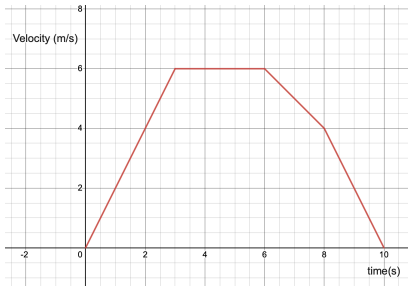
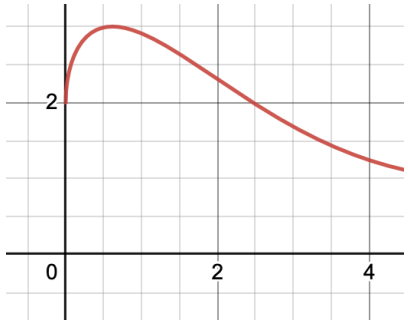
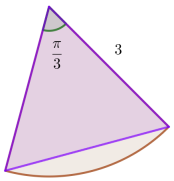
AQA A-Level Mathematics Warmup - Paper 2 2023

A particle has displacement given by the vector $\begin{pmatrix} 3\cos(t) \\ 4e^{-2t} \end{pmatrix}$ find the velocity	Find $I = \int \frac{1}{x\sqrt{\ln(3x)+2}}\,dx$	Sketch $y = \cot(x)$	What does the word "uniform" mean in a mechanics context?	Find the magnitude and direction of the vector $\begin{pmatrix} 4 \\ 6 \end{pmatrix}$
	For the velocity-time graph to the left, find the acceleration between 6 and 8 seconds.		Find the area between the curve with parametric equations $x = t^2$ and $y = \sin(2t) + 2$ and the lines $x = 0$ and $x = 4$.	An explosion of TNT produces an hemispherical shock wave above flat ground. Given that the detonation velocity of TNT is 400 ms^{-1} and ignoring effects of air resistance, find the rate at which the volume of the hemispherical shock wave is increasing 100 m from the blast.
Find the total distance travelled.	Find the average speed for the duration of the motion.	A box of mass 2 kg is held on a rough inclined plane at an angle α by a force parallel to the plane of 2 N. Given that $\sin(\alpha) = \frac{3}{5}$ find the coefficient of friction between the box and the plane.	Draw a labelled force diagram for the situation described to the left.	A marble rolls off a bookshelf that 1.4 m high. Find the time taken for it to reach the ground.
Find the equation of the normal to $y = 2x\cos(x)$ at $x = \frac{\pi}{2}$	Find the sum of the first 10 terms of arithmetic sequence with first term 4 and common difference 2.5	Find the area remaining when the triangle is removed from the sector. 	Solve $2\sin^2(x) + 5\cos(x) - 4 = 0$ for $0° \leq x \leq 360°$	Find the first 4 terms in the binomial expansion for $(3+2x)^{-2}$

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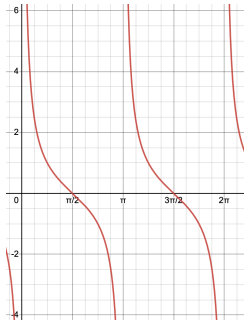
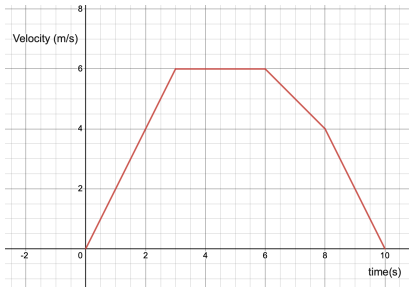
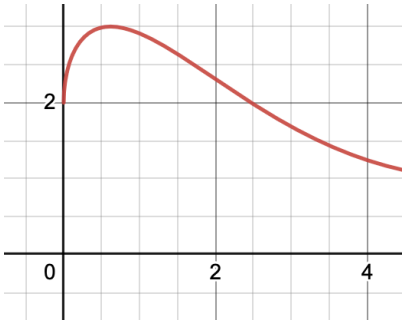
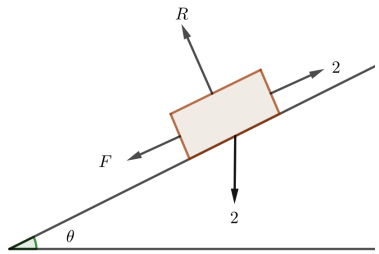
$\begin{pmatrix} -3\sin(t) \\ -8e^{-2t} \end{pmatrix}$	Use the substitution $u = \ln(3x) + 2$ to obtain $I = 2\sqrt{\ln(3x) + 2}$		The mass is evenly spread throughout the body.	Magnitude: $\sqrt{4^2 + 6^2} = 2\sqrt{13}$ Direction: $\theta = \arctan\left(\frac{3}{2}\right) \approx 56.3°$ above the positive $x-$axis
	-1 ms^{-1}		$\frac{dx}{dt} = 2t$ so the area is $\int_0^4 2t(\sin(2t) + 2)\ dt = 33.49$ square units.	$\frac{dV}{dt} = \frac{dV}{dr} \times \frac{dr}{dt}$ $= 2\pi r^3 \times 400$ When $r = 100$ $\frac{dV}{dt} \approx 25132741$ m^{3}s^{-1}
Split into 4 sections. $9 + 18 + 10 + 4 = 41$ m	Using $v = \frac{s}{t}$ Average speed $= 4.1$ ms^{-1}	Resolve perpendicular to the plane: $R = 2\cos(\alpha) = \frac{8}{5}$ Resolve parallel to the plane $F = 2 - 2\sin(\alpha) = \frac{4}{5}$ So $\mu = \frac{F}{R} = \frac{1}{2}$		$\frac{2}{7}$ second
$y = \frac{x}{\pi} - \frac{1}{2}$	$S_n = \frac{1}{2}[2a + (n-1)d]$ so $S_10 = \frac{1}{2}[2 \times 4 + 9 \times 2.5]$ $= \frac{61}{4}$	Area of sector $= \frac{1}{2} \times 3^2 \times \frac{\pi}{3} = \frac{3\pi}{2}$ Area of triangle $= \frac{1}{2} \times 3 \times 3 \times \sin\left(\frac{\pi}{3}\right) = \frac{9\sqrt{3}}{4}$ Area remaining ≈ 0.81	Using $\sin^2(x) + \cos^2(x) = 1$ we obtain $2\cos^2(x) - 5\cos(x) + 2 = 0$. Hence $\cos(x) = 2$ or $\cos(x) = \frac{1}{2}$. So $x = 60°, 300°$	$\frac{1}{9} - \frac{4}{27}x + \frac{4}{27}x^2 - \frac{32}{243}x^3$