Coimisiún na Scrúduithe Stáit
State Examinations Commission

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Fisic *Gnáthleibhéal*

Marking Scheme *Leaving Certificate Examination, 2004*

Physics *Ordinary level*

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State Examinations Commission

LEAVING CERTIFICATE EXAMINATION

PHYSICS – ORDINARY LEVEL

MARKING SCHEME

2004

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 (120 marks)

Three questions to be answered.

Question 1 40 marks

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

labelled diagram to show:
enclosed / fixed volume of gas / air 6
method of measuring volume e.g. volume scale
method of measuring pressure e.g. pressure gauge
method of varying pressure / volume any two 2 × 3

NOTE: no labels, deduct 2

Copy this table and fill in the last row by calculating $\frac{1}{\text{Volume}}$ for each measurement **7 × 1**

Pressure /kPa	100	111	125	143	167	200	250
Volume /cm^3	5.0	4.5	4.0	3.5	3.0	2.5	2.0
$\frac{1}{\text{Volume}}$ /cm^{-3}	**0.20**	**0.22**	0.25	**0.28/ 0.29**	**0.33**	**0.40**	**0.50**

one mark for filling in each 1/volume including value given 7 × 1

6 inverted values e.g. 1/5, etc. (3)

Plot a graph on graph paper of pressure against $\frac{1}{\text{Volume}}$ **4 × 3**

label one axis 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
if *p* versus *V* is graphed, maximum mark 2 × 3

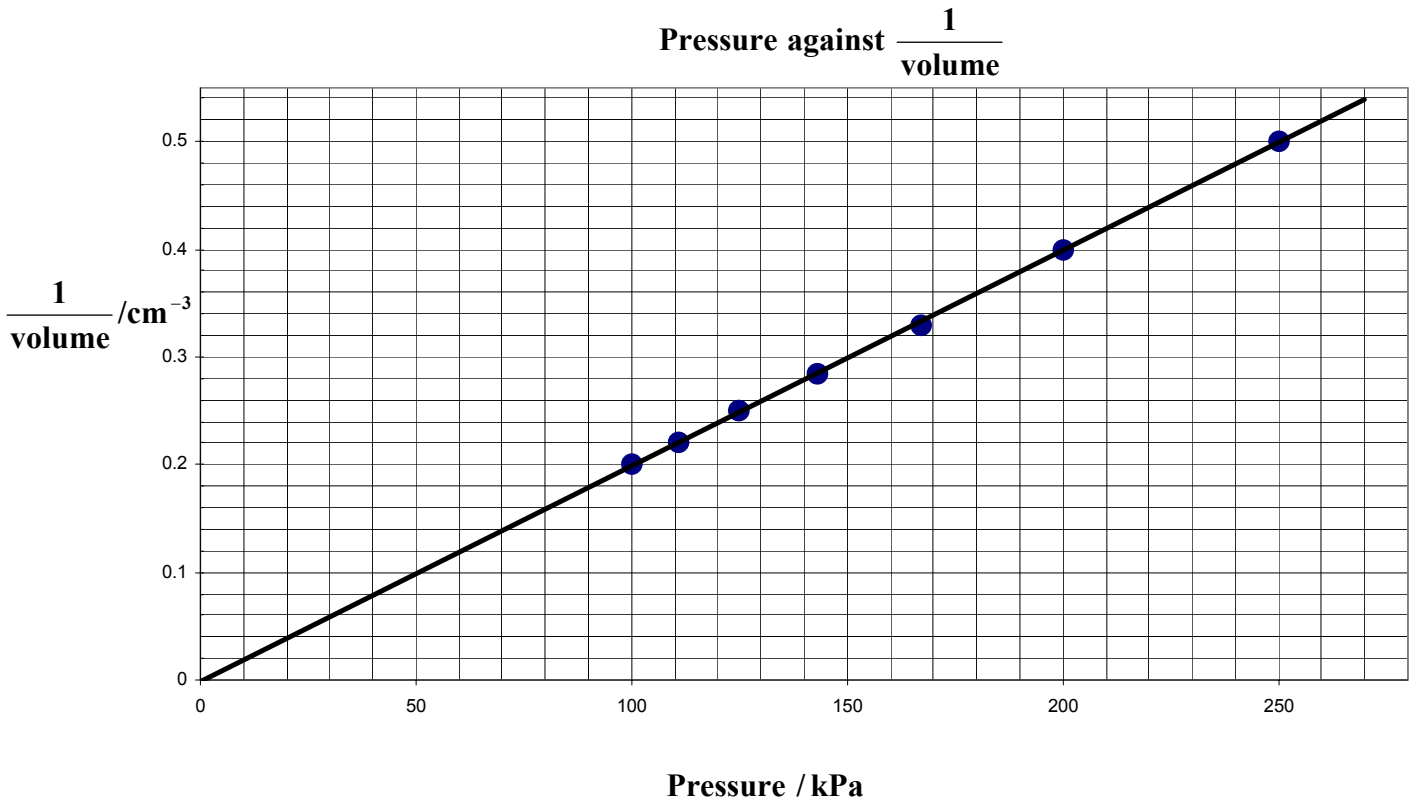
Explain how your graph verifies Boyle's law **2 × 3**

(straight) line // constant 3
through origin /shows that pressure ∝ 1/volume // some correct variation of Boyle's law 3

Give one precaution that the student took in carrying out the experiment **3**

after changing pressure wait a short time before taking readings / read the volume of the oil from the bottom of the meniscus / read the volume scale at eye level,
safety precaution e.g. do not exceed the pressure limit of the apparatus, etc. any one 3

Q1. Plot a graph on graph paper of pressure against $\frac{1}{\text{volume}}$



Pressure /kPa	100	111	125	143	167	200	250
Volume /cm^3	5.0	4.5	4.0	3.5	3.0	2.5	2.0
$\frac{1}{\text{Volume}}$ /cm^{-3}	**0.20**	**0.22**	0.25	**0.28 / 0.29**	**0.33**	**0.40**	**0.50**

Question 2 40 marks

Draw a labelled diagram of the apparatus used **6 + 2 × 3**

labelled diagram to show
liquid / water in a calorimeter // block of metal 6
method of heating liquid // method of heating metal
stirrer // joulemeter
thermometer
insulation

any two 2 × 3

incorrect experiment, maximum mark 6 + 3

NOTE: no labels, deduct 2

What measurements of mass did the student take during the experiment? **2 × 3**

mass of substance / liquid / water, mass of metal, mass of calorimeter, mass of calorimeter + liquid/water any two 2 × 3
mass of the metal block (2 × 3)
inconsistency between the apparatus and the measurements (3)

What temperature measurements did the student take during the experiment? **2 × 3**

initial/ minimum temperature of the substance / liquid / water /metal / calorimeter 3
final / maximum temperature of the substance/ liquid / water /metal / calorimeter 3
change in temperature (of the water) (2 × 3)
temperature of the substance/ liquid / water /metal / calorimeter (3)

Give a formula used to calculate the specific heat capacity of the substance **10 or 6 or 3**

$E = m_w c_w \Delta\theta_w + m_c c_c \Delta\theta_c$ // $E = m_w c_w \Delta\theta_w$ 10
$m_w c_w \Delta\theta_w / m_c c_c \Delta\theta_c$ (6)
$Q = / E = / VIt / m_c c_c \theta_c$ (3)
Partial mark e.g. attempts word version of the equation (3)

Give one precaution that the student took to get an accurate result **6 or 3**

lagging, use sensitive thermometer / use a thermometer graduated to 0.1°C, ensure that heating coil is completely immersed in the liquid, stir the liquid, large temperature change, etc. any one 6

the precaution can be implied from the diagram if it has not already been awarded marks above

partial answer e.g. repeat / average (3)

Question 3 40 marks

Name a monochromatic light source **6 or 3**

sodium (lamp) / laser 6

partial answer e.g. any gas that produces a line spectrum, yellow / red (3)

Draw a labelled diagram of the apparatus that you used in the experiment **6 + 2 × 3**

diffraction grating/ Young's slit 6

monochromatic light source

spectrometer // screen

scale // metre stick any two 2 × 3

NOTE: no labels, deduct 2

What readings did you take during the experiment? **6 + 3**

angle on left // distance from grating to screen

angle on right // distance between centre and first order

grating constant / number of lines per metre

any two 6 + 3

any one 6

What formula did you use to calculate the wavelength of the light? **3 × 3**

$(n)\lambda$ 3

$= d / s$ 3

$\sin\theta$ // $\frac{x}{D}$ 3

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

one spectrometer precaution e.g. ensure the fringe not too wide/not too dim, ensure that the crosshairs are on the centre of the fringe, level the table, focus the telescope (for infinity), measure the angle between the first order images on the left and on the right, adjust the collimator, use the Vernier scale, ensure that the diffraction grating is perpendicular to the (monochromatic) light, use a grating with a large number of lines, ensure D is large, repeat for different orders and take the average, etc. 4

partial answer e.g. repeat the experiment (2)

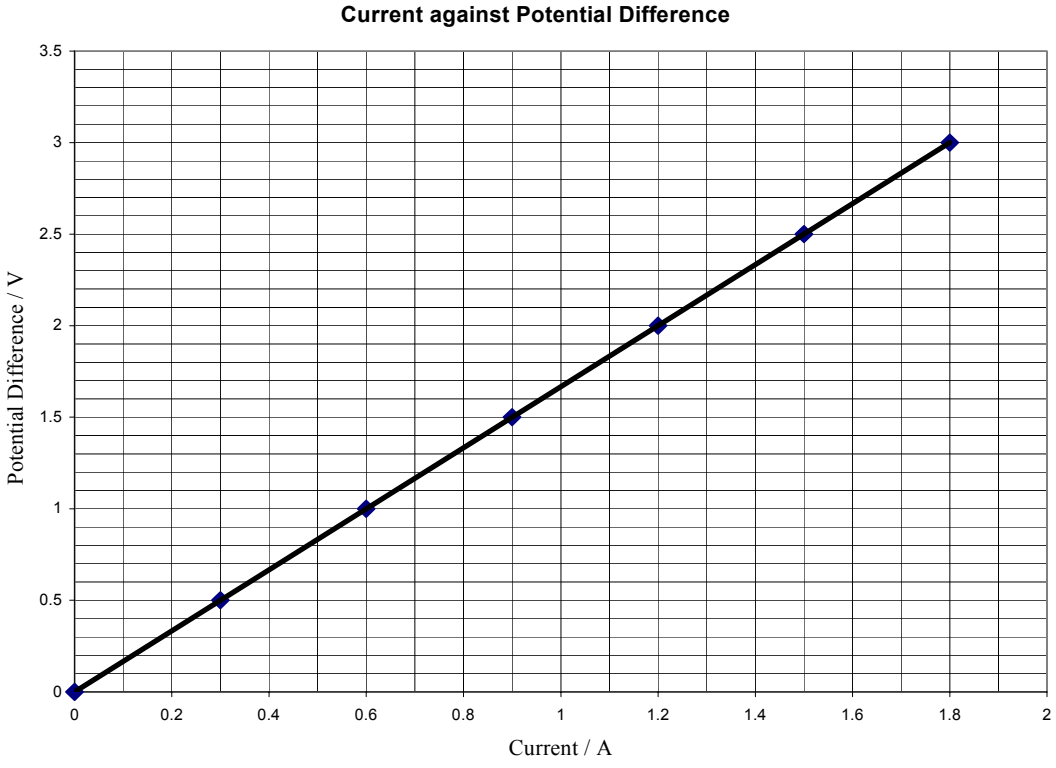
Question 4 40 marks

Name the instrument used to measure the current **6 or 3**
ammeter /milliammeter / galvanometer 6
A / multimeter (3)

How was the potential difference measured in the experiment? **4 or 2**
voltmeter 4
V / multimeter / from the voltage (2)
ammeter and voltmeter named but in reverse order (6)

Name the apparatus Y and give its function in the experiment **6 + 3**
rheostat / variable resistor / potential divider 6
varies the resistance / potential / voltage / current / power 3
resistor (3)

Draw a graph on graph paper of the current against the potential difference **4 × 3**
label one axis 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



Calculate the slope of your graph and hence determine the resistance of the copper sulfate solution **3 × 3**

1.67 ± 0.2 (Ω) or value consistent with graph 3 × 3
correct substitution into slope formula // 0.60 (2 × 3)
slope formula // two points highlighted on the graph (3)

SECTION B (280 Marks)

Five questions to be answered

Question 5 any *eight* parts 56 marks

Total the best 8 from 10 parts

(a) **Calculate the potential energy of the ball** **7 or 4**
98 (J) 7
substitute into equation (4)

(b) **Explain the term thermometric property** **4 + 3**
(physical property that) changes (measurably / continually) 4
with (changing) temperature 3
partial answer e.g. valid example (4)

(c) **Give one application of the Doppler effect** **7 or 4**
measuring speed / speed gun, (measuring) red shift, ultrasonic scanners,
used to study blood flow, used to study heart beat, etc. any correct application 7
partial answer e.g. example of Doppler effect (4)

(d) **Name two primary colours of light** **7 or 4**
red, blue, green any two 7
any one (4)

(e) **Which one of the following is not part of the electromagnetic spectrum?** **7**
sound waves 7

(f) **Name the electrical component represented in the diagram** **7 or 4**
capacitor / condenser 7
partial answer e.g. parallel plate, stores charge, battery (4)

(g) **Name two safety devices that are used in domestic electric circuits** **7 or 4**
fuse, (trip) switch / miniature circuit breaker / MCB, residual current
device / RCD, earthing, etc. any two 7
any one (4)

(h) **Calculate the force on the conductor** **7 or 4**
7.5 (N) / 750 (T A cm) 7
correctly substituted two quantities into the formula (4)

(i) **Which one of the following is emitted from a metal surface** **7**
electrons 7

(j) **What is nuclear fission?** **7 or 4**
break up of nucleus / atom 7
partial answer e.g. release of energy / neutrons (4)
diagram may merit full marks

Question 6 56 marks

Define (i) velocity, (ii) acceleration **2 × (2 × 3)**

(i) velocity: rate of change // distance ÷ time / speed 3
(of) displacement // in particular direction 3
$v = \frac{s}{t}$ (2 × 3)
correct unit (3)

(ii) acceleration: rate of change // change in velocity/speed 3
of velocity/speed // per second 3
$a = \frac{v - u}{t}$ (2 × 3)
correct unit (3)

Describe an experiment to measure the velocity of a moving object **4 × 3**

apparatus: trolley
timer / photogate // motion sensor
procedure: measure distance // connect datalogger to sensor
measure time // start program

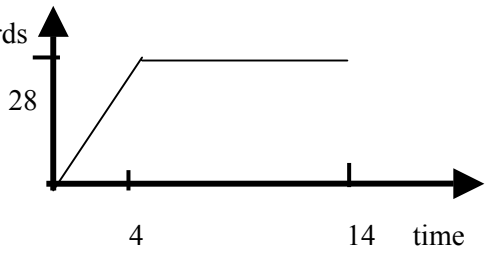
conclusion: $v = \frac{s}{t}$ // chose distance versus time graph

any four 4 × 3

accept valid alternatives
a labelled diagram may merit marks

Sketch a velocity–time graph **2 × 4 + 3**

one labelled axis,(name / symbol / unit acceptable) 4
accelerating from origin to t = 4 s 4
no acceleration from t = 4 s onwards 3



Calculate the acceleration of the cheetah during the first 4 seconds **3 × 3**

a = 7 (m s^{-2}) 3 × 3
correct substitution into equation i.e. 28 = 0 + *a* (4) (2 × 3)
substitutes one value correctly (3)

Calculate the resultant force acting on the cheetah while it is accelerating **6 or 3**

1050 (N) / answer consistent with the calculated value for acceleration above 6
correct substitution into formula (3)

Name two forces acting on the cheetah while it is running **2 × 3**

gravitational / gravity / weight
friction
air resistance / drag
(propulsion) force of muscles, etc. any two 2 ×3

Question 7 56 marks

What is meant by conduction? **2 × 3**

(transfer) of heat 3

without the movement of matter / atoms // through metals / solids //
atoms vibrate // (by vibration) from molecule to molecule 3

Name two other ways of transferring heat **2 × 3**

convection / example 3

radiation / example 3

Describe an experiment to show how different solids conduct heat at different rates **4 × 3**

apparatus: a number of different metal rods, 3

heat source 3

procedure: heat all the ends of the rods at the same time, rods same length and same thickness, other valid detail 3

observation/conclusion: e.g. wax melts on (different) rods at different times, (different) rods conduct heat at different rates 3

accept valid alternatives

a labelled diagram may merit marks

Give two ways in which the *U*-value of a house can be reduced **6 + 2**

insulation / fibreglass in attic

insulation in cavity wall

double glazing

carpets

any two 6 + 2

any one (6)

What energy conversion takes place in a solar panel? **2 × 3**

light / solar 3

to heat 3

Why are the pipes in the solar panel usually made from copper? **2 × 3**

good 3

conductor / reference to metal 3

partial answer (3)

Why are the pipes in the solar panel usually painted black? **2 × 3**

good // poor 3

absorber (of radiation) // reflector 3

partial answer e.g. black attracts heat (3)

Why does the warm water rise to the top of the solar panel? **2 × 3**

lower 3

density 3

convection / water expands (2 × 3)

partial answer e.g. it is lighter, reference to water currents (3)

Question 8 56 marks

Explain diffraction **2 × 3**

spreading out (of a wave) 3
around an obstacle / opening 3
bending of waves around corners (2 × 3)
labelled diagram or correct example may merit marks

Explain interference **2 × 3**

waves meeting 3
add / change in amplitude / displacement 3
labelled diagram or correct example may merit marks

Describe an experiment to demonstrate the interference of sound **6 + 3 + 2**

apparatus: two sources e.g. two loudspeakers // tuning fork 6
procedure: walk between speakers // rotate (vibrating) tuning fork (near ear) 3
observation/conclusion: observed sound varies in loudness 2
labelled diagram may merit marks
accept valid alternatives

What is the name given to the points on the string marked **6 + 3**

(i) X = node / null (point) (ii) Y = antinode two correct 6 + 3

correct names mismatched / one correct (6)

partial answer e.g. crest/trough (3)

How many wavelengths are contained in the distance marked L? **6 or 3**

two 6
four (3)

State two factors on which the natural frequency of a stretched string depends **6 + 3**

length / l
tension / T
thickness / mass per unit length / (linear density) / cross-sectional area / radius / μ
material any two 6 + 3
any one (6)

Calculate the frequency of the note **3 × 3**

f = 240 - 243 (Hz) 3 × 3
correct substitution into both sides of the equation / 340 ÷ 1.4 (2 × 3)
correct substitution into one side of the equation (3)

Question 9 56 marks

What is an electric current? **6 + 3**

flow of / movement

charge / electrons / electricity — two lines 6 + 3; one line (6)

partial answer e.g. unit (3)

Name two other effects of an electric current **6 + 3**

magnetic / deflects compass

chemical — two lines 6 + 3; one line (6)

partial answer e.g. light / sound (3)

Describe an experiment to show the heating effect of an electric current **4 × 3**

apparatus: source e.g. power supply 3

conductor e.g. bulb, wire 3

procedure: set up the circuit / allow current to flow 3

observation/conclusion: wire gets hot 3

accept valid alternatives

a labelled diagram may merit marks

State two factors on which the heating effect of an electric current depends **2 × 3**

size of current, (size of) voltage, resistance / length of coil, amount of time any two 2 × 3

Calculate the current that flows through the heater **2 × 3**

8.7 (A) / 0.0087 (kA) 2 × 3

correct substitution into one side of the equation (3)

What is the kilowatt-hour? **2 × 3**

energy 3

used by a 1 kW (appliance/device) in 1 hour 3

unit used by the ESB (2 × 3)

partial answer e.g. reference to joule (3)

Calculate the cost of using a 2 kW electric heater for 3 hours at 10 cent per kilowatt-hour **2 × 4**

60 (cent) / 0.6 (euro) 2 × 4

multiplies at least two of the quantities / 2 × 3 / 6 (units) (4)

Question 10 56 marks

What is radioactivity? **6 + 3**

disintegration / decay
of nuclei / atoms
emission of radiation / energy /α / β / γ any two lines 6 + 3
any line (6)

Name the French physicist who discovered radioactivity in 1896 **6 or 3**
(Henri) Becquerel / Curie 6
partial answer e.g. named nuclear scientist (3)

Name the radiations labelled X, Y and Z in the diagram **6 + 3 + 3**

(i) X = alpha / α (ii) Y = gamma / γ (iii) Z = beta / β
three correct 6 + 3 + 3
two correct / all radiations named correctly but mismatched maximum mark (6 + 3)
any one correct (6)

Which one is the most ionising? **6**
alpha / α / X 6

Name a detector of ionising radiation **6**

GM tube / / cloud chamber / ionisation tube /
scintillation counter / gold leaf electroscope / solid state detector
photographic film, ZnS screen, etc. any one 6

Outline the principle on which the detectors works **6 or 3**
ionisation, blackens film, fluorescence 6
partial answer e.g. principle inconsistent with the named detector (3)

(i) Two precautions that should be taken when dealing with radioactive sources **5 or 3**

(thick) shielding, long life (containers), never eat / drink / smoke in vicinity,
security (against theft), isolating, use protective clothing / gloves / use a tongs
when handling, labelling, minimise time spent using radioactive source,
keep as far away from source as possible, use warning signs, etc. any two 5
any one (3)

(ii) One use of a radioactive source **3**
carbon dating, radiotherapy, sterilising medical equipment, killing bacteria in food
finding leaks in pipes and seals, checking thickness of materials, smoke alarm
tracers in medicine / agriculture, energy source e.g. pacemakers, etc. any one 3

(iii) One harmful effect of radiation **3**
cancer, skin burns, sickness, cataracts, cause sterility, damage to crops,
genetic, etc. any one 3

Question 11 56 marks

(a) **Draw a diagram to show how a ray of light is transmitted through an optical fibre** **7 or 4**

incident ray in fibre
reflected ray in fibre — two correct 7
one correct / no fibre shown (4)

(b) **How is the escape of light from the sides of an optical fibre prevented?** **7 or 4**

cladding/coating with glass/plastic (of lower/different refractive index), because of total internal reflection 7
partial answer (4)

(c) **Name a material that is used in the manufacture of optical fibres.** **7**

glass / plastic / sand / silicon 7

(d) **What is the bending of light as it moves from one medium to another called?** **7**

refraction / refracted 7

(e) **What is meant by the refractive index of a material?** **7 or 4**

$(n =) \frac{\text{Sin } i}{\text{Sin } r}$ // $\frac{1}{\text{Sin } c}$ // $\frac{\text{Real depth}}{\text{Apparent depth}}$ // ability to refract / bend light 7

partial answer e.g. one error in equation (4)

(f) **Define the critical angle.** **4 + 3**

angle in denser medium
that gives angle of refraction of 90^0 — two correct 7
one correct (4)
partial answer e.g. depends on the refractive index / where t.i.r. occurs (4)
a labelled diagram may merit full marks

(g) **When will total internal reflection occur?** **4 + 3**

when angle of incidence is greater
than critical angle — two correct 7
one correct (4)
partial answer e.g. when using optical fibres (4)

(h) **Give one use for optical fibres** **7 or 4**

endoscope, telecommunications, binoculars, correct specific ornament/toy, to supply light to inaccessible places, etc. — any one 7
partial answer e.g. ornaments, toys (4)

Question 12 56 marks

part (a)

Define momentum **2 × 3**

mass 3

(multiplied) by velocity 3

$p = mv$ (2 × 3)

Give the unit of momentum **3**

kg m s^{-1}, N s 3

State the principle of conservation of momentum **3 × 3**

momentum before 3

equals 3

momentum after (in a closed system / when no external force acts) 3

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ (3 × 3)

(total) momentum is conserved (2 × 3)

Calculate the initial velocity of the boat after the child steps out **3 × 3 + 1**

correct substitution into both sides of the equation i.e. $0 = (40)(2) + (50)x$ 3 × 3

each term omitted deduct 3

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ in context (2 × 3)

1.6 (m s^{-1}) (10)

part (b)

Give one difference between a real image and a virtual image **6**

a real image can be obtained on a screen / a virtual image cannot, in a real image the light rays meet / in a virtual image they do not, a real image is always inverted/ a virtual is erect, a real image is in front / a virtual image is behind, etc. 6

Use a ray diagram to show the formation of a real image by a concave mirror **2 × 3**

one ray reflected correctly 3

second ray reflected correctly 3

How far from the mirror will the image be formed? **3 × 3 + 1**

Equation method	Diagram method	
left hand side of equation substituted correctly	// focus shown at 20 cm	3
right hand side of equation substituted correctly	// object shown at 30 cm	3
correct rearrangement	// image near 60 cm	3
calculation	// done on graph paper	1
v = 60 (cm)		(10)

Give two uses for a concave mirror **2 × 3**

torch / headlights /searchlight, dentist mirror, cosmetic / shaving mirror, solar furnace, (reflecting) telescopes, etc. any two 2 × 3

part (c)

What is electromagnetic induction?		**2 × 3**
emf / voltage / potential difference / current is induced		3
(due to)changing (magnetic) flux / field // moving magnet		3

Name another device that is based on electromagnetic induction		**3**
dynamo, generator, induction motor, induction cooker, etc.	any one	3

Name the parts of the transformer labelled A, B and C in the diagram		**6 + 3**
A = primary / input (coil)		
B = secondary / output (coil)		
C = (iron) core / former	any two	6 + 3
	any one	(6)
partial answer e.g. coil in A or B, reference to step-up (transformer)		(3)

What is the voltage across B?	**10 or 6 or 3**
690 (V) / three times bigger	10
correct substitution into both sides of the equation / ≈ 77 / three times smaller	(6)
partial answer e.g. correct substitution into one side of the equation	(3)

part (d)

What are X-rays?		**2 × 3**
electromagnetic / stated property e.g. high energy		3
radiation / waves / rays		3

How are electrons emitted from the cathode?		**6 or 3**
thermionic emission / heat		6
partial answer		(3)

What is the function of the high voltage across the X-ray tube?		**2 × 3**
to accelerate/ pull / attract /give more energy to	// to produce	3
electrons	// cathode rays / X -rays	3

Name a suitable material for the target in the X-ray tube		**4**
tungsten, molybdenum		4

Give one use of X-rays		**6 or 3**
to photograph bones/ internal organs, to treat cancer, to detect flaws in materials, to determine the thickness of materials, etc.	any one	6
partial answer e.g. reference to photograph / medicine / industry, etc		(3)