A2-2005 Q5

On a straight road, a stationary police motor-cyclist is passed by a stolen car travelling at a speed of 15 m s^{-1}. At time t = 0, when the car is level with him, the motor-cyclist accelerates at 4.0 m s^{-2} for 5.0 s and then travels at a constant speed.

(a) Draw speed – time graph during the period t= 0 to t = 15 s

(i) the stolen car, (ii) the police motor-cyclist.

(b) Use the graphs you have drawn to determine

(i) the greatest speed of the motor-cyclist,

(ii) the distance travelled by the motor-cyclist whilst accelerating,

(iii) the distance the car has travelled during the period from t = 0 to the moment when the motor-cyclist is level with it.

(12 marks)

A2-2008 Q1

1. What must be the speed of a lead bullet if it melts when it strikes a steel slab? The initial temperature of the bullet is 27 °C. The melting point of lead is 327 °C, its latent heat of melting is 2.1×10^4 J kg^{-1} and its specific heat capacity is 126 J kg^{-1} $°C^{-1}$. Assume that all of the kinetic energy is converted to heat energy in the bullet.

(4 marks)

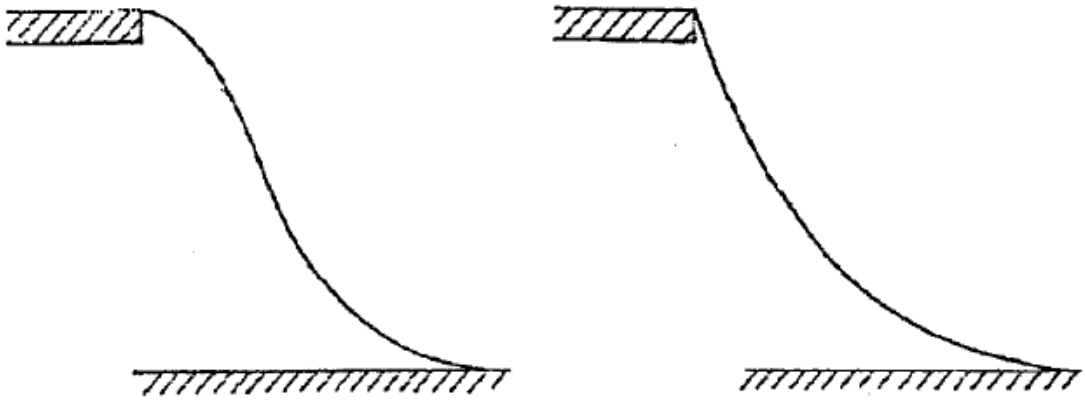
A2-2008 Q4

4. A juggler tossing juggling balls can handle two balls per second; i.e. it takes at least 0.5 seconds to catch a ball with one hand and start it upwards again with the other hand. If he is juggling five balls altogether, to what minimum height must he throw them?

(4 marks)

A2-2009 Q1

A flexible track is fixed in two alternate arrangements, as shown in Fig. 1. The length of the track used is the same in each case, and the height through which it falls from the bench to the floor is the same. A toy car is released at rest and slides down the track. Air resistance can be ignored.



(i) (ii)

Fig. 1

(a) Explain how the speed of a given car at the bottom of track (i) would compare with the speed at the bottom of track (ii). Would it be faster, slower or the same? Give a reason for your answer.

(2 marks)

(b) Explain how the time taken for the car to slide down slope (i) would compare with the time taken on slope (ii). Give a reason for your answer.

(2 marks)

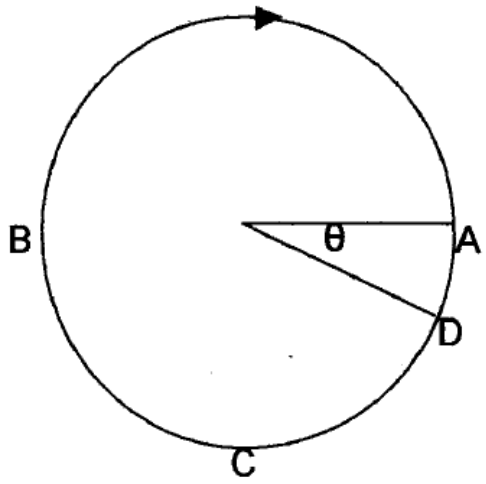
(c) Suppose a car of twice the mass is now used. How would the times compare for track (i) and track (ii) now? Give a reason for your answer.

(2 marks)

[6]

A2-2007 Q5

A particle moving at constant speed, v, follows a clockwise circular path of radius, r, with period of orbit, T.



a) Sketch the circle shown on the left and draw the velocity vectors at both A and B. Write down the magnitude of the velocity change, and hence the magnitude of the average acceleration between A and B in terms of v and T, and hence show that the average acceleration in terms of v and r is given by,

$$a_{average} = \frac{2}{\pi}\frac{v^2}{r}$$

b) Draw a vector diagram of the velocities at A and C, and determine the magnitude of the change of velocity between A and C.

c) Draw a vector diagram of the velocities at A and D, and write down the magnitude of the change of velocity, Δv, between A and D in terms of v and θ.

d) Show that the time taken, Δt, for the particle to move from A to D through angle θ (in radians) is given by $\Delta t = \frac{r\theta}{v}$.

e) Write down the magnitude of the acceleration between A and D, and find the limiting value as θ tends to zero.

(14 marks)

Hint: the cosine rule is $a^2 = b^2 + c^2 - 2bc\cos A$

and as θ tends towards zero, $\cos\theta \approx 1 + \frac{\theta^2}{2}$