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**Leaving Certificate Examinations 2002**

Physics

Higher Level

Marking scheme

**In considering this marking scheme the following points should be noted:**

1. In many instances only key words are given, words that must appear in the **correct context** in the candidate's answer in order to merit the assigned marks.
2. Words, expressions or statements separated by a solidus, /, are alternatives which are equally acceptable.
3. Answers that are separated by a double solidus, //, are answers which are mutually exclusive. A partial answer from one side of the // may not be taken in conjunction with a partial answer from the other side.
4. The descriptions, methods and definitions in the scheme are not exhaustive and alternative valid answers are acceptable.
5. The detail required in any answer is determined by the context and manner in which the question is asked and by the number of marks assigned to the answer in the examination paper. Therefore, in any instance, it may vary from year to year.
6. For lack of units, or incorrect units, one mark is deducted, as indicated. This is shown as (3-1), or (4-1) etc., in the right hand column.
7. Each time an arithmetical slip occurs in a calculation one mark is deducted. This is shown as (3-1), or (4-1) etc., in the right hand column.

## Section A 120 Marks

Marks awarded for the THREE best answers

### Question 1

*Calculate the sum of .....forces.....*

up =  $2 + 4 = 6$  (N) 3

down =  $2 + 1 + 1.8 + 1.2 = 6$  (N) 3

resultant force /vector sum = 0 / forces up = forces down 3

( If weight of metre stick is omitted, give a maximum of 6/9 )

*Calculate the sum of .....moments .....*

moment = force  $\times$  distance (stated or implied) 3

sum of anticlockwise moments = (+)2.8 (N m) / 280 (N cm) 3

$1 \times 40.5$  3

sum of clockwise moments = 2.797 ( or 2.8) (N) 3

(+)2.8 - 2.797  $\approx$  0 / 2.8  $\approx$  2.797 3

sum of moments is zero / sum of clockwise = anticlockwise

/ law verified 3

(Deduct 3 marks if moments are taken about a point other than the 10 cm mark)

*Describe how the centre of gravity.....*

balance metre stick on a suitable fulcrum 3

read / mark position of equilibrium 3

*Why is it ..... vertically*

spring balance gives correct reading / friction or additional forces /

distance along metre stick = perpendicular distance / distance

can be read directly / reference to  $\text{Cos } \vartheta$  or  $\text{Sin } \vartheta$  7

## Question 2

### *Advantage of room temperature*

heat lost to surroundings	3
heat gained	3
approximately equal	3

### *Describe how mass of ice is found*

final mass (of calorimeter + contents)	3
initial mass of calorimeter + water	3
subtract	3

### *Calculate c*

$(mc\Delta\theta)_{Al} + (mc\Delta\theta)_{water} = (ml)_{ice} + (mc\Delta\theta)_{melted\ ice}$	6
(ml missing 0; any other missing item - 3)	
fall in temperature = 16.2 °C	3
substitution into formula containing ml	3
$3.2 \times 10^5 \text{ J kg}^{-1}$	3
(-1 for lack of units or incorrect units)	

### *Two reasons why answer is not exact*

thermometer not sensitive enough
lack of insulation
lack of stirring
heat loss/gain to surroundings
too long for ice to melt
inside of calorimeter tarnished
splashing
heat capacity of thermometer

any two, 4 +3

### Question 3

***Describe with diagram***

fixed length of string and method of measuring tension	3
tuning fork / signal generator and magnet	3
find frequency and tension when resonance occurs	3
change frequency and repeat	3
(-3 for lack of a diagram)	

***Why was length kept constant?***

frequency varies with length / keep all other factors constant	6
(For $f \propto l$ give 3)	

***Plot a graph***

square root of tension / frequency squared	3
label axes	3
plot 6 points correctly	3
straight line	3
good fit	3
(No graph paper maximum first 2×3)	

***Estimate tension***

( $\sqrt{T} =$ ) 5.5 to 5.7	4
30.2 to 32.5 N	3
(-1 for lack of units or incorrect units)	

## Question 4

### *Diagram of apparatus*

variable power source and ammeter in series	3
voltmeter in parallel	3
electrodes in solution	3
anode and cathode correctly labelled	3

### *Draw graph*

axes labelled	3
6 points plotted correctly	3
straight line	3
good fit	3
(No graph paper maximum first 3)	

### *Calculate resistance*

two points on graph	3
method for slope	3
19.5 to 20.5 $\Omega$	3
(-1 for lack of units or incorrect units)	

### *Sketch*

straight line	4
starting at $v > 0$	3

## Question 5

### MARKS AWARDED FOR THE EIGHT BEST ANSWERS

- (a)  $v = r\omega$  4  
5 (rad) s<sup>-1</sup> 3
- (b)  $t = T - 273$  7  
(Any reference to Kelvin and 273 /  
specific example e.g 273 K = 0° C 4)
- (c) Solar constant by time /  $1.35 \times 10^3 \times 3.16 \times 10^7$  4  
 $4.27 \times 10^7$  kJ /  $4.27 \times 10^{10}$  J 3
- (d) change in frequency / pitch / wavelength 4  
movement 3
- (e)  $\frac{P}{A}$  // rate at which sound energy passes / no. of watts 4  
explain // per unit area 3
- (f)  $\frac{1}{200}$  /  $5 \times 10^{-6}$  m 7
- (g)  $\frac{1}{2} CV^2$  4  
 $7.2 \times 10^{-3}$  J 3
- (h) cutting off supply / current / power 7  
( fault / difference in current between live and neutral /  
safety / protects against electrocution  
/ current in earth (wire) 3)
- (i) magnetic flux density (B), Current (I), Length (l), angle  
any two 4 + 3
- (j) splitting (large) nucleus 4  
release of energy / radiation / nuclei / neutrons 3

## Question 6

### *State Newton's 2<sup>nd</sup> Law*

force is proportional	3
rate of change of momentum	3
( $F = ma$	3
explain symbols	3)

### *Name Law and give statement*

Hooke's	3
restoring force $\propto$ (= to k times)	// Extension $\propto$ 3
displacement	// force / load / weight 3

### *Name and describe motion*

simple harmonic / SHM	3
$a = -\omega^2 s$	// acceleration is $\propto$ to 3
explain	// displacement / distance (and direction) 3

### *2 other examples*

stretched elastic / pendulum, oscillating magnet, springs of car,  
vibrating tuning fork, object bobbing in water waves,  
ball in saucer, etc . or any system that obeys Hook's law  
any two, 2 by 3

### *Calculate k*

$F = mg / 60 \times 9.8 / 588$ (N)	3
$1.2 \times 10^5 \text{ N m}^{-1}$	3
(-1 for lack of units or incorrect units)	

### *Calculate(i) period*

$\frac{k}{m} = \omega^2$	4
$\omega = 38 \text{ (s}^{-1}\text{)}$	3
$T = \frac{2\pi}{\omega}$	3
0.16 to 0.17 s	3

$$T = 2\pi \sqrt{\frac{m}{k}} \quad 7$$

substitution 3

0.16 to 0.17 s 3

(-1 for lack of units or incorrect units)

### *Calculate (ii) no. of oscillations*

(f =) $\frac{1}{T}$	4
6 (5.88 to 6.25)	3



## Question 7

### **Explain the terms (i) constructive interference**

2 waves combine 3  
wave of greater amplitude 3

### **Explain (ii) coherent**

same frequency / wavelength 3  
in phase / constant phase difference 3

### **Condition for destructive interference**

out of phase / path difference // trough meets 3  
by  $(n + \frac{1}{2})$  wavelength // crest / peak 3

### **Wave nature of light**

diffraction grating / Young's slits // 2 polaroids 3  
spectrometer and light source / laser // light source 3  
shine light through grating or slits // shine light, rotate one 3  
interference pattern // change in intensity 3

### **(i) Calculate $\lambda$ for radiowaves**

$v = f\lambda$  3  
 $10^4$  m / 10 km 3

### **(ii) What is the minimum distance**

half wavelength / 5 km 3  
1500 km + 5 km 3  
1505 km 3

### **(iii) Calculate minimum $h$**

Pythagoras theorem (any implication) 3  
substitution 3  
61 km..... // 61000 m 5  
(-1 for lack of units or incorrect units)

## Question 8

### **Define (i) power**

rate //  $VI$  /  $\frac{W}{t}$  /  $RI^2$  3  
of doing work / using energy // explain symbols 3

### **(ii) resistivity**

resistance of a piece of material //  $\frac{RA}{l}$  3  
unit length and unit area.....// explain R, A and l 3

### **Demonstration of heating effect**

apparatus 3  
circuit 3  
way of detecting heat change 3  
result 3

### **Calculate (i) resistance**

$A = \pi r^2$  3  
 $7.85 \times 10^{-5}$  /  $2.5 \times 10^{-5} \pi$  3  
 $R = \frac{\rho l}{A}$  /  $\rho = \frac{RA}{l}$  3  
Substitution 3  
9.5 to 9.6  $\Omega$  3  
(-1 for lack of units or incorrect units)

### **(ii) current**

$W = VI$  3  
200 A 3  
(-1 for lack of units or incorrect units)

### **(iii) energy lost**

$(P =) I^2 R$  3  
 $3.8 \times 10^5$  W / 0.38 MW 3  
(-1 for lack of units or incorrect units)

### **Reducing energy lost**

thicker cables  
lower resistivity / resistance  
higher V (tension)  
EHT 5

## Question 9

### *Production of X-rays*

hot cathode / filament	3
labelled target	3
indication of high voltage	3
vacuum / shield / cooling / window	Any two, $2 \times 3$

### *X-ray inverse of photoelectric*

X-ray	Photoelectric
Electrons / cathode rays in	electrons out
radiation / light out	radiation / light in

6 + 3

### *Demonstrate photoelectric effect.*

suitable light	// shine light	3
metal plate / cap	// photocell	3
(negatively charged) electroscope	// milliammeter	3
leaves fall	// current	3

### *Einstein's explanation.*

photon / energy packet / quantum	3
$E = hf$	3
gives (all) energy to electron	3
work function / threshold frequency or wavelength	3
rest as kinetic energy of electron / electrons released	3
(final 4 x 3 may be obtained by writing Einstein's photoelectric equation)	

### *Applications of photocell*

burglar alarm	
smoke alarms	
safety switch	
light meters	
automatic lights	
counters	
automatic doors	
control of central heating burners	
sound track in films	
scanner	
reading bar codes	
stopping conveyer belt	3 + 2

## Question 10 (a)

### *Four fundamental forces*

gravitational	3
electromagnetic	3
strong (nuclear)	3
weak (nuclear)	3

### *Name of force for binding nucleus*

strong	3
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### *Two properties of force*

short range, strong(est), act on nucleons, binds nucleus	Any two, 2 x 3
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### *Outline of Cockroft and Walton*

moving protons	3
high voltage	3
alpha particles released	3
screen / microscope	2

### *Nuclear equation*

${}^1_1\text{H}$	/	${}^1_1\text{p}$	3
${}^4_2\text{He}$	/	${}^4_2\alpha$	3
${}^1_1\text{H} + {}^7_3\text{Li}$			3
$\rightarrow {}^4_2\text{He} + {}^4_2\text{He}$	/	$2 {}^4_2\text{He}$	3

### *Energy released*

$E = mc^2$	3
Mass defect	3
$3.0 \times 10^{-29}$ (kg)	3
$2.7 \times 10^{-12}$ J	3
(-1 for lack of units or incorrect units)	

## Question 10 (b)

### *What is a semiconductor?*

resistivity 3  
between conductor and insulator 3

### *Explain change in resistance*

increasing temperature frees 3  
more charge carriers/ electrons 3  
greater conductivity / lower resistance 3

### *Sketch graph*

labelled axes 3  
concave upward curve 3

### *Structure of transistor*

3 layers 3  
npn or pnp, labelled 3  
1 connection to each layer 3

### *Explain how circuit operates*

input voltage changes base voltage /current 3  
controls current through  $R_4$  /  $I_c$  / voltage across  $R_4$  3  
small change in input current / voltage 3  
large change in output current / voltage 3

### *Sketch graphs of input and output voltages*

varying input 3  
magnified varying output 3  
out of phase 3

### *Another use for transistor*

switch / inverter / current amplifier / logic gate / NOT gate 5

## Question 11

- (a) copper is a conductor. 4  
good 3
- (b) force /  $\frac{F}{Q}$  4  
per unit charge / explain symbols 3
- (c) experience (a large) force 7
- (d) ions act as charge carriers 7  
(moving / flowing 3)
- (e) electrons / current / charge / flow(s) to or from ground 4  
through conductor / copper / air 3
- (f) neutralises charged clouds 4  
conducting charge / lightning / current to earth 3
- (g) act as (lightning) conductors 7  
(current through body / injury / electrocution 3)
- (h) point effect / point discharge (or implied) 4  
( current) leakage / sparking / fire 3

## Question 12

Marks awarded for the TWO best answered parts

### 12 (a)

*State principle of conservation of momentum*

momentum before = momentum after / equation 3

no external force 3

*Mass of gas*

$mv$  3

50 m 3

$50000 \times 2 = 50000 \times 0.5 + 50m$  3

1500 kg / 1515 kg 3

(-1 for lack of units or incorrect units)

*Direction*

forward / towards space station / to right 4

*Change in direction*

gas expelled in one direction 3

rocket in other direction 3

### 12 (b)

*Laws of refraction*

incident ray, refracted ray and normal in same plane 3

$\sin i / \sin r$  is a constant 3

*Optical structure of eye*

shape of eye 3

(labelled) lens 3

labelled retina 3

*How does eye focus objects*

change shape of lens / accommodation 3

changes focal length / focus / power 3

*Calculate (i) power (ii) focal length*

power = (-) 5 (m) 4

(-) 0.2 m // (-) 20 cm 3

(-1 for lack of units or incorrect units)

## 12 (c)

### *em induction*

(induced) e.m.f (in a conductor / coil / wire) 3  
when magnetic flux / field changes 3

### *Lenz's law*

direction of (induced) current / voltage / emf 3  
opposes change causing it 3

### *Why is current reduced?*

(back) e.m.f. in coil 3  
increased magnetic flux // increases 3  
increases back e.m.f. // self inductance 3  
reduces voltage / reduces current 3

### *Application*

dimmer switch / smooth d.c. / tuning radios / braking trains  
/ damping in balances / induction coil 4

## 12 (d)

### *Name the scientist*

Rutherford / Geiger / Marsden 4

### *What was observed*

most alphas passed straight through 6  
some deflected / scattered through large angles 3

### *Why in vacuum*

to prevent alphas colliding with other particles (and  
being scattered) / range of alphas in air is (very) short 6  
(any reference to collisions 3)

### *Conclusion*

nucleus / small dense core 6  
positive / surrounded by empty space / orbiting electron cloud 3