OCR

RECOGNISING ACHIEVEMENT

Mark Scheme 2825/03
June 2002

1. (a) (i) Digram showing:
Any movement of upper layers to the right relative to lower layers, but not amounting to slip; (1)
Same relative movement of top three layers relative to one below, but no slip. (1) [2]

(ii) Diagram showing:
Relative movement of horizontal planes as in (i); (1)
Slip between any two adjacent horizontal layers; (1)
(If slip shown between top two layers and bottom two layers, 2 max) (1) [3]

(b) (i) Separation of atoms in A increased; (1)
Return to original separation when forces removed. (1) [2]
(No mention of atoms, 1 max. No mention of force 1 max.)

(ii) Slip occurs between atomic layers in B / B has stretched beyond elastic limit / B shows plastic deformation; (1)
B contains dislocations / defects (A does not) / B contains more dislocations than A / B has been work hardened. (1) [2]

2. (a) Circuit to pass current through copper slab; (1)
Voltmeter correctly placed to measure Hall voltage. (1) [2]
(Connections must be to faces, not edges, of slab. Marks can be gained independently)

(b) $I = nAve$ / $v = I/nAe$; (1)
Correct substitution; (1)
$V = 4.3 \times 10^{-5}$ m s^{-1} (1) [3]

(c) $V_H = Bvd$ (1)
$B = V_H/vd = 1.5 \times 10^{-6} / (4.3 \times 10^{-5} \times 0.02)$ (e.c.f.) (1)
$= 1.7$ T (1) [3]
(If 0.001 in place of 0.02, 1 max)

(d) Hall voltage is bigger; (1)
Because v is bigger / n is smaller. (1) [2]

3. (a) Having a north and south pole / like a bar magnet / magnetism arising from electron spin (movement) [1]

(b) (i) The magnetic poles align; (1)
in the direction of the field. (1) [2]

(ii) Dipoles lose alignment / become randomly orientated [1]

(c) (i) 1. B_1 - flux density / strength of magnetising field; (1)
2. B_2 - flux density / strength of field in iron. (1) [2]

(ii) When B_1 is reduced to zero, B_2 remains large; (1)
OR The material has high remanence (1) with further explanation (1); [2]
(1 max for statements such as: The material is hard to demagnetise / magnetically hard / requires high energy for demagnetisation).

(iii) Hysteresis loop encloses a large area; (1)
Core generates too much heat (so transformer would be inefficient); (1)
Material has high coercivity. (1)
Magnetism of the material is not easy to reverse; (1) Max [2]

4. (a) (i) Circuit complete a.c. supply, transformer, meters and load.
(-1 if: one or two meters omitted or misplaced / supply is d.c. / load omitted).

(ii) Read meters; (1)
Calculate powers using P = IV; (1)
Efficiency expression. (1) [3]

(b) (i) Heat generated (in the core) by eddy currents / Heat generated in the core by hysteresis effects / Heating of the coils by the current. [1]
(No mark if heat not mentioned).

(ii) Faraday's law: Induced e.m.f. / voltage proportional to / equal to rate of Flux change. [1]

(iii) Efficiency decreases as frequency increases; (1)

Rate of change of flux increases with frequency; (1)
Higher (induced) current in core produces more heat. (1)
OR
Higher frequency means more circulations of hysteresis loop; (1)
and greater generation of heat / hysteresis losses. (1) max [3]

(iv) Material is magnetically soft / has hysteresis loop of small area / has high sensitivity / is easy to magnetise and demagnetise. [1]

5. (a) (i) The temperature at which the resistance of a substance reduces to zero. [1]
(No mark if no suggestion of threshold).

(ii) 4.2 K marked on temperature axis; (1)
Resistance falling – straight line or curve – from 10 K to 4.2 K; (1)
Sudden descent to zero resistance at 4.2 K. (1) [3]

(b) (i) Super conductor is used to make the coil of an electromagnet; (1)
and cooled to below the transition temperature / cooled with liquid helium. (1) [2]

(ii) Material has very low resistance / can carry very high current; (1)
Very strong magnetic fields can be produced; (1)
Minimal generation of heat; (1)
Electromagnet much smaller than the conventional type; (1)
Electromagnet cheap to run because of low power generation (1) max [2]

(iii) Difficult to produce / maintain the required low temperature / Difficulty of making wires out of the superconducting materials / Possibility of switching to normal state. [1]

6. (a) (i) $E = hf$ / $E = hc/\lambda$ (1)
$= 6.6 \times 10^{-34} \times 3.0 \times 10^{8} / 1.3 \times 10^{-6} = 1.5 \times 10^{-19}$ J (1) [2]

(ii) Energy gap between valence band and conduction band; (1)
is greater than the energy provided by one photon. (1) [2]

(iii) Infra-red has longer wavelength than visible light; (1)
so Rayleigh scattering is less than with infra-red. (1) [2]

(b) Award 1 mark for each sensible remark: e.g.

Bandwith / range of wavelengths of laser light is smaller;
Laser produces a beam of greater power / intensity;
Laser beam has better directional properties / produces narrower beam;
Laser is capable of faster switching. Max [3]

7. (a)

V/V	I/mA	P/mW	I_L/μA	lg (P/mW)	lg (I_L/μA)
3.0	101	303	350	2.48	2.54
4.0	120	480	1050	2.68	3.02
5.0	141	705	2560	2.85	3.41
6.0	149	894	4680	2.95	3.67
7.0	165	1155	8420	3.06	3.93

-1 for 2 errors; -2 for 3 errors; -3 for 4 or more errors. [3]

(b) All points correctly plotted (-1 for 1 error); (2)
Best straight line drawn. (1) [3]

(c) The (log/log) graph is a straight line. [1]

(d) Realisation that n is gradient; (1)
Triangle, using at least 2/3 length of line, used for calculation of gradient; (1)
Δy and Δx values correctly read; (1)
Correct value of n (2.4 with tolerance of 0.1). (1) [4]

8. (a) sensible feature **and** reason one mark for each up to a maximum of 4, e.g.**(4)**

- 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 / 1900 h **and** ref. to (consumption for) cooking
- Peaks greater in January at tea time / 1700 h **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** 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)

(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 (1)
volume = mass / density or equivalent (1)
calculation e.g. volume (s^{-1}) = $1.02 \times 10^6 / 1.0 \times 10^3 = 1.02 \times 10^3$ 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 (648m) **(1)or** $(4.11 \times 10^5)^{0.5}$ = 641 m (648m) (1)

(iii) Two comments relevant to the feasibility **ecf (ii)** one mark for each to a maximum 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 may gain credit if *rapid* response to change in demand is mentioned
- use of peak power at night to store 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