

RJC JC1 LECTURE TEST 1 (2006)

SCORE

35

Measurement and Kinematics

NAME/REG NO:

CLASS:

07S0

Answer all questions in the spaces provided in this question paper.

1. An expression for the frictional force exerted on a spherical object moving through a fluid is given by

$$F = 6 \pi \eta r v$$

where F is the frictional force

r is the radius of the object

η is the viscosity of the fluid, and

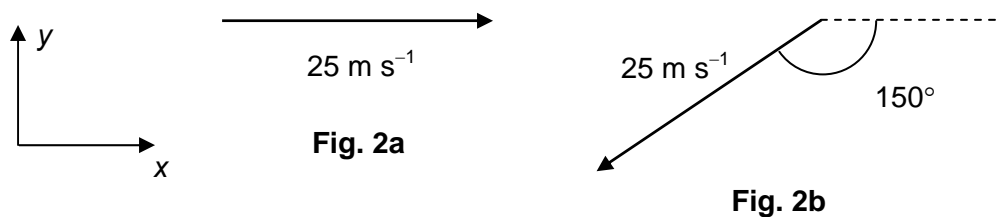
v is the speed of the object

Determine the units of η expressed in SI base units.

[3]

2. A particle has an initial velocity of 25 m s^{-1} in the x – direction, as shown in Fig. 2a. At a later time, its velocity is 25 m s^{-1} at an angle of 150° to its original direction, as shown in Fig 2b. (Directions are indicated by measuring angles clockwise from the original direction.)

What is the change of velocity that has taken place in this interval?

[3]

3. The dimensions of a cylinder (shown in Fig. 3) were measured by a student using a pair of vernier callipers. He recorded his readings as follows:

Diameter, $d = 4.10$ cm
Height, $h = 6.80$ cm

The vernier callipers may be read to ± 0.01 cm.

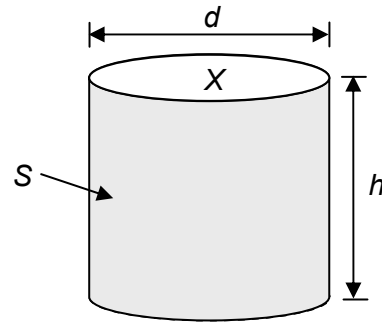


Fig. 3

- a) What is the area S of the outer curved surface of the cylinder? State your answer with its uncertainty. [Note: S is given by $S = \pi dh$.] **[4]**
- b) Calculate the percentage uncertainty of the cross-sectional area X of the cylinder. **[2]**
- c) Hence, find the absolute uncertainty of the total surface area A of the cylinder. **[3]**

4. A small steel ball-bearing of mass m is released a few centimetres above the surface of a viscous liquid contained in a tall, wide jar. In falling through the liquid, the ball-bearing experiences a retarding force $F = k v$ where v is the velocity of the ball-bearing and k is a constant. The graph below shows the variation of its downward displacement with time t after entering the liquid.

[Take $g = 9.8 \text{ m s}^{-2}$.]

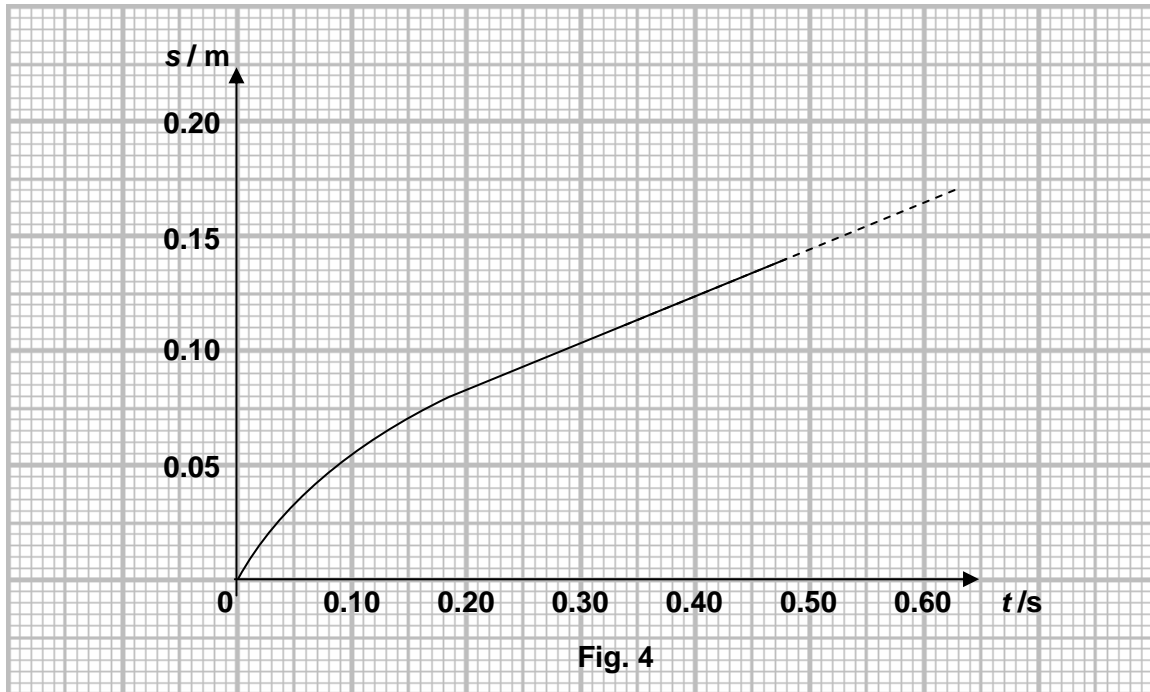


Fig. 4

- a) Deduce the initial velocity of the ball-bearing on entering the liquid. [2]
- b) Deduce the height above the surface where the ball-bearing was released. Ignore air resistance. [2]
- c) Describe qualitatively the motion of the ball-bearing between $t = 0$ s and $t = 0.4$ s. [2]

- d) Given that the acceleration a of the ball-bearing is given by $a = \frac{(mg - kv)}{m}$ and the value of k is 0.013 kg s^{-1} , deduce the mass of the ball-bearing. [3]

- e) Sketch a well-labeled graph of the velocity against time showing the motion of the ball-bearing from **the point of release** till it hits the bottom of the jar. [4]



- f) If the ball-bearing hits the base of the jar at $t = 2.0 \text{ s}$, determine the depth of the liquid in the jar. [4]

- g) Sketch on Fig. 4 the variation of the displacement of the ball-bearing if the liquid was replaced with one that causes a higher k value. [3]