B3. This question is in **two** parts. **Part 1** is about kinematics and mechanics. **Part 2** is about resolution and the Doppler effect.

Part 1 Kinematics and mechanics

(a) Define *linear momentum*. *[1]*

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(b) State, in terms of momentum, Newton's second law of motion. *[1]*

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(c) Show, using your answer to (b), how the impulse of a force F is related to the change in momentum Δp that it produces. *[1]*

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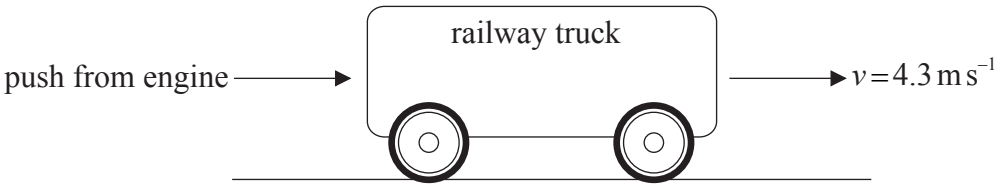
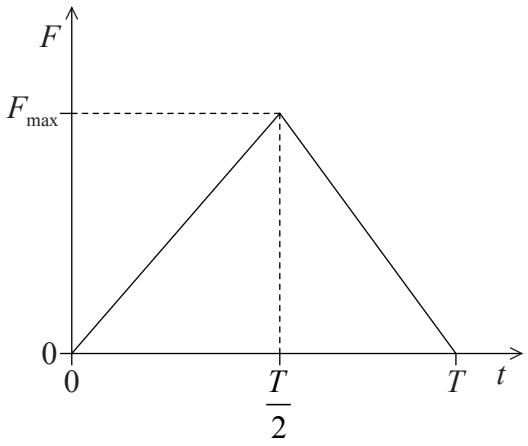
(Question B3, part 1 continued)

(d) A railway truck on a level, straight track is initially at rest. The truck is given a quick, horizontal push by an engine so that it now rolls along the track.



The engine is in contact with the truck for a time $T = 0.54\,\text{s}$ and the initial speed of the truck after the push is $4.3\,\text{m s}^{-1}$. The mass of the truck is $2.2 \times 10^3\,\text{kg}$.

Due to the push, a force of magnitude F is exerted by the engine on the truck. The sketch shows how F varies with contact time t.



(i) Determine the magnitude of the maximum force F_{max} exerted by the engine on the truck. *[4]*

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(Question B3, part 1 continued)

(ii) After contact with the engine ($t = 0.54\,\text{s}$) the truck moves a distance 15 m along the track. After travelling this distance the speed of the truck is $2.8\,\text{m s}^{-1}$. Assuming a uniform acceleration, calculate the time it takes the truck to travel 15 m. *[2]*

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(iii) Calculate the average rate at which the kinetic energy of the truck is dissipated as it moves along the track. *[2]*

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(iv) When the speed of the truck is $2.8\,\text{m s}^{-1}$ it collides with a stationary truck of mass $3.0 \times 10^3\,\text{kg}$. The two trucks move off together with a speed V. Show that the speed $V = 1.2\,\text{m s}^{-1}$. *[2]*

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(Question B3, part 1 continued)

(v) Outline the energy transformations that take place during the collision of the two trucks. *[2]*

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