AN ROINN OIDEACHAIS AGUS EOLAÍOCHTA

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 × distance (stated or implied)	3
sum of anticlockwise moments = (+)2.8 (N m) / 280 (N cm)	3
1×40.5	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 Cos ϑ or Sin ϑ	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

$(mc\Delta\vartheta)_{Al} + (mc\Delta\vartheta)_{water} = (ml)_{ice} + (mc\Delta\vartheta)_{melted\ ice}$ 6

(*ml* missing 0; any other missing item - 3)

fall in temperature = 16.2 ^{o}C 3
substitution into formula containing *ml* 3
3.2×10^{5} 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 Ω	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^{-1} 3

(b) $t = T - 273$ 7
(Any reference to Kelvin and 273 /
specific example e.g 273 K = 0^{o} C 4)

(c) Solar constant by time $/1.35\times10^{3}\times3.16\times10^{7}$ 4
4.27×10^{7} kJ / 4.27×10^{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) $\frac{1}{200}$ / 5×10^{-6} m 7

(g) $\frac{1}{2}CV^{2}$ 4
7.2×10^{-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 2nd 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 α 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

$F = mg$ / 60×9.8 / 588 (N) 3

1.2×10^5 N m^{-1} 3

(-1 for lack of units or incorrect units)

Calculate(i) period

$\frac{k}{m} = \omega^2$ 4

$\omega = 38$ (s^{-1}) 3

$T = \frac{2\Pi}{\omega}$ 3

0.16 to 0.17 s 3

$T = 2\pi\sqrt{\frac{m}{k}}$ 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 intencity	3

(i) Calculate λ 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

7.85×10^{-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 Ω 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

$(P =)\ I^2R$ 3

3.8×10^5 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 × 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

Two properties of force

short range, strong(est),	
act on nucleons, binds nucleus	Any two, 2 x 3

Outline of Cockroft and Walton

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

Nuclear equation

${}_{1}^{1}H$	/	${}_{1}^{1}p$	3
${}_{2}^{4}He$	/	${}_{2}^{4}\alpha$	3
${}_{1}^{1}H + {}_{3}^{7}Li$			3
$\rightarrow {}_{2}^{4}He + {}_{2}^{4}He$	/	$2\,{}_{2}^{4}He$	3

Energy released

$E = mc^2$	3
Mass defect	3
3.0×10^{-29} (kg)	3
2.7×10^{-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