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Mark schemes must be read in conjunction with the question papers and the report on the examination.

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Cambridge is publishing the mark schemes for the October/November 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.
Section A

1 (a) (i) weight = \( \frac{GMm}{r^2} \)
= \((6.67 \times 10^{-11} \times 6.42 \times 10^{23} \times 1.40)/(\frac{1}{2} \times 6.79 \times 10^6)^2 \)
= 5.20 N

C1

A1 [3]

(ii) potential energy = \(-\frac{GMm}{r}\)
= \(-\frac{6.67 \times 10^{-11} \times 6.42 \times 10^{23} \times 1.40}{\frac{1}{2} \times 6.79 \times 10^6} \)
= \(-1.77 \times 10^7 \) J

C1

M1

A0 [2]

(b) \( \frac{1}{2} mv^2 = 1.77 \times 10^7 \)

\( v^2 = (1.77 \times 10^7 \times 2)/1.40 \)

\( v = 5.03 \times 10^3 \) m s\(^{-1} \)

C1

A1

\( or \quad \frac{1}{2} mv^2 = \frac{GMm}{r} \)

\( v^2 = (2 \times 6.67 \times 10^{-11} \times 6.42 \times 10^{23})/(6.79 \times 10^6/2) \)

\( v = 5.02 \times 10^3 \) m s\(^{-1} \)

(C1)

(C1)

(A1) [3]

(c) (i) \( \frac{1}{2} \times 2 \times 1.66 \times 10^{-27} \times (5.03 \times 10^3)^2 = \frac{3}{2} \times 1.38 \times 10^{-23} \times T \)

\( T = 2030 \) K

C1

A1 [2]

(ii) \( \text{either because there is a range of speeds} \)

\( \text{some molecules have a higher speed} \)

\( \text{or some escape from point above planet surface} \)

\( \text{so initial potential energy is higher} \)

M1

A1

(M1)

(A1) [2]

2 (a) temperature scale calibrated assuming linear change of property with temperature

neither property varies linearly with temperature

B1

B1 [2]

(b) (i) does not depend on the property of a substance

B1 [1]

(ii) temperature at which atoms have minimum/zero energy

B1 [1]

(c) (i) 323.15 K

A1 [1]

(ii) 30.00 K

A1 [1]
3 (a) acceleration proportional to displacement/distance from fixed point and in opposite directions/directed towards fixed point  

M1 A1 [2]

(b) energy \( = \frac{1}{2} m \omega^2 x_0^2 \) and \( \omega = 2\pi f \)  

C1  

\[ = \frac{1}{2} \times 5.8 \times 10^{-3} \times (2\pi \times 4.5)^2 \times (3.0 \times 10^{-3})^2 \]  

C1  

\[ = 2.1 \times 10^{-5} \text{ J} \]  

A1 [3]

(c) (i) at maximum displacement above rest position  

M1 A1 [2]

(ii) acceleration \( = (-)\omega^2 x_0 \) and acceleration \( = 9.81 \text{ or } g \)  

C1  

\[ 9.81 = (2\pi \times 4.5)^2 \times x_0 \]  

C1  

\[ x_0 = 1.2 \times 10^{-2} \text{ m} \]  

A1 [2]

4 (a) e.g. storing energy  

separating charge  

blocking d.c.  

producing electrical oscillations  

tuning circuits  

smoothing  

preventing sparks  

timing circuits  

(any two sensible suggestions, 1 each, max 2)  

B2 [2]

(b) (i) \( -Q \) (induced) on opposite plate of \( C_1 \) by charge conservation, charges are \(-Q, +Q, -Q, +Q, -Q\)  

B1 B1 [2]

(ii) total p.d. \( V = V_1 + V_2 + V_3 \)  

B1  

\[ Q/C = Q/C_1 + Q/C_2 + Q/C_3 \]  

B1  

\[ 1/C = 1/C_1 + 1/C_2 + 1/C_3 \]  

A0 [2]

(c) (i) energy \( = \frac{1}{2} CV^2 \) or energy \( = \frac{1}{2} QV \) and \( C = Q/V \)  

C1  

\[ = \frac{1}{2} \times 12 \times 10^{-6} \times 9.0 \]  

A1 [2]

\[ = 4.9 \times 10^{-4} \text{ J} \]

(ii) energy dissipated in (resistance of) wire/as a spark  

B1 [1]
5 (a) supply connected correctly (to left & right) B1
load connected correctly (to top & bottom) B1 [2]

(b) e.g. power supplied on every half-cycle
greater average/mean power
(any sensible suggestion, 1 mark) B1 [1]

(c) (i) reduction in the variation of the output voltage/current B1 [1]
(ii) larger capacitance produces more smoothing M1
either product RC larger
or for the same load A1 [2]

6 (a) unit of magnetic flux density B1
field normal to (straight) conductor carrying current of 1 A M1
force per unit length is 1 N m⁻¹ A1 [3]

(b) (i) force on particle always normal to direction of motion M1
(and speed of particle is constant)
magnetic force provides the centripetal force A1 [2]
(ii) \[ \frac{mv^2}{r} = Bqv \] M1
\[ r = \frac{mv}{Bq} \] A0 [1]

(c) (i) the momentum/speed is becoming less M1
so the radius is becoming smaller A1 [2]
(ii) 1. spirals are in opposite directions M1
so oppositely charged A1 [2]
2. equal initial radii M1
so equal (initial) speeds A1 [2]
### Question 7

(a) (i) packet/quantum of energy of electromagnetic radiation  
M1  
A1  \( \text{[2]} \)

(ii) minimum energy to cause emission of an electron (from surface)  
B1  \( \text{[1]} \)

(b) (i) \( \frac{hc}{\lambda} = \Phi + E_{\text{max}} \)  
c and \( h \) explained  
M1  
A1  \( \text{[2]} \)

(ii) 1. either when \( 1/\lambda = 0 \), \( \Phi = -E_{\text{max}} \)  
or evidence of use of x-axis intercept from graph  
or chooses point close to the line and substitutes values of \( 1/\lambda \) and \( E_{\text{max}} \) into \( \frac{hc}{\lambda} = \Phi + E_{\text{max}} \)  
\( \Phi = 4.0 \times 10^{-19} \text{ J} \) (allow \( \pm 0.2 \times 10^{-19} \text{ J} \)  
C1  
A1  \( \text{[2]} \)

2. either gradient of graph is \( 1/hc \)  
gradient = \( 4.80 \times 10^{24} \rightarrow 5.06 \times 10^{24} \)  
M1  
\( h = \frac{1}{(\text{gradient} \times 3.0 \times 10^6)} \)  
= \( 6.6 \times 10^{-34} \text{ J s} \rightarrow 6.9 \times 10^{-34} \text{ J s} \)  
A1  
or chooses point close to the line and substitutes values of \( 1/\lambda \) and \( E_{\text{max}} \) into \( \frac{hc}{\lambda} = \Phi + E_{\text{max}} \)  
values of \( 1/\lambda \) and \( E_{\text{max}} \) are correct within half a square  
(C1)  
(M1)  
\( h = 6.6 \times 10^{-34} \text{ J s} \rightarrow 6.9 \times 10^{-34} \text{ J s} \)  
(A1)  \( \text{[3]} \)
(Allow full credit for the correct use of any appropriate method)  
(Do not allow ‘circular’ calculations in part 2 that lead to the same value of Planck constant that was substituted in part 1)

### Question 8

(a) (i) probability of decay (of a nucleus) per unit time  
M1  
A1  \( \text{[2]} \)

(ii) \( \lambda t_{1/2} = \ln 2 \)  
\( \lambda = \frac{\ln 2}{(3.82 \times 24 \times 3600)} \)  
\( = 2.1 \times 10^{-6} \text{ s}^{-1} \)  
M1  
A0  \( \text{[1]} \)

(b) \( A = \lambda N \)  
\( 200 = 2.1 \times 10^{-6} \times N \)  
C1  
\( N = 9.5 \times 10^7 \)  
C1  
ratio = \( \frac{(2.5 \times 10^{25})}{(9.5 \times 10^7)} \)  
\( = 2.6 \times 10^{17} \)  
A1  \( \text{[3]} \)
Section B

9 (a) any value greater than, or equal to, 5 kΩ  B1 [1]

(b) (i) ‘positive’ shown in correct position  B1 [1]

(ii) \[ V^+ = \frac{(500/2200) \times 4.5}{1} \approx 1 \text{ V} \]
\[ V^- > V^+ \text{ so output is negative} \]
green LED on, (red LED off)  M1
(allow full ecf of incorrect value of \( V^+ \))  A1 [3]

(iii) \( \text{either } V^+ \text{ increases or } V^+ > V^- \)  M1
green LED off, red LED on  A1 [2]

10 quartz/piezo-electric crystal  B1
p.d. across crystal causes \( \text{either } \) centres of (+) and (–) charge to move  B1
or crystal to change shape
alternating p.d. (in ultrasound frequency range) causes crystal to vibrate  B1
when crystal cut to produce resonance  B1

11 (a) sharpness: ease with which edges of structures can be seen  B1
contrast: difference in degree of blackening between structures  B1 [2]

(b) (i) \[ I = I_0 e^{-\mu x} \]
\[ \frac{I}{I_0} = \exp(-0.20 \times 8) \]
\[ = 0.20 \]  A1 [2]

(ii) \[ \frac{I}{I_0} = \exp(-\mu_1 \times x_1) \times \exp(-\mu_2 \times x_2) \text{ (could be three terms)} \]
\[ \frac{I}{I_0} = \exp(-0.20 \times 4) \times \exp(-12 \times 4) \]
\[ \frac{I}{I_0} = 6.4 \times 10^{-22} \text{ or } I/I_0 \approx 0 \]  A1 [3]

(c) (i) sharpness unknown/no  B1 [1]

(ii) contrast good/yes (ecf from (b))  B1 [1]
12 (a) e.g. carrier frequencies can be re-used (without interference) (M1)
   so increased number of handsets can be used (A1)
   e.g. lower power transmitters (M1)
   so less interference (A1)
   e.g. UHF used (M1)
   so must be line-of-sight/short handset aerial (A1)
   \textit{(any two sensible suggestions with explanation, max 4)} B4 [4]

(b) computer at cellular exchange B1
    monitors the signal power B1
    relayed from several base stations B1
    switches call to base station with strongest signal B1 [4]