calculate the momentum of the electron. *(2 marks)*

(b) Calculate the magnitude of the force acting on the electron that makes it follow the curved path. *(2 marks)*

(c) Show on a copy of **Figure 8** the direction of this force when an electron is at point P. *(1 mark)*

AQA, 2002

8 **Figure 9** shows a simple accelerometer designed to measure the centripetal acceleration of a car going round a bend following a circular path.

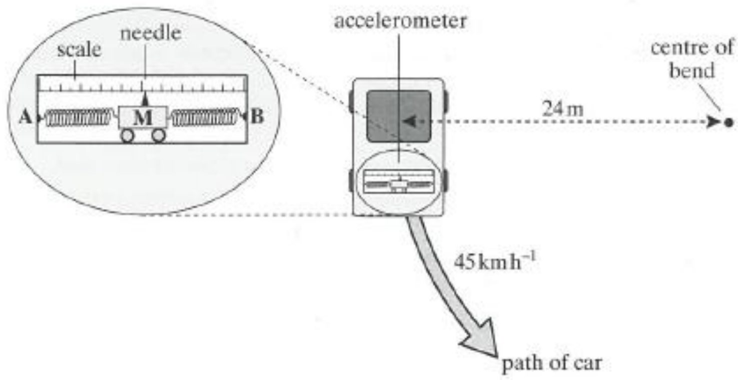

Figure 9

The two ends A and B are fixed to the car. The mass M is free to move between the two springs.

The needle attached to the mass moves along a scale to indicate the acceleration.

In one instant a car travels round a bend of radius 24 m in the direction shown in **Figure 9**. The speed of the car is $45\,\text{km}\,\text{h}^{-1}$.

(a) State and explain the direction in which the pointer moves from its equilibrium position. *(3 marks)*

(b) (i) Calculate the acceleration that would be recorded by the accelerometer.

(ii) The mass M between the springs in the accelerometer is 0.35 kg. A test shows that a force of 0.75 N moves the pointer 27 mm.

Calculate the displacement of the needle from the equilibrium position when the car is travelling with the acceleration in part (i). *(4 marks)*

AQA, 2003