**MATH037001**

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Examination for the Module MATH0370

(June 2006)

Introduction to Applied Mathematics 2

Time allowed: **2 hours**

Attempt all questions. Marks for each question are given in the right hand margin.

Take $g = 10\text{ms}^{-2}$ unless stated otherwise.

1. The acceleration, $a\ ms^{-2}$, of a particle moving in a straight line is $a = 7 - 2t$. If the velocity, $v$, is $12m/s$ when $t = 2$, then calculate

   (a) the time when $a = 3m/s^2$,

   (b) $v$ in term of $t$,

   (c) the distance travelled in the first second,

   (d) the maximum velocity. (8)

2. A cat chases a mouse through a coiled flexible pipe so that after $t$ seconds the mouse has passed through $3 + 12t - t^2\ m$ of pipe and the cat has passed through $10t\ m$ of pipe.

   (a) When does the cat catch the mouse?

   (b) At what speeds are the cat and the mouse running when the cat catches the mouse? (8)

3. The brakes of a train are able to produce a retardation of $1.5\ m/s^2$. The train is approaching a station and is scheduled to stop at a platform there.

   (a) How far away from the station must the train apply its brakes if it travelling at 100km/h?

   (b) If the brakes are applied $50\ m$ beyond this point, at what speed will the train enter the station? (10

4. Granny and Ambrose visit an ice rink. Granny $(m = 80kg)$ whizzes around the rink with a velocity of $6\ m/s$. She suddenly collides with Ambrose $(m = 40kg)$ who is at rest directly in her path. Rather than knock him over, she picks him up and continues in motion without "braking." Determine the velocity of Granny and Ambrose after the collision. (6)

5. A billard ball, A, moves with a speed $4\ m/s$ and directly impacts on an identical billard ball, B, moving towards A with speed of $2\ m/s$. If the ball, A, is brought to rest by the collision,

   (a) what is the speed of the ball B after the impact and

   (b) what is the coefficient of restitution? (8)

**CONTINUED...**

6.  What is the kinetic energy of a $2\,kg$ body that has fallen from rest through a height of $20\,m$ and what is its speed at that point? (6)

7.  A block of mass $2\,kg$ is held steady on an inclined plane The coefficient of friction between the block and the plane is $0.5$. Determine whether or not the block moves when released if the angle of the plane makes with the horizontal is

    (a) $20^o$ and

    (b) $40^o$. (10

8.  A stone is slung from a catapult with speed $30\,m/s$ at angle $\alpha$ to the horizontal on a horizontal stretch of ground. Assume that the angle $\alpha$ is such that $sin(\alpha) = \frac{3}{5}$ and $cos(\alpha) = \frac{4}{5}$. Find

    (a) the greatest height reached,

    (b) the distance the stone goes before hitting the ground, and

    (c) its speed and direction when its hits the ground. (12

9.  A parachutist A, falling vertically at $10\,m/s$, observes a parachutist B who appears to be moving away from A at $2\,m/s$ along a path inclined at $20^o$ above the horizontal. Find the actual speed and direction of parachutist B. (10

10. A tug tows 3 barges in line and has an acceleration of $0.02\,m/s^2$. Each barge has a mass of $80\,tonnes$. The water offers resistance of $12.5\,N$ to each barge. If the towing ropes are horizontal and along the line of the barges, find the tension on each coupling (10

11. A truck of mass $40\,kg$, runs smoothly on horizontal rails. A light inextensible rope is attached to the front of the truck and runs parallel to the rails until it passes over a light frictionless pulley. The end of the the rope hangs vertically over a shaft and is attached to a $10\,kg$ load. Find

    (a) the acceleration of the truck,

    (b) the tension in the rope,

    (c) the magnitude of the force on the pulley. (12

**END**