Pack 1

Exemplification Of Standards

External Assessment

Higher Physics

DETAILS OF THE INSTRUMENTS FOR EXTERNAL ASSESSMENT

Extract from Arrangements Document for Higher Level Physics.

"There will be a total of 90 marks for the paper.
Approximately 36 marks will be allocated to questions that require candidates to demonstrate achievement of a sample of the performance criteria associated with Outcome1 (O1) for the three component units.

Approximately 54 marks will be allocated to questions that require candidates to:

- demonstrate achievement of a sample of the performance criteria associated with Outcome 2 (O2) and Outcome 3 (O3) for the three component units;
- integrate knowledge and understanding, problem solving and analytical skills acquired through study of the component units;
- apply knowledge and understanding to solve problems in contexts which are less familiar than those associated with a study of the component units;
- solve problems which are less structured or set in more complex contexts;
- demonstrate knowledge and understanding of uncertainties within the contexts of any of the component units.

EXAMINATION PAPER SPECIFICATION

	Outcomes 1	*Outcomes 2 and 3*	*Total*
Mark allocation for: whole paper	36 ± 4	54 ± 4	90
each component unit	12 ± 3	18 ± 4	30 ± 4

GRADE DESCRIPTIONS

Course assessment will be based on achievement of the outcomes for the component units but will differ from the unit assessment in a number of regards. In undertaking the course assessment, candidates will be expected to demonstrate that the knowledge and understanding, problem solving and practical skills, which they acquired through their study of the component units, have been retained, and can be integrated and applied in contexts which are less familiar and more complex than those associated with study of the units.

The descriptions below indicate the nature of the achievement which is required for the award of grade C and a grade A in the course assessment.

Grade descriptions at "C"
Candidates can:

- use the appropriate knowledge and understanding acquired through the study of the component units
- apply knowledge set in contexts similar to those associated with the component units
- demonstrate the ability to integrate skills acquired in component units to solve problem
- apply knowledge and understanding to solve problems set in less familiar contexts

Grade descriptions at "A"
Candidates can:

- solve problems in which the concepts and given information may not be specified in the Content Statements
- apply knowledge and understanding to solve problems which are less structured or are set in more complex contexts

The above descriptions indicate the value of the course award over achievement of the individual units.

GUIDANCE NOTES ON MARKING INSTRUCTIONS

The following marking instructions contain the major points given to markers at the markers meeting..

The Answer and Marks column shows the solutions, with alternatives, and partial marks that can be gained by the candidate.
The notes, in italics, in the Notes/Comments column indicate points which the markers should be aware of for partial marks, deduction of marks or maximum deduction of marks.
The comments in the Notes/Comments column give information on the performance of candidates in that part of the question and perhaps techniques that could be used to improve poor performance. It may be a surprise to realise that candidates lose many marks in certain topics areas.
The column headed KU/PS indicates the category in which that part of the question was placed when the Paper was constructed and vetted. "KU" is used to indicate O1, "PS" indicates O2 or O3. Questions in these categories are designed to satisfy the Grade descriptions at "C".
"PS+" indicates that the question has been designed to give candidates the opportunity to demonstrate the ability to satisfy the Grade descriptions for an "A" award.

NOTES ON CANDIDATES SCRIPTS USED FOR EXEMPLIFICATION

A "C" candidate would be expected to obtain a reasonable number of marks in those questions categorised as KU or PS.
An "A" candidate would ideally be expected to obtain all the marks in those questions categorised as KU or PS and a reasonable number of marks in those categorised as PS+.
In reality the "C" candidate will gain some of the marks from the PS+ questions perhaps because their knowledge and understanding of the context of the question is good or because they have previous experience of the context of the question. The "A" candidate may not gain all the marks available in the questions designated KU or PS but is likely to gain sufficient marks in the PS+ type questions to achieve a total mark greater than the cut-off for the award of an "A".
The cut-offs for a grade A and a grade C assume that the range of scientific language, contexts and application of knowledge and understanding is commensurate with the standards associated with the grade descriptors.

MARKING INSTRUCTIONS WITH COMMENTS

HIGHER LEVEL PHYSICS 2000 SECTION B

Deduct only (1/2) mark maximum per question for incorrect significant figures
Deduct only (1/2) mark maximum per question for use of $g = 10 m s^{-2}$

Q 21		ANSWER AND MARKS	NOTES/COMMENTS	KU/PS	MARK
(a)	(i)	Horizontal component of velocity $=7 \cos 60$ $=3.5 \text{ m s}^{-1}$ (1)	*Deduct* (1/2) *if missing or incorrect unit* Candidates are generally very good at giving the components of a vector. A few made the mistake of having their calculators set for radian units. Candidates should be encouraged to set out their answers in the same order as in the question paper and to have the appropriate question label [e.g. (i)] next to their response.	KU	1
	(ii)	Vertical component of velocity $=7 \sin 60$ $=6.1 \text{ m s}^{-1}$ (1)	*Deduct* (1/2) *if missing or incorrect unit*	KU	1
(b)		Taking vector direction to the right as positive $s = ut + \frac{1}{2}at^2$ (1/2) $2.8 = 3.5 \times t + \frac{1}{2} \times 0 \times t^2$ (1/2) $t = \frac{2.8}{3.5} = 0.8 \text{ (s)}$ **OR** $t = \frac{s}{v}$ (1/2) $= \frac{2.8}{3.5}$ (1/2) $= 0.8 \text{ (s)}$	*There needs to be an indication that the 0.8 s has been worked out : if not then deduct* (1/2). Most candidates used the correct vector component in their responses. Candidates are quite good at using equations of motion especially where the signs of the directions of the variables are not required. It should be noted that there is no preferred positive direction for vectors in SQA questions. Candidates should be able to interpret graphs irrespective of which sign convention has been used in the question.	*KU*	1
(c)		Taking vector direction upwards as positive $s = ut + \frac{1}{2}at^2$ (1/2) $= 6.1 \times 0.8 + \frac{1}{2}(-9.8) \times (0.8)^2$ (1/2) $= 1.74 \text{ m}$ (1) **OR** *If candidate calculates maximum height then finds distance fallen through and uses this to calculate height of dish.* 2 equations (1/2) substitution (1/2) final answer (1)	*u and a must have opposite signs: if not this is wrong physics and there is only* (1/2) *mark maximum.* *Deduct* (1/2) *if candidate uses g=10 m s^{-2}* Some candidates assumed incorrectly that the coin was at its maximum height when it reached the dish. It is clear from the diagram that this is not the situation. There may a tendency for candidates not to read a question in detail but assume that it is identical to a problem they have solved in the past.	PS	2

		QUESTION 21 CONTINUED	It is in this type of question that too many candidates, even very able ones who eventually gain an A award, lose marks needlessly because of incorrect use of signs. The choice of sign is of course arbitrary but it must be consistent within a part of a question. Very few candidates draw a sketch diagram showing the positive direction of vectors or a list of variables with their appropriate signs. Although this may take a few seconds to do many candidates would benefit by using this technique. Some candidates attempted to solve this using trigonometry involving the distance and speed.		
(d)		Kinetic energy is less. **(1/2)** *can stand alone* Total energy is unchanged. **(1/2)** When coin enters the dish, it has more (gravitational) potential energy than when it left the contestant's hand. **(1)** **OR** E_k less *must have this* (1/2) Because speed is less (1/2) $Ek = 1/2\ mv^2$ (1) **OR** *Full marks if done by calculation* E_k at start =24.5 J (1/2) Gain in E_p =17.1 J (1/2) E_k at end =7.4 J (1/2) E_k less at end (1/2)	*Term gravitational energy not acceptable.* *Note* *"Some energy converted to heat energy" (0)* An A candidate would be expected to achieve some of the available marks with no wrong Physics in the response. A few had difficulty with the language and took " as it enters the dish " to mean when it is at rest in the dish.	PS+	2
					(7)

HIGHER LEVEL PHYSICS 2000 SECTION B

Deduct only (1/2) mark maximum per question for incorrect significant figures
Deduct only (1/2) mark maximum per question for use of $g = 10\text{m s}^{-2}$

Q 22		ANSWER AND MARKS	NOTES/COMMENTS	KU/PS	MARK
(a)	(i)	Taking vector direction upwards as positive $v^2 = u^2 + 2as$ **(1/2)** $v^2 = (0)^2 + 2\times(-9.8)\times(-2.0)$ **(1/2)** $v^2 = 39.2$ $v = 6.3\text{ m s}^{-1}$ **(1)** **OR** $\frac{1}{2}mv^2 = mgh$ (1/2) $\frac{1}{2}\times 15\times v^2 = 15\times 9.8\times 2.0$ (1/2) $v^2 = 39.2$ $v = 6.3\text{ m s}^{-1}$ (1)	*Deduct (1/2) if candidate uses g = 10m s^{-2}* *Deduct (1/2) if missing or incorrect unit* *Watch out for u and v being interchanged. This is wrong Physics and candidate is awarded (1/2) mark for formula only.* *Candidate can use the sign convention downward to be positive but again must be consistent.* This question involves the use of signs and many candidates lost marks even although it is categorised as KU. The loss of marks may be because of having *a* and *s* with opposite signs, resulting in taking the square root of a negative number and ending up with the correct answer but through wrong physics. Candidates also often insert the initial value of the velocity in place of *v*; this is treated as wrong physics.	KU	2
	(ii)	Taking vector direction upwards as positive Initial momentum of mass =15x(-6.3) $= -94.5\text{ (kg m s}^{-1}\text{)}$ **(1/2)** *The (1/2) is for momentum =mv* Final momentum =0 Change in momentum =*mv-mu* =0-(-94.5) $= 94.5\text{ (kg m s}^{-1}\text{)}$ **(1/2)** impulse on mass = change in momentum of mass $F_{\text{on mass}} \times \Delta t = (mv - mu)$ **(1/2)** $F_{\text{on mass}} = \frac{94.5}{0.02}$ $= 4725$ **(1/2** From NIII Force on pipe is -4725 N Force on **pipe** is 4725 N **downwards.** **(1)** *(1/2) for 4725N and (1/2) for direction*	*If there is no indication of direction either through use of sign convention or using words in final answer then deduct (1/2)* *Deduct (1/2) if missing or incorrect unit in final answer.* This is another example of a situation where 2 1/2 marks are often lost. Candidates should realise that a difference of vectors is always "final value - initial value". This is equally true of change in momentum and change in velocity.. A consistent sign convention should be used. Some candidates although starting with the correct formulae used the value of the initial velocity as *v* in the formula. This may have been because of poor technique or because the final velocity in (i) becomes the initial velocity for part (ii) of the question. Classified as PS+ because of the complex nature of the problem.	PS+	3

		QUESTION 22 CONTINUED ***OR*** $v = u + at$ (1/2) $0 = -6.3 + a \times 0.02$ $a = 315\,(\text{m s}^{-2})$ (1/2) F on mass $= ma$ (1/2) $= 15 \times (315)$ $= 4725$ N (1/2) From NIII Force on **pipe** is 4725 N **downwards** (1)			
(b)		• Same change in momentum (1) OR same impulse • Time of contact increased **(1/2)** • Average force on pipe decreased **(1/2)** **OR** Longer stopping time (1/2) $Ft = \Delta mv$ (1) Smaller force (1/2) **OR** Longer stopping time (1/2) $a=(v-u)/t$ **and** $F_{un} = ma$ (1) Smaller force (1/2) **OR** Longer stopping distance (1/2) Fs= change in E_k (1) Smaller force (1/2) **OR** Longer stopping distance (1/2) $s = ut + 1/2\ at^2$ and $F_{un} = ma$ (1) Smaller force (1/2)	Problem solving directly related to content statements. Candidates generally find this type of question difficult to answer and practice is required in this area. In this type of situation there are generally a maximum of four points. Candidates would be advised to give brief statements rather than to try to give an extended answer. . Usually the question can be answered by identifying • the quantity whose value has changed and whether its value has increased or decreased. • the relevant relationship/s involved • the quantities which have remained constant. • how the changes in the physical quantities affect the outcome.	PS	2
(c)		• Area of end of X < area of end of Y **(1/2)** OR X more pointed or sharper • Pressure = force/area **(1/2)** • Pressure of X > pressure of Y **(1/2)** • More damage done by X **(1/2)**	Some candidates stated that there was more damage done by Y because X had a greater surface area. A common misconception was that the "pressure was spread over a smaller area"	PS	2
					(9)

HIGHER LEVEL PHYSICS 2000 SECTION B

Deduct only **(1/2)** mark maximum per question for incorrect significant figures
Deduct only **(1/2)** mark maximum per question for use of $g = 10 \text{m s}^{-2}$

Q 23		ANSWER AND MARKS	NOTES/COMMENTS	KU/PS	MARK
(a)		pressure at bottom = $AP + \rho gh$ **(1/2) (1/2)** $= 101000 + 1000 \times 9.8 \times 1.05$ **(1/2)** *for addition* $= 111290$ N **Data (1/2)**	• *Deduct* (1/2) *if candidate uses* $g = 10 \text{m s}^{-2}$ • *Deduct* (1/2) *if missing or incorrect unit* • *must write down final answer - if not then deduct* (1/2) • *If use wrong value for* ρ *then maximum*(11/2) *(treat as arithmetical slip)* This was generally well done.	KU	2
(b)		Pressure difference = 111290 -108350 =2940 (Pa) **(1)** upthrust = pressure difference x area **(1/2)** = 2940 × 0.40 = 1176 N **(1)** **OR** $F_{bottom} = p \times A$ *(1/2)* =11290 × 0.4 =44516 (N) 0.4 (1/2) F_{top} =108350 × 0.4 =43340 (N) (1/2) Upthrust = 44516-43340 (1/2) = 1176 N (1)	**OR** *Pressure difference = 10290-7350* *=2940 (Pa)* *if* $p \neq 2940$ *or there is an attempt to calculate a pressure difference then candidate can still get (1/2) for* $F = p \times A$ *If use* p_{bottom} *= upthrust then this is wrong physics 0 marks.* *If candidate writes down "upthrust =pressure difference" this is regarded as bad form if candidate finishes answer successfully - otherwise no partial marks can be awarded.* *Deduct (1/2) if missing or incorrect unit* Some candidates stated "upthrust = pressure difference" or "upthrust = pressure on bottom area" Although this problem can and was solved using Archimedes' Principle and marks were awarded for such a solution, Archimedes' Principle is not in the contents of the syllabus. This Principle would not form a valid explanation for the occurrence of upthrust. Candidates should be able to distinguish between buoyancy force (upthrust) and the term buoyancy.	PS	3

(c)		**QUESTION 23 CONTINUED** Upthrust is greater **(1)** *must have this* Density of sea water >density of fresh water **(1/2)** Pressure difference in sea water greater **(1/2)** **OR** Upthrust is greater (1) Density of sea water is greater (1/2) Weight of liquid displaced is greater (1/2)	*Accept values for the appropriate densities* *Correct answer with no justification (0)* *Correct answer and wrong physics (0)* *Correct answer with correct but irrelevant physics (1)* Some candidates seemed to work toward the answer to the question they expected rather than the question that was set. They expected the upthrust to remain constant.	PS+	2
					(7)

HIGHER LEVEL PHYSICS 2000 SECTION B

Deduct only (1/2) mark maximum per question for incorrect significant figures

Q 24		ANSWER AND MARKS	NOTES/COMMENTS	KU/PS	MARK
(a)		$C = \frac{Q}{V}$ **(1/2)** $= \frac{(32 \pm 1) \times 10^{-6}}{(2.56 \pm 0.01)}$ **(1/2)** $= \frac{32x10^{-6} \pm 3.1\%}{2.56 \pm 0.4\%}$ **(1/2)** $= 1.25 \times 10^{-5}\,F \pm 3.1\%$ **(1/2) (1/2) (1/2)**	*No uncertainty calculated (1 1/2)* *Accept 12.5μF* *Q=(32 ± 1) deduct (1/2)* *If absolute error calculated correctly no penalty but must have stated 3.1% error* *Partial marks for 3.1% (1/2)* *0.4% (1/2)* *do not accept 3.5% sum* Generally well done but presentation of answers could have been better.	PS	3
	(i)	$E = 1/2\ CV^2$ **(1/2)** $= 1/2 \times 2200x10^{-6} \times (12)^2$ **(1/2)** $= 0.16$ J **(1)**	*Need E=1/2 QV and Q=VC as alternative for formula (1/2) mark* *C= 2200 deduct (1/2)* *Deduct (1/2) if missing or incorrect unit* Some use of $E = 1/2\ QV$ and then substituting $Q = 2220x10^{-6}$.	KU	2
	(ii) (A)	• Switch S is opened, C discharges **(1)** • Current in relay coil for a short time or until C discharges **(1/2)** • So relay closed for short time (so lamp on for a short time) **(1/2)**	*If add bulb less bright deduct (1/2)* Not well done. Many not distinguishing between the current in the capacitor circuit and the current in the lamp circuit. The expression "voltage through" used rather than "voltage across".	PS	2
	(ii) (B)	Lamp on for less time **(1)** 1. Smaller C stores less charge (or energy) 2. C takes less time to discharge **(do not allow drain)** 3. Current in relay coil for less time **(1)** for any of the three statements	Badly done. Many stated that the capacitor would charge more quickly or that the lamp would be less bright.	PS+	2
					(9)

HIGHER LEVEL PHYSICS 2000 SECTION B

Deduct only **(1/2)** mark maximum per question for incorrect significant figures

Q 25		ANSWER AND MARKS	NOTES/COMMENTS	KU/PS	MARK
(a)	(i)	Photovoltaic mode **(1)**	Variable response to a simple question testing KU.	KU	1
	(ii)	The light causes electron-hole pairs **(1/2)** (to be created) in the junction **(1/2)**	*Accept free charge carriers or positive and negative charges.* *If only electrons are released (0)* This was very badly done.	KU	1
	(iii)	Reading on the voltmeter will increase. **(1)**	Mostly correct answers for this part.	PS	1
(b)	(i)	e.m.f = 0.508 V **(1)**	*Deduct (1/2) if missing or incorrect unit.* A question which integrates the content of units 2 and 3 which might have caused difficulty but was generally well done.	PS	1
	(ii)	$r = \frac{E-V}{I}$ **(1/2)** $= \frac{0.508-0.040}{2.00\times10^{-3}}$ **(1/2)** $= 234\Omega$ **(1)** **OR** $E = I(R+r)$ (1/2) $0.508 = 0.002(20+r)$ (1/2) $r = 234\Omega$ (1) **OR** $R_{Total} = \frac{0.508}{2.00\times10^{-3}}$ $= 254(\Omega)$ (1/2) $r = 254-20$ (1/2) $= 234\Omega$ (1) **OR** $\frac{R_1}{R_2} = \frac{V_1}{V_2}$ (1/2) $\frac{r}{20} = \frac{0.468}{0.040}$ (1/2) $= 234\Omega$ (1)	*Deduct (1/2) if missing or incorrect unit* *I=2.00 deduct (1/2)* *If corrigenda to question have not been used do not penalise.* Again well done by many candidates although some did not notice the unit of current was mA.	PS+	**2**

(c)		**QUESTION 25 CONTINUED** • With 10Ω resistor in the circuit there is more current **(1)** • p.d. across internal resistance increases OR lost volts increases **(1)** **OR** $I = \frac{E}{R_{total}}$ (1/2) $= \frac{0.508}{244}$ (1/2) 0.0021 (A) (1/2) $V_{reading} = 0.0021 \times 10$ (1/2) $= 0.021\,V$ **OR** $V_{tpd} = E - Ir$ (1/2) As I increases (1/2) (Ir) increases (1/2) and therefore V_{tpd} decreases. (1/2)	*Statements opposite are independent marking.* Very badly done. Although this is classified as PS+ it was expected that many of the A candidates would recognise this situation from previous work. Many responded that as R decreased then V would decrease, as I was constant.	PS+	2
					(8)

HIGHER LEVEL PHYSICS 2000 SECTION B

Deduct only (1/2) mark maximum per question for incorrect significant figures

Q 26		ANSWER AND MARKS	NOTES/COMMENTS	KU/PS	MARK
(a)	(i)	Period = 4 divisions $= 4 \times 2.5 \times 10^{-3}$ =0.01 (s) **(1/2)** $f = \frac{1}{period}$ **(1/2)** $= \frac{1}{0.01}$ = 100 Hz **(1)**	*If v=fλ wrong physics (0)* *If period =10 deduct(1/2)* *If period =5 divisions giving f=80Hz then* (1 1/2) *If period not 4 or 5 divisions then* (1/2) *only for f=1/T* *Accept cycles/second* • *Deduct* (1/2) *if missing or incorrect unit*	KU	2
	(ii)	V_{peak} = 2divisions =2x5 = 10 (V) **(1/2)** $V_{rms} = \frac{Vpeak}{\sqrt{2}}$ **(1/2)** =7.1 (V) **(1/2)** $I_{rms} = \frac{V_{rms}}{R}$ $= \frac{7.1}{200}$ **(1/2)** = 0.036 A **(1)** **OR** $I_{peak} = \frac{10}{200}$ (1/2) = 0.05 (A) (1/2) $I_{rms} = \frac{I_{peak}}{\sqrt{2}}$ (1/2) $= \frac{0.05}{\sqrt{2}}$ (1/2) = 0.036 A (1)	*If I=10/200 =0.05 get (1/2) for V=10* volts *If Vpeak ≠ 10 deduct (1/2)* Some candidates again answered the question they expected i.e. V_{rms} rather than what was asked.	PS	3
(b)		Half cycle missing **(1/2)** Because diode conducts only every half cycle **(1/2)** **OR** when it is forward biased V_{peak} across the resistor is less **(1/2)** Because there is a p.d. across the diode **(1/2)** **OR** less current in the circuit	*Candidates must give a reason for the change.* "Negative voltages removed" was a common reason given for the effect.	PS+	2
					(7)

HIGHER LEVEL PHYSICS 2000 SECTION B

Deduct only **(1/2)** mark maximum per question for incorrect significant figures

Q 27		ANSWER AND MARKS	NOTES/COMMENTS	KU/PS	MARK
(a)		Intensity = power per unit area **(1)** **OR** intensity = number of watts per m^2 **(1)** **OR** intensity = $\frac{\text{incident power}}{\text{area it falls on}}$ **(1)**	*I=Nhf (1/2)* *I=P/A (1/2)* *Unless symbols explained in words* $I = \frac{power}{area}$ *(1)* Generally well done.	KU	1
(b)		Intensity depends on distance **(1)**	*If $I \propto 1/d$ (1)* *If ray of light has a uniform intensity which does not alter with distance (1)* Generally well done.	PS	1
(c)	(i)	42^0 **(1)**	*Accept values 41.5^0 to 42.5^0* Generally well done.	PS	1
	(ii)	$n = \frac{1}{\sin\theta_c}$ **(1/2)** $= \frac{1}{\sin 42}$ **(1/2)** $= 1.49$ **(1)** OR By measuring angles on diagram $n_s = \frac{\sin\theta_1}{\sin\theta_2}$ (1/2) $= \frac{\sin(40\pm1)}{\sin(25\pm1)}$ (1/2) $= 1.52$ (1/2) If n=1.5 or 1.50 do not accept unless evidence of calculation/formula	θ must be consistent with answer to c(i) Candidates are usually very competent when asked to apply this relationship.	KU	2
	(iii)	Decreases **(1)**		PS	1
					(6)

HIGHER LEVEL PHYSICS 2000 SECTION B

Deduct only **(1/2)** mark maximum per question for incorrect significant figures

Q 28		ANSWER AND MARKS	NOTES	KU/PS	MARK
(a)	(i)	Electrons are emitted from a metal surface **(1/2)** when exposed to electromagnetic radiation/ light/photons **(1/2).**	*Not "radiation" as this might imply nuclear radiation.* Too many candidates tried to explain this in terms of incoming electrons and outgoing photons.	KU	1
	(ii)	Threshold frequency **(1)**	*A large number of candidates answered "freshhold"*	KU	1
	(iii)	• More photons (are incident on the surface) **(1)** • More electrons **(1/2)** are ejected per second **(1/2)** ***OR*** "More photons (are incident on surface (1) More charge (1/2) is transferred in 1s (1/2)" **OR** "more photons (1) more electrons/charge (1/2) in one second (1/2)" *All answers to (iii) are independent marks*	*Photoelectric current proportional to intensity (0) as this is not an explanation.* Very few candidates stated that there were more photons and the importance of "per second" was not recognised.	PS	2
(b)	(i)	$E = hf$ **(1/2)** $= 6.63\times10^{-34} \times 9\times10^{14}$ (data **1/2** mark) $=5.97\times10^{-19}$ J **(1)**	(1/2) *for value of h as long as obvious reference to h.* *Deduct* (1/2) *if missing or incorrect unit.* *Generally well done.*	KU	2
	(ii)	number of photons $= \frac{40.5\times10^{-6}}{5.97\times10^{-19}}$ **(1/2)** $= 6.78\times10^{13}$ J **(1/2)**	*If 40.5 used then deduct* (1/2) *If use I=Nhf* (0) *need time and area* No partial marks. Very many attempted to use the relationship $I = Nhf$ *but* did not recognise the importance of area and time in this relationship.	PS	1
	(iii)	Longer time **(1/2)** since fewer uv photons **(1)** per second **(1/2)** **OR** longer time (1/2) as less uv light (1 1/2) **OR** longer time (1/2) as sunlight contains other wavelengths/ frequencies of light. (11/2) **OR** longer time (1/2) for required number of uv photons (1) to deliver the energy needed (1/2) **OR** longer time (1/2) since same number of uv photons needed (1/2) but there are fewer uv photons (1).	*Do not allow sunlight has more colours than uv light.* Many candidates stated that the intensity of sunlight was less or same intensity so same time required.	PS+	2
					(9)

HIGHER LEVEL PHYSICS 2000 SECTION B

Deduct only **(1/2)** mark maximum per question for incorrect significant figures

Q 29		ANSWER AND MARKS	NOTES/COMMENTS	KU/PS	MARK
(a)	(i)	x=222 **(1/2)** y= 86 **(1/2)**	Generally well done	KU	1
	(ii)	There is a decrease/loss in mass after the decay **(1/2)** From $E=1/2\ mc^2$ energy is released **(1/2)** OR Mass is lost (1/2) and converted to energy (1/2) OR mass loss and energy are equivalent (1)	*If "mass defect" is used deduct (1/2) mark as this is specific to reduction to individual particles.*	KU	1
	(iii)	Total mass before $=3.75428\times10^{-25}$ (kg) Total mass after $= 3.75419\times10^{-25}$ (kg) **(1/2)** Decrease in mass $= 9\times10^{-30}$ kg **(1/2)** **Some attempt must be made at calculating mass loss for dotted line to be used** Energy released $=mc^2$ **(1/2)** $=9\times10^{30} \times (3\times10^{8})^2$ **(1/2) for data** $=8.1 \times 10^{-13}$ J **(1)**	*Accept 8.68×10^{-30} kg* *Full marks for candidates who use energy equivalent of mass throughout.* Generally well done.	PS+	3
(b)		Final E_k $=1/2\ mv^2 + qV$ **(1/2)** **(1/2)** $= 1/2\times6.64832 \times 10^{-27} \times (1.5 \times 10^{7})^2$ **(1/2)** $+ 3.2\times10^{-19} \times 25000$ **(1/2)** $= 7.479\times10^{-13} + 8\times 10^{-15}$ **(1/2)** $=7.56\times10^{-13}$ (J) **(1/2)**	*If V = 25 V then deduct* (1/2) If work out $E_k = 1/2\ mv^2$ $= 1/2\times6.64832\times10^{-27}\times (1.5\times107)^2$ then (1) Very badly done. Many did not recognise that the mass of the alpha particle had been given in introduction to the question	PS+	3
					(8)

Paper Analysis grid

	Outcome 1				Outcome 2/3					
Unit 1	1a	1b	1c	1d	2a	2b/3d	2c/3f	2d/3b /3g	3e	A
1	1									
2		1								
3					1					
4						1				
5	1									
6						1				
7				1						
21(a)		2								
(b)		1								
(c)						2				
(d)							2			2
22(a)(i)		2								
(ii)						3				3
(b)							2			
(c)							2			
23(a)		2								
(b)						3				
(c)							2			2
PC totals	(2)	(8)	(0)	(1)	(1)	(10)	(8)	(0)	(0)	(7)
Outcome totals	11				19					
Unit 2										
8	1									
9		1								
10			1							
11			1							
12		1								
13							1			
24(a)									3	
(b)(i)						2				
(ii)(A)			2							
(ii)(B)							2			2
25(a)(i)			1							
(ii)				1						
(iii)							1			
(b)(i)					1					
(ii)						2				2
(c)							2			2
26(a)(i)		2								
(ii)						3				
(b)							2			2
PC totals	(1)	(4)	(5)	(1)	(1)	(7)	(8)	(0)	(3)	(8)
Outcome totals	11				19					
Unit 3										
14		1								
15					1					
16			1							
17		1								
18				1						
19						1				
20				1						
27(a)	1									
(b)								1		
(c)(i)					1					
(ii)		2								
(iii)							1			
28(a)(i)				1						
(ii)	1									
(iii)							2			
(b)(i)		2								
(ii)						1				
(iii)							2			2
29(a)(i)					1					
(ii)			1							
(iii)						3				3
(b)						3				3
PC totals	(2)	(6)	(2)	(3)	(3)	(8)	(5)	(1)	(0)	(8)
Outcome totals	13				17					
PAPER	35				55					23