INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

M99/430/S(2)M

MARKSCHEME

May 1999

PHYSICS

Standard Level

Paper 2

11 pages

SECTION A

A1. (a) *Solution:*

- For fixed lights 25 mm on film represents 30 m on runway, so 1 mm on film represents 30/25 = 1.2 m.

Marking:

- Knowing how to do it, *i.e.* method: *[1 mark]*
- Details, *i.e.* measurement and arithmetic *[1 mark]*

(b) (i) $v = 26/2 = 13$ mm s^{-1} on film.
Thus $V = 13 \times 1.2 = 15.6$ m s^{-1} on runway.

(ii) $v' = 50/2 = 25$ mm s^{-1} on film
Thus $V' = 25 \times 1.2 = 30$ m s^{-1} on runway

Marking: since both parts do the same thing, mark for *aspects* overall, as follows:

- Getting distance values off film *[1 mark]*
- Time interval 2 s and getting $\Delta s/\Delta t$ values *[1 mark]*
- Conversions to runway velocities *[1 mark]*

(c) *Solution:*
$\Delta V = 30 - 15.6 = 14.4$ m s^{-1} *[1 mark]*
$\Delta t = 6$ s *[1 mark]*
$a = \Delta V/\Delta t = 14.4 / 3 = 2.4$ m s^{-2}. *[1 mark]*

A2. (a) (i) Right *[1 mark]*
(ii) 4 m *[1 mark]*
(iii) 5 cm *[1 mark]*
(iv) 0.5 m moved in 0.1 s, *i.e.* $v = 0.5 / 0.1 = 5$ m s^{-1}. *[1 mark]*
(v) 0.8 s for 1 oscillation or wave, *i.e.* $f = 1 / 0.8 = 1.25$ Hz. *[1 mark]*

(b) (i) Drawn upward *[1 mark]*
(ii) Moves from 2 cm to 4.6 cm, *i.e.* $\Delta s = 2.6$ cm. *[1 mark]*
Time taken is $\Delta t = 0.1$ s, so $v = \Delta s/\Delta t = 2.6 / 0.1 = 26$ cm s^{-1} *[1 mark]*
(iii) 0.8 s *[1 mark]*

A3. (a) $^{14}_{6}C \rightarrow ^{14}_{7}N + ^{0}_{-1}e + v$ *[2 marks]*

(b) (i) Sample activity depends on both the probability of decay of a nucleus and the number present to decay. With time, as nuclei in the sample decay, there are fewer nuclei left to decay, and hence activity decreases even though the probability of individual decays remains the same. *[3 marks]*

(ii) 52 → 13 counts per minute is a factor of 4 decrease. *[1 mark]*
This will take two half-lives, or 11 600 years. *[2 marks]*

B1. 1. (a) *Solution and markscheme:*

'General method marks' for grasping the 'whole picture' approach required, *i.e.* knowing there are two stages, that momentum conservation applies in the collision, work-energy applies in the skidding, and how they are connected via the combined velocity. ***[3 marks]***

Then the other marks for details of steps in each stage, as follows:

Collision phase: Conservation of momentum:
$m_v v_v = (m_v + m_c) V$ (Eqn 1). 2 unknowns v_v and V ***[2 marks]***

Skidding phase: Work-energy:
$1/2\,(m_v + m_c)\,V^2 = F.d = 0.3\,m_c g\,d$ (Eqn 2). ***[3 marks]***
$V^2 = (\mu\,(3/8)\,m_c\,g\,d)\,/\,1/2\,(m_v + m_c)$
$= (0.8\ \ 3/8\ \ 800\ \ 10\ \ 15)\,/\,(1/2\ 2000) = 36$
$V = 6\ \mathrm{m\,s^{-1}}$ ***[2 marks]***

Substituting this in Eqn 1:
$v_v = V\,(m_v + m_c)/m_v = 6\ (2000)\,/\,1200 = 10\ \mathrm{m\,s^{-1}}$ ***[2 marks]***

(b) *Safety belt:*

(Use overall judgement in marking out of 3, but following may be a guide).

Belt is no use in collision. Impact is from behind, the seat pushes her forward, belt plays no part. ***[1 mark]***.

However during the skidding, vehicles are decelerating ***[1 mark]***, and seat belt would restrain her from continuing forward at constant velocity to hit steering wheel/windshield ***[1 mark]***. ***[3 marks]***

Headrest.

(Use overall judgement in marking out of 3, but following may be a guide).

During collision, car and seat accelerated forward. If no headrest, seat pushes drivers body forward ***[1 mark]***, but not head, which is 'left behind' so neck is bent back and 'whiplash' injury occurs to neck ***[1 mark]***. Headrest plays no part in skidding phase however ***[1 mark]***. ***[3 marks]***

B1. 2. **(a)** Parabola shape. *[1 mark]*

(b) Use judgement of understanding of approach, linking two connected phases.
Possible guideline as follows:

Sliding on ramp: conservation of energy:
$1/2\ mv^2 = mg\ h_1$ *[1 mark]*
$v^2 = 2\ g\ h_1$ or $v = \sqrt{(2gh_1)}$ *[1 mark]*

In the air: projectile motion:
Vertical component of motion:
Time to fall: $s = 1/2\ a\ t^2$ *[1 mark]*
So $t^2 = 2s/a = 2\ h_2/g$, $t = \sqrt{(2h_2 / g)}$ *[1 mark]*

Horizontal component of motion:
$x = vt = \sqrt{(2gh_1)} \times \sqrt{(2h_2 / g)} = 2\sqrt{(h_1\ h_2)}$ *[2 marks]*

B2. **(a)** Current I is proportional to potential difference V,
or equivalently resistance R is constant, independent of V and I. *[1 mark]*

(b) Different ways of reasoning, so use judgement in marking answer and reasoning out of ***[3 marks]***.

Answer: A brightest, then B, then C and D equally.

One way of reasoning:
All current goes through A, so brightest. It then splits, but more goes to B than to C and D since the latter two are in series and their path offers twice the resistance of path B. Hence B next brightest. Then C and D get equal currents and are equally bright, though dimmer than all the others. *[3 marks]*

(c) Equivalent resistance of the circuit:
C and D in series: 3 + 3 = 6 ohms equivalent.
6 ohms in parallel with 3: gives 2 ohms equivalent
This in series with A: 2 + 3 = 5 ohms equivalent *[3 marks]*

(d) Various ways of answering so use judgement out of ***[4 marks]***.
One possible answer scheme:

Total current is 15 V / 5 ohms = 3A *[1 mark]*

Current splits in ratio 2:1, so 1/3 or 1A goes to right branch, bulbs C and D. *[1 mark]*

PD across D: $V = IR = 1 \times 3 = 3V$ *[1 mark]*

Power for D: $P = I \times V = 1A \times 3\ V = 3\ W$. *[1 mark]*

(e) *Along these lines*:
Conduction electrons accelerate in electric field due to applied PD, gaining KE, ***[1 mark]*** but then collide with lattice atoms, losing their energy to them ***[1 mark]***, which appears as increased vibration / thermal energy of the atoms, *i.e.* increased temperature ***[1 mark]***.
Judge overall. ***[3 marks]***

(f) A greatest resistance, C and D least resistance. ***[2 marks]***
Explanation in terms of greater current, hotter, higher resistance etc. ***[2 marks]***

(g) *Mark answer and reasoning together out of **[3 marks]**. Various ways of explaining; use judgement.*

Reasoning: A, being hotter with higher resistance, has a relatively greater PD across it than in the simple ohmic case. ***[1 mark]***. This leaves less PD across the parallel section (or, parallel section has relatively smaller resistance and PD than otherwise) ***[1 mark]***. Thus D has smaller PD than in non-ohmic situation. ***[1 mark]***. ***[3 marks]***

(h) Ammeter in series with D. ***[1 mark]***
Voltmeter across bulb D. ***[1 mark]***

(i) Voltmeter reading increases.
Voltmeter now essentially reads the PD across bulb B. This is greater than was the PD across C or D before. ***[2 marks]***
(Furthermore, the PD across B increases when D burns out, since current through A decreases, so PD across A decreases so PD across B is larger than before — however do not require this answer!)

B3. 1. (a) 'Heat gained' = 'heat lost' (in common though disputed terminology) ***[1 mark]***

$$m_i s_i (0 - T_i) + m_i L_i + m_i s_w (T - 0) = m_w s_w (T_w - T)$$

$$120 \times 2.1 \times 12 + 120 L_i + 120 \times 4.2 \times 15 = 400 \times 4.2 \times 7$$ ***[4 marks]***

(Here for simple numbers have kept masses in g and energies in kJ. Then L_i value would be in kJ g^{-1}. Alternatively, safe to put masses in kg and energies in J)

(b) Terms in the order above:
Heat gained by ice warming + heat gained by ice melting + heat gained by melted ice warming = heat lost by water cooling ***[4 marks]***

(c) No heat exchange with the environment. ***[1 mark]***

(d) Otherwise heat will flow in from the environment, and temperature of mixture will increase. *[1 mark]*

(e) Description in terms of energy provided to molecules, breaking break bonds between them. *i.e.* bringing them out of the intermolecular potential energy well. *[2 marks]*

During process, energy supplied goes into increased PE of molecules, rather than increased KE, hence no temperature increase. *[2 marks]*

B3. 2. (a) The heat flow will be the same through both layers — they are in series with no other path for heat to flow, so heat flow though one must continue through the other. *[2 marks]*

(b) *Answer*: Less than across board.
Reasoning:
Either: Purely physical reasoning: To obtain the same heat flow rate, for equal thickness, there must be a greater temperature difference across the less conductive layer.
Or: Reasoning from equation: $Q/t = k\ \Delta T/ l$,
which gives $\Delta T = Q/t \times l/k$, or $\Delta T \propto 1/k$ (if Q/t and l are constant).
i.e. ΔT larger for the smaller value of k.
*(**[3 marks]** either method)* *[3 marks]*

(c) *Different approaches; two given below.*
Marking: By judgement out of ***[5 marks]***, looking for the main issues, *e.g.*

METHOD 1:
Since the heat flow rate Q/t, thickness L and area A are the same for both layers,
$Q/t = k_w A\ \Delta T_w / L = k_B A\ \Delta T_B / L$
$\therefore kw\ \Delta T_w = k_B\ \Delta T_B$ *[2 marks]*
$\therefore \Delta T_B / \Delta T_w = k_w / k_B = 2 / 1$ *[1 mark]*
$\therefore (25 - T) / (T - (-5)) = 2$ where T is the temp of the interface *[1 mark]*
$\therefore (25 - T) = 2 (T+5)$
$\therefore T = 5$ °C *[1 mark]*
(Note that this is closer to -5 °C than 25 °C)

METHOD 2:
This is equivalent, but by thinking in terms of ratios one can do the problem mentally, as follows: *(Mark allocation is merely a guide – look for understanding if issues).*
Since the ratio of the conductivities board : wood is 1:2
and heat flow rate is the same *[1 mark]*
the ratio of the temperature differences must be 2:1. *[1 mark]*
Thus the total temperature difference of 30° must be divided up in the ratio 2:1, *[1 mark]*
i.e. as 20° in the board and 10 ° in the wood. *[1 mark]*
The interface temperature must thus be 5 °C. *[1 mark]*