OXFORD
INTERNATIONAL
AQA EXAMINATIONS

INTERNATIONAL A-LEVEL
Physics

PH04 – Unit 4 Energy and Energy Resources

Mark scheme

June 2018

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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' 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 from aqa.org.uk

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

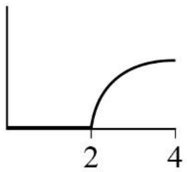
Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question	Marking guidance	Mark	Comments
01.1	Use of $\frac{1}{2}\pi r^2 \rho v^3 = 7700$ ✓ $v = 10.6$ m s^{-1} ✓	2	
01.2	Not all of the (kinetic) energy of the wind is recovered ✓ Correct identification of a mechanical or electrical inefficiency ✓ **or** Explanation of why all of the KE is not used in terms of continuity or Betz's Law ✓	2	e.g. friction at a named point or electrical heating at a named point
01.3	(Turbines should be positioned to) minimise the effect of wind shadows ✓ (Which is when) a turbine removes kinetic energy from the wind leaving less available (for a subsequent turbine) ✓	2	Accept placed on a hill (or other suitable location) where there is likely to be a higher wind speed for one mark.

Question	Marking guidance	Mark	Comments
02.1	Q (= ml = 14.3 × 334000) = 4.7(8)x10^6 J ✓	1	Answer to 2 or more sf

Question	Marking guidance	Mark	Comments
02.2	Calculation of surface area $A = 6 \times 0.25 \times 0.25 = 0.375$ m^2 ✓ Rate of energy transfer = $\frac{4776200}{2 \times 24 \times 60 \times 60}$ = 27.64 W ✓ Use of Rate of energy transfer = $\frac{kA\Delta\theta}{L}$ ✓ k = 0.025 - 0.030 W m^{-1} K^{-1} ✓	4	Condone use of 0.26 or 0.27 in calculating area Condone a recognisable attempt at time e.g. 24x60x60 or 2x24x60 for second mark ecf their rate and their area for third mark no ecf for final mark

Question	Marking guidance	Mark	Comments
02.3	Temperature = 0 °C for 2 days ✓ Curve with decreasing gradient from 2–4 days ✓ 	2	

Question	Marking guidance	Mark	Comments
03.1	Use of $E_K = \frac{1}{4\pi\varepsilon_0}\frac{qQ}{R}$ ✓ Converts 8 MeV to J ✓ R = 2.84 × 10^{-14} m ✓	3	
03.2	Calculates two values of R_0 ✓ Calculates three values of R_0 ✓ Concludes that the values are consistent ✓ OR Uses one data row to calculate R_0 and from that predicts the value of R for another data row. ✓ Predicts the value of R for a third data row. ✓ Concludes that the predicted values of R are close to those in the table. ✓ OR Shows that $R_1 / R_2 = A_1^{1/3} / A_2^{1/3}$ for a pair of data rows.✓ Repeats for another pair of data rows.✓ Concludes that the ratios support R being proportional to the cube root of A.✓	3	Ignore powers of ten.

03.3	Alpha particles have mass of the same order of magnitude as the target nucleus ✓ Results affected by nuclear recoil **or** momentum transfer ✓ Distance of closest approach depends on the alpha particle energy ✓ Closest approach ≠ (or must be bigger than) the nuclear radius ✓ The de Broglie wavelength of high energy electrons is of the order of the nuclear radius ✓ Providing large diffraction angles ✓ Max 3	3	

Question	Marking guidance	Mark	Comments
04.1	Use of $T = I\,\alpha$ ✓ Use of $T = Fr$ ✓ R = 2.52 N ✓	3	
04.2	ω (= 0 + 25.0 × 1.5) = 37.5 rad s^{-1} ✓	1	

04.3	$\theta = \frac{1}{2}\alpha t^2$ ✓ = 28.125 rad ✓ Number of revolutions $= \frac{28.125}{2\pi} = 4.48$ ✓ Distance = $4.48 \times 2 \times \pi \times 0.14 = 3.94$ m ✓ OR $\theta = \frac{1}{2}\alpha t^2$ ✓ = 28.125 rad ✓ Use of $s = r\theta$ ✓ Distance = 3.94 m ✓ OR (For a point on circumference) Use of $v = \omega r$ ✓ $v = 5.25$ ms^{-1} ✓ Use of $s = \left(\frac{u+v}{2}\right)t$ Or $v^2 = u^2 + 2as$ ✓ Distance = 3.94 m ✓ ✓	4	Must see unrounded answer for final mark

04.4	$\Delta h = 3.94\sin(30) = 1.97$ m ✓ Loss of GPE = $mg\Delta h = 34.8$ J ✓	2	If use s = 3.9 m from 4.3 then Loss of GPE = 34.4 J

04.5	Use of $E_{k(rot)} = \frac{1}{2} I \omega^2$ ✓ = 9.9 J ✓	2	ecf their ω from 4.2 and any previously calculated incorrect value for I.
04.6	There will be no (change in) rotational kinetic energy There is no frictional torque producing an angular acceleration **or** All the GPE lost is transferred into translational kinetic energy	2	Accept the (change in) rotational kinetic energy will be reduced Accept the sphere will roll or slide for second mark.

Question	Marking guidance	Mark	Comments
05.1	Correctly identifies the region of the graph in which fusion occurs ✓ When light nuclei fuse to make heavier nuclei they move closer to the peak ✓ There is an increase in BE per N so energy is released ✓ Product has less mass than the combined mass of the two parents. ✓ MAX 3	3	
05.2	Identifies BE per N for uranium–235 at 7.5–7.8 MeV A ✓ Identifies BE per N for product at 8.6–8.9 MeV B ✓ Change in binding energy = (B–A) × 235 or 236 ✓ Answer in range 188–330 MeV ✓ Correctly converts their answer in MeV into J ✓	5	Condone use of 233 or 234 for the candidate that recognises that 2 or 3 neutrons are emitted in the fission
05.3	Release of (high-energy) neutrons from fission ✓ to cause (subsequent) fission neutrons need to be slowed ✓ Other relevant detail: For example, slowing is achieved by collision with moderator atoms **or** neutrons sustain the chain reaction **or** the number of neutrons available controls the rate of fissions ✓	3	

05.4	Suitable material named ✓ Absorb neutrons (without undergoing fission) ✓ Can be raised or lowered (into the core) to maintain the desired rate of fission (owtte) ✓ Can be lowered automatically in an emergency shutdown ✓ Max 3	3	eg (alloys of) boron **or** silver **or** indium **or** cadmium **or** hafnium Candidates can get the 1st mark and then any 2 out of 3

Question	Key	Question	Key	Question	Key
6	D	**20**	C	**34**	C
7	A	**21**	C	**35**	C
8	C	**22**	D		
9	B	**23**	B		
10	B	**24**	D		
11	D	**25**	D		
12	B	**26**	D		
13	C	**27**	B		
14	C	**28**	B		
15	C	**29**	C		
16	D	**30**	A		
17	B	**31**	B		
18	B	**32**	A		
19	B	**33**	B		