SCOTTISH QUALIFICATIONS AUTHORITY

2000 Physics
Higher
Finalised Marking Instructions

Strictly Confidential

These instructions are **strictly confidential** and, in common with the scripts entrusted to you for marking, they must never form the subject of remark of any kind, except to Scottish Qualifications Authority staff. Similarly, the contents of these instructions must not be copied, lent or divulged in any way now, or at any future time, to any other persons or body.

Markers' Meeting

You should use the time before the meeting to make yourself familiar with the question paper, instructions and any scripts which you have received. Do **not** undertake any final approach to marking until **after** the meeting. Please note any points of difficulty for discussion at the meeting.

Note: These instructions can be considered as final only after the markers' meeting when the full marking team has had an opportunity to discuss and finalise the document in the light of a wider range of candidates' responses.

Marking

The utmost care must be taken when entering and totalling marks. Where appropriate, all summations for totals must be carefully checked and confirmed.

Where a candidate has scored zero marks for any question attempted, "0" should be entered against the answer.

Recording of Marks

The mark for each **question**, where appropriate, should be entered **either** on the grid provided on the back page of the answer book, **or** in the case of question/answer books, on the grid (if provided) on the last page of the book. Where papers assess more than one element, care must be taken to ensure that marks are entered in the correct column.

The **Total** mark for each paper or element should be entered (in red ink) in the box provided in the top-right corner of the front cover of the answer book (or question/answer book).

Always enter the **Total** mark as a **whole number**, where necessary by the process of rounding up.

The transcription of marks, within booklets and to the Mark Sheet, should always be checked.

2000 Physics Higher
Section A
Finalised Marking Instructions

1.	C	11.	A
2.	D	12.	B
3.	D	13.	A
4.	B	14.	D
5.	E	15.	A
6.	D	16.	C
7.	A	17.	C
8.	C	18.	E
9.	D	19.	B
10.	E	20.	C

HIGHER LEVEL PHYSICS

INSTRUCTIONS

1. The marks awarded for each part as indicated in the marking scheme should be recorded in the right hand inner margin. The total mark awarded for each question should be recorded, in the outer margin, at the start of the answer for that question.

2. The fine division of marks shown in the marking scheme may be recorded within the body of the script beside the candidate's answer. If such marks are shown they must total to the mark in the inner margin.

3. Negative marks or marks to be subtracted should not be shown. An inverted vee may be used instead.

4. The number recorded should always be the mark awarded.
The number out of which a mark is scored SHOULD NEVER BE SHOWN AS A DENOMINATOR (½ will always mean one half mark and never 1 out of 2)

5. Make sure that "6" can be distinguished from "0" and a "1" from a "7"

6. Fractional marks, if awarded to individual questions, should be recorded in the right hand inner margin of the script.

7. Where square ruled paper is enclosed inside answer books it should be clearly indicated that this item has been considered. Marks should be transferred to the script inner margin and marked "G".

8. The individual question totals that are transferred to the grid on the cover of the answer book should be those shown in the outer margins of the answer book.

9. Fractional marks if awarded to individual questions should be recorded in the grid. The total, including fractional marks, should be shown at the bottom of the grid.

10. The total script mark, if necessary rounded up to the next whole number, should be transferred to the box at the top of the front page of the script.

11. Check all additions carefully by summing marks from the first page to the last page of the script then from the last to the first page.

GENERAL INSTRUCTIONS

a) No marks allowed for a description of the wrong experiment or one which would not work. Full marks should be given for information conveyed directly by a sketch.

b) Surplus answers: where a number of reasons, examples etc are asked for and a candidate gives more than the required number then wrong answers may be treated as negative and cancel out part of the previous answer.

c) Full marks should be given for a correct answer to a numerical problem even if the steps are not shown explicitly. The part marks shown in the scheme are for use in marking partially correct answers.

d) Where 1 mark is shown for the final answer to a numerical problem ½ mark may be deducted for an incorrect unit.

e) Where a final answer to a numerical problem is given in the form 3^{-6} instead of $3x10^{-6}$ then deduct ½ mark.

f) Deduct ½ mark if an answer is wrong because of an arithmetical slip.

g) No marks may be awarded in a part question after the application of a wrong physics principle (wrong formula, wrong substitution) unless specifically allowed for in the marking scheme.

h) In certain situations, a wrong answer to a part of a question can be carried forward within that part of the question. This would incur no further penalty provided that it is used correctly. Such situations are indicated by a horizontal dotted line in the marking instructions.
Wrong answers can always be carried forward to the next part of the question, over a solid line, without penalty.

i) No marks should be awarded for a formula unless an attempt is made to substitute data from the question.

j) Where a triangle type "relationship" is written down and then not used or used incorrectly then any partial ½ mark for a formula should not be awarded.

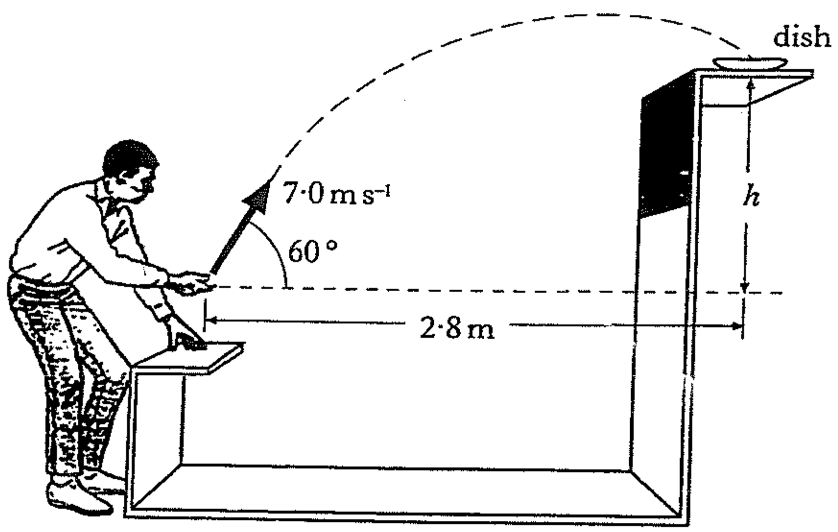
k) In numerical calculations, if the correct answer is given then coverted wrongly in the last line to another multiple/submultiple of the correct unit then deduct ½ mark.

SECTION B

Write your answers to questions 21 to 29 in the answer book.

Marks

21. At a funfair, a prize is awarded if a coin is tossed into a small dish. The dish is mounted on a shelf above the ground as shown.



A contestant projects the coin with a speed of $7{\cdot}0\,m\,s^{-1}$ at an angle of 60° to the horizontal. When the coin leaves his hand, the **horizontal distance** between the coin and the dish is 2·8 m. The coin lands in the dish.

The effect of air friction on the coin may be neglected.

(*a*) Calculate:

(i) the horizontal component of the initial velocity of the coin;

(ii) the vertical component of the initial velocity of the coin. **2**

(*b*) Show that the time taken for the coin to reach the dish is 0·8 s. **1**

(*c*) What is the height, *h*, of the shelf above the point where the coin leaves the contestant's hand? **2**

(*d*) How does the value of the kinetic energy of the coin when it enters the dish compare with the kinetic energy of the coin just as it leaves the contestant's hand?

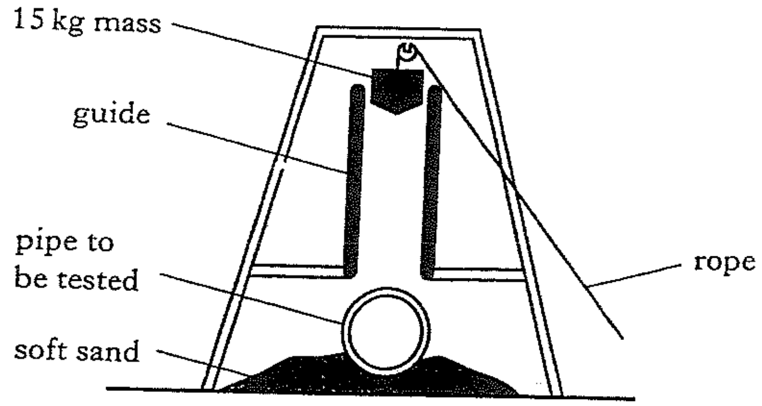
Justify your answer. **2**

(7)

[Turn over

Answer and mark allocation	Notes	Inner margin	Outer margin
21.(a) (i) horizontal comp of vel = 7 cos60 = 3.5 m s^{-1} (½) (½)		1	7
(ii) vertical comp of vel = 7 sin60 = 6.1 m s^{-1} (½) (½)		1	
(b) HORIZONTALLY → + $s = ut + ½at^2$ (½) $2.8 = 3.5 \times t + ½ \times 0 \times t^2$ $t = 2.8 / 3.5 = 0.8$ s (½)	accept : t = s/v (½) = 2.8/3.5 (½) = 0.8 s need indication that 0.8 s has been worked out	1	
(c) VERTICALLY ↑ + $s = ut + ½at^2$ (½) $= 6.1 \times 0.8 + ½ \times (-9.8) \times 0.8^2$ (½) = 1.74 m (½) (½)	if a = 10 m s^{-2} deduct (½)	2	
(d) Kinetic energy is less (½) Total energy is unchanged(½) When coin enters dish, it has more gravitational potential energy (1) than when it left the contestant's hand.		2 +	

22. The apparatus shown below is used to test concrete pipes. *Marks*



When the rope is released, the 15 kg mass is dropped and falls freely through a distance of 2·0 m on to the pipe.

(*a*) In one test, the mass is dropped on to an uncovered pipe.

(i) Calculate the speed of the mass just before it hits the pipe.

(ii) When the 15 kg mass hits the pipe the mass is brought to rest in a time of 0·02 s. Calculate the size and direction of the average unbalanced force on the **pipe**. **5**

(*b*) The same 15 kg mass is now dropped through the same distance on to an identical pipe which is covered with a thick layer of soft material.

Describe and explain the effect this layer has on the size of the average unbalanced force on the pipe. **2**

(*c*) Two 15 kg masses, X and Y, shaped as shown, are dropped through the same distance on to identical uncovered concrete pipes.

When the masses hit the pipes, the masses are brought to rest in the same time.

Which mass causes more damage to a pipe?

Explain your answer in terms of pressure. **2**

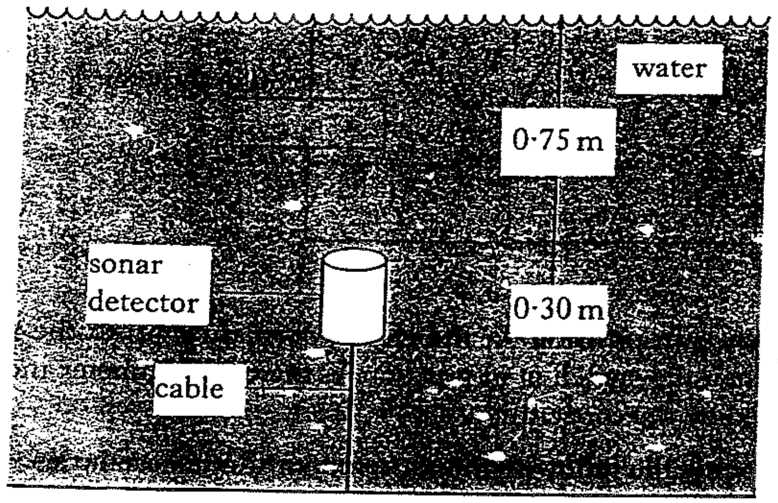
(9)

4

Answer and mark allocation	Notes	Inner margin	Outer margin
22.(a)(i) VERTICALLY ↓ + $v^2 = u^2 + 2as$ (½) $v^2 = (0)^2 + 2 \times 9.8 \times 2.0$ (½) $v^2 = 39.2$ $v = 6.3\ m\ s^{-1}$ (½) + (½)	OR $½mv^2 - 0 = mgh$ (½) $½ \times 15 \times v^2 = 15 \times 9.8 \times 2.0$ (½) $v^2 = 39.2$ $v = 6.3\ ms^{-1}$ (½) (½) $g = 10\ N\ kg^{-1}$ deduct (½)	2	9
(ii) initial mom of mass = 15 x 6.3 = 94.5 (kg ms^{-1}) (½) (the (½) is for mom=mv) final mom of mass = 0 change in mom of mass = 0 - 94.5 = –94.5 (kg ms^{-1}) (½) impulse on mass=change in mom of mass (average) F_{un} on mass ∴ Δt= –94.5 (½) $F_{un} \times 0.02 = -94.5$ F_{un} on mass= –4725 N (½) From Newton 3 : F_{un} on pipe=+4725 N (½) (½) (or 4725 N downwards)	OR v=u +at (½) ↓ + 0=6.3 + ax0.02 a= –315 (ms^{-2}) (½) F_{un} on mass=ma (½) =15x(–315) =–4725(N)(½) From Newton III F_{un} on pipe=+4725N (½)(½) OR impulse=change in mom $F_{un} x \Delta t = 94.5$ (½) (1) $F_{un} = 94.5/0.02$ =4725N downwards (½)(½) (½) if there is no indication of direction either through use of a sign convention or using words deduct (½)	3 +	
(b) same change in momentum (1) (or same impulse) time of contact increased (½) average F_{un} on pipe decreased (½)		2	
(c) both X and Y exert same average F_{un} on pipe (½) area of X < area of Y (½) pressure = force/area (½) pressure of X>pressure of Y(½) (so more damage done by X)		2	

Marks

23. A sonar detector is attached to the bottom of a fresh water loch by a vertical cable as shown.



The detector has a mass of 100 kg. Each end of the detector has an area of $0{\cdot}40\,m^2$. Atmospheric pressure is 101 000 Pa.

(*a*) The total pressure on the top of the detector is 108 350 Pa.

Show that the total pressure on the bottom of the detector is 111 290 Pa. **2**

(*b*) Calculate the upthrust on the detector. **3**

(*c*) The sonar detector is now attached, as before, to the bottom of a **sea water** loch. The top of the detector is again 0·75 m below the surface of the water.

How does the size of the upthrust on the detector now compare with your answer to (*b*)?

You must justify your answer. **2**

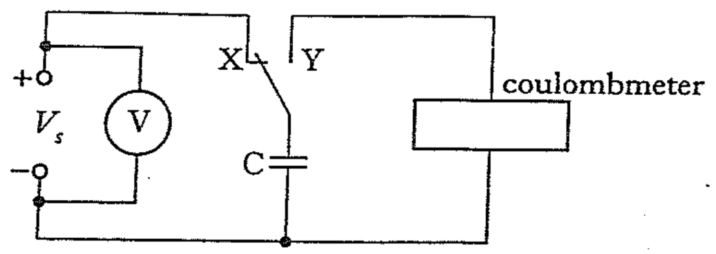
(7)

[Turn over

Answer and mark allocation	Notes	Inner margin	Outer margin
23.(a) pressure at bottom=AP + ϱgh (½) (½) =101000+1000x9.8x1.05 (½) (½) =111290 Pa	(½) is for adding $g=10Nkg^{-1}$ deduct (½) **OR** $p_{bottom}=p_{top} + \varrho gh$ (½) (½) =108530+1000x9.8x0.30 (½) (½) =11290Pa Candidates who only use $p=\varrho gh$ get (½) for formula and (½) for $\varrho=1000\ kgm^{-3}$	2	7
(b)pressure diff = 111290 - 108530 = 2940(Pa) (1) upthrust =pressure diff x area(½) =2940 x 0.40 (½) =1176 N (½) (½) OR F_{bottom} = p x A(½) = 111290 x 0.4 = 44516(N)(½) F_{top} = 108350 x 0.4 = 43340(N)(½) Upthrust = 44516 - 43340 (½) = 1176 N (½) (½)	Accept pressure diff=10290-7350 =2940(Pa) (1) Accept F = p x A (½) If p $\neq$ 2940 or there is an attempt to calculate a pressure difference, these candidates can still get (½) F = p x A Accept p_{bottom}=10290 Pa Accept p_{top}=7350 Pa	3	
(c) Upthrust is greater (1) $\varrho_{sea\ water} > \varrho_{fresh\ water}$ (½) pressure diff in sea water greater (½) OR Upthrust is greater (1) $\varrho_{sea\ water}$ is greater(½) wt of liq disp is greater(½)	Accept values for the appropriate densities Correct ans no justific^n(0) Correct ans and WP(0) Correct ans with correct irrelevant Physics(1)	2	

Marks

24. (a) In an experiment to measure the capacitance of a capacitor, a student sets up the following circuit.



When the switch is in position X, the capacitor charges up to the supply voltage, V_s. When the switch is in position Y, the coulombmeter indicates the charge stored by the capacitor.

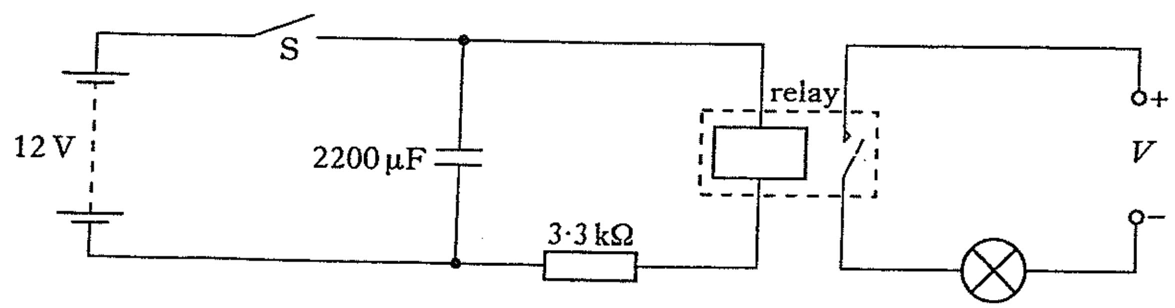
The student records the following measurements and uncertainties.

Reading on voltmeter = $(2{\cdot}56 \pm 0{\cdot}01)$ V
Reading on coulombmeter = $(32 \pm 1)\,\mu$C

Calculate the value of the capacitance and the percentage uncertainty in this value. You must give the answer in the form

value ± percentage uncertainty. **3**

(b) The student designs the circuit shown below to switch off a lamp after a certain time.



The 12 V battery has negligible internal resistance.

The relay contacts are normally open. When there is a current in the relay coil the contacts close and complete the lamp circuit.

Switch S is initially closed and the lamp is on.

(i) What is the maximum energy stored in the capacitor?

(ii) (A) Switch S is now opened. Explain why the lamp stays lit for a few seconds.

(B) The 2200 μF capacitor is replaced with a 1000 μF capacitor.

Describe and explain the effect of this change on the operation of the circuit. **6**

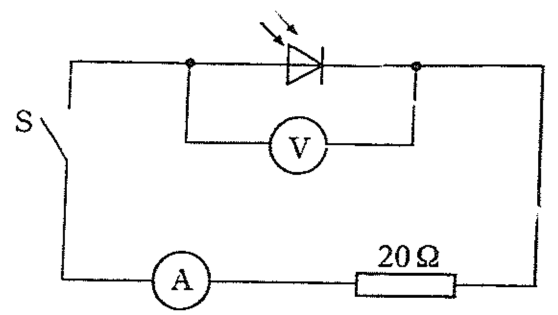
(9)

6

HIGHER PHYSICS SECTION B 2000

Answer and mark allocation	Notes	Inner margin	Outer margin
24(a) $C = Q / V$ (½) $= (32\pm1)\text{x}10^{-6} / (2.56\pm0.01)$ $= 32\text{x}10^{-6}\pm3.1\%$ (½)/$(2.56\pm0.4\%)$(½) $= 1.25\text{x}10^{-5} \pm 3.1\%$ F (½) (½) (½)	Q = (32±1) deduct (½) (½) for 3.1% (½) for 0.4%	3	9
(b)(i) $E = \frac{1}{2}CV^2$ (½) $= \frac{1}{2}\text{x}2200\text{x}10^{-6}\text{x}(12)^2$ (½) $= 0.16$ J (½) (½)	C=2200 deduct (½)	2	
(ii)(A) S opened, C discharges (1) (through 3.3k and relay) Current in relay coil for short time(½) so relay closed for short time(½) (so lamp on for short time)	Accept residual magnetism(1) keeps relay closed(1) (for short time)	2	
(B) lamp on for less time(1) since: smaller C stores less charge (or energy) C takes less time to discharge current in relay coil for less time	ANY TWO opposite (½) mark EACH	2 +	

25. A photodiode is connected in a circuit as shown below. *Marks*



Switch S is open.
Light is shone on to the photodiode.
A reading is obtained on the voltmeter.

(*a*) (i) State the mode in which the photodiode is operating.

(ii) Describe the effect of light on the material of which the photodiode is made.

(iii) The intensity of the light on the photodiode is increased. What happens to the reading on the voltmeter? 3

(*b*) Light of a constant intensity is shone on to the photodiode in the circuit shown above.

The following measurements are obtained with S open and then with S closed.

	S open	S closed
reading on voltmeter/V	0·508	0·040
reading on ammeter/mA	0·00	1·08

(i) What is the value of the e.m.f. produced by the photodiode for this light intensity?

(ii) Calculate the internal resistance of the photodiode for this light intensity. 3

(*c*) In the circuit above, the 20 Ω resistor is now replaced with a 10 Ω resistor.
The intensity of the light is unchanged.
The following measurements are obtained.

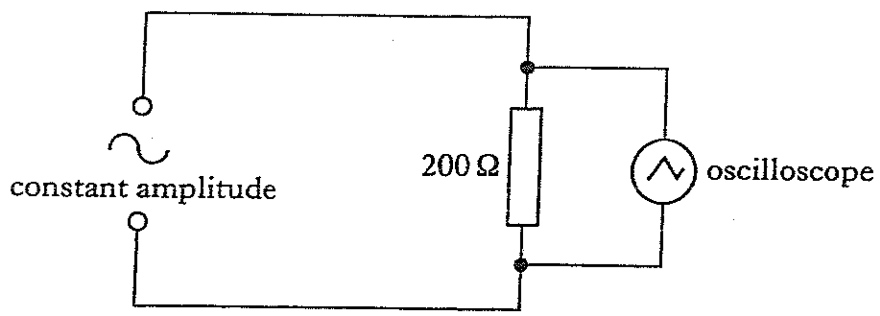
	S open	S closed
reading on voltmeter/V	0·508	0·011

Explain why the reading on the voltmeter, when S is closed, is smaller than the corresponding reading in part (*b*). 2

(8)

Answer and mark allocation	Notes	Inner margin	Outer margin
25(a)(i) photovoltaic mode (1)		1	8
(ii) The light causes electron - hole pairs(½) (to be created) in the junction(½) (or intinsic layer)	for electron-hole pairs accept free charge carriers or positive and negative charges If only electrons are released (0) marks	1	
(iii) it will increase (1)		1	
(b)(i) e.m.f. = 0.508 V (½) (½)		1	
(ii) $r = E - V/I$(½) $= 0.508 - 0.040 / 2.00\text{x}10^{-3}$ (½) $= 234\ \Omega$ (½)(½) **OR** $R_T = 0.508/2.00\text{x}10^{-3}$ $= 254\ (\Omega)$ (½) $r = 254 - 20$ (½) $r = 234\ \Omega$ (½)(½) **OR** $R_1/R_2 = V_1/V_2$ (½) $r/20 = 0.468/0.040$ (½) $r = 234\ \Omega$ (½)(½)	I=2.00 deduct (½)	2	
(c) With 10 Ω resistor in circuit there is more current (drawn from photodiode)(1) p.d. across internal resistance increases(1) **OR** lost volts increases	The statements opposite are independent marking **OR by calculation** $I = emf / R_T$ (½) $= 0.508/244$(½) $= 0.0021(A)$ (½) $V_{reading} = 0.0021\text{x}10$ (½) $= 0.021\ V$	2	

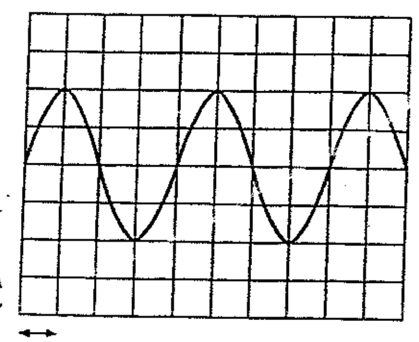
26. A circuit is set up as shown below. The amplitude of the output voltage of the a.c. supply is kept constant. *Marks*



The settings of the controls on the oscilloscope are as follows:

y-gain setting = 5 V/division
time-base setting = 2·5 ms/division

The following trace is displayed on the oscilloscope screen.



(*a*) (i) Calculate the frequency of the output from the a.c. supply.

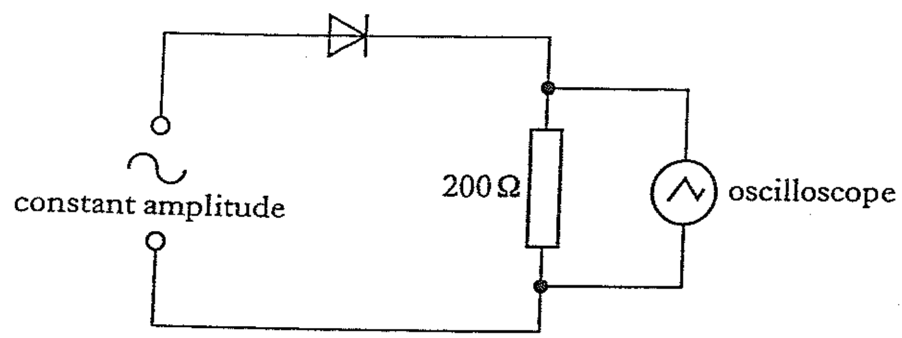
(ii) Calculate the **r.m.s. current** in the 200 Ω resistor. 5

Answer and mark allocation	Notes	Inner margin	Outer margin
26(a)(i) period = 4 divs = $4 \times 2.5 \times 10^{-3}$ = 0.01 (s) (½) f = 1 / period(½) = 1 / 0.01 = 100 Hz (½) (½)	if period=10 deduct (½)	2	7
(ii) V_{peak} = 2divs = 2 x 5 = 10 (V) (½) $V_{rms} = V_{peak}/\sqrt{2}$ (½) = 7.1 (V)(½) $I_{rms} = V_{rms} / R$ = 7.1 / 200 (½) = 0.036 A (½) (½)	if I= 10/200 = 0.05 A get (½) only for V=10V OR I_{peak}=10/200=0.05(A) (½) (½) $I_{rms} = I_{peak}/\sqrt{2}$ (½) = 0.05/√2 (½) = 0.036 A (½) (½)	3	

Marks

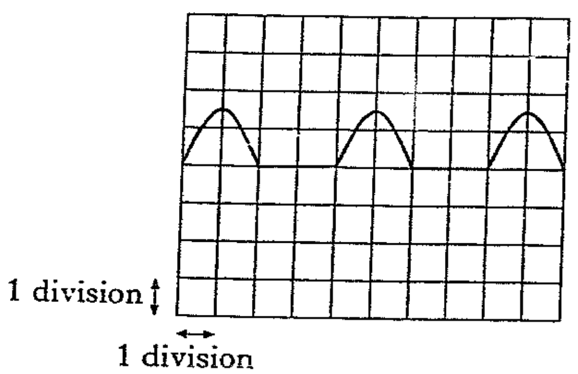
26. (continued)

(*b*) A diode is now connected in the circuit as shown below.



The settings on the controls of the oscilloscope remain unchanged.

Connecting the diode in the circuit causes **changes** to the original trace displayed on the oscilloscope screen. The new trace is shown below.



Describe and explain the changes to the original trace. **2**

(7)

[Turn over

9

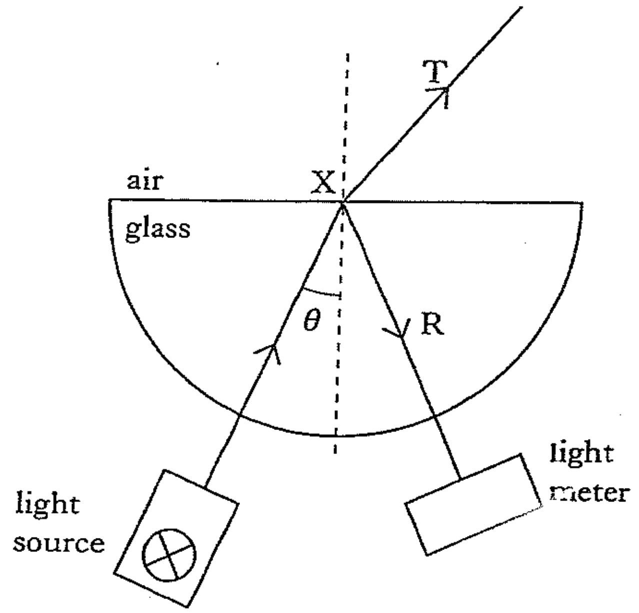
Answer and mark allocation	Notes	Inner margin	Outer margin
26(b) Half cycle missing or half wave missing (½) since diode only conducts every half cycle **or** diode only conducts one way (½) V_{peak} across resistor less(½) since p.d. developed across diode (½)	description on own gets (0) there **must** be an explanation for each description given	2 +	

Marks

27. A student is investigating the effect that a semicircular glass block has on a ray of monochromatic light.

She observes that at point X the incident ray splits into two rays:

T — a transmitted ray
R — a reflected ray.



The student uses a light meter to measure the intensity of ray R as angle θ is changed.

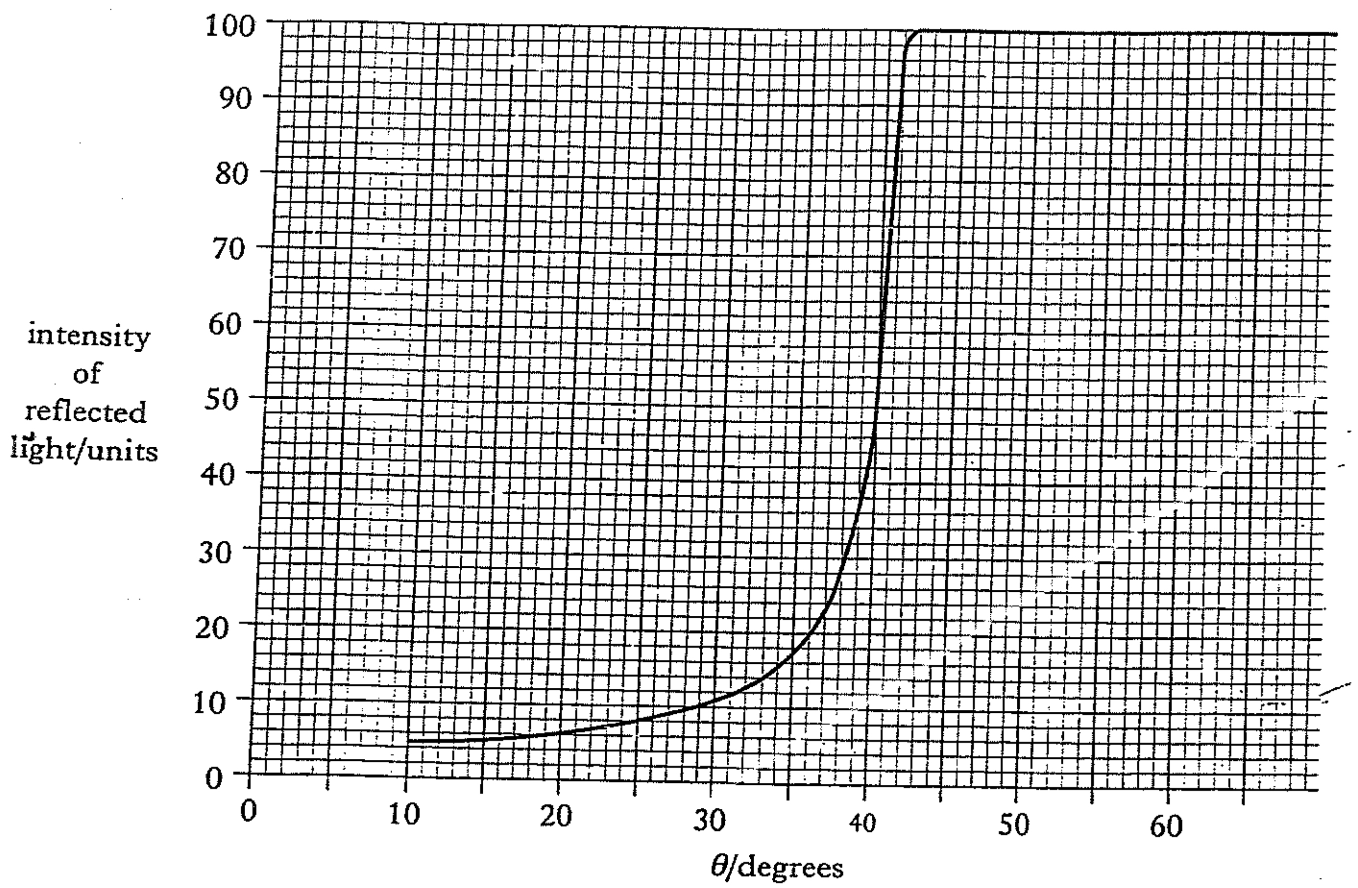
(a) State what is meant by the *intensity* of a radiation. **1**

(b) Explain why, as angle θ is changed, it is important to keep the light meter at a constant distance from point X for each measurement of intensity. **1**

Answer and mark allocation	Notes	Inner margin	Outer margin
27(a) Intensity = power per unit area (½) (½) OR intensity=incident power/area it falls on (½) (½) OR intensity=number of watts per m^2 (½) (½)		1	6
(b)Intensity depends on distance (squared)(1)	Reading on light meter depends on distance(1)	1	

27. (continued) *Marks*

(*c*) The graph below is obtained from the student's results.



(i) What is the value of the critical angle in the glass for this light?

(ii) Calculate the refractive index of the glass for this light.

(iii) As the angle θ is increased, what happens to the intensity of ray T? **4**

(6)

[Turn over

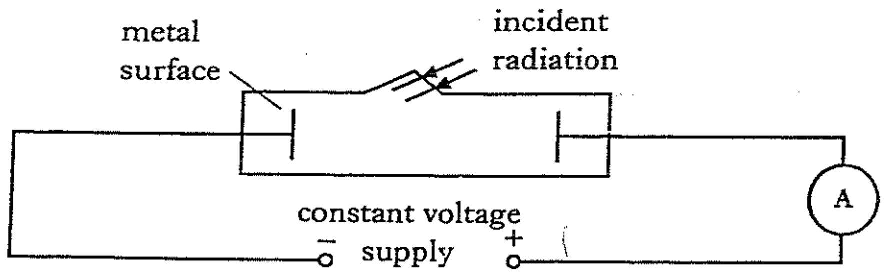
HIGHER PHYSICS SECTION B 2000

Answer and mark allocation	Notes	Inner margin	Outer margin
(c)(i) 41° (½)(½)	Accept 40.5° to 41.5°	1	
(ii) $n = 1/\sin\theta_c$ (½) $= 1/\sin 41$ (½) $= 1.52$ (1)	θ_c consistent with (c)(i) OR by measuring angles on diagram $_a n_g = \sin\theta_1/\sin\theta_2$ (½) $= \sin(40\pm1)/\sin(25\pm1)$ (½) (½) $= 1.52$ (½)	2	
(iii) Decreases (1)		1	

Marks

28. (a) The apparatus shown below is used to investigate photoelectric emission from a metal surface when electromagnetic radiation is shone on the surface.

The intensity and frequency of the incident radiation can be varied as required.



(i) Explain what is meant by *photoelectric emission* from a metal.

(ii) What is the name given to the minimum frequency of the radiation that produces a current in the circuit?

(iii) A particular source of radiation produces a current in the circuit.

Explain why the current in the circuit increases as the intensity of the incident radiation increases. **4**

(b) A semiconductor chip is used to store information. The information can only be erased by exposing the chip to ultraviolet radiation for a period of time.

The following data is provided.

Frequency of ultraviolet radiation used	= $9{\cdot}0 \times 10^{14}$ Hz
Minimum intensity of ultraviolet radiation required at the chip	= $25\ W\,m^{-2}$
Area of the chip exposed to radiation	= $1{\cdot}8 \times 10^{-9}\ m^2$
Time taken to erase the information	= 15 minutes
Energy of radiation needed to erase the information	= $40{\cdot}5\ \mu J$

(i) Calculate the energy of a photon of the ultraviolet radiation used.

(ii) Calculate the number of photons of the ultraviolet radiation required to erase the information.

(iii) Sunlight of intensity $25\ W\,m^{-2}$, at the chip, can also be used to erase the information.

State whether the time taken to erase the information is greater than, equal to or less than 15 minutes.

You must justify your answer. **5**

(9)

12

Answer and mark allocation	Notes	Inner margin	Outer margin
28(a)(i)Electrons are emitted from a metal surface(½) when exposed to e.m. radiation/light (½)		1	9
(ii) Threshold frequency (1)		1	
(iii) More photons (are incident on surface)(1) more electrons(½) are ejected per second(½)	**OR** more photons (are incident on surface)(1) more charge(½) is transferred in 1 s (½) **OR** more photons(1) per second(½) more electrons (or charge) produced(½) **IN GENERAL** more photons(1) more electrons/charge(½) in one second(½) All the answers to (iii) are **INDEPENDENT MARKS**	2	
(b)(i)E = hf (½) $= 6.63\times10^{-34} \times 9\times10^{14}$ (½) $= 5.97\times10^{-19}$ J (½) (½)		2	
(ii)no of photons=$40.5\times10^{-6}/5.97\times10^{-19}$ (½) $= 6.78\times10^{13}$ (½)	if 40.5 used deduct (½)	1	
(iii)longer time(½) since fewer UV photons(1) per second(½)	**OR** longer time(½) for the required number of UV photons(1) to deliver the energy needed(½) **OR** longer time(½) since same number of UV photons needed(½) but there are fewer UV photons(1) (in this intensity of sunlight)	2 +	

Marks

29. Radium (Ra) decays to radon (Rn) by the emission of an alpha particle.
Some energy is also released by this decay.
The decay is represented by the statement shown below.

$$^{226}_{88}\text{Ra} \longrightarrow {}^{x}_{y}\text{Rn} + {}^{4}_{2}\text{He}$$

The masses of the nuclides involved are as follows.

Mass of $^{226}_{88}\text{Ra}$ = $3{\cdot}75428 \times 10^{-25}$ kg

Mass of $^{x}_{y}\text{Rn}$ = $3{\cdot}68771 \times 10^{-25}$ kg

Mass of $^{4}_{2}\text{He}$ = $6{\cdot}64832 \times 10^{-27}$ kg

(a) (i) What are the values of x and y for the nuclide $^{x}_{y}\text{Rn}$?
(ii) Why is energy released by this decay?
(iii) Calculate the energy released by one decay of this type. **5**

(b) The alpha particle leaves the radium nucleus with a speed of $1{\cdot}5 \times 10^7$ m s^{-1}.
The alpha particle is now accelerated through a potential difference of 25 kV.
Calculate the **final** kinetic energy, in joules, of the alpha particle. **3**

(8)

[END OF QUESTION PAPER]

Answer and mark allocation	Notes	Inner margin	Outer margin
29(a)(i) x=222 (½) y=86(½)		1	8
(ii)There is a decrease in mass(½) after the decay From $E=mc^2$ (½) energy is released	OR mass and energy are equivalent(1)	1	
(iii)total mass before=$3.75428\text{x}10^{-25}$(kg) total mass after =$3.75419\text{x}10^{-25}$(kg) (½) decrease in mass=9×10^{-30} (kg) (½) energy released=mc^2 (½) =$9\text{x}10^{-30}\text{x}(3\text{x}10^8)^2$ (½) =8.1×10^{-13} J (½) (½)	accept $8.68\text{x}10^{-30}$(kg) if use mass defect deduct (½) if m=$8.68\text{x}10^{-30}$ kg E=$7.81\text{x}10^{-13}$ J if m≒decrease in mass can still get (½) for $E=mc^2$ and (½) for $c=3\text{x}10^8$ ms^{-1} Full marks for candidate who uses energy equivalent for mass throughout	3 +	
(b)final $E_k=\frac{1}{2}mv^2 + qV$ (½) (½) =½x$6.64832\text{x}10^{-27}\text{x}(1.5\text{x}10^7)^2$ (½) + $3.2\text{x}10^{-19} \times 25000$ (½) (½) =$7.479\text{x}10^{-13}$ + $8\text{x}10^{-15}$ = 7.56×10^{-13} J (½)	If V=25 V deduct (½) If q≠$3.2\text{x}10^{-19}$ maximum 2 out of 3 i.e (½)+(½) for two formulae, (½) for v and (½) for V If final E_k = qV =$3.2\text{x}10^{-19}\text{x}25000$ (½) (½) = 8×10^{-15} J If energy **gained** = qV (½) =$3.2\text{x}10^{-19}\text{x}25000$ (½) (½) = 8×10^{-15} J	3 +	

[END OF MARKING INSTRUCTIONS]