



**Cambridge International Examinations**  
Cambridge International General Certificate of Secondary Education

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**COMBINED SCIENCE**

**0653/31**

Paper 3 Extended Theory

**October/November 2016**

MARK SCHEME

Maximum Mark: 80

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**Published**

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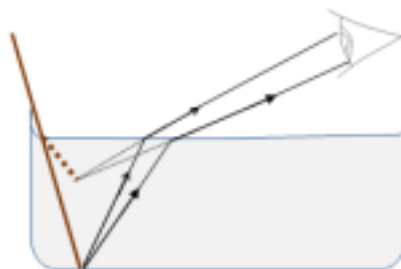
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- 1 (a) (i) light/radiation (energy) ;  
kinetic (energy) ; [2]
- (ii) (average) speed = distance/time =  $9/12 = 0.75$  (m/s) ; [1]
- (b) (i) 0.9 (m/s) ; [1]
- (ii) straight line – **constant** acceleration ;  
curved line – **not constant** acceleration / deceleration ; [2]
- (c) (i) work done =  $mgh$  / =  $10 \times 10 \times 6$  ;  
= 600 (J) ; [2]
- (ii) power = energy transferred / time taken ;  
=  $600/120 = 5$  (W) [2]
- 2 (a) neutrons 12 ;  
electrons 11 ; [2]
- (b) 2,8,1 ; [1]
- (c) same (number) ; [1]
- (d) (i) loss of **one** electron ; [1]
- (ii) Neon/Ne ; [1]
- (e) Li (actual 180 °C) 100 – 200 °C ;  
Cs (actual 28.5 °C) 21 – 35 °C ; [2]
- (f) NaCl is a compound / strong forces between ions / particles ;  
NaCl solution is a mixture / weak forces between water and ions / NaCl ; [2]

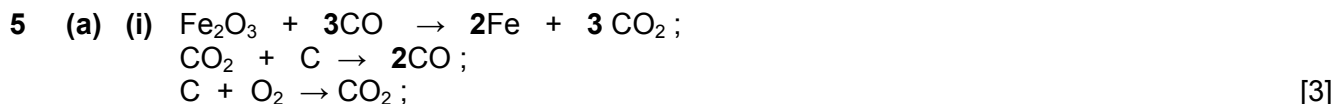
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- 3 (a) geotropism / geotropic ; [1]
- (b) auxins ;  
(produced) at tip of seedling ;  
gather on side of seedling away from light ;  
cause more cell elongation on dark side ; [3]
- (c) (i) the number of germinating seeds increases as the pH increases ;  
the idea that low pH shows greater acidity ;  
use of data to support description; [2]
- (ii) acid denatures the enzymes (needed for germination) / owtte ; [1]
- (iii)  $(3/20 \times 100 =) 15 (\%)$  ; [1]
- (d) (i) reference to sulfur dioxide / nitrogen oxides ;  
*one from*  
description of process causing emission of polluting gases ;  
description of mixing / dissolving of gases in rainwater ; [max 2]
- (ii) acid rain reduces germination / growth / causes crop to die / avp ; [1]
- 4 (a) (i) evaporation / molecules break free (from surface) ;  
(thermal energy from Sun causes) water molecules to move faster / gain more K.E. ;  
(more) molecules moving fast enough / have enough energy to escape surface ; [3]
- (ii) paint trough white / polished metal trough / other reasonable suggestion ; [1]
- (b) (i) refraction ; [1]
- (ii) two diverging rays from same point on stick to the surface ; [max 3]  
at least one ray refracted (to eye) ;  
refracted rays diverge ;  
rays to eye projected back and converge to show the equivalent point on the image ;



| Page 4 | Mark Scheme                             | Syllabus | Paper |
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- (c) sound (waves for speech and hearing) ;  
description of sound waves – need for a medium / description of compression and rarefaction / longitudinal / any other correct ;  
microwaves (between mobile phones) ;  
description of microwaves – e / m radiation / no need for medium / transverse / any other correct ; [max 3]



- (ii)  $\text{CO}_2$  / carbon dioxide ;  
forms CO / carbon monoxide / loses oxygen ;  
**or**  
 $\text{Fe}_2\text{O}_3$  / iron (III) oxide / iron oxide /  $\text{Fe}^{3+}$  / iron ions ;  
forms Fe / iron / loses oxygen / (ions) gain electrons ; [2]

(b) (i) aluminium is more reactive than carbon ; [1]

(ii) (ions) must be mobile / able to move ; [1]

(iii) ( $\text{Al}^{3+}$ ) gains (3 electrons) and ( $\text{O}^{2-}$ ) loses (2 electrons) ; [1]

(c) (i) (aluminium) lighter / lightweight / less dense / resists corrosion better ; [1]

(ii) (alloys) stronger (than pure Al) ; [1]

6 (a) (i)  $48^\circ\text{C}$  ; [1]

(ii) the activity decreases at higher temperatures ; [1]

(b) (i) growth / repair ; [1]

(ii) vitamins / named vitamin ;  
prevent diseases / named disease / role of named vitamin ; [2]

(iii) (milk **B**)  
it contains less fat ; [1]

(c) prevents constipation ; [1]

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- 7 (a) (i)  $1.5 + 0.5 + 0.6 = 2.6$  (V) ; [1]
- (ii)  $R = V \div I / 0.5 \div 0.3$  ;  
 $= 1.67 / 1.7$  (ohms) ; [2]
- (iii) power =  $V \times I$  ;  
 $= 2.6 \times 0.3 = 0.78 / 0.8$  (W) ; [2]
- (b) if in parallel, lamp **would light even if motor not turning** / owtte ; [1]
- 8 (a) (i) petroleum ; [1]
- (ii) boiling point ; [1]
- (b) (i)  $C_3H_6$  ; [1]
- (ii) ethene ; [1]
- (iii) test bromine / bromine water ;  
 $C_3H_8$  no change / stays orange and  $C_2H_4$  (orange) to colourless ; [2]
- (c) (octane +) oxygen  $\rightarrow$  carbon dioxide + water ; [1]
- 9 (a) umbilical cord ;  
an artery ;  
placenta ;  
oxygen ; [4]
- (b) (i) sexual intercourse ;  
**sharing** needles ;  
blood transfusions ;  
from mother to baby at birth ;  
from mother to baby during breast feeding ;  
avp ; [max 2]
- (ii) reduces immunity / makes a person more susceptible to disease ;  
attacks white (blood) cells ; [max 2]



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- 1 (a) (i) X-rays (no mark)  
reference to highest frequency /  $v = f\lambda$  / as  $f$  increases,  $\lambda$  decreases ; [1]

(ii)

|  |        |              |  |           |  |             |
|--|--------|--------------|--|-----------|--|-------------|
|  | X-rays | ultra-violet |  | infra-red |  | radio waves |
|--|--------|--------------|--|-----------|--|-------------|

radio (waves) in correct box ; [1]

- (b) (i)  $3 \times 10^8$  m/s because all e/m waves travel at same speed ; [1]

- (ii)  $v = f\lambda$  ;  
 $\lambda = 3 \times 10^8 / 200 \times 10^6 = 1.5$  (m) ; [2]

- (c) (i) kinetic ;  
sound ; [2]

- (ii) (higher pitch) A **and** (larger amplitude) A ; [1]

- (d) closer together in compression / further apart in rarefaction ; [1]

- 2 (a) atomic / proton (number) ; [1]

- (b) (i) F ;  
H ;  
B, E, F (any order) ; [3]

- (ii) high density ;  
high melting point ;  
coloured compounds ;  
(act as) catalysts ;  
(also allow any general metal property) [max 2]

- (c)  $3+ / Al^{3+}$  ;  
 $2- / O^{2-}$  ; [2]

- (d)  $Mg_3N_2$  ; [1]

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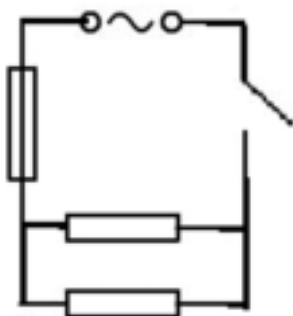
- 3 (a) from the top, label lines going to  
the nucleus ;  
the cell membrane ;  
the cytoplasm ; [3]

- (b) (i) contains chloroplasts ;  
which contain chlorophyll ;  
which trap sunlight/absorb light energy ;  
and turn light energy into chemical energy ; [max 2]

- (ii)  $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$   
formulae ;  
balancing ; [2]

- 4 (a) (i) length ; [1]

(ii)



- a.c. supply, fuse, resistor, switch symbols ;  
(any 2 correct, 1 mark; all 4 correct 2 marks)  
resistors in parallel ;  
supply, switch, fuse all in series, fuse controlling both parallel branches ; [4]

- (b) distance between molecules in gas greater than in liquid ;  
reference to increase in (steam) pressure/pressure forces steam out ; [2]

- (c) metals expand on heating ;  
brass expands more than steel ;  
so bends and breaks contact ; [max 2]

| Page 4 | Mark Scheme                             | Syllabus | Paper |
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- 5 (a) stopwatch / timer ; [1]
- (b) (i) CO<sub>2</sub>/gas produced/lost from the reaction ;  
CaCO<sub>3</sub> used up/no CaCO<sub>3</sub> left ; [2]
- (ii) steeper initial line starting at same point ;  
levels off at same mass ; [2]
- (iii) increases ;  
more effective/successful collisions between particles /  
particles collide more often/more chance of collisions ;  
[max1] if no reference to both particles and collisions [2]
- (c) (1st) filtration ;  
(2nd) evaporation/heating/crystallisation ; [2]
- (d) (1st) chlorine and calcium identified ;  
(2nd) at correct electrodes ; [2]
- 6 (a) (i) arrow drawn going from plasma into alveolus ; [1]
- (ii) thin wall ;  
good blood supply/many capillaries ;  
large surface area (of alveolus) ;  
moist surface ; [max 2]
- (b) (i) 0.6 dm<sup>3</sup> ; [1]
- (ii) (0.6 × 3 =) 1.8 (dm<sup>3</sup>) ; [1]
- (c) (i) became faster ;  
became deeper/owtte ; [2]
- (ii) to get more oxygen (to the cells) ;  
for respiration ;  
to release energy/for muscle contraction ;  
to remove carbon dioxide more quickly ; [max 3]

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- 7 (a) weight of ball (+ cords) ;  
effect of Earth's gravitational field (*accept* gravity) on mass of ball etc ;  
(*allow* both marks if second point is made without first) [2]
- (b) (i) (total) upward force increases in proportion to / with extension / in accordance with Hooke's Law ; [1]
- (ii) 100 (N) ;  
when cords are fully stretched, no further movement / change in length / forces balanced ; [2]
- (c) (i)  $(KE =) \frac{1}{2} mv^2 / \frac{1}{2} \times 0.055 \times (20)^2 ;$   
= 11 (J) ; [2]
- (ii) PE gained = KE lost =  $mgh / h = 11 \div (0.055 \times 10) ;$   
= 20 (m) ; [2]
- 8 (a) wood ; [1]
- (b) (i) reference to difference in molecular size ;  
reference to difference in intermolecular forces (of attraction) ; [2]
- (ii)  $C_8H_{18}$  ; [1]
- (iii) cracking ; [1]
- (iv) test bromine / bromine water ;  
propene result decolourises  
**and**  
octane result no change ; [2]

|               |                                                |                 |              |
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- 9 (a)** Sun ;  
environment ;  
water flea ;  
turtle ; [4]
- (b)** two food chains correctly written (at least as far as the small fish) showing small fish in different trophic levels ;  
ref. to small fish at level 3 or 4 in the chosen food chains ; [3]
- (c)** eutrophication ;  
reference to  
increased algal / surface plant growth ;  
restricted light ;  
failure of photosynthesis (in underwater plants) ;  
death / decomposition of underwater plants ;  
removal of oxygen from water (by respiring decomposers) ;  
death / suffocation of underwater animals ; [max 2]



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- 1 (a) (i) work done = force  $\times$  distance /  $F \times d / 300 \times 0.4$  ;  
= 120 ;  
J ; [3]
- (ii) 120 (J) ;  
allow ecf from (i) [1]
- (b) (i)  $KE = \frac{1}{2} mv^2 / \frac{1}{2} \times 0.1 \times (30)^2$  ;  
= 45 (J) ; [2]
- (ii) efficiency = energy out / energy in  $\times 100$  (or equivalent) ;  
=  $(45 / 120) \times 100 = 37.5$  (%) ; [2]
- (iii) (slowed down by) air resistance / friction / other reasonable opposing force ; [1]
- 2 (a) (i) stopwatch / timer ; [1]
- (ii) calcium / Ca ; [1]
- (b) *concentration*  
higher concentration increases speed / less time for the reaction ;  
higher number of particles / particles are closer together ;  
(so) particles collide more often ;  
*temperature*  
Higher temp increases speed / less time for the reaction ;  
particles have more energy / are moving faster ;  
(so) particles collide more often / particles collide with more energy /  
more successful collisions ; [max 4]
- (c) calcium  
magnesium  
zinc  
iron  
copper ;  
all 5 correct [1]
- (d) (test-tube **A**) tin is less reactive than magnesium ;  
(test-tube **B**) lead is more reactive than copper ; [2]

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- 3 (a) (i) blood passes through the heart twice for each circuit/there are two circulation paths – one to the lungs and one to the body ; [1]
- (ii) **C and** the aorta ;  
takes blood from left ventricle /chamber with the thickest wall /blood has to go greater distance / owtte ; [2]
- (iii) (valves)  
prevent backflow of blood ;  
(wide lumen)  
reduces resistance of blood flow ; [2]
- (b) (i) to supply more oxygen / glucose (to the cells / muscles) ;  
for respiration ;  
to release / supply more energy (for contraction of muscles) ;  
to remove carbon dioxide more quickly ; [max 3]
- (ii) any suitable activity, e.g. walking **and**  
activity is more energetic / active / uses more oxygen than sitting but is less energetic / active / uses less oxygen than running ; [1]
- 4 (a) (i)
- |                 |  |              |  |           |  |             |  |
|-----------------|--|--------------|--|-----------|--|-------------|--|
| Gamma radiation |  | ultra-violet |  | infra-red |  | radio waves |  |
|-----------------|--|--------------|--|-----------|--|-------------|--|
- infra-red ;  
in correct box ; [2]
- (ii) All e/m waves travel at same (high) speed (*in vacuo*) ; [1]
- (b) (i) (matt) black ; *accept* reasonable alternatives that have a deep hue, e.g. deep (or dark) blue  
black is a better absorber of i/r ; [2]
- (ii) conduction ;  
convection ; [2]
- (iii) water expands on heating ;  
heated / hot / warm water less dense than cold, (so rises while cold sinks)  
; owtte [2]

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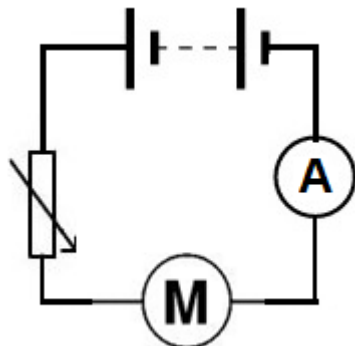
- 5 (a) (i) methane ; [1]
- (ii) fossil / non-renewable ;  
fractional distillation ; [2]
- (b)  $C_8H_{18}$  ;  
 $C_2H_4$  ; [2]
- (c) (i) contains carbon & hydrogen ;  
*and one of*  
a compound / molecule ;  
only ; [2]
- (ii)  $C_6H_{12}$  because (general formula is)  $C_nH_{2n}$  / unsaturated / contains a  
double bond ; [1]
- (iii) bromine / bromine water ;  
(alkanes) no change  
and  
(alkenes) decolourised ; [2]
- 6 (a) (stamen)  
longer / found dangling outside the flower ;  
(stigma)  
feathery / larger / found outside the flower ; [2]
- (b) slide 1 – no mark  
smaller / lighter therefore can be carried by the wind ;  
smoother surface therefore less friction / air resistance ; [max 1]
- (c) (i) any two from  
increased rate of transpiration (at 27 °C) / more water lost from plant ;  
molecules have more (kinetic) energy ; [2]
- (ii) any value less than 1.1 cm because the rate of evaporation / transpiration is  
lower in humid conditions ; [1]
- (d) root X – no mark  
it has root hair cells ;  
larger surface area for absorption of water ; [2]
- (e) traps light energy ;  
converts it to chemical energy / glucose ; [2]

|               |                                                |                 |              |
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7 (a) (i) 50 (cm) ; [1]

(ii) maximum displacement (from no displacement to peak) ; [1]

(b)



variable resistor symbol ; [3]  
ammeter symbol ;  
all connected in series to form a complete circuit ;

(c) (i)  $R = V \div I = 3 \div 2$  ; [2]  
 $= 1.5 (\Omega)$  ;

(ii) power =  $V \times I = 3 \times 2$  ; [2]  
 $= 6 \text{ watt(s) / W}$  ;

8 (a) solid at room temp/below melting point ; [2]  
ions must be mobile ;

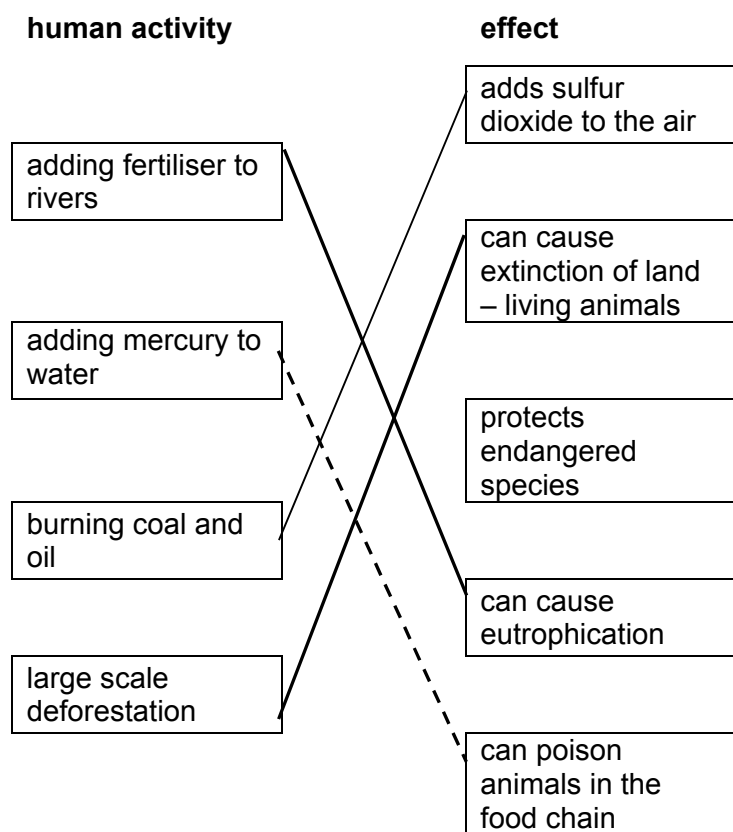
(b) ions move towards the anode/positive electrode ; [2]  
ions lose (two) electrons/(two) electrons move to the anode/ions are discharged/become atoms ;

(c) reduced because it loses oxygen ; [1]  
accept aluminium (ions) gain electrons

(d) 2 electrons in 1st shell and 8 in 2nd shell ; [1]

(e) ionic ; [2]  
metal and non-metal combined ;

9 (a)



[3]

(b) (i) burning fossil fuels / deforestation ;

[1]

(ii) (explanation of greenhouse gas) absorbs heat / infra-red radiation from the earth ;  
 causes the temperature of the atmosphere to rise / global warming carbon dioxide is a greenhouse gas ;  
 consequence, e.g. flooding / melting ice caps / changes in weather patterns / avp ;

[3]