1. A particle P of mass 2 kg is moving with velocity $(3\mathbf{i} + 4\mathbf{j})\,\text{m s}^{-1}$ when it receives an impulse.

Immediately after the impulse is applied, P has velocity $(2\mathbf{i} - 3\mathbf{j})\,\text{m s}^{-1}$.

(a) Find the magnitude of the impulse.

(5)

(b) Find the angle between the direction of the impulse and the direction of motion of P immediately before the impulse is applied.

(3)

(Total for Question 1 is 8 marks)

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2. A cyclist and his bicycle have a total mass of 75 kg. The cyclist is moving **up** a straight road inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{21}$.

The non-gravitational resistance to motion is modelled as a constant force of magnitude R newtons.

The cyclist is working at a constant rate of 280 W and moving at a constant speed of $2\,\text{m s}^{-1}$.

(a) Find the value of R.

(4)

Later the cyclist cycles **down** the same road on the same bicycle.

He is again working at a constant rate of 280 W and the resistance to motion is now modelled as a constant force of magnitude 60 N.

(b) Find the acceleration of the cyclist at the instant when his speed is $3.5\,\text{m s}^{-1}$.

(4)

(Total for Question 2 is 8 marks)