OXFORD
INTERNATIONAL
AQA EXAMINATIONS

INTERNATIONAL A-LEVEL PHYSICS

(9630)

PAPER 4
Mark Scheme

Specimen 2019

V2.0

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.

Section B

Question	Marking guidance	Mark	Comments
01.1	substitutes into $E = UA\Delta\theta$ for any part – insulated or not ✓ uses standard values ✓ adds their values for all four parts ✓ 2660 (W) cao but condone sf ✓	4	
01.2	Neutron correct in both places $^{1}_{0}\mathrm{n}$ ✓ Xenon correct $^{144}_{54}\mathrm{Xe}$ ✓	2	
01.3	ANY 2 from: Converts MeV into J ✓ Divides 600 x 10^6 by candidate's energy value ✓ Multiplies by $\frac{235}{N_A}$ ✓ PLUS 7.3 x10-3 (g s^{-1}) ✓	3	Look for 200 x 1.6 x 10^{-19} Or 3.2 x 10^{-11} Key values to look for: 1.88 x 10^{11} fissions s^{-1} 3.1 x 10^{-5} mol
01.4	walls ✓ area × (difference between standard insulation and additional insulated) *U*-value is recognised or calculated **or** *Q* **or** change in *Q* is calculated for new values ✓ walls = 36 (432), windows = 32 (403), roof = 21 (252) ✓	3	

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01.5	Any three from: • Boron is a strong neutron absorber OR has a high absorption cross-section wtte ✓ • The idea that the magnitude of the neutron flux is proportional to the rate of fission or power ✓ • Inserting more of the control rods into the reactor (absorbs more neutrons) and slows the reaction ✓ • The idea that inserting all of the control rods quickly and completely will do an emergency shutdown ✓	3	

Question	Marking guidance	Mark	Comments
02.1	Use of $T = I\alpha$ ✓ Use of $\omega = \alpha t$ ✓ 0.219 (rad s^{-1}) to at least 3 sf ✓	3	Use of equation is rearrangement or substitution
02.2	Use of $E = \frac{1}{2}I\omega^2$ leading to 1.2 x 10^9 (J) to 1.3 x 10^9 (J) ✓	1	
02.3	Mentions law of conservation of momentum ✓ Moment of inertia of the space station will increase (as the astronaut moves) ✓ Angular velocity of space station will decrease OR change in angular velocity will be very small (since change of astronaut's position has little effect on moment of inertia)✓	3	A candidate that successfully estimates the change (around 3x10^{-3}% for a 100kg astronaut) can get all 3 marks as the candidate will have used all 3 ideas

Question	Marking guidance	Mark	Comments
03.1	any attempted use of $mg\Delta h$ = power (or numerical equivalent) ✓ correct sub into $mg\Delta h = 9 \times 10^7$ or (m/t =) $9 \times 10^7/(9.81 \times 610)$ (condone power of 10) or correct use of efficiency (condone power of 10) ✓ (m/t =) $9 \times 10^7/(0.95 \times 9.81 \times 610)$ seen or equivalent ✓ (m/t =) 1.6×10^4/15800 (kg s^{-1}) ✓	4	
03.2	correct sub into P = E/t (t=) 180 ÷ 0.09 seen/ (t=) 180 × 109 ÷ 9 ×107 seen/or 2000 (h)/7.2 × 106 (condone power of 10) (operating time per day=) 7.2 × 106/365 or 2000/365 5.48 or 5.5 (hours)	3	
03.3	Energy can be stored when there is excess electrical energy (owtte)	1	

Question	Marking guidance	Mark	Comments
04.1	PV = nRT n = PV/RT = $1 \times 10^5 \times 2.5 \times 10^{-3}$)/(8.31 × (37 +273) ✓ 0.097 ✓	2	
04.2	Mean KE of each molecule = $\frac{3}{2}kT$=1.5 × 1.38 × 10^{-23} × (37 + 273) ✓ = 6.42 × 10–^{21} (J) ✓	2	
04.3	Mean KE of the oxygen and nitrogen molecules is the same ✓ Because mean KE of each molecule α T (K) ✓ If mass of oxygen molecule is greater than mass of nitrogen then the rm speed of oxygen must be less than the rms sped of nitrogen ✓	3	

Question	Marking guidance	Mark	Comments
05.1	$\Delta m = (2 \times 1.00728 + 2 \times 1.00867)$ ✓ – 4.00151 ✓ = 0.03039u ✓	3	
05.2	Binding energy/nucleon = $(\Delta m \times c^2)/4$ ✓ $= (0.03039 \times 1.661 \times 10^{-27} \times (3 \times 10^8)^2)/4$ $= 1.14 \times 10^{-12}$J = (7.1 MeV) ✓	2	
05.3	$\Delta E = (2 \times 118 \times 8.45) - (235 \times 7.65)$ ✓ = 196 Mev ✓ The amount of energy released is approximately 200 MeV and the same value the text book states ✓	3	

Question	Marking guidance	Mark	Comments
06.1	$E = P \times t = 2000 \times 120 = 240000$ J ✓ $c = E /(m \times \Delta\theta) = 240000/(0.725 \times 75)$ ✓ = 4414 J ✓ $Kg^{-1}\,^{o}C^{-1}$ ✓	4	
06.2	Leave the heater in the water ✓ To allow all the thermal energy to transfer from the heater to the water ✓ Stir the water ✓ To ensure all the water is at the same temperature ✓ Allow other sensible ways.	4	

Question	Marking guidance	Mark	Comments
07.1	**remove heat** from the gas ✓ correct reference to equation (eg Δ*Q* negative, *W* zero, then Δ*U* must be negative so *U* decreases) ✓ allow gas to do work ✓ correct reference to equation (eg *W* positive, Δ*Q* zero, then Δ*U* must be negative so *U* decreases) ✓	4	
07.2	W (= pdV) = $1.0 \times 10^5 \times 10 = 1.0 \times 10^6$ J ✓ (1.0 MJ)	1	
07.3	Δ*U* =– 4.9 (MJ) + 1 (MJ) ✓ Δ*U* = (–)3.9 MJ ✓	2	
07.4	graph to show: straight line between (20, 1.0) and (10, 1.0) ✓ direction showing decreasing volume ✓	2	

Question	Marking guidance	Mark	Comments
08.1	Assumption 1 ✓ Assumption 2 ✓	2	2 max
08.2	uses k.e. = 3/2 *kT* **and** *T* = 294 K ✓ = 6.17×10^{-21} ✓	2	

Section B

In this section, each correct answer is awarded 1 mark.

Question	Key
9	D
10	A
11	A
12	B
13	A
14	D
15	D
16	A
17	B
18	D
19	C
20	D
21	D
22	A
23	A