PHYSICS DEPARTMENT
S 5 TEST
May 2009
Paper 1
2 hour 45 min

Answer ALL questions
Use, where necessary:
Gravitation acceleration, g = 9.8 ms^{-2}

1. (a) (i) What is meant by ***dimensions*** of a physical quantity? (1)
(ii) State one application of dimensions. (1)

(b) The total energy, E, of a satellite of mass m, moving with a velocity v in an orbit of radius R is given by

$$E = \frac{GMm}{r} - GMmR^x + \frac{mv^y}{2}$$

where r is the radius of the earth and M the mass of the earth.
Find: (i) the dimensions of G (3)
(ii) the constants x and y (2)

(c) (i) The speed, v, of a transverse wave travelling along a stretched string is given by

$$v = \mu^a T^b$$

where T is the tension in the string and μ is its mass per unit length. Find the constants a and b. (3)

(ii) The moment of inertia, I, has the same dimensions for all shapes. That of a solid sphere of mass m and radius r is given by $\frac{2}{5}mr^2$.

Students of S5 were asked to write down the formula for moment of inertia of a rectangular bar of mass m, width a and length b. The following are some of the formulae they wrote.

$$I = \frac{m(a+b)}{12}, \quad I = \frac{m(a^2+b^2)}{12}, \quad I = \frac{m^2(a+b)}{12}, \quad I = \frac{ma^2}{12b}$$

Which one do you think is correct and why? (2)

2. (a) What is meant by the following?
(i) displacement (1)
(ii) uniform acceleration (1)

(b) A stone is released from the top of a tree. Sketch:
(i) the displacement-time graph (1)
(ii) the velocity-time graph (1)

(c) A motorist approaching a kindergarten with a speed of 90 kmh^{-1}, notices a road sign and begins retarding uniformly just as he passes the road sign. He does so for 5 s after which he moves at a constant speed for 100 m. He finally accelerates at double the retardation and passes the next road sign just as he attains the original speed. If the distance covered during acceleration is 37.5 m, sketch a velocity-time graph for the motion between the two road signs and use it to find: (2)

(i) the distance between the two road signs (3)

(ii) the constant speed during the journey (3)

(iii) the time taken at constant speed (2)

3. (a) Write down the equations of uniformly accelerated motion. (3)

(b) A particle is projected with a velocity u at an angle θ to the horizontal. Derive an expression for its horizontal range. (4)

(c) A particle A is projected vertically upwards with a velocity of 49 ms^{-1}. 5 seconds later another particle B is also projected vertically upwards from the same point with a velocity of 60 ms^{-1} to hit B. Find

(i) the time B takes to hit A (4)

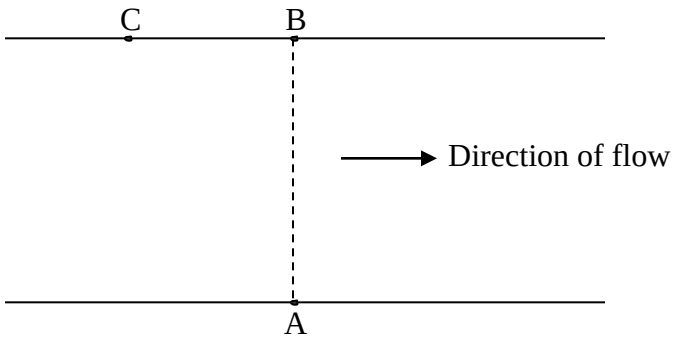
(ii) the height at which the two particles meet. (2)

(iii) the velocity of B relative to A when the two meet (4)

(d) A particle slides from rest down a smooth inclined plane that falls 1 m vertically for every 7 m length of the plane. What will the particle's velocity be after covering 15 m along the plane? (3)

4. (a) Distinguish between ***relative velocity*** and ***resultant velocity***. (2)

(b) Two points A and B are directly opposite on the banks of a river 51 m wide which flows at 2 ms^{-1}. C is another point 25 m upstream from B along the bank.



A man who can swim at 4 ms^{-1} in still water swims from A to C. How long does the journey take? (6)

(c) At 8.00 am a boat P, moving at 15 kmh^{-1} due West is at a point A. At the same time another boat Q, at point B 10 km south-east of A moving at 20 kmh^{-1} aims at catching up with P. Find

(i) the direction in which Q must sail in order achieve the aim (6)

(ii) at what time Q catches up with P (3)

5. (a) (i) Define a **thermometric property** and give two examples. (2)

(ii) State the advantages and disadvantages a thermocouple thermometer has compared to a platinum-resistance one. (3)

(b) Describe how temperature may be measured using a constant-volume gas thermometer. (A diagram may be optional) (4)

(c) (i) With reference to platinum resistance thermometer define temperature on the Celsius scale. (2)

(ii) The resistance R_θ of platinum varies with temperature θ^oC as measured by a constant-volume gas thermometer according to the equation

$$R_\theta = R_o(1 + 8000\alpha\theta - \alpha\theta^2)$$

where α is a constant. Calculate the temperature on the platinum scale corresponding to 400^oC on this gas scale. (3)

(ii) Explain why the two thermometers do not agree exactly. (1)

6. (a) (i) Define specific heat capacity of a substance. (1)

(ii) State **two** advantages and **one** disadvantage of the continuous flow method over the method of mixtures for determining the specific heat capacity of liquids. (3)

(b) In a continuous flow method for determining the specific heat capacity of a liquid the following data were obtained.

P.d/V	Current/A	Mass of liquid collected in 15 min /kg	Inflow temperature /^oC	Outflow temperature /^oC
6.0	2.5	0.220	25.0	35.0
7.2	3.0	0.366	25.0	35.0

(i) Draw a labelled diagram of the apparatus needed to obtain such data. (4)

(ii) Calculate the specific heat capacity of the liquid. (3)

(iii) Find the rate at which heat is lost to the surroundings. (2)