



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

COMBINED SCIENCE

0653/31

Paper 3 Extended Theory

May/June 2016

MARK SCHEME

Maximum Mark: 80

Published

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- 1 (a) xylem ;
phloem ;
upwards and downwards ;
transpiration ; [4]
- (b) (i) *parts of cell in their order*
1 cell wall ;
gives the cell shape / support ;
2 (large) vacuole ;
for support / storage of water / sugar / other correct nutrients ; [4]
- (ii) no chloroplasts present ;
ref. to no requirement for photosynthesis ; [2]
- 2 (a) (i) gas syringe / measuring cylinder of water inverted over water ;
delivery tube with bung from conical flask to gas syringe / measuring cylinder ; [2]
- (ii) particles become less crowded / less concentrated / fewer particles ;
less frequent collisions / less chance of collision ; [2]
- (b) $2\text{HCl} + \text{CaCO}_3 \rightarrow (\text{CaCl}_2 +) \text{CO}_2 + \text{H}_2\text{O}$
formulae correct ;
balanced dependent on correct formulae ; [2]
- (c) limewater ;
milky / white precipitate ; [2]
- (d) nitric acid ;
sodium carbonate / oxide / hydroxide ; [2]
- 3 (a) (i) curved line / not a straight line ; [1]
- (ii) idea that gradient of graph = acceleration /
acceleration = change in speed $\div$ 2 (or other suitable) = $4.25 / 4.3 \text{ (m/s}^2\text{)}$; [2]
- (iii) idea that under graph = distance travelled ;
 $(\frac{1}{2} \times 2 \times 8.5) + (10 \times 8.5) 93.5 \text{ (m)}$; [2]
- (b) convex lens drawn across front of camera where rays change direction and
labelled correctly ; [1]
- (c) (i) $\text{K.E.} = \frac{1}{2} m v^2$;
 $\frac{1}{2} \times 10 \times 8.5 \times 8.5 = 361 / 361.25 \text{ (J)}$; [2]
- (ii) no energy is actually lost / destroyed / owtte ;
some energy transformed to thermal (heat) / sound ; [2]

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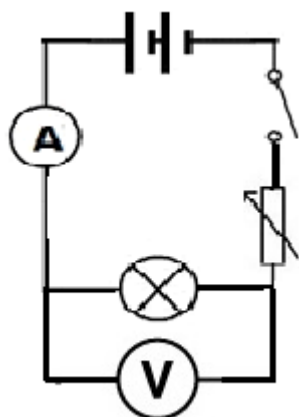
- 4 (a) (i) B and C** (in either order) ; [1]
- (ii) aorta ; [1]
- (iii) (high pressure needed) to send blood to the body ; [1]
- (b)** thick wall ;
to withstand high pressure (of blood) ;
or
elastic fibres in wall ;
to allow recoil/propel blood through the artery ; [2]
- (c) (i)** to supply oxygen/glucose to the heart muscle ; [1]
- (ii) plaque/cholesterol/fatty deposits ; [1]
- (iii) smoking ;
fatty diet ;
lack of exercise ; [max 2]
- 5 (a) (i) U** ;
- (ii) P ; [2]
- (b) (i) A/D** ; [1]
- (ii) C ;
(contains a) double bond/unsaturated ; [2]
- (iii) they are compounds/not (single) elements ; [1]
- (c)** four shared pairs shown ; [1]
- (d) (i)** more (fossil) fuels burned/increased numbers of vehicles/
references to increasing deforestation/slash and burn/other correct ; [1]
- (ii) global warming/runaway greenhouse effect/any relevant negative
consequence ; [1]
- 6 (a)** mass ;
density ; [2]
- (b)** thermometer scale goes below the freezing point of water/0 °C/goes down to
negative values ; [1]

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- (c) (i) infrared ;
adjacent to microwaves ; [2]
- (ii) all e/m waves/radiations travel at same speed (in a vacuum) ; [1]
- (iii) paint bulb black / focus or reflect radiation onto bulb ; owtte [1]
- 7 (a) ideas of:
food chain **A** has two trophic levels / **B** has three ;
energy is always lost between trophic levels ; [2]
- (b) less energy needed / reduces energy wasted ;
by respiration ;
by movement ;
by maintaining body temperature ; [max 2]
- (c) (i) run off from rain / accidental spillage ; [1]
- (ii) (surface plants / named example) grow rapidly / reference to algal bloom ;
(plants lower in lake / named example) die ;
due to lack of light / inability to photosynthesise ; [3]
- 8 (a) (i) 2, 8, 1 ; [1]
- (ii) (any) oil / paraffin ;
Rb is very reactive / prevents reaction with oxygen / water ; [2]
- (iii) rubidium / Rb and chlorine / Cl_2 ; [1]
- (b) (i) temperature increase ; [1]
- (ii) $+1 / \text{Li}^+$;
 $-2 / \text{O}^{2-}$;
electron(s) transfer / lost from lithium (atoms) to oxygen (atoms) ; [3]
- 9 (a) (i) variable resistor / resistance / rheostat ; [1]
- (ii) to change the current in / p.d. across the lamp / owtte ;
to change the resistance in the (main) circuit ;
(in any order) [2]

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(b)



voltmeter correctly connected in parallel with lamp only ;
 other components all in series ;
 [accept equivalent circuits, variable resistor in any position other than in parallel
 with voltmeter]

[2]

(c) (i) $(R =) V/I$;
 $= 6/3 = 2 \text{ } (\Omega)$;

[2]

(ii) R increases with p.d. / current ;
 description of non-uniform increase ;

[2]



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1 (a)

ingestion	mouth ;
absorption of digested food	small intestine ;
secrete digestive enzymes	two from salivary glands ; small intestine ; pancreas ;

[4]

- (b)** has a thin wall / (wall) one cell thick / walls are permeable ;
(reject semi-permeable)
allows (rapid) diffusion ;

[2]

- (c) (i)** 2.7 ± 0.1 ;

[1]

- (ii)** enzyme has become denatured ;
use of graph e.g. enzyme shows no activity at pH 8 / above about 4.5 ;
enzyme / active site has changed shape / enzyme cannot bind to
substrate / owtte ;

[max 2]

- (iii)** smooth curve showing a rounded maximum ;
maximum at pH 8 ± 0.2 ;

[2]

- 2 (a) (i)** electrolysis ;

[1]

- (ii)** Pb^{2+} **and** Br^- ;

[1]

- (iii)** name: bromine ;
colour: brown / orange-brown ;

[2]

- (b) (i)** $\text{CuCl}_2(\text{aq}) \rightarrow \text{Cu}(\text{s}) + \text{Cl}_2(\text{g})$
state symbols (aq) on LHS and (s) and (g) on RHS ;
all formulae correct ;

[2]

- (ii)** test: (damp) litmus paper ;
result: bleaches / turns white ;

[2]

- (c) (i)** increase ;

[1]

- (ii)** 2, 7 ;

[1]

- (iii)** 10 ;

[1]

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- 3 (a) weight ;
(do not allow gravity or gravitational force)
accept weight in a list if other members are neutral [1]
- (b) (i) **P** placed at co-ordinates (8, 8) ; [1]
- (ii) statement of formula
distance = (average) speed $\times$ time /
(distance =) area under graph ;

working and answer
1. $8 \times 4 = 32(\text{m})$;

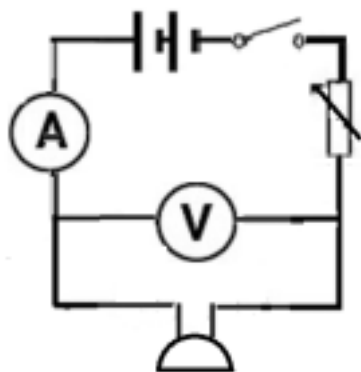
2. $\frac{1}{2} \times 8 \times 1 = 4(\text{m})$; [3]
- (c) (i) thermal / heat ; *accept* sound [1]
- (ii) working
(PE =) $mgh / 150 \times 10 \times 10$;
(= $150 \times 10 \times 10$) = 15 000 (J) ; [2]
- (iii) use of PE lost = KE gained (= 15 000 J) ;
use of (KE =) $\frac{1}{2} mv^2 / \sqrt{(15\,000 \times 2 / 150)}$;
($\sqrt{(15\,000 \times 2 / 150)}$) = 14.1 (m/s) (*accept* 14) ; [3]
- 4 (a) cell membrane ;
ions ;
xylem ; [3]
- (b) (i) $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
correct formulae ;
balanced (dependent on formulae) ; [2]
- (ii) traps light (energy) ;
converts it to chemical energy ; [2]
- 5 (a) **P** ;
S ; [2]
- (b) (i) (thermal / catalytic) cracking ; [1]
- (ii) molecule **B**
contains a (C=C) double bond ; [1]
- (iii) (aqueous) bromine ;
result for propane no change / mixture remains coloured ;
result for propene decolourises ; [3]

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- 6 (a) (thermal) expansion (of sea water)/(sea) water volume increases ; [1]
- (b) (i) infra-red located in correct position ; [1]
- (ii) all e/m radiation travels at same speed/speed of light ; [1]
- (c) faster/more energetic molecules (able to) escape/leave surface/evaporate ;
(average) speed/energy of remaining molecules less/lower ; [2]
- (d) land surface better absorber of infrared radiation/other correct ; [1]
- 7 (a) (i) $(114\,200 \div 2\,400\,000) \times 100$;
= 4.8/4.76(%) ; [2]
- (ii) $(114\,200 - 52\,000 - 39\,200) = 23\,000$ (kJ/m²/year) ; [1]
- (iii) too much energy lost between trophic levels/not enough energy or very low energy (in secondary consumers/carnivores) to pass on to another level ; [1]
- (iv) protein synthesis/cell division/growth ; [1]
- (b) (i) burning fossil fuel ;
(release of) sulfur dioxide/oxides of nitrogen (to the atmosphere) ;
SO₂/NO_x dissolves/mixes in/reacts with water/rain (water) ; [max 2]
- (ii) numbers would reduce (no mark)
less energy/food available in plants for herbivores ;
fewer herbivores to provide energy/feed the carnivores ; [max 2]
- 8 (a) exothermic ;
chemical (potential) ;
heat/thermal ; [3]
- (b) decreases ;
particles collide less often/collide with less energy ; [2]
- (c) (i) speed of reaction is zero ;
copper is less reactive than hydrogen/copper does not react with (dilute) acid ; [2]
- (ii) carbon reduction/heat with carbon ; [1]
- 9 (a) (i) variable resistor/variable resistance/rheostat ; [1]
- (ii) to change the resistance in the (main) circuit ;
to change the current through the buzzer/p.d. across the buzzer ; [2]

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(iii)



ammeter symbol correctly drawn ;
ammeter in series with buzzer and rest of circuit correct ;

[2]

- (b) (correct reading from graph at 6 V is) 0.015 A ;
(resistance at 6 V = $6 \div 0.015$) = 400 (Ω) ;

[2]

- (c) $v = f\lambda / 3000 \times 0.11$;
= 330 (m/s) ;
time = $1000 / 330 = 3.03$ (s) ; (accept 3 s) (allow ecf from previous stage)

[3]



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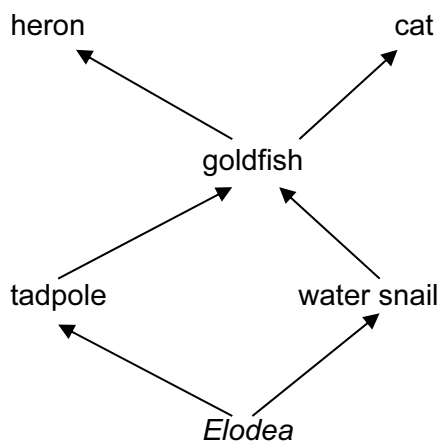
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- 1 (a) (i) contains two (or more) different atoms/substances/elements/compounds ;
NOT chemically joined together / NOT chemically combined ; [2]
- (ii) **A C D** ;
spots from **Y** match spots in **A, C** and **D** / owtte ; [2]
- (b) O-H bond / –OH shown ;
rest of molecule correct ; [2]
- (c) (i) ethene + water / steam → ethanol ; [1]
- (ii) double bond shown ;
rest of molecule correct ; [2]
- (iii) bromine (solution) ;
(ethane) no reaction / owtte ;
(ethene) decolourises bromine ; [3]
- 2 (a) 10 (V) ; [1]
- (b) (i) $(R =) V / I$;
 $= 2 / 0.4 = 5$;
 Ω ; [3]
- (ii) $(P =) VI$;
 $= 12 \times 0.4 = 4.8 \text{ (W)}$; [2]
- (iii) resistance of **Y** is greater than resistance of **X** /
pd across **Y** is greater than pd across **X** ; [1]
- (c) all lights get full mains voltage / shone at max brightness ;
each light can be switched on / off independently ;
if one light fails, the others will still work ; [max 2]
- 3 (a) as the light intensity increases the rate of photosynthesis increases ;
further detail using numbers extracted from the graph e.g. increase in rate
declines at 0.06 ; [2]
- (b) (i) similar shaped line drawn below the existing one ; [1]
- (ii) fewer bubbles per minute / amount of photosynthesis has decreased ;
less chlorophyll / fewer chloroplasts present / fewer leaves / fewer stomata
present to release oxygen ; [2]
- (c) (i) tadpole, goldfish, heron ; [1]

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- (ii) goldfish does not eat/digest/absorb all of the tadpole ;
energy lost due to respiration/other life process/heat energy lost ; [2]

- (d) food web correctly drawn with *Elodea* and goldfish only written once ;
arrows in correct direction ;
e.g.



[2]

- 4 (a) 2, 8, 1 [1]

- (b) (i) $2\text{Na(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{NaOH(aq)} + \text{H}_2\text{(g)}$; [2]

- (ii) rubidium melts ;
flame ;
gas given off ;
temperature increase ; [max 2]

- (iii) chemical (potential energy) $\rightarrow$ thermal or heat/light/kinetic (energy) [1]

- (c) reference to filled outer shell in Group VIII elements ;
Group I has 1 electron in outer shell that can be lost ; [max 2]

- (d) (i) CO_2 absorbs heat radiated from Earth's surface/prevents heat escaping into space ; [1]

- (ii) extremes of weather/flooding caused by excessive rain or rising sea levels/drought/fires/increasing storm damage to humans or habitats ; [1]

- 5 (a) (gravitational) potential ; [1]

- (b) (speed =) distance/time ;
 $= 2 \times 990 / 6 = 330 \text{ (m/s)}$; [2]

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- (c) (i) vibrations in different directions ;
longitudinal vibrations move in same direction as wave/energy moves ;
transverse vibrations move at right angles to direction that wave/energy moves ;
longitudinal waves need a medium to travel through ; [max 1]
- (ii) 20 Hz (allow 10 Hz) and 20 000 Hz (allow 25 000 Hz) ; [1]
- (d) (i) temperature at which a solid changes state and becomes a liquid ; [1]
- (ii) particles are randomly arranged ;
most particles are touching ; [2]
- (e) 3×10^{-8} m/s (no mark)
all electromagnetic waves travel at the same speed (in vacuo) ; [1]
- 6 (a) (artery)
thick wall ;
prevents bursting ;
OR
contains elastic tissues ;
for recoil/smoothing flow of blood ;
AND
(vein)
contain valves to prevent backflow of blood ; [3]
- (b) towards ;
deoxygenated ;
oxygenated ;
pulmonary vein ;
away from ; [5]
- 7 (a) chlorine (gas) ; [1]
- (b) (i) at least two different sizes of atom ;
one of the atoms in the majority and generally in a regular arrangement ; [2]
- (ii) the layers of metal atoms cannot easily slide over each other/owtte ; [1]
- 8 (a) (i) acceleration = change in speed/time or $(-)8/40$;
= $(-)0.2$ (m/s²) ; [2]
- (b) (calculate the) area under the graph ;
further detail such as how to calculate area of rectangle and triangle/add
separate areas together ;
 $(8 \times 60) + (\frac{1}{2} \times 8 \times 40)$;; [max 2]

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(c) R and Q ; [1]

(d) (i) first reflection at correct angle (by inspection) ;
ray passes down fibres and emerges at the other end ; [2]

(e) (i) endoscope / key hole surgery ; [1]

(ii) surgery not needed or minimal trauma / other correct ; [1]

9 (a) $C_6H_{12}O_6$ and $6H_2O$; [1]

(b) (i) (mucus)
traps pathogens / dust / other valid named substance ;
(cilia)
beat upward to remove mucus from airway ; [2]

(ii) cilia become paralysed / move more slowly ;
by tar / heat ;
so mucus / pathogens / dust not removed from the trachea ; [max 2]

(c) collects / picks up oxygen from mother's blood (in uterus) ;
by diffusion ; [2]

(d) (i) amniotic (fluid) ; [1]

(ii) fetus could be physically damaged / infection / other correct ; [1]