Coimisiún na Scrúduithe Stáit
State Examinations Commission

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Fisic *Gnáthleibhéal*

Marking Scheme *Leaving Certificate Examination, 2003*

Physics *Ordinary Level*

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LEAVING CERTIFICATE EXAMINATION

2003

PHYSICS

ORDINARY LEVEL

MARKING SCHEME

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. Mathematical errors carry a penalty of one mark.

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

7. The abbreviation h/m denotes hit or miss, i.e. the answer is either correct or not.

8. 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 (120 marks)

Three questions to be answered.

Question 1 40 marks

Draw a labelled diagram of the apparatus used in the experiment **3 × 3**

labelled diagram to show:

trolley and runway / rider and air track	3
timer device e.g. tickertimer / photogates (and timer) / powdertrack (and timer)	3
means of applying force	3

NOTE: no labels, deduct 2

How was the effect of friction reduced in the experiment? **2 × 3**

raise / lift up / tilt	// level	// rider (suspended)	// oil	3
runway	// air track	// (on) air	// wheels	3
wheels with bearings				(2 × 3)

Describe how the student measured the applied force **6 + 3**

record mass / weigh	6
detail e.g. (from electronic) balance / applied force = *mg* / mentions newtons	3

record the mass may be implied

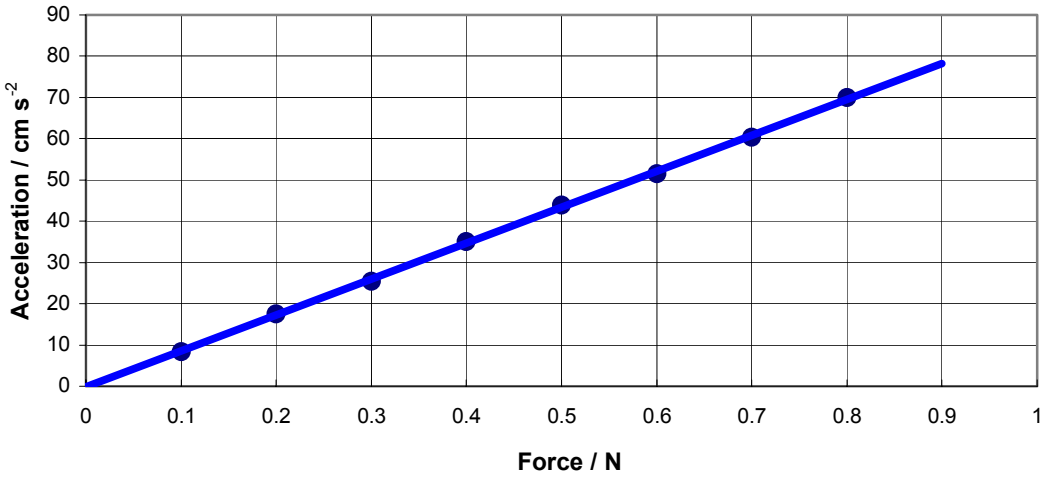
Plot a graph, on graph paper, of the acceleration against the applied force **4 × 3**

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, maximum mark 3×3

wrong axes and scale with a line drawn, maximum 2×3

(Acceleration against the applied force)



What does your graph tell you about the relationship? **4 or 2**

(acceleration is) proportional (to the applied force) / linear	4
partial answer	(2)

Question 2 **40 marks**

Draw a labelled diagram of the apparatus used to measure *l* **4 × 3**

labelled diagram to show:
thermometer 3
calorimeter / beaker, water, ice, insulation, stirrer, balance any three 3 × 3
incorrect experiment, maximum mark 3×3

NOTE: no labels, deduct 2

What measurements did the student take before adding the ice to the water? **3 × 3**

mass of calorimeter, mass of water, mass of calorimeter + water, mass of ice,
temperature of water , temperature of ice any three 3 × 3

What did the student do with the ice before adding it to the water? **6 or 3**

crush / dry 6

partial answer e.g. ensure the ice was 0 ºC (3)

How did the student find the mass of the ice? **6 + 3**

subtract // weigh 6
final mass from initial mass // detail 3

Give one precaution that the student took to get an accurate result **4 or 2**

insulation, crush, dry, repeat and take average, use lots of ice, transfer ice quickly,
use heated water in calorimeter, large temperature change etc. any one 4
partial answer e.g. repeat / average (2)

Question 3 40 marks

Draw a labelled diagram of the apparatus used in the experiment **4 × 3**

labelled diagram to show:

air column / resonance tube	// CRO	3
frequency source e.g. tuning fork / signal generator		3
metre stick stated or implied	// microphone	3
method of varying (the air column) length / frequency	// reflecting surface	3

NOTE: no labels, deduct 2

Describe how the student found the wavelength of the sound wave **3 × 3**

over the resonance tube, hold the vibrating tuning fork / speaker 3
(adjust the length of the air column until) resonance occurs 3
$\lambda = 4 \times$ length of air column 3
measure the length of the air column (2)
accept valid alternatives
a labelled diagram may merit marks

How did the student find the frequency of the sound wave? **6 h/m**

(read it) from the tuning fork / signal generator / used tuning forks of known frequency 6

How did the student calculate the speed of sound in air? **3 × 3**

substituted 3
measurements / frequency and wavelength 3
(into the) formula 3
(c =) $f\lambda$ (3 × 3)

Give one precaution that the student took to get an accurate result **4 or 2**

repeated using different frequencies (and took an average), end-correction,
(took measurements from the) sharpest resonance etc. any one 4
partial answer e.g. repeat / average (2)

Question 4 **40 marks**

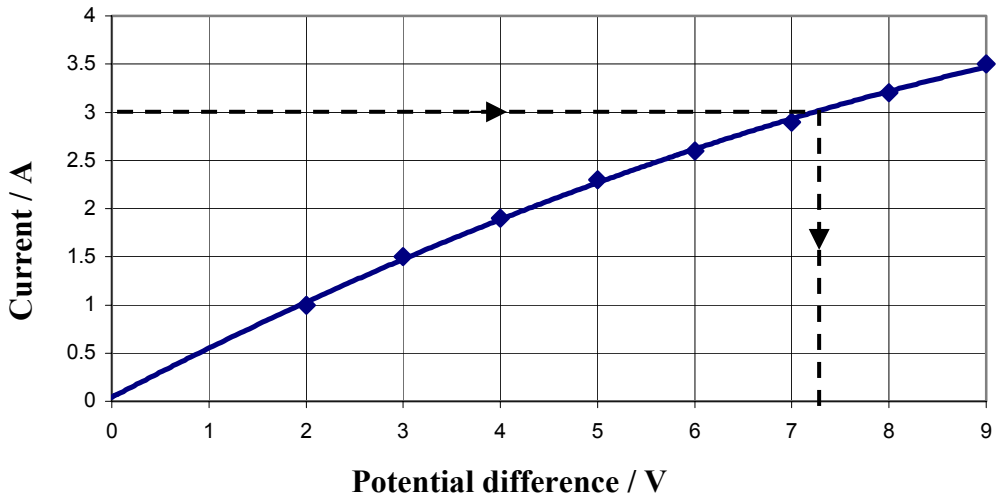
Name the apparatus X. What does it measure? **2 × 3**
ammeter / milliammeter / galvanometer 3
current / amps / answer consistent with named apparatus 3

Name the apparatus Y. What does it do? **2 × 3**
rheostat / (variable) resistance / potential divider 3
varies resistance / voltage / potential / current 3
Y is a resistor and limits the current (2×3)

Draw a graph, on graph paper, of the current against the potential difference **4 × 3**

label axes correctly, (name / symbol / unit acceptable) 3
plot three points correctly 3
plot another three points correctly 3
smooth curve / straight line 3
if graph paper is not used, maximum mark 3×3

(Current against potential difference)



Use your graph to find the resistance of the bulb when the current is 3 A **10 or 7 or 4**
R = 2.4 ± 0.2 (Ω) or value consistent with graph 10
horizontal line drawn from 3 A on the vertical axis to the curve and dropped vertically to the potential difference axis / V ≈ 7.2 ± 0.2 (V) (7)

horizontal line drawn from 3 A on the vertical axis to the curve / $V = IR$ / $R = \frac{V}{I}$ (4)

Explain why the resistance of the bulb when the current is 1.5 A is different **6 or 3**
resistance of bulb increases with current / temperature 6
(wire is) hotter (when current is larger) // ohm's law is not obeyed (6)
partial answer e.g. reference to ohm's law (3)

SECTION B (280 Marks)

Five questions to be answered

Question 5 any *eight* parts 56 marks

Take the <u>best 8</u> from 10 parts

(a) 50 (kg m s^{-1}) / 5000 (kg cm s^{-1}) / 50 000 (g m s^{-1}) 7
0.5 / 2 (4)

(b) (when a fixed mass of gas is kept at a constant temperature)
the pressure varies inversely with the volume // pV = constant 7
partial answer e.g. fixed mass of gas kept at a constant temperature (4)

(c) solar / wind / tidal / hydro / biomass 7
partial example e.g. dams (4)

(d) 27 ± 0.5 (ºC) / 300 - 273 7
273 stated or implied / 573 (4)

(e) conduction, convection, radiation any two 7
any one (4)

(f) light waves are transverse // sound waves are longitudinal 7
light waves can be polarised // sound waves cannot be polarised (7)
light waves travel through vacuum // sound waves cannot travel through vacuum (7)
light waves travel (much) faster in air // sound waves travel slower in air (7)
light waves are electromagnetic // sound waves are not electromagnetic (7)
light waves have a shorter wavelength // sound waves have a longer wavelength (7)
valid example e.g. lightning is seen before thunder is heard (7)
partial answer e.g. sound travels around corners // incorrect converse (4)

(g) virtual / behind the mirror, magnified, erect any two 7
any one (4)
diagram may merit full marks

(h) any valid example e.g. kinetic to electric 7
partial answer e.g. kinetic to chemical (4)

(i) changing (a.c.) voltages / currents 7
reference to changing // name of device (4)

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

Question 6 **56 marks**

Copy and complete the following statement of Newton's law **4 × 3**

force / F 3
masses / m 3
square of distance / d^2 3
distance instead of square of distance (2)
any two in the correct order 3

What is meant by the term acceleration due to gravity? **6 or 3**

acceleration of falling objects (due to the earth) // the speeding up of falling objects // speeding up due to weight // speeding up due to the pull of the earth 6
partial answer e.g. speeding up / pull of the earth / falls to earth / weight / 9.8 m s^{-2} / g (3)
definition of acceleration (3)

What is the weight of the astronaut on the surface of the moon? **6 or 3**

192 (N) / (120 × 1.6) 6
1176 (N) / (120 × 9.8) / 120 (3)

Describe how the speed of the stone changes as it reaches its highest point **6 h/m**

slows / stops 6

Calculate the highest point reached by the stone **4 × 3**

s = 195.3 (± 0.3 m) / $s = \frac{625}{3.2}$ 4 × 3

$0 = (25)^2 + 2\ (-1.6)\ s$ (3 × 3)
two quantities substituted correctly into the equation (2 × 3)
one quantity substituted correctly into the equation (3)
u = 25 (m s^{-1}), v = 0 (m s^{-1}), a = - 1.6 (m s^{-2}) any two (3)

Calculate how high the astronaut can throw the same stone **3 × 3**

s = 31.9 (± 0.3 m) 3 × 3
$0 = (25)^2 + 2\ (-9.8)s$ (2 × 3)
one quantity substituted correctly into the equation (3)
a = - 9.8 (m s^{-2}) and u = 25 (m s^{-1}) (3)

Why is the acceleration due to gravity on the moon less **5 or 3**

moon has less mass 5
reference to different masses // moon smaller // earth bigger (3)

Question 7 56 marks

State the laws of refraction of light **2(2 × 3)**

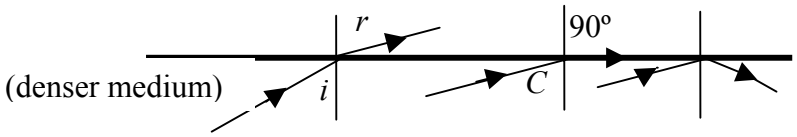
the incident ray / angle, the normal and the refracted ray 3
(are all in the) same plane 3

the sine of the angle of incidence / Sin *i* 3
is proportional to the sine of the angle of refraction 3

$Sin\, i \propto Sin\, r$ // $\frac{\text{Sin}\, i}{\text{Sin}\, r} = \text{constant}$ (2 × 3)

law of reflection, maximum mark 2 × 3
a labelled diagram may merit marks

Explain, with the aid of a labelled diagram
(i) total internal reflection, (ii) critical angle **2(2 × 3)**



(i) total internal reflection occurs when the angle of incidence (in the more dense medium) is greater than the critical angle 3
and light is reflected back (into the more dense medium at the boundary) 3
(ii) critical angle is the angle of incidence in the more dense medium 3
which causes an angle of refraction of 90∠ (in the less dense medium) / above which total internal reflection occurs 3
a labelled diagram may merit all of the marks

Calculate the refractive index of the glass **3 × 3**

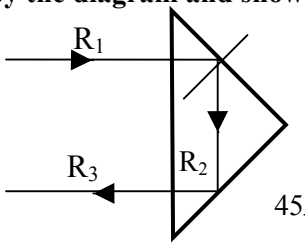
$(n = \frac{1}{Sin\, C} = \frac{1}{Sin\, 42^0} =)\ 1.5$ 3 × 3

(C in grad. n =) 1.63 / (C in rad. n =) 1.09 (3 × 3 – 1)

$\frac{1}{Sin\, 42^0}$ / $\frac{1}{0.669}$ (2 × 3)

C= 42º (3)
C taken to be 45˚, maximum mark 2 × 3

Copy the diagram and show the path of the ray **3 × 3**



first correct ray 3
second correct ray 3
third correct ray 3

Explain why the ray follows the path that you have shown **6 or 3**

reference to total internal reflection in context 6
explanation consistent with an incorrect diagram (2 × 3)
partial answer (3)

Give two uses of total internal reflection **2 × 4**

telecommunications / fibre optics, medicine / endoscope, reflective road signs,
(prism) reflectors any two 2 × 4

Question 8 56 marks

What is an electric current? **2 × 3**

flow of / movement 3
charge / electrons / electricity 3

unit (3)

Give the standard colour of the insulation on the wires **3 × 3**

L (live) is brown // red 3
N (neutral) is blue // black 3
E (earth) is green-yellow / green / yellow 3
two correct colours which are mismatched (3)

What is the purpose of the wire connected to the terminal E on the plug? **6 or 3**

(earth wire) protects from electrocution / shock // (ensures) potential at zero //
draws / conducts (leaking) current to earth / ground (safely) 6
partial answer /earth / protection / fuse blows / safety (3)

Explain why a fuse is used in a plug **2 × 3**

prevents // protects people or equipment from // safety (from) 3
large current 3
partial answer (3)

Calculate the current that flows when the kettle is first plugged in **3 × 3**

8.7 (A) 3 × 3

$\frac{2000}{230}$ (2 × 3)

one quantity substituted correctly into the equation // $I = \frac{P}{V}$ (3)
P = 2000 (W), V = 230 (V) (3)

This current will only flow for a very short time. Explain why **6 or 3**

current / 8.7 (A) larger than fuse rating // current too big // fuse blows 6
partial answer (3)

How does bonding improve safety in the home? **6 + 3**

earth / potential at zero / low potential // prevents electrocution 6
metal pipes connected / taps connected 3
partial answer / safe (3)

Name a device that is often used in domestic electric circuits instead of fuses **5 h/m**

(miniature) circuit breakers / MCBs // trip switches //
residual current devices / RCDs 5

Question 9 56 marks

What is a magnetic field? **2 × 3**

region (where) / space 3
magnetism / force is experienced / detected 3

Give one use of the earth's magnetic field **5 h/m**

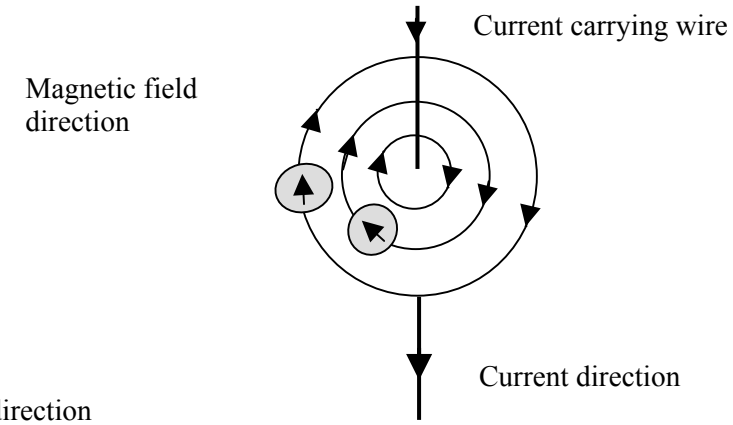
navigation / compass // protection from solar winds 5

Describe how to demonstrate the magnetic effect of an electric current **4 × 3 + 6**

apparatus	e.g. battery, circuit / conductor	2 × 3
detector	e.g. compass / iron filings	3
procedure	e.g. close the circuit / connect up stated or implied	3
observation	e.g. compass deflects	6

a labelled diagram may merit marks
electromagnet experiment // force on a current carrying conductor experiment fits the scheme

Draw a sketch of the magnetic field around a straight wire carrying a current **3 × 3**



current direction 3
shape of magnetic field 3
magnetic field direction consistent with the current 3
relevant right hand rule stated or implied (2 × 3)

Describe what happens when a current flows through the conductor **6 h/m**

(conductor / magnet) moves / jumps / deflects / vibrates 6

Name two devices that are based on the effect demonstrated in this experiment **2 × 3**

loudspeaker, appropriate meters, (electric) motor any two 2 × 3

What would happen if (i) a larger current flowed in the conductor? **3**

(i) bigger force / deflection // hotter // melts 3

What would happen if (ii) the current flowed in the opposite direction? **3**

(ii) (conductor) moves / jumps / deflects in the opposite direction 3

Question 10 56 marks

What is radioactivity? **2 × 3**

disintegration / decay of nuclei / atoms 3
emission of radiation / energy / α / β / γ 3
decay of unstable nuclei (2 × 3)

Give the function of <u>any two</u> of these **2 ×(6 or 3)**

(fuel rod) source of energy //contain uranium / fissionable material 6
partial answer (3)
(control rod) absorb neutrons // speed up / slow down / stop reaction 6
partial answer (3)
(moderator) slows down neutrons //makes neutrons easier to capture // ensures chain reaction continues 6
partial answer (3)
(heat exchanger) transfers heat / energy // heats water/steam // cools coolant 6
partial answer (3)
transposed incorrect answers, maximum mark 6

What is nuclear fission? **3 × 3**

splitting / breaking 3
(of large) nucleus / atom 3
(with) release of (large amounts of) energy / two nuclei of roughly equal size 3
diagram may merit marks

What is a chain reaction? **3 × 3**

(at least one) neutron released 3
(during) fission (reaction) stated or implied 3
causes more fission / absorbed by another nucleus 3
self sustaining reaction (3 × 3)
repeats continuously // relevant mention of critical mass (2 × 3)
diagram may merit marks

Name three types of radiation that are present in a nuclear reactor **3 × 3**

alpha / α 3
beta / β 3
gamma / γ 3

Name an instrument used to detect radiation **5 h/m**

GM tube, solid state detector, cloud chamber, ionisation tube, scintillation counter, gold leaf electroscope etc. any one 5

Give two precautions that are taken when storing the plutonium **2 × 3**

(thick) shielding, long life (containers), security (against theft), isolating, handling / use a tongs, labelling etc. any two 2 × 3

Question 11 56 marks

(a) (resistivity) between that of a conductor and insulator 7
neither a good conductor nor a good insulator (7)
partial answer / valid example / reference to p-type or n-type material (4)

(b) silicon / germanium / selenium etc. 7

(c) (positive) holes and electrons 7
one correct (4)
partial answer e.g. positive and negative (4)

(d) adding (suitable) impurities (to improve conductivity) 7
partial answer e.g. reference to extrinsic (4)

(e) p-type material contains more holes (than n-type material) 7
n-type material contains more (free) electrons (than p-type material) (7)
partial answer / valid example (4)

(f) (the junction) between the p-type and the n-type material (in contact) 7
partial answer (4)
labelled diagram may merit full marks

(g) a device that contains a p-n junction // allows current to flow in one direction only 7
partial answer e.g. contains a depletion layer // named example e.g. LED (4)

(h) radio, television, computer, battery charger, mobile phone charger etc. any one 7

Question 12 56 marks

Part(a)

Define the moment of a force **2 × 3**

force (by) 3
(perpendicular) distance (from fulcrum) 3
turning effect of a force / *Fd* (2 × 3)
(unit is) N m (3)

Explain why the handle on a door is on the opposite side to the hinges **7 or 4**

larger turning effect / moment (of force) // larger distance (between force and axis) 7
partial answer e.g. easier to open (4)

Calculate the moment of the 2 N weight about the 20 cm mark **5 or 3**

0.1 (N m) / 2 × 0.05 // 10 (N cm) / 2 × 5 5
0.6 / 60 / 40 / 30 (3)

What is the moment of *W* about the 20 cm mark? **5 or 3**

W × 0.3 (N m) // W × 30 (N cm) 5
0.2W / 20W / 50W (3)

Find the value of *W* **5 or 3**

W = 0. 33 (N) 5
0.1= W × 0.3 // 10 = W × 30 (3)
full marks may be obtained if the answer is consistent with the value calculated for W above

Part (b)

Name two primary colours **2 × 3**

red, green, blue any two 2 × 3
one correct (3)

What are complementary colours? **2 × 3**

primary and secondary (colour) // two (colours) 3
(when mixed give) white light 3
valid example e.g. blue and yellow (2 × 3)

Describe an experiment to demonstrate that white light is made up of light of different colours **3 × 3**

apparatus (white)light source,(slit), prism, (screen) // CD // Newton's disc 3
procedure shine light through the prism // (white) light // rotate 3
observation (seven different) colours on the screen // colours // white 3
mixing the three primary colour lights // diffraction grating method fits the scheme
a labelled diagram may merit full marks

Copy this diagram and indicate on it the positions of the following **7 or 5 or 3**

short wavelength → long wavelength						
gamma rays	**X-rays**	**ultraviolet**	light	**infrared**	**microwaves**	radio waves

all four correct 7
any two correct (5)
any one correct (3)

Part (c)

What is the unit of electric charge? **6 or 3**

coulomb / C 6

amp (3)

Describe, with a labelled diagram, how to charge a conductor by induction **4 × 3**

apparatus e.g. conductor (mounted on insulated stand) and a charged object / rod 3

procedure hold / bring the charged rod near the conductor 3

earth the conductor (while the charged rod is near) 3

remove the earth then the charged rod 3

a labelled diagram may merit marks

charge by friction, maximum 2 × 3

NOTE: no labels, deduct 2

Give two examples where build-up of electric charge can lead to explosions **2 × 3**

dust e.g. flour mill explosions, inflammable vapours e.g. fuelling aircraft, lightning any two 2 × 3

How can the build-up of electric charge on an object be reduced? **4 h/m**

earthing / grounding 4

Part(d)

What is a photon? **2 × 3**

bundle / packet 3

of energy / light 3

$E = hf$ (2 × 3)

Name the parts labelled A and B **2 × 3**

(A is the photo) cathode 3

(B is the photo) anode 3

reverse order (3)

What happens at A when light falls on it? **2 × 3**

electrons / charged particles // current 3

are released / emitted // flows 3

gains energy / galvanometer / meter deflects / turns on (3)

What happens in the circuit when the light falling on A gets brighter? **2 × 3**

current / I // meter reading 3

increases 3

Give an application of a photocell **4 h/m**

alarms, automatic doors, safety switches, light meters, solar cells etc. any one 4