A Level Physics Online

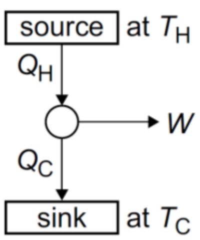
AQA Physics - 7407/7408

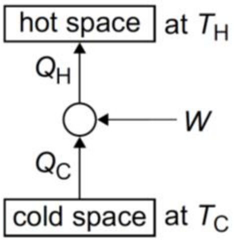
Module 11: Engineering Physics

You should be able to demonstrate and show your understanding of:	Progress and understanding: 1	2	3	4
11.1 Rotational Dynamics				
11.1.1 Concept of Moment of Inertia				
$I = mr^2$ for a point mass $I = \Sigma mr^2$ for an extended object				
Qualitative knowledge of the factors that affect the moment of inertia of a rotating object.				
Expressions for moment of inertia will be given where necessary.				
11.1.2 Rotational Kinetic Energy				
$E_k = ½\, I\, \omega^2$				
Use of flywheels in machines and factors affecting the energy storage capacity of a flywheel.				
Use of flywheels for smoothing torque and speed, and for storing energy in vehicles, and in machines used for production processes.				
11.1.3 Rotational Motion				
Angular displacement, angular speed, angular velocity, angular acceleration: $\omega = \Delta\theta / \Delta t$ $\alpha = \Delta\omega / \Delta t$				
Representation by graphical methods of uniform and non-uniform angular acceleration.				

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	2	3	4
Equations for uniform angular acceleration: $\omega_2 = \omega_1 + \alpha t$ $\theta = \frac{1}{2} (\omega_1 + \omega_2) t$ $\theta = \omega_1 t + \frac{1}{2} \alpha t^2$ $\omega_2^2 = \omega_1^2 + 2\alpha\theta$				
Students should be aware of the analogy between rotational and translational dynamics.				
11.1.4 Torque and Angular Acceleration				
$T = Fr$ $T = I\alpha$				
11.1.5 Angular Momentum				
Angular momentum $= I\omega$				
Conservation of angular momentum.				
Angular impulse = change in angular momentum $T \Delta t = \Delta(I\omega)$ where T is constant.				
Applications may include examples from sport.				
11.1.6 Work and Power				
$W = T\theta$ $P = T\omega$				
Awareness that frictional torque has to be taken into account in rotating machinery.				

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	2	3	4
11.2 Thermodynamics and Engines				
11.2.1 First Law of Thermodynamics				
Quantitative treatment of first law of thermodynamics: $Q = \Delta U + W$ Where Q is energy transferred to the system by heating, ΔU is increase in internal energy and W is work done by the system.				
Applications of first law of thermodynamics.				
11.2.2 Non-flow Processes				
Isothermal, adiabatic, constant pressure and constant volume changes.				
$pV = nRT$				
Adiabatic change: $pV^{\gamma} = constant$				
Isothermal change: $pV = constant$				
At constant pressure $W = p\Delta V$				
Application of first law of thermodynamics to the above processes.				
11.2.3 The p-V Diagram				
Representation of processes on p–V diagram.				
Estimation of work done in terms of area below the graph.				
Extension to cyclic processes: *work done per cycle = area of loop*				
Expressions for work done are not required except for the constant pressure case, $W = p\Delta V$				
11.2.4 Engine Cycles				
Understanding of a four-stroke petrol engine cycle and a diesel engine cycle, and of the corresponding indicator diagrams.				

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	2	3	4
Comparison with the theoretical diagrams for these cycles; use of indicator diagrams for predicting and measuring power and efficiency.				
Input power = calorific value × fuel flow rate				
Indicated power as *(area of p–V loop)* × *(no. of cycles per second)* × *(no. of cylinders)*				
Output or brake power, $P = T\omega$				
Friction power = indicated power – brake power				
Engine efficiency; overall, thermal and mechanical efficiencies. *Overall efficiency = brake power / input power* *Thermal efficiency = indicated power / input power* *Mechanical efficiency = brake power / indicated power*				
A knowledge of engine constructional details is not required.				
Questions may be set on other cycles, but they will be interpretative and all essential information will be given.				
11.2.5 Second Law and Engines				
Impossibility of an engine working only by the First Law.				
Second Law of Thermodynamics expressed as the need for a heat engine to operate between a source and a sink.				
Efficiency $= W/Q_h = (Q_h - Q_c) / Q_h$				
Maximum theoretical efficiency $= (T_h - T_c) / T_h$				
				

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	2	3	4
Reasons for the lower efficiencies of practical engines.				
Maximising use of W and Q_H for example in combined heat and power schemes.				
11.2.6 Reversed Heat Engines				
Basic principles and uses of heat pumps and refrigerators.				
A knowledge of practical heat pumps or refrigerator cycles and devices is not required.				
				
Coefficients of performance: refrigerator: $COP_{ref} = Q_c / W = Q_c / (Q_h - Q_c) = T_c / (T_h - T_c)$ heat pump: $COP_{hp} = Q_h / W = Q_h / (Q_h - Q_c) = T_h / (T_h - T_c)$				