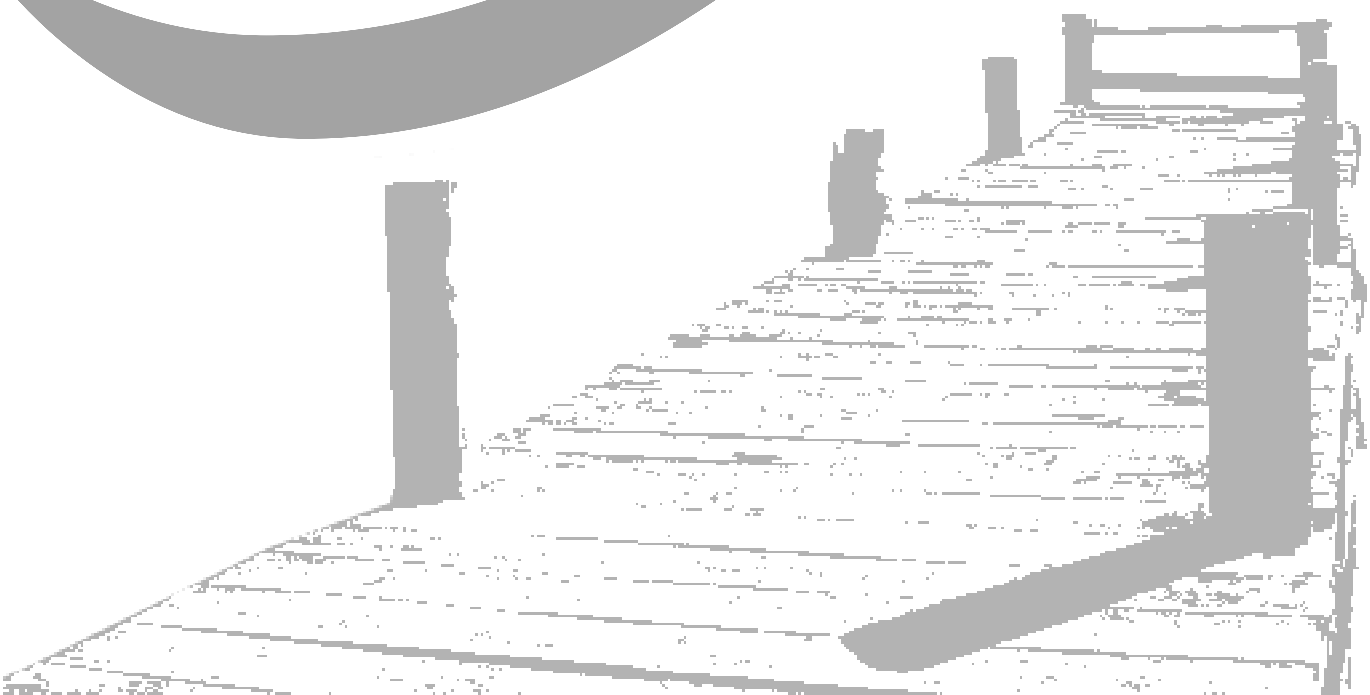
GCE
AS and A Level

Physics A

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 5C: Approved specimen mark scheme

Version 1.1



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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 2451

Specification A

PHA5C Applied Physics

Mark Scheme

The specimen assessment materials are provided to give centres a reasonable idea of the general shape and character of theplanned question papers and mark schemes in advance of the first operational exams.

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.
It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

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PHA5C: Applied Physics

Question 1		
(a)	22 000 (rev min^{-1}) × 2π/60 ✓ (=2300 rad s^{-1}) energy stored (=½ $I\omega^2$) = ½ × 0.60 × 2300^2 ✓ (=1.6 MJ)	**2**
(b) (i) (ii)	$t = E/P = \dfrac{1.6\times10^6}{8.7}$ ✓ = 1.84 × 10^5 s ✓ (51 hours) torque = $\dfrac{\text{power}}{\text{average speed}} = \dfrac{8.7}{(2300/2)}$ = 7.5(6) × 10^{-3} ✓ N m ✓ **or** $T = I\,a$ = 0.60 × 2300/(1.84 × 10^5) = 7.5 × 10^{-3} ✓ N m ✓	**max 3**
(c)	in **B** more of the mass is at a greater radius than in **A** ✓ so I greater and so energy stored greater (for same speed) ✓	**2**
	Total	**7**

Question 2		
(a) (i) (ii)	energy: kinetic energy = ½$I\omega^2$, → small stored energy [or less work/energy needed to produce change] power = rate of energy change, fast change → high power torque: $T = I\alpha$, α large so large torques needed unless I small, momentum , impulse: $L = I\omega$, impulse = ΔL so unless I small, large angular impulses are needed *marking*: for any **one** of the above: for correct consideration ✓ for mathematical justification ✓ explanations based on $I = mr^2$ ✓ low **mass**, small diameter ✓	**4**
(b) (i) (ii) (iii)	$\alpha = \dfrac{\omega_1 - \omega_2}{t} = \dfrac{120+120}{50\times10^{-3}}$ = 4.8 × 10^3 rad s^{-2} ✓ $T = I\alpha$ = 4.4 × 10^{-5} × 4.8 ×10^3 = 0.21(1) N m ✓ (allow C.E. from incorrect value of α from (i)) $\theta = \left(\dfrac{\omega_1+\omega_2}{2}\right)t = \left(\dfrac{120+0}{2}\right)25\times10^{-3}$ = 1.5 rad ✓	**3**
	Total	**7**

Question 3		
(a)	(use of pV^{γ} = constant gives) $1.01 \times 10^{5} \times (4.25 \times 10^{-4})^{1.4} = 1.70 \times 10^{5} \times V^{1.4}$ ✓ V calculated correctly (= 2.93×10^{-4} Pa) ✓	**2**
(b)	$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ ✓ $T_1 = 273 + 23 = 296$ (K) ✓ $T_2 = \frac{1.7\times10^{5}\times2.93\times10^{-4}\times296}{1.01\times10^{5}\times4.25\times10^{-4}}$ ✓ = 343 K (70ºC) ✓	**4**
	Total	**6**

Question 4		
(a) (i)	work done = area enclosed by curve ABCD = 20 kJ (± 2 kJ)✓ satisfactory method used to find area e.g. counting squares ✓ correct scaling factor used (e.g. 1 small square = 40 J) ✓	**6**
(ii)	power = 20 kJ per cycle × 3 cycle per second = 60 kW (± 6 kW)✓	
(iii)	input power (= fuel flow rate × calorific value) $= 2.4 \times 10^{-2} \times 34 \times 10^{6}$ = 816 kW✓ efficiency = $P_{out}/P_{in} = \frac{60\times10^{3}}{816\times10^{3}} \times 100 = 0.07$ or 7%✓	
(b)	*modified engine:* same mass of steam required less fuel required because of recycled heat greater work output per cycle because loop larger same speed so greater power output greater efficiency as P_{out} is greater and P_{in} less ✓✓✓ any three	**3**
	Total	**9**

Question 5			
(a)	(i)	$P_{out} = 0.36 \times 34.2 = 12.3\,kW$ ✓	3
	(ii)	$P_{farm} = 12.3 \times 2.5 = 30.8\,kW$ ✓	
	(iii)	$P_{stream} = 30.8 - 12.3 = 18.5$ kW ✓	
(b)		**two** reasons in support of either choice heat pump ✓ both systems use the same fuel so cost of same amount of fuel is same ✓ heat pump uses less fuel for the same output ✓ (or gives greater output for same amount of fuel ✓) can also use energy rejected from engine for heating ✓	**max 3**
		Total	**6**

	Assessment Objectives	
Question No	*Ability tested*	*Marks*
1 (a)	AO1	**2**
(b)	AO1/AO2	**3**
(c)	AO2	**2**
	Question Total	**7**
2 (a)	AO1	**2**
(b)	AO2	**5**
	Question Total	**7**
3 (a)	AO1/AO2	**2**
(b)	AO2	**4**
	Question Total	**6**
4 (a)	AO1/AO2	**6**
(b)	AO2	**3**
	Question Total	**9**
5 (a)	AO1	**3**
(b)	AO2/AO3	**3**
	Question Total	**6**
	Total	**35**

	Summary	
Marks	*Ability tested*	*%*
13	AO1 Knowledge and Understanding	37
21	AO2 Application	60
1	AO3 How Science Works	3

	Summary Common Section & Section C Applied Physics	
Marks	*Ability tested*	*%*
26	AO1 Knowledge and Understanding	35
45	AO2 Application	60
4	AO3 How Science Works	5