A Level OCR Physics

Chapter 7 Work energy and power

Question	Answers	Extra information	Mark	AO	Spec reference
1(a)	$v = 30 \text{ km hr}^{-1} = \dfrac{130 \times 1000 \text{ m}}{60 \times 60} = 36\ (36.1) \text{ m s}^{-1}$ use of $v = u + at$ and $u = 0$ $a = \dfrac{v - u}{t} = 19 \text{ m s}^{-2}$		1 1	2	3.1.2a
(b)	$s = ut + ½ at^2$ or $v^2 = u^2 + 2as$ $s = ½ \times 19 \times 1.9^2 = 34$ m	allow ecf here for answer to part 1(a)	1 1	2	3.1.2a
(c)	KE at the top = KE at bottom – GPE $½ mv_2^2 = ½ mv_1^2 - mgh$ $v_2^2 = v_1^2 - 2gh = 36^2 - (2 \times 9.81 \times 62.5)$ $v_2 = 8.4 \text{ m s}^{-1}$	must use change in energy not equations of motion	1 1 1	2	3.3.2
(d)	Any three from: • the magnetic flux linkage with the copper fins • causes emf to be induced in the copper/Faraday's law • this causes a magnetic field which opposes the change/Lenz's law • which slows down the car Safety: • this would work even in a power cut • cannot stop car completely as relies on movement	for full marks answer must include relevant comment about safety	max 4	3	6.3.3
2(a)	KE = $½ mv^2$ or $v = \dfrac{160\,000}{60 \times 60} = 44.4 \text{ m s}^{-1}$ KE = $½ \times 75 \times 44.4^2 = 74$ kJ		1 1	2	3.3.2a
(b)	GPE = $mgh = 75 \times 9.81 \times 152 = 112$ kJ		1 1	2	3.3.2b

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(c)	W = GPE – KE = 38 kJ $W = Fd$ distance = $\frac{152}{\sin 6}$ = 1450 m $F = \frac{38\,000}{1450}$ = 26 N		1 1	2	3.3.1b
(d)	the elastic cord will stretch increasing the time over which the change in momentum occurs/impulse increases for the same change in momentum the force will be less. OR acceleration decreased because time for change in velocity increased $F = ma$ so F decreases		1 1	2	3.5.1c
3(a)	GWh is a unit of energy/power × time = 11 × 10^9 × W × 60 × 60 = 3.96 × 10^{13} J	1 or 2 marks for calculation in joules	1 1	2	4.2.5c
(b)	$\rho = \frac{m}{V}$ $m = \rho V$ mass per second = 390 000 kg s^{-1} $P = \frac{\Delta W}{\Delta t} = \frac{mgh}{\Delta t}$ = 9.81 × 390 000 × 500 = 1.9 × 10^9 W		1 1 1	2	3.2.4a 3.3.3
(c)	capacity = 3.96 × 10^{13} J time = $\frac{3.96 \times 10^{13}\text{ J}}{1.9 \times 10^{9}\text{ W}}$ = 20 842 s = 5 hours 50 mins		1	2	3.3.3a

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(d)	efficiency = $\frac{\text{useful power output}}{\text{input power}}$ efficiency = $\frac{1.7 \times 10^9}{1.9 \times 10^9}$ = 0.89 or 89%		1	2	3.3.3c
(e)	the generators work less efficiently as pumps/example of named transfer of energy		1	3	3.3.3c
4(a)	**Level 3 (5–6 marks)** Clear explanation of method, diagrams **and** explanation of calculations. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Some explanation of method, a diagram and some calculations. *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Limited explanation and diagram **or** limited calculations and diagram. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	**Indicative scientific points may include:** **Diagrams** • circuit diagram – ammeter in series and voltmeter in parallel with the motor • apparatus diagram – motor using pulley to lift masses – or method of measuring velocity of the load, e.g. timing card passing through light gate when you are sure load lifted at constant speed **Method** • measuring power of the motor same for all methods; need to record the potential difference across the motor and the current through • measure mass of load lifted using scales	6	3	4.2.5

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		• time how long it takes to lift load a set height OR use light gate to measure velocity of the load **Calculations** • calculate electrical power using $P = IV$ • efficiency = $\frac{\text{useful energy out}}{\text{total energy in}}$ • total electrical energy in given by $E = ItV$ • useful energy out given by *mgh* • efficiency = $\frac{ItV}{mgh}$ • plot a graph of efficiency versus load OR output power $P = Fv = mgv$ $v = \frac{d}{t}$ (using length of timing card measured with a ruler. efficiency = $\frac{mgv}{IV}$			
(b)(i)	Torque is the moment of a couple (it is equal to Fd).		1	1	3.2.3b
(ii)	torque = Fd		1	1	6.3.1e

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	or for a motor $F = BIl$ torque = $BIld$ $l \times d$ is the area therefore torque is proportional to area		 1		
5(a)	Allow any sensible suggestion that allows speed at a point: e.g. Skateboarder helmet has timing card attached/hand passes through light gate positioned at set distance. Length of hand/timing card used with time to determine speed. Placing a grid in front of ramp and filming with stopwatch in view. Use measurements of distance based on wheels/front of skateboard and time to determine speed.	how distance and time measured for 2 marks	2	3	3.1.2a
(b)(i)	line of best fit drawn y-intercept used – 367 J (allow within half a small square)		1 1	2	1.1.3d
(ii)	The skateboarder will reach end of the ramp as still has KE until x = 2.3 m OR had 55 J of KE when x = 2 m		1	2	3.3.2
(c)(i)	line drawn parallel to first passes through (2,0) (0,313)	 ± half a square	1 1	2	1.1.3d
(ii)	KE = ½ mv^2 313 =½ 70 v^2 v = 3.0 m s^{-1}	allow ecf from part 5(c)(i) here	1	2	3.3.2a
6(a)	Hooke's law states that force is directly proportional to extension would expect to see a straight line through the origin wtte		1 1	1	3.4.1b
(b)	work done is area under graph counting squares = 69 squares ± 3 or 1 square = 0.2 N × 0.02 m = 4×10^{-3} J work done = 0.28 (0.276) J	allow 0.26 J to 0.29 J	1 1 1	2	3.4.21

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(c)	work done stretching the spring = kinetic energy of pellet KE = ½ mv^2 0.28 J = ½ × 0.01 kg × v^2 v = 7.4 m s^{-1}	range of velocity is 7.6 to 7.2 allow ecf from 6(b)	1 1	2	3.3.2a
(d)	the unloading curve would be lower/less force required for each extension/hysteresis energy has been transferred to the internal energy of the elastic as it was stretched.		1 1	3	3.4.1d
7(a)	KE = ½ mv^2 or $P = \frac{E}{t}$ the mass of air hitting the blades per second is given by $m = \rho V = \rho Av$ $P = ½ \rho AVv^2$	use of either of these equations gains first mark	1 1	3	3.3.2a and 3.3.3a
(b)	$P = ½ \rho Av^3$ $1.0 \times 10^6 = 0.5 \times 1.2 \times A \times 13^3$ $A = \frac{1.0 \times 10^6}{0.5 \times 1.2 \times 13^3}$ $r^2 = \frac{A}{\pi}$ r = 15.5 m		1 1	2	3.2.4
(c)	$P \propto A$ and $A \propto r^2$ so actual power input to blades is = 4 × greater		1	2	3.3.3c

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	$\text{efficiency} = \dfrac{\text{useful output power}}{\text{total input power}} \times 100\%$ $\text{efficiency} = \dfrac{1\text{ MW}}{4\text{ MW}} \times 100\% = 25\%$		1		
(d)	$E = 49 \times 10^9 \times 60 \times 60 = 1.764 \times 10^{14}$ J $P = \dfrac{E}{\text{number of seconds in a year}} = 5.6$ MW		1	2	4.2.5c
8(a)	$P = Fv = 10 \times 5 = 50$ W		1	2	3.3.3b
(b)	$P = Fv$ $F = \dfrac{250}{5} = 50$ N		1	2	3.3.3b
(c)	Bike will accelerate because work done per second by cyclist greater than work done against resistance forces. or Frictional force of the road pushing the bike forward is greater than the resistance forces pushing the bike back.		1	3	3.2.2
(d)	weight arrow acting vertically down normal reaction arrow perpendicular to slope drag / resistance arrow parallel to slope frictional force between bike wheel and road acting forwards	all three arrows labelled the arrows must be on the object, not near it	1 1 1 1	2	3.2.1e
(e)	attempt to find resultant of forces parallel to the slope: $(95 \times 9.81) \sin\theta$ or $F = \dfrac{250}{5} = 50$ N or drag = 10 N equating forces parallel to slope because moving at a constant speed		1 1	2	3.3.1

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	$(95 \times 9.81) \sin\theta + 10 = 50$ N $\sin\theta = \frac{40}{95 \times 9.81}$ $\theta = 2.5°$		1		