OCR
RECOGNISING ACHIEVEMENT

GCE

Science

Advanced GCE **A2 7885**

Advanced Subsidiary GCE **AS 3885**

Combined Mark Schemes And Report on the Units

June 2005

3885/7885/MS/R/05

Oxford Cambridge and RSA Examinations

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Advanced Subsidiary GCE Science (3885)

MARK SCHEMES FOR THE UNITS

REPORTS ON THE UNITS

Mark Scheme 2841
June 2005

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT= answers which are not worthy of credit ( ) = words which are not essential to gain credit __ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument

Question	Expected Answers	Marks
1 (a)	emergent / canopy (layer);	1
(b) (i)	decomposer (organism) / detritivore / saprophytes;	1
(ii)	roots absorb; nutrient / mineral ions; in solution / by active transport / dissolved in water; over a large (surface) area / via root hairs; (2 points from the above list)	2
(c) (i)	use of all five values / 0.0275; 0.0055 %;	2
(ii)	4800; ecf from (i)	1
(iii)	weathering / lightning / fixation / (addition of) fertilizer / import / transport by wind / transport by water / transport by organisms;	1
(d) (i)	(in number of) neutrons; nitrogen-15 has one more / ora;	2
(ii)	a beam of (moving) ions; is deflected; by a magnetic field / magnet; lighter / lower mass ions are affected more ora / deflected more ora / path is bent more ora / beams are separated / beams are pulled apart / beams are split depending on mass; (3 points from the above list)	3
	[Total: 13]	

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Question	Expected Answers	Marks
2 (a) (i)	time taken for the radioactivity / (rate of) decay / mass / amount; to fall to half (of its original value);	2
(ii)	there would be (almost) none / too little left to measure;	1
(b) (i)	a neutron; is converted into a proton and a β particle / electron;	2
(ii)	at top 228; at bottom 89;	2
(c)	charge: α positive, γ neutral / none; penetrating power: β medium γ high; ionising power: α high β medium; (1 mark for each correct horizontal row)	3
(d) (i)	α radiation does not penetrate (fully) through thicker windows; **ora**	1
(ii)	γ radiation does not ionize gas (fully) if pressure is lower / there are fewer atoms; **ora**	1
(e)	photographic / scintillation counter / cloud chamber;	1
	[Total: 13]	

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Question	Expected Answers	Marks
3 (a)	chloroplast;	1
(b)	(reactant) water; (reactant) NADP / electron; (products) oxygen; (products) hydrogen atoms / hydrogen ions / protons (NOT hydrogen); (products) $NADPH_2$ / reduced NADP / reduced electron acceptor / ATP; (products) electrons; (3 points from the above list) (no marks if overall equation for photosynthesis given instead)	3
(c)	values within ranges 650 - 670 nm; 420 - 430 nm;	2
(d) (i)	white light consists of all the colours; some colours are absorbed / removed / taken out by pigment / remaining colours are seen;	2
(ii)	only green (and yellow) are not absorbed / are transmitted / are reflected;	1
(iii)	only carotenes are left; absorbing blue (and green) and letting through red;	2
(e)	(specular) reflection; scattering / diffuse reflection; transmission; refraction; heating; electrons emitted; (2 points from the above list)	2
	[Total: 13]	

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Question	Expected Answers	Marks
4 (a)	grid / side by side / regular arrangement; of squares / points / fraction of image / element of picture;	2
(b) (i)	there is a one-to-one relationship / the area covered by a pixel is the area sensed by one sensor;	1
(ii)	grey scale is proportional to the intensity / brightness of the radiation / black is where there is no radiation, white is where it is strongest;	1
(c)	it emits no thermal infrared / emits no heat / is cold;	1
(d) (i)	a different colour is used for each image / channel / (array of) sensors; colours are not those of the radiation that is sensed / what is seen is not the real colour / colours are changed to make it easier to understand;	2
(ii)	left label (for sea) purple / red plus blue right label (for Antarctica) blue;	1
	[Total: 8]	

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Question	Expected Answers	Marks
5 (a)	at each level, idea that a unit is made up of a group of sub-units / cells —> tissues —> organs —> systems ; that are working together / performing a particular function / carrying out a task; named system; eg circulatory system, respiratory system named organ from that system; eg heart, lungs	4
(b)	for each organelle 1 mark for naming organelle; 2 marks max for structure; 2 marks max for role; **and** max of 4 for each of two of the bullet points below • **nucleus**; structure largest organelle in cell; double outer membrane; nuclear pores, for transport; contains nucleolus (that manufactures ribosomes); contains chromosomes / DNA / genetic material; role controls activity of cell / chemical reactions / synthesis; • **smooth endoplasmic reticulum / SER** ; structure folded membrane / consisting of tubes /sacs; role site of synthesis ; of lipids; • **rough endoplasmic reticulum / RER**; structure folded membrane / consisting of tubes /sacs / studded with ribosomes; role site of synthesis ; of proteins • **Golgi apparatus**; structure stack of flattened sacs; joined to ER at one end; role packages chemicals produced for transfer within and outside cell; adds sugars to proteins;	

Question	Expected Answers	Marks
	• **mitochondrion**; structure surrounded by double membrane; highly folded inner membrane (cristae); role where aerobic respiration takes place; transferring energy from food / producing ATP; • **lysosome**; structure (very) small spherical sacs; single outer membrane; keeps contents separate from cytoplasm; role contains (high) concentration of digestive enzymes; breaks down old organelles / cells; • **plasma / cell membrane;** structure phospholipid; bilayer; fluid-mosaic model; embedded proteins; embedded lipids; role transport of nutrients / materials; receptors and message senders; keeps cell contents together;	7
	quality of written communication **organization & vocabulary** 2 marks **A** answer is clearly and coherently organized throughout **and** **B** appropriate specialist vocabulary is used extensively; 1 mark **A** answer shows a degree of organization **and** **B** some appropriate use of specialist vocabulary is made; 0 mark **A** answer is not organized **and** **B** appropriate specialist vocabulary is not used; (Candidates must satisfy both strands A and B to gain the marks at a particular level. Otherwise the marks for a lower level should be awarded.)	2
	[Total: 13]	

Mark Scheme 2842
June 2005

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Question	Expected Answers	Marks
1 (a)	Hydrogen molecules well-separated and randomly arranged; Petrol molecules **touching** and randomly arranged;	2
(b) (i)	Molecules collide with the wall; Collision changes momentum of molecules / collision is elastic Exert a force on the wall; Pressure = force / area; (any two points)	2
(ii)	400×10^5 Pa / 4×10^7 Pa; (1 mark for working e.g: calculates ratio of volumes = 400 / multiplies 1×10^5 by calculated ratio / applies $P_1V_1 = P_2V_2$)	2
(c) (i)	Oxygen is gained (by hydrogen) *not just "added"* AW oxygen reacts / combines / bonds <u>with hydrogen</u> / adds to a hydrogen molecule	1
(ii)	Carbon dioxide AW carbon monoxide; AVP other oxidation products e.g. ethanol NOT sulphur dioxide, nitrogen oxides	1
(iii)	(for carbon dioxide) causes global warming / greenhouse effect (for carbon monoxide) toxic / causes breathing problems / causes photochemical smog *no ecf from (ii)*	1 TOTAL: 9 MARKS

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Question	Expected Answers	Marks
2 (a) (i)	High temperature / heat AW spark; high pressure	2
(ii)	$2NO + O_2 \rightarrow 2NO_2$ AW 1, ½, 1 or any multiple of 2,1,2; (1 mark for correct formulas in unbalanced equation) *formulas 1 mark, balancing 1 mark if formulas correct*	2
(b) (i)	reacts with / collides with an oxygen molecule; AW $O + O_2 \rightarrow O_3$ Allow other balanced and chemically sensible suggestions e.g. $2NO + O \rightarrow N_2 + O_3$	1
(ii)	Correct plotting of points; Smooth curve through points;	2
(iii)	130 minutes (± 10 mins)	1
(iv)	Calculate another value for half-life (starting at a different point) AW shows this on graph; If first order, half-lives will be constant AW calculate rates from graph (at different concentrations) Rate is proportional to concentration (award second mark only if reference made to use of graph)	2
(v)	Rate = $k [NO_2]^1$ ("1" not necessary); 1 mark if k omitted / no indication of concentration / LHS of equation omitted	2
(c) (i)	Rate-determining step;	1
(ii)	No light present / light is also necessary for the reaction; *Ignore reference to temperature*	1
(d)	Stratosphere;	1
		TOTAL: 15

Question	Expected Answers	Marks
3 (a) (i)	Negative; Arrows show direction of movement / force on a positive charge **AW** current flows towards negative charge / field lines run from positive to negative charge	2
(ii)	Does not allow a current to pass through it / not a conductor of electricity; **AW** does not allow heat to pass through it / not a conductor of heat	1
(iii)	Particle loses an electron / electrons; Becomes charged (ignore sign of charge) / gives formula of an ion **AW** +ve ion moves towards –ve cloud once it has been formed ecf; **AW** air becomes conducting	2
(iv)	field strength increases;	1
(b)	Field strength = 150000 (N C^{-1}) / 1.5 x 10^5 (N C^{-1}) (1 mark for working: rearranges equation field strength = force / charge ecf)	2
(c) (i)	<u>Field</u> lines ; Are closer together / more in same area;	2
(ii)	Power = voltage x current / W = V x I	1
(iii)	300 000 000 / 3 x 10^8 ;ecf from (b) (ii) W; *allow correct conversion of answer to kW, MW etc*.	2
(d)	**effect of alternating nature of field** Field is alternating below power lines; Not alternating below thundercloud; **effect of exposure** people living beneath power lines are constantly exposed to field; Exposure to fields beneath thunderclouds is temporary	2
		TOTAL: 15 MARKS

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Question	Expected Answers	Marks
4 (a)	Double bond AW propene is unsaturated	1
(b) (i)	$C_6H_{12}O_6$ / $C_6(H_2O)_6$	1
(ii)	Made up of carbon hydrogen and oxygen; ratio of H to O is 2:1 AW have formula $C_x(H_2O)_y$ scores 2 marks	2
(c) (i)	**Raw materials** Starch produced naturally from plants / does not require artificial input of raw materials ; Poly(propene) uses up <u>non-renewable</u> raw materials / raw materials derived from crude oil; *(polypropene requires more raw materials than starch =1)* ***energy input*** Starch does not require artificial input of energy; Polypropene requires energy / fuel; *(polypropene requires more energy than starch = 1)* ***waste products*** starch produced naturally so no harmful emissions / waste; Example of harmful emission from polypropene production e.g. solvent waste / heavy metal catalyst; *(starch produces less <u>harmful</u> waste than polypropene =1)*	2
(ii)	Enzymes / microorganisms will break down starch / starch will <u>bio</u>degrade; Poly(propene) does not biodegrade / disposed of by burning or in landfill; *(Polypropene decomposes slower than starch = 1)* AW starch decomposes to produce glucose Polypropene may decompose to produce harmful products *(polypropene decomposes to produce more harmful products than starch)*	2 TOTAL: 8 MARKS

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Question	Expected Answers	Marks
5 (a)	A: Active site / site where reaction occurs / place where substrate binds B: helix C: sheet 1 mark for "secondary structure" in either B or C	3
(b)	Ribbon diagrams shows protein chain / amino acid sequence; Space-filling diagram shows side chains / surface of protein / groups of atoms; **AW** ribbon diagram shows secondary structure well; Space-filling diagram shows tertiary structure / overall structure / 3D structure well	2
(c)	**Temperature:** Rate increases with temperature up to a certain point then declines / there is an optimum temperature; Increase in rate (at low temperatures) occurs because more frequent / energetic collisions between substrate and enzyme / active site; At high temperature / above optimum temperature enzyme is denatured; Denatured = Loses 3-D structure / active site changes shape; Bonds maintaining 3-D structure break Result of denaturing is that substrate cannot fit into / bind to active site; **pH:** Activity is a maximum at a certain pH / there is an optimium pH Changes in pH cause H^+ ions to be lost / gained; Side groups / active site has different charge; Substrate cannot bind if charge distribution is different; Very high / low pH (e.g. pH =2 or 12) cause denaturing; (marks for describing denaturing if not awarded already) **Inhibitors**: Presence reduces or stops enzyme activity; Competitive and non-competitive inhibitors; For competitive: Inhibitor can compete with substrate for active site; Inhibitor can bind to / fit into active site;	

	Stops substrate entering / binding For non-competitive: inhibitor can bind to another site on enzyme; Causes tertiary structure to alter; Substrate can no longer fit into active site; Concentration Activity increases as <u>substrate</u> concentration increases <u>up to a certain level;</u> Activity increases as <u>enzyme</u> concentration increases increasing concentration increases rate of collision (with active site); At high substrate concentrations all active sites are full; Substrate cannot react until an active site becomes available; Any **two** factors 4 max from any single factor **QWC**: Organization and vocabulary **2 marks** A: answer is clearly and coherently organized throughout **and** B: appropriate specialist vocabulary is used extensively (e.g. substrate, active site, competitive, denaturing, optimum) **1 mark** A: answer shows a degree of organization **and** B: some appropriate use of specialist vocabulary is made **0 mark** A: answer is not organized B: appropriate specialist vocabulary is not used	6 2 TOTAL: 13 MARKS

Mark Scheme 2843/01
June 2005

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Question	Expected Answers	Marks
1 (a)	manure worms;	1
(b)	the worms ingest/eat/consume sewage sludge; digest sewage sludge in their gut; and excrete vermicompost;	3
(c)	an organism/virus or bacterium/micro-organism/microbe; that causes disease/harms health/harmful to humans;	2
(d) (i)	plant debris;	1
(ii)	heat/temperature of 70 ^{o}C;	1
(e)	too time-consuming/too costly;	1
		Total: 9
2 (a)	diagram should show the following features: dimensions 1 m across, 1 m deep, 70 m long (not to scale) shown on same diagram as; top third of bed populated by worms; thin layer of new sewage sludge added at top of bed each day; thin layer of vermicompost at base of bed/bottom layer of treated sewage removed each day;	4
(b)	40 days gives worm eggs time to hatch and mature; so that worms are not harvested/lost from the bottom of the bed;	2
(c) (i)	pathogens are digested/absorbed; by the worms;	2
(ii)	pathogens are outcompeted; by benign soil microbes;	2
(d)	conditions in the worm bed are monitored; samples are tested in an independent laboratory; (Quality control scores 1 mark maximum).	2
(e)	the worms are given a small amount of sewage sludge to eat each day; thus they more efficiently/easily digest it than if they were added to a large pile of sewage sludge;	2
		Total: 14

Question	Expected Answers	Marks
3 (a)	the large increase in growth of carrots treated with vermicompost; cannot be explained by the nutrients present in the (small) amount used;	2
(b)	(plant) hormones extracted from vermicompost; produce the same amount of growth as vermicompost itself;	2
(c)	no heat treatment/high temperatures involved in the production of vermicompost; **ora**	1
(d)	the beneficial soil microbes in vermicompost; may be outcompeting organisms that cause plant disease;	2
(e)	sewage sludge contains heavy metals; very small amounts of vermicompost are used for same amount of plant growth; thus less vermicompost needed than conventional treated sewage; and it will take much longer for that limit on heavy metals to be reached;	4 Total:11
4 (a)	volume of each worm bed is 70 m^3 ;	1
(b)	mass of sewage sludge in each worm bed is 0.9 x 70 = 63 tonnes;	1
(c)	63 tonnes of sewage sludge processed in 40 days; (can be implied by used of the two values) 63 ÷ 40 tonnes processed in 1 day/365÷40/9.125 sewage cycles per year; 63 ÷ 40 x 365 tonnes/9.125 x 63 tonnes = 575 tonnes processed in 365 days;	3
(d)	number of worm beds is 15 000 ÷ 575; answer: 26/27 beds, quoted as nearest whole number;	2
(e)	number of water treatment plants needed to treat 1 million tonnes of sewage sludge is 1 000 000 ÷ 15 000 = 67 treatment plants (do not penalize second time if non-integral number is quoted)	1
(f)	sewage sludge can no longer be dumped at sea or buried in landfill sites	1
(g)	**advantag**e useful/saleable product, vermicompost, produced from sewage sludge / treated/recycled sewage waste easier to dispose of / reduced cost of sludge management; **disadvantage** limited demand for vermicompost in a large city / expensive to set up; (credit other valid points for both advantage and disadvantage)	2 Total:11

Mark Scheme 2844
June 2005

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Question1	**Expected Answers**	**Marks**
(a) (i)	Location – near factories / industrial pollution; Near towns / domestic pollution; Near farms / pesticide pollution / fertilisers; Near nothing – no pollution; 2 from above	**2**
(a) (ii)	Number of repetitions; Weather / recent rainfall; Time of sampling / season; Tributaries bringing water from elsewhere; Type of pollution expected; 2 from above	**2**
(b)	Rate of flow/ Nature and amount of sediment/colour Visible pollution /colour/ rubbish in water/ plant life/ animal life; pH;	**1**
(c)	Phosphates are plant nutrients; Cause eutrophication / excess growth of plants; Light blocked; Plants die; Bacteria feed on / bacteria increase; Use up all the oxygen; Kills fish etc;	**4**
(d)	Particular wavebands of <u>visible</u> light; Produced by filters; Shone through sample in solution; Absorption takes place; Transmitted light detected; Concentration is directly proportional to absorbance; Calibration of colorimeter; Reference with distilled water; 4 from above	**4** **Total: 13**

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Question2	**Expected Answers**			**Marks**
(a)	Semi permeable membrane allows passage of water molecules; but not larger molecules; Water molecules pass in both directions; Normal osmosis net movement of water from high water conc. to low; Pressure on polluted side, causes more water molecules to flow into clean side; Because more collisions with membrane; Pollutant molecules too big, so gets left on dirty side;			**5**
(b)	Pure water for beer; pharmaceutical industry; Sewerage treatment; Electronics;			**2**
(c) (i)	Water molecules are in random motion; In collision with molecules of membrane; Root cell membrane is semi permeable; Water molecules can fit through holes in the membrane; Water moves in both directions;			**3**
(c) (ii)	When the solute concentration Is greater inside the cell than outside ora ; AW when water concentration or number of water molecules is greater outside than inside cell ora;			**1**
(c) (iii)	wilts			**1**
(c) (iv)	Leaf firing; Leaf rolling; Wide / deep roots; Waxy / small leaves;			**2**
d	economic			**1** **Total:1 5**

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Question3	**Expected Answers**	**Marks**
(a)	Reversible can go in both directions; Depending on conditions; Nitrogen and hydrogen can be reformed from ammonia;	**2**
(b)	If a system at equilibrium is subjected to change; The system responds to that change;	**2**
c)(i)	Increase in production of ammonia This opposes the increase in pressure; because less molecules of ammonia than Nitrogen and hydrogen;	**2**
(c)(ii)	High pressure favours greater production of ammonia; High pressure increases expense; Increases risk; So compromise with medium pressure;	**3**
(d) (i)	Decreases production of ammonia; Exothermic reactions lead to heating; More heat would cause reaction to reverse direction; This opposes heating; Leads to cooling; endothermic;	**3**
(d) (ii)	At low temperature reaction is slow; High temp increases rate of reaction ; But also increases rate in reverse direction / decrease yield / moves position of equilibrium in the reverse direction; ; So compromise;	**2** **Total: 14**

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Question 4	**Expected Answers**	**Marks**
(a)	Tubers are storage organs/enlarged tips of rhizomes; New plants develop from buds on surface of tuber;	**2**
(b)	Thin slices taken from tips of growing shoot; Contain undifferentiated cells; Sterilised / Aseptic conditions; Sections placed in growing medium / culture jars containing all necessary nutrients; Temp and light intensity controlled; Shoots separated and transplanted; cytokinin reduced; 5 from above	**5**
(c)	Chromosomes condense/ become short and thicker; Chromosomes duplicate / become chromatid pairs; Nuclear membrane breaks up; Pairs of chromatids line up across centre of cell; Chromatid pairs break up, and chromatids move to opposite ends of cell; Cell divides into 2; 2 new cells diploid / 2n; New nuclear membranes formed; 5 from above	**5**
(d)	Plants all genetically identical; If one susceptible to disease / conditions change, all are; entire crops can be wiped out; E.g. Potato blight or other example	**3**
(e)(i)	Self pollination – pollen fertilises ovum of same plant, cross pollination pollen fertilises ovum of different plant;	**1**
(e) (ii)	Cross pollination, gametes all different due to independent assortment	**1**
		Total: 17

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Question5	**Expected Answers**	**Marks**
(a) (i)	Offspring are produced that are always the same phenotype / genotype/ Parents are homozygous for particular characteristic;	**1**
(a) (ii)	Alternative version of gene	**1**
(b) (i)	T is dominant	**1**
(b) (ii)	t is recessive; because not shown in phenotype	**2**
(c)	All the plants with T grow tall; This is ¾ / 75% / 3:1	**3**
(d) (i)	<table><tr><td></td><td>T</td><td>t</td></tr><tr><td>t</td><td>Tt</td><td>tt</td></tr><tr><td>t</td><td>Tt</td><td>tt</td></tr></table> One mark for a correct diagram	**1**
(d) (ii)	75	**1**
(e) (i)	Restrict self pollination by covering / removing anthers; Pollen from one plant brushed onto stigma of other; Seeds obtained and planted; Desirable plants selected ;	**3**
(e) (ii)	Can also increase undesirable characteristics / or give credit to an example; Number of plants with desirable characteristics may be small;	**1**
		Total: 14

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Question 6	**Expected Answers**	**Marks**
(a)	No of Deaths; No of hours counted;	**2**
(b)	Out of 1000 people, on average, one will die	**1**
(c)	Rock climbing	**1**
(d)	Feeling of no control in plane; Skiing is choice; Seriousness of consequence worse in flying; Lack of understanding about technology of flying; High media attention to plane accidents;	**3** **Total: 7**

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Question 7	**Expected Answers**	**Marks**
	Technology Method of identifying gene required; Obtain gene required using restriction enzymes; This is passenger DNA; Insert into vector; Virus or bacterial plasmid; Using restriction enzymes and DNA ligase; This is recombinant DNA; Method of inserting into host; Select for modified plants; Max of 4 **Problems to environment** GM crops with resistance to pests / weeds killer could cross breed with wild varieties to produce of super weeds As yet unknown health hazards; Reduction of biodiversity; ; Max of 2 **Advantages** Pest resistance; Longer shelf life; Quicker growing; Bigger crops; Any other sensible advantage; Max of 2	**Total 6**

QWC	**organization & vocabulary** 2 marks **A** answer is clearly and coherently organized throughout **and** **B** appropriate specialist vocabulary is used extensively; 1 mark **A** answer shows a degree of organization **and** **B** some appropriate use of specialist vocabulary is made; 0 mark **A** answer is not organized **and** **B** appropriate specialist vocabulary is not used; **legibility & grammar** 2 marks **A** text is clearly legible **and** **B** spelling, punctuation, grammar are accurate throughout; 1 mark **A** text is untidy but can be read without difficulty **and** **B** spelling, punctuation, grammar show some mistakes; 0 mark **A** text is difficult to read; **and** **B** spelling, punctuation, grammar show extensive mistakes; (Candidates must satisfy both strands A and B to gain the marks at a particular level. Otherwise the marks for a lower level should be awarded.)	**4**
		Total: 10

Mark Scheme 2845
June 2005

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Question	Expected Answers	Marks
1 (a) (i)	2.05×10^{11} ; 5.60×10^{8} ; (allow 1 mark if both given in form 205×10^{9} (W) and 560×10^{6} (W))	**2**
(ii)	correct significant figures (2); correct value of 0.27 (%);	**2**
(b)	4;	**1**
(c) (i)	7.2; (accept any number of sig figs)	**1**
(ii)	correct use of v^3 (373); and I^2 (576) ; correct value of 92 446 (W), or related value obtained using figures of different accuracies from earlier parts; ecf from (c)(i)	**3**
(d)	it prevents damage / keeps the turbine stable;	**1**
		Total: 10

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Question	Expected Answers	Marks
2 (a) (i)	correct labels to axes; correct scales to axes; correctly plotted points;	**3**
(ii)	humus stores nutrients / holds water; plants need nutrients / water for growth; **AW** biomass falls to ground / biomass is in dead material ; decays / rots (to form humus) ;	**2**
(b) (i)	x10;	**1**
(ii)	humus contains H^+ ions / decaying material produces H^+ ions / ion exchange occurs / H^+ ions are displaced from humus by nutrient ions;	**1**
(c) (i)	a number of species increases as age of dunes increases / b biomass increases as number of species increases / c pH decreases as age increases / d humus content increases as age increases ;	**1**
(ii)	a colonisation takes time to occur / new species can make use of empty niches / succession takes place / b larger species arrive later / c humus containing H^+ ions builds up over time / d humus is broken down more slowly than it is produced ;	**1**
(d)	colour of soil becomes darker with age / stage / herbivore / animal / insect numbers are likely to increase with age/stage / water content increases / decreases with age/stage / salt content of soil decreases with age/stage ; (allow height of dunes as variable only if variation is fully described)	**1** **Total: 10**

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Question	Expected Answers	Marks
3	lithium nucleus contains 3 protons and 4 nuetrons / nucleon number is 7 / mass number is 7; lithium atom contains 3 electrons / atomic number is 3; (electrons are in) shells / energy levels; energy increases with increasing distance from nucleus; shells / energy levels are filled from lowest energy upwards; shell 1 / lowest energy level has 2 electrons; is full; shell 2 has 1 electron / can hold up to 8 electrons; emission occurs when electron changes from higher shell / energy level to lower shell / energy level; here change / transition is to common lower level / shell 2; from levels / shells 3, 4, 5 / down by 1, 2 or 3 levels; a shell / energy level has a precise energy / energy is quantised; transitions lead to precise energy changes; energy is transferred as electromagnetic radiation; energy change is related to frequency of emitted radiation; by $\Delta E / E = hf$; energy is emitted as photon; value of $\Delta E / f$ is related to distance (of higher shell) from nucleus / number of shells / levels changed; each transition leads to a <u>line</u> in the (emission) spectrum; set of transitions produces a <u>series</u> of lines; f is value of frequency; 6.52×10^{14} Hz is lowest frequency / longest wavelength; ora lowest frequency is visible light; higher frequencies are ultraviolet; $c = \lambda f$;	**Total: 10**

Question	Expected Answers	Marks
4	**two** processes named and explained from the following 1 mark for name (in bold) 4 marks max from remainder of list **photosynthesis**; water split into oxygen and hydrogen (atoms); by light / em radiation; in light dependent stage; hydrogen is transported by NAD / as NADH; to light independent stage; carbon dioxide; is reduced; to form carbohydrate / glucose / sugars; can be by C3 or C4 process;	**5**
	atmospheric circulation system / also as climate regulation; water vapour; is less dense than air; moist air rises; at the equator / low latitudes / intertropical convergence zone / ITCZ; absorbing energy / cooling the Earth's surface; rain / condensation / precipitation forms; releasing energy / warming Earth;	**5**
	acid deposition / acid rain; sulphur dioxide; reacts with water to form sulphurous acid / sulphuric(IV) acid / H_2SO_3 ; which is a proton; donor; H^+ ions / H_3O^+ ions / acidic solutions are formed; limestone buildings are damaged; aluminium ions can be liberated from soil / ion exchange occurs; products are toxic to living organisms;	**5**
	greenhouse effect; water vapour; in troposphere; absorbs; thermal infrared radiation; emitted from the Earth; molecules move faster; causing heating;	**5**

	osmosis in cells; plasma; and cell sap / in vacuole; contain dissolved compounds / solutes / nutrients / minerals; water passes through membranes; which are semipermeable; to equalise concentrations; down water potential gradient; keeping cells turgid;	**5**
	ocean circulation system (surface) / also as **climate regulation**; (sub-tropical) gyres; flow clockwise in N. hemisphere / ora; carry warm water; to higher latitudes / example of warm water current; reference to high specific heat capacity of water; ocean currents carry about half of the energy transported polewards; description of effect on climate; currents are wind driven; deflected by land masses; and Earth's rotation / Coriolis force;	**5**
	ocean circulation system (deep water); seawater contains dissolved salt / is saline; water evaporates; at low latitudes;; increasing salinity; water sinks when it reaches Arctic / N. Atlantic; seawater cools; increasing density; sinks when it reaches Antarctic / Weddel Sea; system transports nutrients; locks up carbon dioxide;	**5**
	water / hydrological cycle; evaporation / vaporisation as water vapour; precipitation as rain / snow; run-off / return flow (from land to sea); transpiration; (reservoirs) sea / lakes / rivers; atmosphere; ground water / ice; credit other valid process (respiration max 2 marks)	**5** **Total: 10**

Question	Expected Answers	Marks
5	**for scientific principles** mitochondria are organelles; where respiration occurs; transferring energy from food / glucose; for life processes / essential functions; DNA is a polymer; stored on chromosomes; with a helix / helical structure; consisting of two strands / double; of nucleotides; a phosphate; and deoxyribose / pentose sugar; backbone; with four types of base attached; adenine / A; thymine / T; cytosine / C; guanine / G; (2 marks max for naming bases) strands are linked by hydrogen bonds; between pairs of bases; A paired with T and C paired with G; whole of DNA constitutes organism's genotype; gene is a section of DNA; that carries instructions / codes for; a protein; that determines an aspect of the phenotype / a characteristic; three bases / codon; specifies an amino acid; evolution starts with a mutation; a base change; leading to a new characteristic; mostly this will be disadvantageous; sometimes one gives an advantage; to an individual; giving it a greater chance of survival; more likely to reproduce; and pass on the characteristic to offspring; by inheritance; to offspring; this repeats itself / is cumulative / over time;	

	leading to a whole population; of a new species; adaptation to an environment; can lead to convergent evolution; where species with different ancestors; share similar characteristics; DNA in genes of closely related species is only slightly different; more distantly related species have more DNA differences; break DNA down into fragments; greatest number in common between nearest relatives; DNA analysis is done by electrophoresis / description of process; (24 points from the above list) **for quality of written communication** **A organization & vocabulary** 2 marks **a** answer is clearly and coherently organized throughout **and** **b** appropriate specialist vocabulary is used extensively; 1 mark **a** answer shows a degree of organization **and** **b** some appropriate use of specialist vocabulary is made; 0 mark **a** answer is not organized **and** **b** appropriate specialist vocabulary is not used; **B legibility & grammar** 2 marks **a** text is clearly legible **and** **b** spelling, punctuation, grammar are accurate throughout; 1 mark **a** text is untidy but can be read without difficulty **and** **b** spelling, punctuation, grammar show some mistakes; 0 mark **a** text is difficult to read; **and** **b** sp, punct, gram show a high proportion of mistakes; (Candidates must satisfy both strands a and b to gain the marks at a particular level. Otherwise the marks for a lower level should be awarded.)	**24** **4** **Total: 28**

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Question	Expected Answers	Marks
6	**for scientific principles** radioactive decay occurs with an unstable nucleus; gives out ionising radiation; α-radiation; β-radiation; γ radiation; (max 2 for types of ionising radiation) awareness of significance of half-life; description of core, mantle crust model of planet; lithosphere is crust plus upper mantle; continental lithosphere; oceanic lithosphere; floats on; asthenosphere / part of mantle; driven by convection currents / plumes; at constructive / divergent margin / boundary; plates pushed apart; by formation of new lithosphere; at destructive / convergent margin / boundary; plates pushed together; subduction zone; causes melting of plate / lithosphere; gases and steam / water vapour; rise into magma chamber; vent through surface as volcano; carbon dioxide is taken up by organisms; calcium carbonate shells are produced; form deposits when organisms die; calcium carbonate is insoluble in water; forms a sedimentary rock; limestone; carbon dioxide reacts with water to form carbonic acid / H_2CO_3 ;	

	carbon dioxide levels were is steady state; positive feedback occurred leading to present situation; sunlight / uv radiation / short-wave radiation penetrates atmosphere; and is absorbed by surface of planet; carbon dioxide gas absorbs; (thermal) infrared radiation; emitted by planet; molecules move / vibrate faster ; energy transferred to other gases / molecules collide; carbon dioxide absorbs strongly; this is greenhouse effect; if no CO_2 , atmosphere transmits infrared radiation; albedo effect; of ice is high; reflects (incoming solar) radiation away from planet; (18 points from above list) **for quality of written communication** **A organization & vocabulary** 2 marks **a** answer is clearly and coherently organized throughout **and** **b** appropriate specialist vocabulary is used extensively; 1 mark **a** answer shows a degree of organization **and** **b** some appropriate use of specialist vocabulary is made; 0 mark **a** answer is not organized **and** **b** appropriate specialist vocabulary is not used; **B legibility & grammar** 2 marks **a** text is clearly legible **and** **b** spelling, punctuation, grammar are accurate throughout; 1 mark **a** text is untidy but can be read without difficulty **and** **b** spelling, punctuation, grammar show some mistakes; 0 mark **a** text is difficult to read; **and** **b** sp, punct, gram show a high proportion of mistakes; (Candidates must satisfy both strands a and b to gain the marks at a particular level. Otherwise the marks for a lower level should be awarded.) Total 22	**18** **4**

Mark Scheme 2846/01
June 2005

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Question	Expected Answers	Marks
1 (a) (i)	A label to 20% grey regions; B label in 40% grey region; C label to left-hand boundary; D label to right-hand boundary; E label to centre or right plate;	**5**
(ii)	upward-pointing arrow under right-hand boundary in 40% grey region;	**1**
(b)	**2 marks for plate tectonic theory** a continent is on a plate; plates are moving apart; from a constructive / divergent boundary / by seafloor spreading / because of convection currents in the mantle/ in asthenosphere / magma; (2 points from above list) **1 mark for explaining continental fit** one original continent was split;	**3**
(c)	new data/evidence (for mechanism of plate movement) became available; max of 2 marks for examples of new data eg, ocean floor topography / palaeomagnetic results / radiometric dating; from new technology / spin-off from World War II technology; max of 2 marks for examples of new technology eg, bathymetry / sonar / magnetometers / computers; change in focus of study / paradigm shift; (NOT availability of satellite imagery. NOT seismology) Total: 13	**4**

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Question	Expected Answers	Marks
2 (a)	F = mg;	**1**
(b) (i)	correct squaring of radius; 8.8 / 8.7 N kg^{-1} ; (answer does not have to be to correct number of sig. figs.)	**2**
(ii)	Venus has a different gas in its atmosphere to Earth; carbon dioxide; molecules have a greater mass / gas is denser; gravitational / downward force (on atmosphere) is greater; (3 points from above list) **AW** Venus has a different gas in its atmosphere to Earth; carbon dioxide; more of the atmosphere of Venus is retained; because molecules can less easily escape the planetary gravity; (3 points from above list) **ecf** from (b)(i) if g_{Venus} calculated as greater than g_{Earth} Total: 6	**3**

Question	Expected Answers	Marks
3 (a)	1 mark for 'fail-safe' answer; 1 mark for example: eg, light can be seen upwind / in noisy sea or sound can be heard in fog / big seas / big waves;	**2**
(b) (i)	expansion and contraction / compression; alternately / following each other / periodically; **AW** molecules / particles vibrate; vibrations are passed on to further particles;	**2**
(ii)	same / opposite direction / parallel;	**1**
(iii)	longitudinal; **ecf** from (ii)	**1**
(iv)	light wave travels faster; disturbance is perpendicular / at right-angles to direction of travel of light wave / light wave is transverse; light wave is electromagnetic; light wave has 2 components at right-angles to one another; light has higher frequency / shorter wavelength; no material is disturbed by light wave / light travels in a vacuum / needs no medium; (2 points from above list)	**2**
(c) (i)	2 m;	**1**
(ii)	166 Hz; **ecf** from (i)	**1**
(d) (i)	note is between E and F / (near) E / (near) F; **ecf** from (c) (ii)	**1**
(ii)	3 times;	**1**
(iii)	between B and C because note has frequency of 498 Hz; **ecf** from (c) and (d)(ii) **AW** higher pitch because shorter wavelength / higher frequency;	**1**
(e) (i)	correct s.h.m. waveform;	**1**
(ii)	X marked to rising part of waveform at zero displacement;	**1**
	Total: 15	

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Question	Expected Answers	Marks
4 (a)	(50 x 5000 =) 250 000 stadia; [**AW** (360 ÷ 7 x 5000 =) 257 000 stadia, (accept any number of sig. figs);	**1**
(b)	division of L by 2π _____; 39 809 / 40 000 stadia; **AW** 40946 / 40923 for second point carried forward from AW in (a) **ecf** from (a)	**2**
(c) (i)	3.5×10^4 stadia 1 mark for correct sig. figs.; 1 mark for standard form;	**2**
(ii)	1 mark for answer based on accuracy / precision of measurement; eg: because angle was small / distance was large / we now have more accurate technology / example of modern more accurate technology	**1**
(d)	Earth orbits once per year round Sun; axis of rotation is tilted with respect to (plane of) orbit; at angle of 67 / 66.5 ° (to horizontal) / 23 / 23.5° (to vertical); N. hemisphere tilted towards Sun in summer; **ora** valid explanation of greater insolation due to reduced obliquity / Sun is more directly overhead; valid explanation of longer hours of daylight in summer; in half orbit / 6 months S hemisphere is tilted towards Sun; (4 points from above list)	**4**
	Total: 10	

Question	Expected Answers	Marks
5 (a) (i)	NE pointing arrows on Gulf Stream and N. Atlantic Drift, S pointing arrow on Canaries Current;	1
(ii)	winds blow seawater from W to E; Earth's rotation / the Coriolis force; deflects current clockwise / to right; landmasses also deflect current; (2 points from above list)	2
(b)	(sub-tropical) gyre;	1
(c)	relationship between temperature of water and temperature on land as general statement or specific example; water has a high specific heat capacity; relationship between temperature of water and vaporization from sea as general statement or specific example; leading to greater rainfall; if humid air carried onto land; (2 points from above list)	2
(d)	thermal energy input is into lower latitudes; heat is carried from lower to higher latitudes by ocean currents / ora / oceans account for about half of energy redistribution; (give credit for following if not mentioned in (c) up to max of 2 for (d) water has a high specific heat capacity; specific example of heating by ocean current;)	2
(e)	Weddell Sea / Antarctica / S. Atlantic;	1
(f) (i)	ice has a more open structure than water;	1
(ii)	water - because it has the greater density / greater mass per unit volume / molecules are closer together; (mark is for explanation only)	1
(g)	molecular;	1
(h) (i)	hydrogen bonding;	1
(ii)	correct shape for water molecule; four hydrogens shown around oxygen; tetrahedral geometry indicated / 109° labelled; use of conventional symbol for hydrogen bond; two lone pairs on oxygen shown; (3 points from above list)	3
	Total: 16	

Report on the Units
June 2005

Chief Examiner's Report

Introduction

The entry at A2 was of a similar size and quality to that in previous sessions. The increase in maturity and individuality from AS to A2, that had been noticeable in answers to previous questions, was also clear this year.

The entry at AS was bigger than before. Some Centres with small candidate entries had dropped out. They were replaced by a greater number of new Centres. In addition, some existing Centres now have quite sizeable entries. Some of the new Centres entered students in Year 11. On the whole, these candidates do well in this specificaction. AS Science is a viable subject for more able students who have taken GCSE a year early. It is hoped that the course materials that are available will provide such students with an interesting, relevant and fresh approach to their further study of science.

Another change in the AS entry, unlikely to be connected with the rise in Year 11 students, was the presence of a noticeable 'tail' of about 5% of very low achieving candidates. It would appear either that some students are ill-prepared for the examination, or that they are far from capable of the study of science at this level. However interesting the course materials might be, it is hard to imagine how such students' experience of AS Science could have been anything other than disheartening.

Finally, on a more specific note, there is growing evidence that candidates are unfamiliar with handling numbers in standard form. Centres are reminded that the specification does contain a list of mathematical requirements. Questions can expect candidates to show proficiency in these.

Unit 2841 – Science and the Natural Environment

General Comments:

The paper was a little more demanding than last year's paper, but generally followed the same style. The paper assessed slightly more Physics than Biology or Chemistry concepts. A few more extended answers were required.

The first two questions required students to analyse and manipulate data. The calculations in question 1 were not very demanding. Question 3 required analysis of graphical data. The remaining three questions required candidates to bring together information from different parts of the unit and to use it to explain the scientific background to a variety of context.

Responses ranged from very good to blank answers. The marks scored on question 4 were generally low, for candidates of all abilities. Generally this was due to misinterpretation of the concept, lack of understanding of the concept or lack of detail in the responses.

Detailed explanations are given in the comments on individual questions below.

Comments on individual questions.

Q 1

Most candidates failed to gain the full two marks for question (b)(ii) and (d)(i) on how roots take up nutrients and the difference between the two isotopes. Good answers stated 'by absorption' for (b)(ii) and then went on to explain how; poor answers stopped at absorption. Too many candidates did not use the accepted terminologies such as 'absorption', 'mineral ions' and 'active transport'. Instead terms such as 'suck up by trees' and 'nutrients in water' were used. For (d)(i), candidates stopped at 'they have different neutrons' instead of giving actual numbers.

Almost all candidates attempted the calculation and worked out the average of the values correctly. The less able candidates could not work out the percentage from the values. Most candidates misinterpreted (d)(ii). Good answers described how isotopes are converted into positive ions, followed by how ions are separated. Some able candidates misinterpreted the question and give a detailed account of how isotopes are converted into positive ions instead of addressing the question which asked 'how the ions are separated'.

It maybe helpful for centres to use past papers with the published mark schemes to familiarise candidates with how to interpret questions, and quality of responses expected.

Q 2

Generally this question was answered well. Poor answers were due to the lack of detail, for example in (b)(i), candidates overlooked the word 'describe' and simply stated what a beta particle is, instead of what happens in the nucleus when a beta particle is emitted. For (d)(i) good answers qualified what 'penetrating' means with respect to alpha radiation.

Q 3

Generally answers to this question failed to reach the expected standard. Most candidates misinterpreted (b) as asking for the equation for photosynthesis. Able candidates who interpreted the question correctly lost marks because they wrote a **symbol** equation, instead of a **word** equation for the reaction. A common misconception was that 'pigments turn the colour of the light into different colours'. Good answers used the appropriate terminology to explain that white light consists of all the colours and the pigment **absorbs** some colours and **reflects** others.

Q 4

This question was about the concept of remote sensing imaging. Most candidates could not explain the phrase 'array of pixels', and the relationship between a sensor and a pixel. This was surprising since this concept was covered in the June 2004 paper. A common misconception was the darker the grey scale, the more radiation received, for (b)(ii). Good answers described the relationship, e.g. 'grey scale is proportional to the intensity of the radiation'; "black is where there is no radiation and white is where it is strongest". The less able candidates did not attempt many parts of the question; those who did were confused about the concept of remote sensing imaging.

Q 5

A common misconception was that candidates interpreted a **system** as the description of a process e.g. respiration. Able candidates could build up the concept of the relationship between cells, tissues, organs, systems, with reference to a named system. In (b), cytoplasm was often incorrectly described as an organelle, and the nucleus was correctly identified as an organelle common to plants and animals, but candidates then went on to describe the nucleus of an atom. Able candidates could make a distinction between **structure** and **role**; their answers described the structure of the organelle and how the structure helped them to fulfil its roles.

Candidates were able to pick up written communication marks for answers which clearly differentiated structure and roles of the organelles.

Unit 2842 – Science and Human Activity

General comments

The paper was of a similar style to previous years. Overall, candidates seemed to find it slightly more accessible than in June 2004; the return of a graph-plotting question, for example, provided two marks for most candidates. Conversely, although calculations have been well done by candidates in previous sessions, the added complication of handling standard form in an otherwise straightforward calculation caused a problem for many.

Marks were generally reasonably well spread over questions 1-4; however, it was not unusual to find candidates scoring few if any marks on question 5.

Comments on individual questions

Q1

In (a), the liquid was commonly shown with the molecules quite well separated. Few candidates were able to show both the random arrangement and the fact that molecules are likely to be touching each other in the liquid state. Most other parts of the question were handled well by candidates although the usual confusion between global warming, acid rain and ozone depletion was again evident in (c).

Q2

The graph and half-life determination were well done by most candidates. Many candidates did not show any construction lines on the graph which caused some difficulty if they chose to measure the half-life from points other than t=0 minutes; this could result in answers slightly greater than 130 minutes being obtained. If it was not clear how the candidate had obtained the answer, the mark was not awarded. Candidates should be reminded that when they are told to use a graph, they may well be expected to show some evidence that the graph <u>has</u> been used. Only a minority of candidates in (b)(iv) were familiar with the use of subsequent half-lives to check whether a reaction is first order.

The term 'rate determining step' was unfamiliar to many in (c), and 'troposphere' (and, puzzlingly, tropopause) was given almost as frequently as 'stratosphere' for the part of the atmosphere in which ozone is normally found.

Q3

Candidates frequently resorted to vague generalisations when faced with the term 'insulator'. Ignoring the clue of the context, many answers were along the lines of 'helps to keep things warm'.

The calculations on this paper, and particularly in this question, were less well done than in previous sessions. A serious concern must be raised over the apparent unfamiliarity with handling numbers written in standard form. In particular students performing the calculation $3 \div (2 \times 10^{-5})$ frequently obtained an answer of 1.5×10^{-5} – thus indicating that they are not able to enter such numbers correctly into their calculators. The parts of this question about fields seemed more familiar to candidates, similar questions having occurred in several recent papers.

Q4

Candidates found part (a) very easy but, unexpectedly found part (b) rather difficult. Many seem to have been bemused by the slightly different ways of representing the groups of atoms in the formula and were perhaps unfamiliar with the use of chemical formula in the context of complicated molecules.

Most candidates obtained the mark in (b)(ii) for stating that carbohydrates are made up of C, H and O (which is true of many non-carbohydrates as well) but very few were able to refer to the more precise idea about the 2:1 ratio of H to O.

Many candidates could not distinguish between production and disposal in (c), despite the emboldening of the words. There were some excellent answers, however, but most answers were too imprecise to gain full credit for this question.

In general, there is still much lax use of terms such as molecule and atom (as there was indeed in Q2), so that it was not unusual to see phrases such as 'an atom made up of carbon, hydrogen and oxygen molecules'. On this occasion, as much credit as possible was given but clearly candidates will be expected to use this language more precisely in the future

Q5

Enzyme questions are often highly scoring for candidates. This was not so frequently the case with this question. The region of α-helix was frequently recognised in (a), although the sheet was less commonly named. Very few candidates were able to explain fully the difference between the two ways of representing the enzyme.

A number of extremely good answers were seen to (c) but the greater number which failed to score any credit counterbalanced these. The best candidates gave well-organised and detailed discussions of the factors affecting activity. Most chose temperature as one factor, but pH and inhibitors were common for the second factor. The concentration of enzyme or substrate was less commonly seen.

In the poorer answers, candidates often restated details of the lock and key mechanism for enzyme action without relating it to factors that affect enzyme activity. Many candidates could not distinguish this situation from more general questions about rates of chemical reactions and chose (irrelevantly) to discuss pressure or surface area. Other candidates were able to refer to denaturing of the enzyme, but without being able to give any detail. It was encouraging to find fewer references to enzymes being 'killed' at high temperatures but several other answers referred to enzymes being 'dormant' – or even asleep – at lower temperatures.

Unit 2843/01 - Interpreting Scientific Information

General comments

Although almost all candidates had sufficient time to complete the paper, a few clearly found the article and the questions based on it difficult, and scored very low marks, even though the article was about a relatively simple topic and many of the questions were straightforward. Possibly these particular candidates would have benefited from more practice at reading and interpreting pieces of text as part of their course. However, the majority of candidates made a good attempt at many of the more simple questions. The paper was demanding in that it contained a range of different kinds of task, and thus even the most able candidates found it difficult to gain full marks for all types of question. The paper did, however, allow candidates to demonstrate their mastery of a variety of different interpretive skills.

Comments on individual questions

Q1

Part (a), a simple part question about the type of worm used in sewage treatment, was answered correctly by almost all candidates. In (b), candidates were, in effect, asked to restate a section of the text in biological terms. One such term, 'digest' was contained in the text and so most candidates gained this mark. Many candidates managed to substitute the term 'ingest', or 'eat', for 'chomp' but only a few realized that worms deposit processed sewage sludge as worm casts, a fact that was made clear later in the article. Thus it is important that candidates are encouraged to read the article carefully before answering the questions, as instructed in the question paper. Similarly, to achieve full marks for part (c), candidates needed to have first read the whole article rather than base answers on the first sentence describing pathogens found in the text. Those who had done as they were asked were able to gather that pathogens can be bacteria, viruses and parasitic worms, and that pathogens cause disease in both animals and plants. From this information they could then give a general definition of a pathogen. The answers to both simple part questions in (d) were accessible from the same paragraph of text, and so were done well by most candidates. Of a similarly low demand, part (e) of the question was answered correctly by most candidates.

Q 2

In (a), candidates were asked to draw a relatively simple diagram from equally simple information given in the text. To score full marks, candidates were required to draw a diagram demonstrating the dimensions of a worm bed, with a thin layer of fresh sludge at the top and a thin layer of treated compost at the base, the worms inhabiting the upper third of the bed. In (b), most candidates realized correctly that the choice of 40 days as the residence time for sewage sludge in the worm bed is related to the worms' life cycle. If the compost is harvested in less than forty days it will contain worm eggs; forty days allows the eggs to hatch and the worms to make their way back to the upper layer to work on more sewage sludge. Most candidates answered (c)(i) and (ii) well, realizing that in the top third of the worm bed worms are digesting the pathogens in sewage sludge whereas in the lower part of the bed any remaining pathogens are outcompeted by benign soil microbes that flourish in worm casts. Pat (d) was not answered as well as it might have been in that some candidates who chose to quote directly from the article did so

inadequately. Part (e) required an understanding of the process as a whole and proved demanding though some candidates, and not always those who scored the highest marks overall, gained full marks.

Q 3

In (a), candidates were required to follow a scientific argument, and this proved demanding for many. Carrots were fed so little vermicompost that the substantial amount of extra growth they made cannot be explained in terms of nutrients, and is thought instead to be due to the presence of plant hormones in the vermicompost. Some of the most able candidates gave a correct explanation and scored full marks. Part (b) simply required information to be taken from the text, and was done well by almost all candidates. Part (c), a more demanding part question, was nevertheless done well by many candidates who correctly inferred that in traditional composts the heat generated kills many beneficial soil microbes that are conserved in the worm beds described in the article. In (d), most candidates did well, extracting the correct section of the text as their answer. In (e), the explanation required contains four statements linked together to form an argument, one of which occurs earlier in the text than the other three. Thus this part question was highly demanding. A few of the most able candidates gained full marks and many others did creditably by putting forward a simplified argument.

Q 4

Parts (a) - (e), which tested candidates' numerical skills, were attempted by most and done well by a surprisingly large number of candidates. However, in a few cases, candidates were hampered by not having the use of a calculator and resorted to long division, which slowed them down and sometimes introduced unnecessary errors. A significant minority of candidates clearly does not know how many days there are in a year. In (f), candidates were required to select their answer from the appropriate part of the text, which came from the beginning rather than the end of the article. To their credit, most candidates did this successfully and attained the mark for this part question. In (g), candidates were asked to think about the possibility of using this method of sewage treatment in a different location, and thus to apply knowledge recently gained from reading the article to a new context. This demanding task proved difficult for many otherwise high-scoring candidates, and in fact the very few who gained full marks for this part question tended to be those who had not scored as well on some other parts of the paper, but who had nevertheless understood the basis of the article and were able to apply common sense in answering this last part question.

Unit 2844 – Science and Environmental Management

General Comments

In general, candidates seemed happier answering questions based on biological concepts than those based on physics or chemistry. Those questions relying on recall of knowledge of plant breeding topics and genetic crosses were particularly well answered. Most candidates scored highly in question 5, which was based on Mendel's laws of inheritance. Few candidates scored well in question 3 (on the effect of changing pressure and temperature in the Haber process). More surprisingly, candidates did not score highly in the extended answer question 7, which was about genetic engineering. While most knew some of the advantages and disadvantages, of this process, not many candidates were able to describe how it is carried out.

Most candidates were able to make some attempt at answering most of the questions, and there were very few completely blank answers. Candidates had some knowledge of the topics, but often the answers given were vague and general, and 'unscientific', not enough scientific detail being given to score all the marks. This was particularly noticeable in questions 1(d,) the question on colorimetry, and 2(a) and 2(c), the questions on osmosis. These questions were very variably answered. Some candidates scored full marks, but most were unable to describe the processes in enough detail.

In general, candidates who have scored less well in this paper have done so, because they do not have a sufficient depth of knowledge to gain the higher marks.

Comments on individual questions

Q1

Good answers were given to (a)(i) on the importance of location in relation to farms, factories etc. when choosing sampling sites. Part (a)(ii) was not so well answered, many candidates discussing other factors relating to location again, rather than relating their answers to sampling procedures such as timing of sampling, number of repetitions, weather, seasons etc. In (c), while candidates clearly appreciate that eutrophication leads to lack of oxygen in the water, they failed to discuss that this is the result of bacterial decomposition of dead algae. In (d), some candidates were not familiar with the technique of colorimetry, and some confused it with chromatography. Many had a rough idea of the technique, but their explanations were lacking in detail.

Q 2

In (a) most candidates had got the idea that increasing the pressure in reverse osmosis forces water molecules through a semi-permeable membrane, but did not explain that this was against their concentration gradient, and that water molecules can flow in both directions. In (b), most candidates were able to give examples of the uses of reverse osmosis. In (c)(i), few candidates answered the question by referring to molecular kinetic theory. Candidates often answered question (c)(iv) by discussing a plant's response to short term water stress, rather than discussing adaptations of plants to a dry environment.

Q 3

In (a) and (b), most candidates were happy in describing reversible reactions, but when stating Le Chatelier's principle, they mentioned changes in equilibrium without really understanding the meaning. When it came to describing the effect of changing temperature and pressure in (c), (d) and (e), most candidates discussed the effect on the rate of the forward reaction, not the direction of the reaction, which is what was required.

Q 4

In (a), most candidates did not know how potatoes reproduce by tubers. Part (b) was very variably answered, many candidates confusing tissue culture with other forms of asexual reproduction such as growing cuttings or grafting. Candidates' answers to parts (c) and (d) were quite good on mitosis and the disadvantages of asexual reproduction, but in (e)(ii), many candidates think that self pollination is a form of asexual reproduction.

Q 5

Good answers given to most parts of (a), although many did not describe <u>how</u> selective breeding is carried out. Details such as how pollen is transferred, and how self pollination is prevented were omitted. Planting seeds, then selecting the best offspring were also not discussed.

Q 6

This was generally well answered, but many candidates answered part (c) by repeating the information given in the question rather than explaining the meaning of a 1:1000 risk of death.

Q 7

The answers to this question were rather disappointing considering that GM is a topical issue. Most candidates gained 2 or 3 marks by discussing the advantages and disadvantages, but few were able to gain the highest marks by describing how the process is carried out. When an attempt was made to describe the process, this was often in the vaguest of terms. Candidates described 'finding genes', 'removing genes' and 'inserting genes', but did not describe how this could be done.

Unit 2845 - Synthesis of Scientific Concepts

General comments

Overall, the paper performed in a very similar way to last year's paper. However, the candidates' performance on the different types of question was not the same. In particular, they found the longer extended answer questions (Q5 and Q6) more demanding than usual, whereas the shorter extended answer questions (Q3 and Q4) were more to their liking.

It had been hoped that candidates would do well on Q6. This was based on the topics of the greenhouse effect (which is of widespread interest to the general public as well as forming part of Unit 2842) and plate tectonic theory (which would have been studied soon before the examination in Unit 2846/01 as well as retaining some familiarity from GCSE Science). But scores on this question were low. Similarly, Q5 was deliberately based on two topics - the structure of DNA (Unit 2844) and evolution (Unit 2841) - on which candidates usually do well. Scores were, however, generally poor on this question too.

On the positive side, it was again pleasing to find so many individual answers. Candidates show that they think for themselves at this level, and answers do not share a 'Centre style' that is often evident at AS level. This was particularly true in Q4 where candidates were able to choose their processes from a wide selection of possibilities.

Comments on individual questions

Q1

The demand of this question proved to be moderate, as intended. The only surprise came in part (a)(i) for which very few candidates gained the marks. It was based on a knowledge of three things: the meanings of Giga, Mega and standard form notation. Many candidates failed to give an answer in standard form, using instead a string of zeros after the values given. The meanings of G and M were, however, usually wrong, even to the extent that the two answers did not differ by a factor of 10 to the power 3.

Q2

This question proved difficult for many candidates because they were required to offer scientific explanations for the patterns in the data. So, many marks were lost on (a)(ii), (b)(ii) and (c)(ii). In addition, the meaning of pH was not well understood; few candidates related a fall of 1 in pH value to an increase of x10 in the concentration of hydrogen ions. The increase in number of plant species per km^2 with increasing age of dunes was often chosen as the relationship in (c)(i). An explanation in terms of increased nutrient availability was often given. Although this would explain an increase in biomass or size of plant population with age, it does not necessarily explain the increase in number of species. Quite a number of candidates suggested that evolution had had time to occur during the 300 years of dune formation. It would be worth making sure that students have an idea of appropriate timescales when teaching evolution. Other candidates suggested that cross-pollination between different species had occurred and had given rise to new species. Again it would be worth making sure that students know what cross-pollination is, and that they can give a simple explanation of the term species.

Q3

This question worked well. Candidates' scores were spread across a range from poor to full marks. The three most common errors were as follows.

- Emission was described as occurring when an electron jumps between energy levels, but the direction of the jump was not given. Candidates should know that the jump is downwards in this case and that energy level decreases.
- Many candidates thought that an electron shell itself has a frequency, and that this frequency increases as a shell becomes further from the nucleus. The frequency was not seen as associated with radiation emitted as a result of a change between shells.
- The lowest frequency radiation was often quoted as being 1.09 x 1015 Hz and the highest as being 9.28 x 1014 Hz. It was simply seen as a comparison of 1.09 and 9.28. This again points to a poor understanding of the standard form style of presenting numerical values.

Q4

As mentioned in the general comments, candidates produced good answers to this question. Examples were chosen from across the wide range of possibilities and explanations were generally good.

Q5

This question has already been referred to in the general comments. Only very able candidates scored high marks. Many candidates discussed only DNA structure, omitting to mention evolution despite the use of the word 'evolutionary' on three occasions in the extract in the question. This unit is synoptic, requiring candidates to bring together scientific concepts from different modules of the specification. Discussion of only one concept is not synoptic and does not reach A2 standard. Therefore it cannot justify a score much higher than the 40% chosen as the design threshold for a grade E.

Q6

This question has already been referred to in the general comments. Most candidates simply rewrote the extract, almost word for word. There was very little amplification of the science involved. Such answers could not therefore gain marks for organisation and vocabulary. Legibility and grammar were often, however, good and in some cases produced the only marks.

Unit 2846/01 - Science and Global Processes

General Comments

This paper produced a similar performance to last year, though with even fewer very good or very bad scripts. However, students found Questions 2 and 5 to be much harder than Questions 1 and 3. Considering that this is an A2 unit, the basic skill levels of many students are surprisingly low. The clarity and grammatical accuracy of candidates' writing is often poor. As last year, many candidates have problems with basic mathematics, particularly significant figures and standard forms.

Many students might have improved their marks by paying closer attention to the precise wording of the question stems.

Comments on individual questions

Q1

Most students gained most of the marks for part (a). Many did well on part (b), but there was evidence of inattention to the question, which asked for continental fit to be explained in terms of plate tectonics. Some discussed continental drift and fit in their own terms without reference to plates, and some discussed plates without reference to continents. Part (c) elicited many answers which went little beyond the suggestion that new technology became available. As far as specific technologies are concerned, many incorrectly identified satellite imagery as an important factor in the 1960s/70s, when in fact there was very little relevant satellite data available at this time. Also several students had the rather curious notion that before satellites, we had little idea of the detailed shapes of continents. Few students strayed outside the realms of the technical to suggest possible contributory causes.

Q2

Failure to gain the marks for (b)(i) most frequently came from inability to square the planet radius correctly. A number of students, having obtained a ridiculously high value for the gravity of Venus, ignored the information in the question stem (that it was smaller than the earth's gravity) and pressed on regardless. Part (b)(ii) was hard and defeated most students. Although the answer sought was in terms of the different composition of the Venus atmosphere (heavier gases therefore larger gravitational force), some credit was granted for speculation based on the fact that Venus is a hotter planet.

Q3

The average mark for this question was quite high, but many students benefited significantly from a rather large number of 'error carried forward' marks.
In (a), the key word in the stem is 'both'. Answers amounting to no more than 'so that it can be both seen and heard' were discounted. Some explanation was required of why one or the other signal might not be enough on its own. In (d)(ii), some students were not clear about the exact distinction between the arithmetical operations of multiplication and addition.

Q4

This question produced an average mark similar to that of the whole paper. Marks were most frequently lost on (c)(i) where few were able to express the quantity in the form required (2 sig figs and standard form) and on part (d). This question about the mechanism for the seasons was, in general, poorly done. Many students showed that they were confused about the distinction between what gives rise to day and night and what causes the seasons. Others seemed to think that continuous changes in the tilt of the earth's axis were the cause. Some imagined that the (in fact very very slight) ellipticity of the earth's orbit accounted for the seasons. Many thought that the (again very slight) variation in distance to the sun, rather than the obliquity factor, could account for the difference in insolation between summer and winter.

Q5

This is effectively two sub-questions: one on ocean currents and one on chemistry; the chemistry part was the less poorly done.

In (a)(ii), some students did no more than describe the direction of the current, rather than explain it. Parts (c) and (d) were generally found to be difficult - some students paid insufficient attention to the words 'regional' and 'global' in the stems, although these were highlighted. In (f), some students described the spaces between the molecules as 'air pockets', a very serious misconception; others described them as 'a vacuum'. In (h) (i), the mark is for 'hydrogen bonding'; 'hydrogen' by itself was disallowed, unless the candidate mentioned hydrogen bonding elsewhere. As last year, a number of students are under the impression that water is HO_2.

Coursework components - 2843/2 and 2846/2

Approximately 430 candidates were entered for AS Science; 117 candidates for A2 Science. This represented 26 AS Centres (2843/2) and 18 A2 Centres (2846/2). About one quarter of the Centres were scaled.

It is pleasing that some Centres scaled in previous years by large amounts are now back within tolerance. On the other hand, it is disappointing when Centres repeat the same errors as in previous years and are scaled again.

Centres were generally very prompt in sending coursework for moderation. The administration of Centres was generally good with most Centres correctly using Coursework form GCW048 and counting the best mark in each of Skill Areas P, I, A and E.

For future reference the following points may be useful.

- Centres should include the name of the member of staff responsible and if possible a contact telephone number or e-mail address. This will speed up things if more samples or further information are required.
- It would be helpful if Centres identified the area of the specification involved in each coursework task. This is especially important in A2 for Skill Areas P and A: for high marks it must be shown that the candidate draws information from both AS and A2.

Quality of the work submitted for moderation

There was some excellent work submitted for moderation this year where candidates clearly demonstrated high levels of performance in all Skill areas. Much of the work, however, was little better than that produced at GCSE and it was hard to see progression from GCSE to AS and A2.

Choosing appropriate tasks

Centres used a number of different coursework tasks. In some Centres, candidates only used whole investigations. Candidates then only had one mark in each Skill Area and so had no opportunity to count the best mark or to improve. It may be better to use a whole investigation for AS as this can lead more naturally to a good evaluation in Skill Area E. For A2, it is probably better to design tasks that assess one or two skill areas each.

A good coursework task for AS or A2 level should:

- include content from some part of the AS specification for AS and from both AS and A2 units for A2;
- enable candidates to do some scientific research at an appropriate level to inform their planning;
- enable the candidates to collect ample data with suitable precision and accuracy;
- usually allow candidates to plot one or more line graphs (bar charts and similar are not appropriate at this level);
- enable candidates to do some detailed processing (calculating the average values for three readings is *not* detailed processing);
- allow opportunities for candidates to evaluate their experiments.

Some of the coursework tasks chosen did not meet these criteria.

Suitable tasks used by Centres

The tasks used this year were generally the same as those seen in previous years.

AS

Factors affecting rate of reaction (from Coursework booklet)
Radioactivity of household dust (from Coursework booklet)
Effect of surface area on the rate of decomposition of hydrogen peroxide
Measuring reaction rates of calcium carbonate and hydrochloric acid using a pressure gauge linked to a computer
Finding the order of reaction for the decomposition of hydrogen peroxide
Investigating the effect of temperature on the decomposition of hydrogen peroxide with enzymes in potato
Investigating the amount of oxygen used by respiring seeds
Investigating how temperature affects beetroot stability using a colorimeter
Finding the order of reaction for the reaction of calcium carbonate and dilute hydrochloric acid using loss of mass

A2

Different methods of analyzing for Cu^{2+} ions
(This involved colorimetry and titration. It gave a good comparison of the methods).
Factors affecting enzyme activity incorporating pH
Effects of light intensity on the growth of *Chlorella*

Interpretation of criteria and work of candidates

Many Centres applied the criteria with generosity. It should be remembered that these criteria are hierarchical. For example, to award 1 mark in any Skill Area, 1a and 1b *must* be scored. Some Centres awarded 2 marks, for example, when only 1a and 1b had been scored. Also, in some Centres, if a candidate had achieved 1a, 1b, 3a and had made some progress in 5a, candidates were awarded 4 marks. This should only be 2, as 3b had not been achieved.

Skill Area P - Planning

The guidance on length given in the Coursework manual for Planning is about 800-1000 words and this remains a good guide. Very much less than this probably means that the report does not contain enough background science. Much more than this probably indicates that too much irrelevant material is being included. Many of the reports resembled a list of instructions with little or no science

P.1a The candidate must give a question to be studied, plan a fair test and, if relevant, make a prediction.

P.1b The candidate must choose appropriate equipment.

P.3a The candidate must introduce some scientific knowledge and understanding. For example, in a rate of reaction experiment, they may list factors which affect the rate of reaction and then identify which factor is to be varied and which are to be kept constant.

P.3b The candidate must choose a suitable number and range of observations/measurements to be made..

P.5a At this level the candidate must use a secondary source to inform the plan. It is not enough to list a book . A reference, e.g. a page number or web address, must be given so that it can be checked. The science used should be at AS or A2 level. Often the reports seen lacked science altogether or included science at below Grade C GCSE level. Some reports contained completely wrong science, for example the rate of enzyme reaction increasing with temperature up to 90^{o}C. They should not be given credit for wrong science. A reference to safety, e.g. 'wear a lab. coat' or 'use eye protection', is not enough to award P.5a where clearly P.3a and P.3b were not merited. Perhaps for P5a candidates might use Hazcards for information.

P.7a To be awarded this, the candidate must use and evaluate information from a variety of sources. Again, these must be identified and references given. Very few candidates realised this and some teachers gave P.7a when P.5a was clearly the maximum.

P.7b The candidate must now justify the strategy used, i.e. that it will provide precision and reliability.

Eight marks are available only for exceptional performance in P.7a and P.7b or both.

Skill Area I - Implementing

In Skill Area I, much of the evidence remains in the Centre, and the Moderator can only act on the annotation provided. Although annotation can assist the Moderator throughout in confirming the decisions of the Centre, it is essential here.

I.1a Evidence provided by the Centre.

I.1b The candidate makes some observations or measurements. However, if they are not adequate for the activity, I.1b cannot be given. At this level, they do not have to be recorded in a formal table.

I.3a Evidence provided by the Centre. The candidate is confident in practised techniques, e.g. weighing.

1.3b The observations and/or measurements are recorded in a table devised by the candidate. Correct units are given in the table headings.

1.5a Evidence provided by the Centre. A higher level of competence is seen. For example, a candidate can dilute a given solution accurately to produce five different solutions of different concentrations.

1.5b The candidate must now show precision in the observations and measurements taken. In many cases candidates had three very different results (e.g. 17s , 34s and 51s and they took an average. This does not suggest precision in the results collected.

1.7a Evidence provided by the Centre. The candidate must be fully proficient in all techniques and with all equipment.

1.7b Here the candidate must ensure that the degree of precision is the maximum permitted by the equipment. For example, a thermometer should be used to measure temperature to the nearest 0.5 ^{o}C and a burette consistently to 0.05 cm^{3}.

Skill Area A - Analysing Evidence and Drawing Conclusions

A.1a The candidate carries out some simple processing of evidence, e.g. averaging results.

A.1b The candidate can report a simple trend or pattern, e.g. increasing the concentration of hydrogen peroxide increases the rate of reaction.

A.3a Here the candidate draws an appropriate line graph with a line of best fit when appropriate. If this is not possible, the candidate carries out some numerical calculations at a higher level than for A.1a. Candidates can use computer packages to draw graphs. However, in many cases candidates could not use them properly.

Candidates often cannot draw lines of best fit using a computer package. If there is any doubt graph paper should be used. In some Centres it is pleasing to report that good computer generated graphs were produced.

A.3b The candidate links the conclusion with associated scientific knowledge and understanding. As a guide, it should be linked back to the science given in P.3a.

A. 5a It is here that many candidates fell down. For rate of reaction experiments, they tried to calculate the initial rate by working out a gradient. For this a tangent must be drawn to the curve at 0 and a large triangle drawn. Too often candidates did not draw a tangent but tried to calculate the gradient of the curve or they drew a very small triangle.

A. 5b The link made now is with science at a higher level.

A. 7a For a rate of reaction experiment, the candidate now might use evidence from A.5a to devise a rate equation and write:

$$\text{Rate of reaction} = k[A]^x[B]^y$$

A.7b Now the link is with science at the highest level.
A mark of 8 is available.

Skill Area E - Evaluating Evidence and Procedures

Evaluation is the most difficult Skill Area for candidates. It is perhaps easier here to separate the two strands.

The 'a' strand is about improvements in the investigation. Often an experiment that works very well gives fewer opportunities for evaluation than one that is more open-ended. A candidate who suggests studying a different variable is not meeting the requirements of this strand. Too often candidates are given credit for suggesting the investigation of another variable.

E.1a The candidate makes a relevant comment on the suitability of the experimental procedure.

E.3a The candidate recognises the limitations in the experimental procedure. For example, in a rate of reaction experiment, some gas is lost before the cork attached to the gas syringe can be put into the flask.

E.5a The candidate indicates an improvement. In the above example, perhaps the solid reagent could be put into a small test tube separate from the acid. The reaction is started by shaking the flask.

E. 7a The candidate justifies the improvements in terms of increasing the reliability. In the example given, will the acid enter the small tube sufficiently quickly or will the rate be limited?

The 'b' strand is about the *quality* of the evidence collected and this strand is overlooked by many candidates, A candidate failing to score E.1b cannot be awarded even 1 mark despite reaching 7 marks in the ‘a’ strand.

E.1b The candidate recognises anomalous results. In practice, many candidates either highlighted them in the results table or circled them on graphs. If there are no anomalous results, candidates should state this. Where there are anomalous results, and the candidate ignores their existence, E1.b cannot be given.

E.3b The candidate comments on the accuracy of observations suggesting reasons for anomalous results. For example, when measuring photosynthesis of a plant, the temperature of the water may change. This could account for any anomalous results.

E.5b Candidates may notice from their results that when they take three readings there are differences between them.

E.7b The candidate assesses the significance of the uncertainties. In the above example, perhaps looking at 19 and 25 (ignoring 43) and averaging the value as 22, they could look at the graph and decide whether this point would now be closer to the graph.

The individual reports to Centres are intended to provide positive support to Centres to help them get the Coursework right. Where significant scaling has taken place the work will have been seen by at least two Moderators.

Advanced Subsidiary GCE Science 3885
June 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2841	Raw	60	40	35	30	25	21	0
	UMS	90	72	63	54	45	36	0
2842	Raw	60	42	36	31	26	21	0
	UMS	90	72	63	54	45	36	0
2843	Raw	120	91	81	71	62	53	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3885	300	240	210	180	150	120	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
3885	13.4	27.6	46.2	66.7	84.5	100.0	355

Advanced GCE Science 7885
June 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2841	Raw	60	40	35	30	25	21	0
	UMS	90	72	63	54	45	36	0
2842	Raw	60	42	36	31	26	21	0
	UMS	90	72	63	54	45	36	0
2843	Raw	120	91	81	71	62	53	0
	UMS	120	96	84	72	60	48	0
2844	Raw	90	67	59	52	45	38	0
	UMS	90	72	63	54	45	36	0
2845	Raw	90	52	45	39	33	27	0
	UMS	90	72	63	54	45	36	0
2846	Raw	120	87	79	71	63	56	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
7885	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
7885	7.3	24.5	52.7	80.9	95.5	100.0	113

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