OCR

RECOGNISING ACHIEVEMENT

Mark Scheme 2825/04
June 2002

Question	Expected Answers	Marks
1. (a)	1. repulsive 2. attractive 3. attractive -1 any error	1 [1]
(b) (i)	$F = (Q_1 Q_2)/(4 \pi \varepsilon_0 r^2)$	1
	$= (1.6 \times 10^{-19})^2/(4 \pi \times 8.85 \times 10^{-12}[0.8 \times 10^{-15}]^2)$ accept 8.99×10^9	1
	$= 360$ N or 359.7N unit penalty once, in (i) or (ii)	1
(ii)		1
	$F = m_1 m_2 G/r^2$	1
	$= (1.67 \times 10^{-27})^2 \times 6.67 \times 10^{-11}/(0.8 \times 10^{-15})^2$	1 [6]
	$= 2.9 \times 10^{-34}$ N 0.8/2 gives 1.16×10^{-33} N for 2/3	
	calculations transposed but otherwise correct, 3/6	
(c)	gravitational force (much) less than electrostatic force allow ecf for 1/2	1
	gravitational force is negligible / insignificant / virtually no effect / unimportant / much less / or works out ratio (about 10^{36})	1 [2]
(d)	(so, for protons equilibrium at) separation > x_0 (1)	
	strong force must be attractive (1)	
	strong force (needs to be attractive to) balance repulsive electrostatic force (1)	
	only small change in separation needed to produce 360 N, so equilibrium separation still close to x_0 (1)	
	any 3	3 [3]
2 (a)	number of nucleons: Rb 94, Cs 142, U 235 -1 each	2 [2]
	error	
(b)	graph gives BE/nucleon values of: U 7.4 MeV allow 7.3 - 7.4	
	Rb 8.6 MeV allow 8.5 - 8.6	
	Cs 8.4 MeV -1	2
	each error	1
	multiplies BE/nucleon by nucleon number	
	so total BE for U = 235 x 7.4 (= 1739 MeV)	
	Rb = 94 x 8.6 (= 808 MeV)	1
	Cs = 142 x 8.4 (= 1193 MeV)	1
	so total energy released = 808 + 1193 - 1739 process	1
	= 262 MeV allow 253 - 286 for ecf	
	allow 8.6 + 8.4 - 7.4 = 9.6 MeV for 1/4	[6]
(c) (i)	sketch graph, symmetrical, with equal, smooth peaks and smooth trough -1 any error	2
	correct general shape but not symmetrical gets 1/2	
	two positions, plausibly and symmetrically separated	1
(ii)	correctly labelled	1 [4]
	take into account any numbers which are relevant to symmetry	

3 (a) (i)	mixture of (free) ions / fully ionised gas / electrons stripped from atoms	1		
	detail: consist of nuclei (positive), electrons (negative)	1 1		[2]
(ii)	high temperature /hot / but *not* 'heat' so electrons have enough <u>energy</u> to escape from/break free from atom	1		[2]
(b) (i)	nuclei / particles (but *not* atoms) have enough energy to overcome (mutual) repulsion / Coulomb barrier	1		
(ii)	high density / high pressure / nuclei (or particles) close together / many particles so probability greater / high concentration of particles	1		[2]
(c) (i) 1.	$^{13}_{7}N \rightarrow {}^{13}_{6}C + {}^{0}_{1}\beta + {}^{(0)}_{(0)}\nu$	1		
	nitrogen nucleus decays/splits (*not* fissions) with emission of positron (*not* proton) and neutrino allow $^{1}_{1}p \rightarrow {}^{1}_{0}n + {}^{0}_{1}e + \nu$ and proton decays to neutron, positron and neutrino, for 2/2	1		
2.	$^{12}_{6}C + {}^{1}_{1}H \rightarrow {}^{13}_{7}N$	1		
	carbon nucleus and proton fuse / join together / combine / absorb / capture to form nitrogen (-13) nucleus no mention of 'nucleus' in 1. or 2. -1 once only	1		
(ii)	$4\,{}^{1}_{1}H \rightarrow {}^{4}_{2}He + 2\,{}^{0}_{1}\beta$ (or $2\,{}^{0}_{1}e$) + $2\,{}^{(0)}_{(0)}\nu$ allow $^{12}_{6}C$ or other nuclide on both sides 4 protons form a helium <u>nucleus</u>, 2 positrons and 2 neutrinos	1 1		[6]
4 (a)	to investigate the structure of matter (1) make radio-isotopes (1) create / produce new particles (1) detail: eg high speed particles can cause nuclei (*not* atoms) to split / can change the composition of nuclei (or wtte) (1) to replicate Big Bang / conditions inside a star (1) any 2	2		[2]
(b) (i)	because at this instant dee B is negatively charged *or* dee A is positively charged *or* dee B is at negative potential w.r.t. A	1		[1]
(ii)	there is a magnetic field at right angles to (plane of) dees / plane of motion / upward magnetic field (1) *B* field exerts force on (moving) proton / quotes $F = BQv$ (1) *either* force acts at right angles to direction of motion *or* acts as centripetal force (1) force has no component along direction of motion / changes direction only (1) no electric field / force inside a dee (1) any four	4		[4]
(iii)	*either* proton always takes same time to cover each half orbit *or* time period is independent of radius penalise wrong cause - effect *if* clear *or* shows *f* is independent of *r* allow idea to keep pd synchronised with orbit / proton	1		[1]

(c) (i) at speeds near to speed of light, proton mass increases / changes 1
hence time period of cycle / orbit no longer constant / proton out of synch. with voltage 1 [2]

(ii) (in synchrotron) frequency of accelerating field is changed/reduced/magnetic field is increased / changed so proton remains synchronised with alternating p.d. 1 1 [2]

5 (a) (i) leptons 1
(ii) hadrons/baryons 1 [2]

(b) ${}^{1}_{1}p \rightarrow {}^{1}_{0}n + {}^{0}_{(-)1}e$ (or ${}^{0}_{1}\beta$) + ${}^{(0)}_{(0)}\nu$
particle symbols correct throughout ie letters 1
charge and mass numbers correct throughout, (apart from 0,0 for neutrino) 1 [2]

(c) (i) proton up, up, down (or uud) 1
neutron up, down, down (or udd) 1 [2]

(ii) $u \rightarrow d + e + \nu$
allow $u \; u \rightarrow d + e^{+}$ (or β^{+}) $+ \nu$ $d \; d$ 1 [1]

(iii) before: up quark (proton) baryon number $1/3$ (1)
charge $2/3$ (1)
after: down quark (neutron) baryon number $1/3$ (1)
charge $-1/3$ (0) 2
positron baryon number 0
charge +1
neutrino baryon number 0
charge 0 1
baryon number: $1/3 = 1/3 + 0 + 0$ *or* $1/3 + 1/3 + 1/3 \rightarrow 1/3 + 1/3 + 1/3 + 0$ 1
+ 0 1 [5]
charge $2/3 = -1/3 + 1 + 0$ *or* $2/3 + 2/3 - 1/3 \rightarrow 2/3 - 1/3 - 1/3 + 1 +$
0

6 (a) plots graph: points to within ½ square 2
line to within ½ square of every point -1 each error 1 [3]

(b) (i) tries to find correct intercept 1
$A_0 = 90 \times 10^6$ Bq value of A_0 87 - 95 unit penalty 1
beware 10^6 omitted

(ii) half life = 28 years accept 26 - 30 1 [3]

(c) $\lambda = 0.693/(t_{1/2}) = 0.693/28$ 1
$= 2.5 \times 10^{-2}\,y^{-1}$ [1]

(d) $A/A_0 = e^{-\lambda t}$
$0.01 = e^{-0.025t}$ allow A, A_0 values (where $A_0 = 100A$), not rearranged 1 1
$\ln(0.01) = -2.5 \times 10^{-2} t$ 1 [3]
$t = \ln(0.01)/(-0.025) = 184$ years
2/3 for method involving repeated halving
$A/A_0 = 100/1$ can get 1/3 for ln step
$A/A_0 = 99/100$ can get 2/3 (0, 1, 1). This gives 0.40 y

7 (a) Sensible feature and reason one mark for each up to a maximum of 4, e.g.
- Graph has low value over the first 6 h and ref. to low demand as most people are sleeping
- Demand peaks at mid-day and ref. to (electricity consumed for) cooking
- Demand peaks at 1800 / 1900h and ref. to (consumption for) cooking
- Peaks greater in January at tea time / 1700h and ref. to heating and cooking at the end of work
- Demand does not fall below a min. value and ref. to reason such as street lights / storage heaters
- Similar shapes of graphs for January and August and suggestion that the pattern of the day is similar
- Graph for January is higher than for August and suggestion that the pattern of the day is similar
- Graph for January is higher than for August and ref. to more energy needed for heating
- Graph has a steep slope in morning and ref. to industry switching on appliances (allow 'graph goes up in the morning as people go to work)

(4)

(b) Look for reference to **time** in both marking points, one mark for each up to a maximum of 2, e.g. (2)
- It takes time for (added) coal to burn or / it takes time for coal to give out heat at the required rate
- Coal fires do not go out straight away or / it takes time to cool down

Allow alternative response here if a sensible comment is made about the problems / costs associated with allowing a power station to cool i.e. it is uneconomical to get going again

(c) (i) 66 +/- 2 GW Allow single unlabelled line on graph if it lies in the range (1)

(ii) 74 – graph value e.g. 66 = 8 GW allow 73.5 to 74 GW for peak value (1)
A bald answer of 8 GW with no graph value gets 1 mark

(d) (i) Δ gpe = mgΔh or words or numbers **clearly** arranged to show the change in gpe e.g. Δgpe = m x 9.8 x 100 (1)
power = energy converted / time taken or numbers **clearly** arranged to show power
e.g. power = 1.0×10^9 = m x 9.8 x 100 (1)
volume = mass / density or equivalent (1)
calculation e.g. volume (s^{-1}) = 1.02×10^6 / 1.0×10^3 = 1.02×10^3 m^3 (s^{-1}) (1)

(ii) 1.0×10^3 = 35 x area of reservoir (1) or Vol / s x time = total volume
total volume = $1.0 \times 10^3 \times 4 \times 60 \times 60$ (1)
area = 28.6 m^2 (in one second) (1) or total volume = 1.44×10^7 m^3 (1)
area for 4 h = 28.6 x 4 x 60 x 60 or $1.44 \times 10^7 = 35 \times l^2$ (1)
= 4.11×10^5 m^2 (1)
$(4.11 \times 10^5)^{0.5}$ = 641 m (1) or $(4.11 \times 10^5)^{0.5}$ = 641 m (1)

(iii) Two comments relevant to the feasibility **ecf** (ii) one mark for each to a max. of 2 e.g. (2)
- ref. to physical dimensions / very large area needed
- drop of 100 m may be a problem with regard to geographical siting
- 7 more lakes needed to meet the demand **ecf (c)**
- argument for this type of pumped storage facility to gain credit if *rapid* response to change in demand is mentioned
- use of off-peak power at night to store as energy as gpe
- sensible comment on a *stated* effect on the environment e.g. destroys habitat / affects ecology **do not allow any reference to costs or noise**

(iv) Look for energy conversions for both marks one mark each to max. 2 e.g. (2)
- turbine is inefficient as some of the ke of water is converted into heat
- conversion to heat energy is due to friction in turbine / friction in generator / friction in pipes
- some ke retained by water after passing through turbine / not all ke given to turbine

[Total: 20]