Coimisiún na Scrúduithe Stáit
State Examinations Commission

Scéim Mharcála *Scrúdú na hArdteistiméireachta 2006*

Fisic *Gnáthleibhéal*

Marking Scheme *Leaving Certificate Examination 2006*

Physics *Ordinary Level*

Introduction

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. Marks shown in brackets represent marks awarded for partial answers as indicated in the scheme.

3. Words, expressions or statements separated by a solidus, /, are alternatives which are equally acceptable.

4. 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.

5. The descriptions, methods and definitions in the scheme are not exhaustive and alternative valid answers are acceptable.

6. The context and the manner in which the question is asked and the number of marks assigned to the answer in the examination paper determine the detail required in any question. Therefore, in any instance, it may vary from year to year.

Section A

Three questions to be answered.

Question 1 40 marks

(i) Draw a labelled diagram of the apparatus used in the experiment. **6 +2 × 3**

labelled diagram to show

runway // air track 6

2 trolleys // 2 riders

timer device e.g. tickertimer / photogates (and timer) / powdertrack / motion sensor

detail e.g. means of attaching trolleys or of trolleys moving apart

any two lines 2×3

NOTE: no labels, deduct 2

(ii) How did the student measure the mass of the trolleys? **6 or 3**

used (electronic) balance / (weighing) scales / weighed them 6

partial answer e.g. mentions spiral spring (3)

(iii) Explain how the student calculated the velocity of the trolleys. **3 × 3**

$(\text{velocity} =) \frac{\text{distance}}{\text{time}}$ / $\frac{s}{t}$ 3×3

measure distance and time (2×3)

measure time/ measure distance / use formula (3)

reference to a datalogger would merit at least 2×3

(iv) How did the student determine the momentum of the trolleys? **2 × 3**

mass × velocity 2×3

mass / velocity / using the equation (3)

(v) How did the student verify the principle of conservation of momentum? **7 or 4**

momentum before = momentum after 7

partial answer e.g. momentum before / momentum after (4)

Question 2 40 marks

A student carried out an experiment to verify Snell's law of refraction by measuring the angle of incidence i and the angle of refraction r for a ray of light entering a glass block. The student repeated this procedure two more times. The data recorded by the student is shown in the table.

(i) Draw a labelled diagram of the apparatus used in the experiment. **6 + 2 × 3**

labelled diagram to show
glass block 6
pins / raybox 3
protractor / sheet of paper / detail 3
incorrect experiment, maximum mark 6 + 3

NOTE: no labels, deduct 2

(ii) Describe how the student found the position of the refracted ray. **3 × 3**

draw the incident ray / mark the point of incidence 3
draw the emerging ray / mark the point of exit 3
join 3
a diagram may merit full marks

(iii) How did the student measure the angle of refraction? **4 or 2**

using a protractor // by measuring the angle between the normal and the refracted ray 4
partial answer e.g. identifies the angle of refraction (2)

(iv) Copy this table and complete it in your answerbook. **6 + 3**

angle of incidence *i*	**angle of refraction *r***	**sin *i***	**sin *r***	$\frac{\textbf{sin } i}{\textbf{sin } r}$
30^o	19^o	**0.500**	**0.326**	**1.53**
45^o	28^o	**0.707**	**0.469**	**1.51**
65^o	37^o	**0.906**	**0.602**	**1.50**

any correct row // any correct column 6
other correct rows // other correct columns 3

(v) Use the data to verify Snell's law of refraction. **2 × 3**

$\sin i \propto \sin r$ // $\frac{\sin i}{\sin r} = \text{constant}$ 2×3

partial answer e.g. $i \propto r$ (3)

Question 3 40 marks

(i) Draw a labelled diagram of the apparatus used in the experiment. **4 × 3**

string
means of tightening
means of changing frequency e.g. tuning forks / frequency generator
means of varying length e.g. bridge
detail e.g. means of detecting resonance

any four lines 4 × 3

NOTE: no labels, deduct 2

(ii) Indicate on your diagram the length of the string that was measured. **6 or 3**

distance between bridges 6
partial answer e.g. reference to bridge (3)

(iii) Describe how the student set the string vibrating. **7 or 4**

placed a vibrating tuning fork on the bridge // turned on frequency generator 7
partial answer e.g. pluck it / using a tuning fork (4)

(iv) How did the student know the string was vibrating at its fundamental frequency? **6 or 3**

paper rider falls off / (string) vibrates vigorously / emits sound / resonates /
pitch the same as the tuning fork 6
partial answer e.g. by ear (3)

(v) Draw a sketch of the graph expected in this experiment. **6 + 3**

straight line through origin 6
one axis correctly labelled 3

Question 4 **40 marks**

(i) How did the student measure the resistance of the wire? **6 or 3**

ohmmeter / multimeter 6

partial answer e.g. reference to measuring voltage or current / resistance meter (3)

(ii) Describe with the aid of a diagram, how the student varied the temperature of the wire. **6 + 3**

diagram to show

heat source 6

wire in water bath / thermometer in water bath 3

(iii) Using the data in the table, draw a graph on graph paper of the resistance of the conductor against temperature. Put temperature on the horizontal (X-axis) **4 × 3**

label axes correctly, (name / symbol / unit acceptable) 3

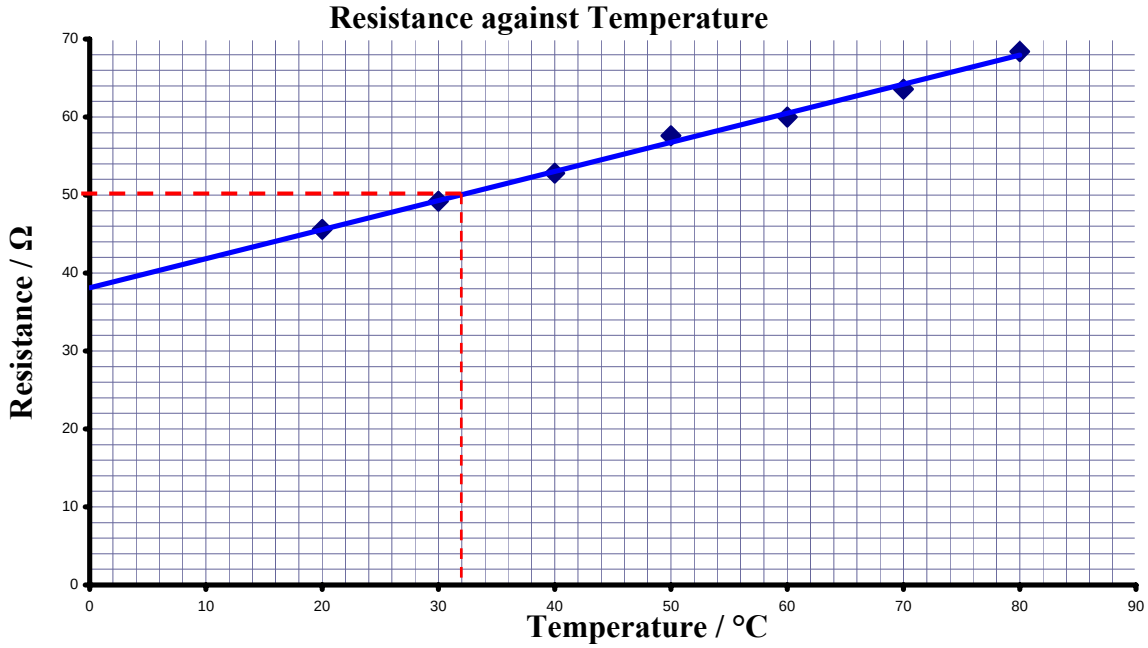
plot three points correctly 3

plot another three points correctly 3

straight line 3

if graph paper is not used / graph through the origin, maximum mark 3 × 3

if temperature is on the Y-axis, maximum mark 3 × 3



(iv) Use the graph to estimate the temperature of the conductor when its resistance is 50 Ω. **7 or 4**

30 – 33 (°C) / answer consistent with graph 7

evidence of using the graph at 50 Ω (4)

(v) What does your graph tell you about the relationship between the resistance of a metallic conductor and its temperature? **6 or 3**

linear / correct relationship consistent with part (iii) above 6

partial answer (3)

SECTION B (280 Marks)
Five questions to be answered

Question 5 any *eight* parts 56 marks
Take the best 8 from 10 parts

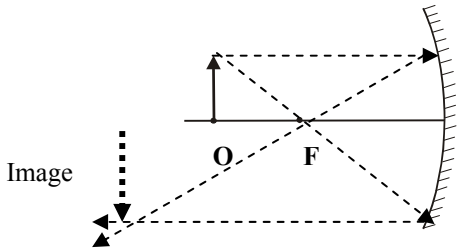
(a) **A person pushed a car a distance of 15 m with a force of 500 N. Calculate the work done by the person. ($W = Fs$)** **7 or 4**
7500 (J) / 7.5 (kJ) 7
partial answer e.g. incomplete substitution into the equation (4)

(b) **Which one of the following instruments can be used to measure the density of a liquid? barometer hydrometer thermometer** **7**
hydrometer 7

(c) **What is friction?** **7 or 4**
force (which) opposes motion 7
partial answer e.g. force / opposes / incomplete answer / example (4)

(d) **Give one example of a thermometric property.** **7 or 4**
resistance / emf / voltage / colour / volume / length / pressure, etc. any one 7
partial answer e.g. definition of thermometric property (4)

(e) **Copy and complete in your answerbook the following diagram to show how a concave mirror forms an image of object O.** **7 or 4**



correct image formed 7
one ray drawn correct (4)

(f) **Give one use of a spectrometer.** **7 or 4**
measure angles/ measure wavelength of light / demonstrate interference / demonstrate diffraction / demonstrate spectra / chemical analysis, etc. 7
partial answer e.g. spectrometer diagram (4)

(g) **Name the electrical component represented in the diagram.** **7 or 4**
variable resistor / rheostat / potentiometer 7
partial answer e.g. resistor / thermistor or function (4)

(h) **State Ohm's law.** **7 or 4**
$V \propto I$ / $V = IR$ 7
V / I / R / $\propto$ (4)

(i) **Give one use of a capacitor.** **7 or 4**
store charge / (radio) tuning / filtering / smoothing / timing / coupling / store energy / flash camera / phone charger, etc. 7
partial answer e.g. storing electric current (4)

(j) **Give two properties of the electron.** **7 or 4**
(small) mass /9.1×10^{-31} kg, (negative) charge/1.6×10^{-19}, orbits the nucleus, outside the nucleus, deflected by electric / magnetic fields, etc. any two 7
any one (4)

Question 6 56 marks

Define the term force and give the unit in which force is measured. **3 × 3**

causes / changes // changes 3
acceleration // velocity / momentum 3
$F = ma$ (2×3)
partial answer e.g. example (3)

N/ newton 3

Force is a vector quantity. Explain what this means. **6 or 3**

(quantity with magnitude and) direction 6
partial answer e.g. magnitude (3)

Give two factors which affect the size of the gravitation force between two bodies. **6 + 3**

mass
distance two correct 6+3
one correct (6)
partial answer e.g. gravitational constant / G / weight (3)

Explain the term acceleration due to gravity, *g*. **6 + 3**

object in free fall / due to the pull/weight of the earth 6
increase in velocity per second / change in velocity per second 3
partial answer e.g. speeding up / weight / 9.8 (3)

Use this data to show that the acceleration due to gravity on the surface of the moon is 1.6 m s^{-2} **3 × 3**

calculates value for g moon 1.63 (m s^{-2}) 3×3
correct substitution into $s = ut + ½ at^2$ / $1.6 = 0 + ½ a(1.4)^2$ (2×3)
partial answer e.g. incomplete substitution into the equation (3)

The astronaut has a mass of 120 kg. Calculate his weight on the surface of the moon. **2 × 3**

(120)(1.6) / 192 (N) 2 × 3
partial answer e.g. incomplete substitution into the equation (3)

Why is the astronaut's weight greater on earth than on the moon? **5 or 3**

acceleration due to gravity is greater on the earth // mass of the earth is greater than the mass of the moon 5
partial answer e.g. reference to (acceleration due to) gravity // different masses of earth and moon (3)

The earth is surrounded by a layer of air, called its atmosphere. Explain why the moon does not have an atmosphere. **3**

(acceleration due to) gravity is less / mass (of the moon) is less 3

Question 7 **56 marks**

What is convection? Name two other ways of transferring heat. **4 × 3**

movement of heat	// hot air	// cold air	3
by circulation/current	// rises	// sinks	3
partial e.g. incomplete answer / example			(3)
conduction			3
radiation			3

a labelled diagram may merit marks

Describe an experiment to demonstrate convection in a liquid. **4 × 3**

apparatus: beaker, liquid, dye, heat source	any three	2×3
	any one	(3)
procedure: add the dye to the liquid and heat		3
observation/conclusion: convection current visible		3

accept valid alternatives
a labelled diagram may merit full marks
convection in a gas, maximum 3×3

Why is insulation used to surround the bricks? Name a material that could be used as insulation. **4 × 3**

prevent /reduce	3
heat loss / energy loss	3
partial answer	(3)

any named insulator e.g. fibre glass / rockwool / cotton wool / aerogel etc.	2×3
partial answer e.g. lagging	(3)

Explain how the storage heater heats the air in the room. **2 × 4**

convection	// hot air rises	// bricks heat by night	4
currents	// cold air replaces it	// heat released to the air by day	4
partial answer			(4)

The total mass of the bricks in the storage heater is 80 kg and their specific heat capacity is 1500 J kg^{-1} K^{-1}. During a ten-hour period the temperature of the bricks rose from 15 °C to 300 °C.
Calculate (i) the energy gained by the bricks; (ii) the power of the heating coil. **4 × 3**

(i) the energy gained by the bricks

$Q = m\,c\,\Delta\theta$ = (80)(1500)(285) / 34 200 000 (J) / 34.2 (MJ)	3×3
two quantities substituted correctly into the equation	(2×3)
one quantity substituted correctly into the equation / 285	(3)

(ii) the power of the heating coil

$(P = \frac{W}{t})\ \frac{3420000}{(10)(60)(60)}$ / 950 (W) // answer consistent with (i)	3

Question 8 56 marks

Describe, using diagrams, the difference between transverse waves and longitudinal waves. **2(6 or 3)**

property e.g. transverse waves vibrate perpendicular to the direction of motion / transverse waves may be polarised / longitudinal waves cannot be polarised / longitudinal waves vibrate parallel to the direction of motion 6
partial answer e.g. can travel through vacuum (3)
description e.g. diagram / converse of stated property 6
partial answer (3)
a labelled diagram may merit full marks

The speed of sound depends on the medium through which the sound is travelling. Explain how sound travels through a medium. **6 + 3**

energy / vibrations // waves 6
transferred from particle to particle // longitudinal 3
partial answer (3)
a labelled diagram may merit full marks

Describe an experiment to demonstrate that sound requires a medium to travel **5 × 3**

apparatus: sealed container / jar 3
sound source / bell 3
pump 3
procedure: pump out the air 3
observation/conclusion: loudness decreases as air is removed 3
accept valid alternatives
a labelled diagram may merit full marks

A ship detects the seabed by reflecting a pulse of high frequency sound from the seabed. The sound pulse is detected 0.4 s after it was sent out and the speed of sound in water is 1500 m s^{-1}.
Calculate **5 × 3**

(i) the time taken for the pulse to reach the seabed;
0.2 s 3

(ii) the depth of the water under the ship
300 (m) // answer consistent with part (i) 2×3
partial answer e.g. incomplete substitution into the equation $s = v\,t$ // 7500 (3)

(iii) the wavelength of the sound pulse when its frequency is 50 000 Hz
0.03 (m) 2×3
partial answer e.g. incomplete substitution into the equation $c = f\lambda$ (3)

Why is the speed of sound greater in water than in air? **5 or 3**

particles are closer together / greater density 5
partial answer e.g. reference to density / better conductor of sound (3)

Question 9 56 marks

(i) What is meant by fission? Name a material in which fission occurs. **2 × 3 + 6**

splitting / break up nucleus (into two) 3
releasing energy / releasing neutrons / releasing radiation / into 2 smaller (nuclei) 3

Uranium / U // Plutonium / Pu 6

(ii) Describe how a chain reaction occurs in the fuel rods.
Explain how the chain reaction is controlled. **5 × 3**

neutron 3
splits a nucleus 3
releasing more neutrons 3
partial answer e.g. continuous fission (3)
a labelled diagram may merit full marks

control rods // moderator 3
move up / move down /absorb neutrons // slows down neutrons 3

(iii) What is the purpose of the shielding? Name a material that is used as shielding. **4 × 3**

prevent // protect 3
radiation (escaping) // humans / environment 3

concrete, lead any one 2×3
partial answer e.g. iron / named metal (3)

(iv) Describe what happens to the coolant when the reactor is working. **5 or 3**

absorbs heat / gets hot 5
partial answer e.g. it circulates / regulates temperature (3)

(v) Give one effect of a nuclear fission reactor on the environment. **6 or 3**

pollution / nuclear waste 6
partial answer e.g. dangerous (3)

(vi) Give one precaution that should be taken when storing radioactive materials. **6 or 3**

store in lead / use a tongs when handling / use safety signs / locked room, etc. 6
partial answer e.g. store in a safe place (3)

Question 10 56 marks

What is a magnetic field? **2 × 3**
region / area /space 3
where iron is attracted / magnetic effect is felt 3

Describe an experiment to show the magnetic field due to a current in a solenoid. **4 × 3**
apparatus: power source, closed circuit/ solenoid, compasses / iron filings any two 2×3
any one (3)
procedure: turn on the current 3
observation/conclusion: compass direction changes / iron filings rearrange /arrows shown on field lines 3
accept valid alternatives
a labelled diagram may merit full marks

Give one use of an electromagnet. State one advantage of an electromagnet over an ordinary magnet. **6 + 3**
electric bell / scrap yard crane / speaker / induction coil / doorbell / relay / etc. 6
partial answer e.g. in TV / radio (3)

can be turned off / can be varied / can be stronger etc. 3

When the switch is closed the aluminium foil experiences an upward force.

Name a device based on this effect. **6 or 3**
(electric) motor / meter /speaker 6
partial answer e.g. radio (3)

Describe what happens if **5 × 3**
(i) the current flows in the opposite direction;
force / foil moves 3
downward / in the opposite direction 3

(ii) a larger current flows through the aluminium foil;
greater / bigger 3
force / jump 3

(iii) the aluminium foil is placed parallel to the magnetic field.
no force / no movement / nothing 3

Calculate the force on the aluminium foil of length 10 cm if a current of 1.5 A flows through it when it is placed in a magnetic field of flux density 3.0 T. **8 or 6 or 3**
F = (1.5)(0.1)(3) = 0.45 (N) 8
correctly substitutes two quantities into the equation $F = ILB$ (6)
partial answer e.g. correct matching of a quantity and its symbol (3)

Question 11 56 marks

Read this passage and answer the questions below.

Electricity is so much part of modern living that we often take it for granted. It is a powerful and versatile energy of great use in the home but can be dangerous if not used properly. The electricity connection into your home comes through the ESB main fuse and the ESB meter. Almost all new electrical appliances now come complete with a fitted 13 Amp, 3-pin plug. Remember, a wrongly wired plug can result in a serious or fatal accident. The first thing to know is the colour code for connecting the cables to the appropriate pin/terminal in the plug. The cables consist of a metal conductor covered in coloured plastic.

When wiring a plug it is most important that all the screw connections are fully tightened. You should leave a little extra slack on the earth wire. You must also fit the correct size fuse. When an appliance is *double insulated* it does not need to be earthed. These appliances will only have two wires, the brown live and the blue neutral, they do not have an earth wire.

(Adapted from *The Safe Use Of Electricity In The Home* by The ESB.)

(a) **Give one use for electricity in the home.** **7**
heating / cooking / lighting /named electrical appliance etc. 7

(b) **What is the function of the ESB meter?** **7**
record units used / enable customer costing 7

(c) **What will happen when a current of 20 A flows through a fuse marked 13 A?** **7**
fuse blows / current stops / switch trips 7

(d) **Give one safety precaution that should be taken when wiring a plug.** **7**
screw connections are fully tightened / leave extra slack on the earth wire / fit the correct size fuse / ensure to match the colour codes 7

(e) **What is the colour of the earth wire in an electric cable?** **7**
green and yellow 7

(f) **Name a common material used to conduct electricity in electric cables.** **7**
copper / aluminium 7

(g) **Why is the coating on electric cables made from plastic?** **7**
insulator / safety 7

(h) **Why are some appliances not earthed?** **7**
they are double insulated / they have insulated housing 7

Question 12 **56 marks**

Part (a)

Define the moment of a force. **6 or 3**

force (multiplied) by distance 6

partial answer e.g. force (multiplied) by / distance (3)

Give one condition that is necessary for the crane to be in equilibrium. **2 × 3**

clockwise moments 3

equal anticlockwise moments 3

partial answer e.g. it is balanced (3)

What is the moment of the 9000 N concrete slab about the axis of the crane? **6 or 3**

90 000 (N m) 6

partial answer e.g. 9000 by 10 (3)

Calculate the value of the load marked X. **6 or 3**

3000 (N) 6

partial answer e.g. 30X (3)

A crane is an example of a lever. Give another example of a lever. **4**

crowbar / nailbar / nutcracker / wheelbarrow / tongs / door handle /
weighing scales / tools, etc. 4

Part (b)

The diagram shows the relative positions of electromagnetic radiations in terms of their wavelength.

gamma rays	**A**	UV	light	IR	microwaves	**B**

(i) Name the radiations marked A and B. **2 × 3**

A = X-rays 3

B = radiowaves / VHF / UHF etc. 3

partial answer e.g. names correct but in the reverse order (3)

(ii) Give one property which is common to all electromagnetic radiations. **6 or 3**

travel at the speed of light / same speed / can travel through vacuum / diffraction /
interference / transverse waves / refracted / reflected /forms of energy, etc. any one 6

partial answer e.g. waves (3)

(iii) Which one of the radiations has the shortest wavelength? **6**

gamma

(iv) Describe how IR radiation is detected. **6 or 3**

thermometer / heat sensor / photographic film 6

partial answer e.g. refers to temperature / heat (3)

(v) Give one use for microwaves. **4**

ovens/cooking, communications /satellite TV / mobile phones / weather radar /
missile guidance / remote control / research / speed gun etc. any one 4

Part (c)

Explain why the gold leaf deflects when the zinc is given a negative charge. **6 + 3**

like charges / electrons

repel — two correct 6+3; one correct (6)

partial answer (3)

UV radiation is then shone on the zinc and the gold leaf falls. Explain why. **3 × 3**

electrons / charge 3

(are) emitted from 3

zinc / metal (cap) / leaf 3

partial answer (3)

What is observed when the experiment is repeated using IR radiation? **6 or 3**

leaf does not collapse / nothing changed 6

partial answer e.g. nothing (3)

Give one application of the photoelectric effect. **4**

photocell / burglar alarms / smoke alarms / automatic doors/ machine safety switches etc. 4

Part(d)

A <u>semiconductor</u> material can be doped to form a <u>p-n junction</u> (semiconductor diode).

Explain the underlined terms. **2(2 × 3)**

a semiconductor has a resistivity / conductivity 3

between a conductor and an insulator / changes (rapidly) with temperature 3

partial answer e.g. has a big resistance / not a good conductor (3)

(p-n junction is the) region connecting p-type (semiconductor) 3

to an n-type semiconductor 3

partial answer e.g. mention of junction voltage / depletion layer / holes / free electrons/ intrinsic/ extrinsic (3)

a diagram may merit full marks

Name a material used as a semiconductor. **6 or 3**

Silicon / Si, germanium / Ge, Aluminium nitride, Boron nitride, etc. any one 6

partial answer e.g. any other element with four electrons in its outer shell (3)

The circuit diagram shows 2 semiconductor diodes and 2 bulbs, labelled A and B, connected to a 6 V d.c. supply.

What is observed when the switch is closed? Explain why? **4 + 2 × 3**

(bulb) B lights // (bulb) A does not light 4

diode near B // diode near A 3

conducts / forward biased // does not conduct / reverse biased 3