AH Mechanics Unit 2 Practice NAB

(Where necessary, take the magnitude of the acceleration due to gravity to be $9.8ms^{-2}$)

Outcome 1

1. A satellite moves in a circular orbit of radius 4500 kilometres around a planet in the plane of its equator. The magnitude of the gravitational force per unit mass that it experiences is 3.8 ms^{-2}. Given that the magnitude of the gravitational force per unit mass at the surface of the planet is 8.2 ms^{-2}, calculate the radius of the planet. (5)

2. A particle is attached at one end of a light inextensible string, the other end of which is fixed. The particle is describing horizontal circles, of radius 0.3 metres, with uniform speed $1.3ms^{-1}$. Calculate the angle the string makes with the downward vertical through the fixed point. (4)

Outcome 2

3. The maximum speed of a particle describing simple harmonic motion about a point O is $6ms^{-1}$. The amplitude of the motion is 80 centimetres. Find the period of the motion and the distance of the particle from O when its speed is $5ms^{-1}$. (4)

Outcome 3

4. A toy train engine of mass 400g, travelling at $4.5ms^{-1}$ on a smooth horizontal track collides with a stationary train carriage of mass 120g. Given that the engine and carriage couple together, use the conservation of linear momentum to find the speed of the combined engine and carriage immediately after the collision. (3)

5. A constant force acting on a particle of mass 6kg increases its speed from $2ms^{-1}$ to 5 ms^{-1} in 6 seconds, where the particle is free to move in the direction of the constant force. Calculate the change in linear momentum of the particle and hence find the magnitude of the constant force. (3)

Outcome 4

6. A smooth brick of mass m kilograms is dropped from scaffolding down a smooth curved chute into a skip. The brick starts from rest and lands in the skip, which is 25 metres vertically below its starting point. Ignoring air resistance, calculate the speed of the brick when it reaches the skip. (3)

7. A body of mass 8 kg is on a rough plane inclined at 30° to the horizontal. It is released from rest and after travelling a distance of 20 metres down the slope has acquired a speed of $12ms^{-1}$. Calculate the work done against friction in travelling down the slope. (3)

8. A rider and moped of combined mass 105kg move along a straight horizontal road against a constant resistance of 600N. Given that the moped is accelerating at $0.3ms^{-2}$, calculate the power at which the moped's engine is working at the instant when the moped's speed is $4ms^{-1}$. (3)

Outcome 5

9. A body moves in a horizontal, straight line in the direction Ox, in a medium which offers a resistance whose magnitude per unit mass is three times the speed of the body. It is also acted on by a constant braking force whose magnitude is 6 times the mass of the body. The initial velocity of the body is $35ms^{-1}$ in the direction Ox.

   Write down an equation of motion for the body and use it to find the time taken for the body to be brought to rest. (5)