Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2014

Marking Scheme

Physics

Ordinary Level

Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.

General Guidelines

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. Marks for a description may be obtained from a relevant diagram, depending on the context.

6. Each time an arithmetical slip occurs in a calculation, one mark is deducted.

7. 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.

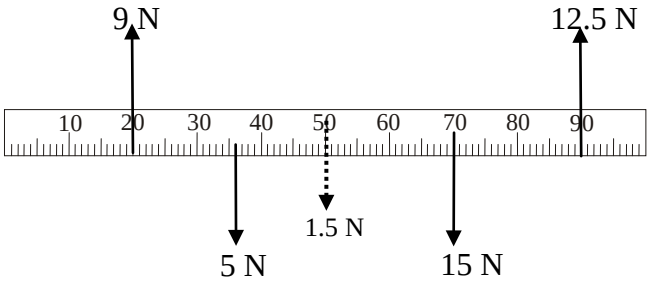
Question 1 40 marks

A student investigated the laws of equilibrium for a set of co-planar forces acting on a metre stick. The weight of the metre stick was 1.5 N and its centre of gravity was at the 50 cm mark. The student applied the forces shown to the metre stick until it was in equilibrium.

(*i*) How did the student measure the upward forces? **4 or 2**

newton balance 4
partial answer e.g. balance, written on weights (2)

(*ii*) Copy the diagram and show all the forces acting on the metre stick. **2 × 3**



copy diagram and show given forces 3
shows weight /1.5 N downward at 50 cm mark 3

(*iii*) (*a*) Find the total upward force acting on the metre stick. **6 or 3**

(9 + 12.5 =) 21.5 (N) 6
partial answer (3)

(*b*) Find the total downward force acting on the metre stick. **6 or 3**

(5 + 15 + 1.5 =) 21.5 (N) 6
partial answer e.g. 5 + 15 (3)

(*c*) Explain how these values verify one of the laws of equilibrium. **3**

forces are equal // sum of acting forces is zero // forces up = forces down 3

(*iv*) (*a*)Find the sum of the anticlockwise moments of the upward forces about the 0 mark. **6 or 3**

((9)(0.2) + (12.5)(0.9) = 1.8 + 11.25 =) 13.05 (N m) 6
partial answer e.g. one moment correct, F× d, recognises the forces involved (3)

(*b*) Find the sum of the clockwise moments of the downward forces about the 0 mark. **6 or 3**

((5)(0.36) + (1.5)(0.5) + (0.7)(15) = 1.8 + 0.75 + 10.5 =) 13.05 (N m) 6
partial answer e.g. one moment correct, F× d, recognises the forces involved (3)

(*c*) Explain how these values verify the other law of equilibrium. **3**

moments are equal // sum of the moments equals zero 3

Question 2 40 marks

A student carried out an experiment to measure the specific latent heat of fusion of ice. The following is an extract from her report.

> **"I got ice which was at 0 °C and prepared it for my experiment by crushing and drying it. I added the ice to water in a calorimeter and waited for the ice to melt before taking more measurements. I used the measurements to calculate the specific latent heat of fusion of ice. I then repeated my experiment."**

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

labelled diagram to show:

calorimeter (with water)	3
thermometer // temperature sensor	3
ice	3
other detail e.g. insulation/(electronic) balance/stirrer, etc.	3

incorrect experiment, maximum mark 3×3

NOTE: no labels, deduct 1

(*ii*) What measurements would the student have taken for this experiment? 6 + 2× 3

mass of empty calorimeter
mass of calorimeter and water // mass of water
mass of calorimeter with water and ice // mass of (dried) ice
initial temperature of water
final temperature of water (and melted ice) // temperature difference

any three lines	6 + 2 × 3
any line	(6)

some measurements may be inferred from the diagram

masse(s) and temperature(s)	(6)
partial answer	(3)

(*iii*) How was the ice crushed ? 4 or 2

any valid method e.g. (place in a plastic bag/towel and hit) with a hammer // blended	4

a diagram may merit full marks

partial answer	(2)

(*iv*) Why was the ice crushed? 6 or 3

crushed ice melts faster // reference to larger surface area // to ensure all the ice is 0 °C	6
partial answer e.g. more accurate, less heat loss	(3)

(*v*) Why was the experiment repeated? 6 or 3

increase accuracy // to get average	6
partial answer	(3)

Question 3 40 marks

An experiment was set up to investigate how the fundamental frequency of a stretched string varied with its length. The length, *l*, of the string and its fundamental frequency, *f*, were recorded. The procedure was repeated for different values of *f* and *l*.

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

labelled diagram to show:

sonometer and string		3
tuning fork(s)	// signal generator	3
bridge(s) and metre stick / detail	// bridges and magnet / detail	3

other valid methods acceptable

NOTE: no labels, deduct 1

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

distance between bridges indicated	6
partial answer	(3)

(*iii*) Describe how the string could have been set vibrating. 3

place a vibrating tuning fork on bridge // send signal from signal generator through it 3

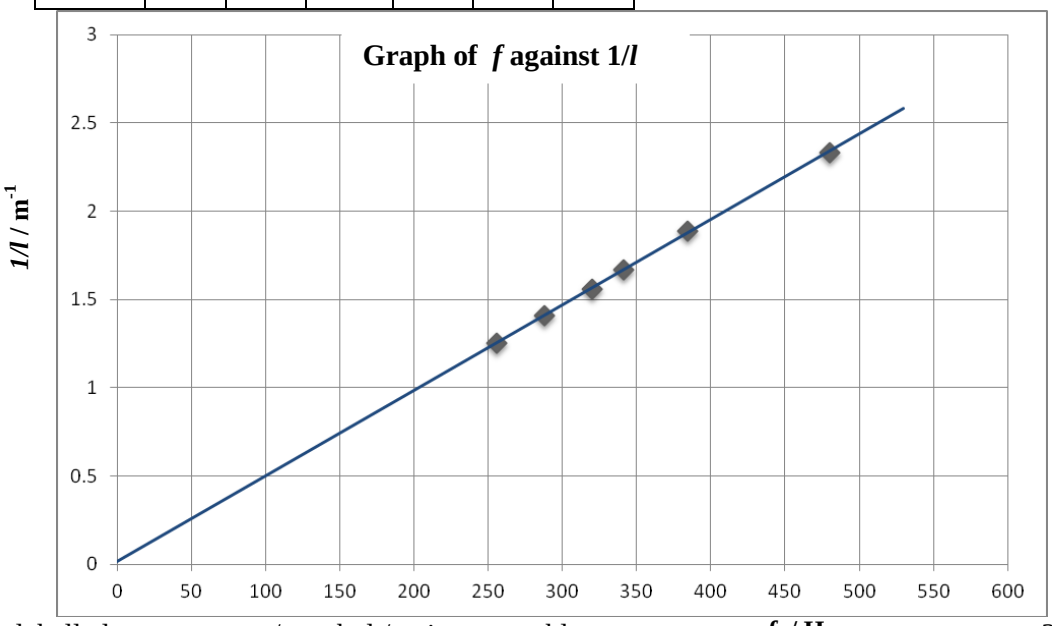
(*iv*) How was the frequency determined? 6 or 3

read off the tuning fork	// read off the signal generator	6
partial answer		(3)

(*v*) Copy and complete the table into your answer book. Draw a graph on graph paper of *f* on the *X*-axis against 1/*l* on the *Y*-axis. What conclusion can be drawn from your graph? 5 + (3 × 3) + 2

f (Hz)	256	288	320	341	384	480
l (m)	0.80	0.71	0.64	0.60	0.53	0.43
1/*l* (m^{-1})	1.25	1.41	1.56	1.67	1.89	2.33

5 × 1



labelled axes – names/ symbol / unit acceptable 3

plot five points correctly 3

straight line graph 3

if graph paper is not used or if f is on the Y – axis maximum mark 2× 3

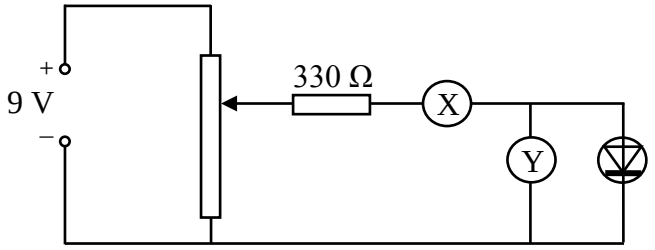
conclusion; f and l are inversely proportional // fl = constant // linear relationship //

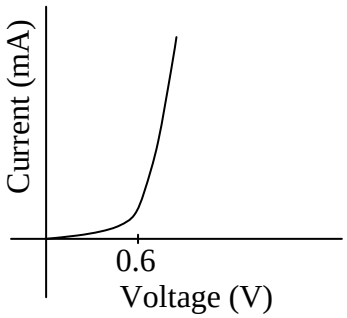
$f \propto \frac{1}{l}$ // answer consistent with the graph, etc 2

Question 4 40 marks

A student carried out an experiment to investigate the variation of current, *I*, with voltage, *V*, for a semiconductor diode in forward bias and wrote the following report.

"I set up the circuit shown below for the experiment. During the experiment I varied the voltage and I recorded the current flowing at the different voltages and plotted a graph of my results, as shown below."





(*i*) How was the voltage changed in this experiment? **6 or 3**
using the potential divider // by varying the resistance/the battery/power supply 6
partial answer (3)

(*ii*) What is the function of part X? **6 or 3**
measure current 6
partial answer e.g. ammeter (3)

(*iii*) What is the function of part Y? **6 or 3**
measure voltage 6
partial answer e.g. voltmeter (3)

Note: answers (*ii*) and (*iii*) reversed maximum mark 6

(*iv*) What does the graph tell you about conduction in a diode? **2 (6 or 3)**
current varies linearly with voltage until 0.6 V // little current is conducted below 0.6 V, etc 6
partial answer e.g. no current flows until there is a voltage (3)
after 0.6 V the current increases (rapidly) with voltage, etc 6
partial answer (3)
Note: incomplete description of the total graph may merit 9 marks e.g. non-ohmic

(*v*) How would a student connect the diode in reverse bias? **6 or 3**
switch the polarity of battery / diode 6
partial answer (3)

(*vi*) What is the function of the 330 Ω resistor? **4 or 2**
protection / limit the current 4
partial answer (2)

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 crane, powered by an electric motor, has a bucket that weighs 540 N when empty. The crane uses the bucket to lift 800 N of concrete up 75 m on a building site. Calculate the work done by the crane's motor. 7

((540 + 800)(75) =) 1.005×10^5 (N m) 7

(*b*) Which of the following are vector quantities and which are scalar quantities? 7

force and velocity are vectors quantities

time and mass are scalar quantities four correct 7

***(c)* Which of the following is used in the flash of a camera ?**

electroscope hydrometer capacitor barometer 7

capacitor 7

(*d*) What is the Doppler effect? 7

(apparent) change in (wave) frequency due to motion (of the wave source) 7

(*e*) Name the lens shown and give an application of it. 7 or 4

(bi) convex / converging

used as a magnifying glass/(eye) glasses /binoculars/camera/etc. two lines correct 7

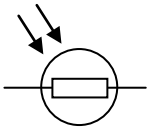
one line correct (4)

(*f*) What is meant by the *U*-value of a material? 7 or 4

measure of the heat flow through 1 m^2 of material each second (perpendicular to the direction of flow) when a temperature difference of one degree exists between the two sides 7

partial answer (4)

(*g*) Name the component with the symbol shown in the diagram. 7



light dependent resistor / LDR 7

(*h*) Name a piece of laboratory equipment used to separate white light into its colours. 7

(glass) prism // (diffraction) grating 7

(*i*) How are X-rays produced? 7

(when high speed) electrons hit a metal target 7

(*j*) In the Sun, a mass of 4×10^9 kg is converted into energy every second. Calculate the energy released each second. 7

($E = m\,c^2 = (4\times 10^9)(3 \times 10^8)^{\,2}$ =) 3.6×10^{26} (J) 7

Question 6 56 marks

Sir Isaac Newton deduced that the weight of an object is due to the force of gravity.

Define force and give the unit of force **2(3 × 3)**

(force) causes / changes // (F=) m // (rate of) change of 3

acceleration // momentum 3

partial answer e.g. change shape, push, pull (3)

Unit: newton / N / kg m s^{-2} 3

State Newton's law of universal gravitation.

force proportional / $F \propto$ 3

product of masses / $m_1 m_2$ 3

inversely proportional to the square of the distance between them / $\propto \frac{1}{d^2}$ 3

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

Use the equation below, which is from page 56 of the *Formulae and Tables* booklet, to calculate, to one decimal place, the acceleration due to gravity on Mars. The radius of Mars is 3.4×10^6 m and the mass of Mars is 6.4×10^{23} kg.

$g = \frac{GM}{d^2}$ **10 or 7 or 4**

$(g = \frac{GM}{d^2} = \frac{(6.67 \times 10^{-11})(6.4 \times 10^{23})}{(3.4 \times 10^6)^2} =) 3.7\ (\mathrm{m\,s^{-2}})$ 10

one error (7)

partial answer e.g. correct value for G, one correct substitution (4)

In August 2012 the *Curiosity* rover landed on Mars. The wheels of the rover are not as strong as the wheels that would be needed if the rover was to be used on Earth.

Give a reason for this. **6 or 3**

weighs less on Mars // gravity is less on Mars // the mass of Mars is smaller than mass of Earth 6

partial answer e.g. Mars is smaller, less friction (3)

The *Curiosity* rover was built on Earth to travel on the surface of Mars.

The rover has a mass of 899 kg. Find

(*i*) the weight of *Curiosity* on Earth **6 or 3**

$W = mg = (899)(9.8) = 8.8 \times 10^3$ (N) 6

partial answer (3)

(*ii*) the mass of *Curiosity* on Mars **6 or 3**

899 (kg) // the same as on Earth 6

partial answer (3)

(*iii*) the weight of *Curiosity* on Mars **4 or 2**

$W = mg = (899)(3.7) = 3.3 \times 10^3$ (N) 4

answer consistent with calculated g for Mars or mass used in (*ii*) (4)

partial answer (2)

The *Curiosity* rover communicates with Earth using radio waves, which are part of the electromagnetic spectrum.

Name one other part of the electromagnetic spectrum. **6 or 3**

microwaves, infra-red, visible light, ultra-violet, X-rays, gamma rays any one 6

partial answer e.g. phone waves (3)

Question 7 56 marks

(*a*) The temperature of an object can be measured using a thermometer which is based on a suitable thermometric property.

(*i*) What is heat? **6 or 3**
(a form of) energy / $mc\Delta\theta$ /ml 6
partial answer e.g. it is measured in joules (3)

(*ii*) What is meant by temperature? **6 or 3**
degree of hotness // measurement of hotness/coldness 6
partial answer e.g. it is measured in °C (3)

(*iii*) Give an example of a thermometric property. **6 or 3**
length (of a liquid column), resistance (of a thermistor / conductor), emf / voltage (generated by a thermocouple), colour (of certain crystals), volume (of a gas at constant pressure), pressure (of a constant volume of gas), etc 6
partial answer e.g. definition (3)

(*iv*) The SI unit of temperature is the kelvin. Give another temperature scale. **6 or 3**
Celsius /°C // Fahrenheit /°F 6
partial answer e.g. degrees (3)

(v) Express 310 K in the units of the scale you have named in part (*iv*). **6 or 3**
310 – 273 = 37± 0.2 (°C) 6
partial answer e.g. refers to 273 (3)

(*b*) The photograph shows an experiment to compare the heat transfer in different metals. A piece of wood is placed in a drop of wax at the end of each piece of metal and a heat source is used to heat the metals at the centre of the apparatus.

(*i*) How is heat transferred in metals? **6 or 3**
conduction // vibrating atoms (transfer energy) 6
partial answer (3)

(*ii*) Name the two other methods of heat transfer **2 × 4**
convection 4
radiation 4
partial answer e.g. examples (4)

(*iii*) How can this experiment be used to find out which of the metals is best at allowing heat transfer? **6 or 3**
(heat under the centre) the piece of wood which falls first indicates the best conductor 6
partial answer e.g. incomplete answer (3)

(*iv*) State one way to make sure that this is a fair test. **6 or 3**
ensure that there is only one (independent) variable // heat in the centre /ensure there is an equal amount of heat for each metal // ensure that the metal strips are the same length // ensure to have the same amount of wax, etc 6
partial answer e.g. repeat (3)

Question 8 56 marks

A ray of light can undergo both reflection and refraction.

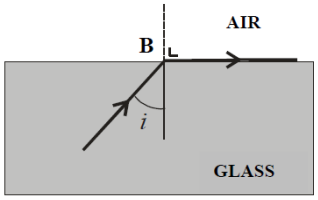
(*i*) Explain what is meant by reflection of light. **2 × 3**
sending back / returning / bouncing 3
from a mirror / (shiny) surface 3
a diagram may merit full marks
partial answer (3)

(*ii*) State the laws of reflection of light. **9 or 6 or 3**
the incident ray, (the normal) and the reflected ray are all in the same plane
the angle of incidence is equal to the angle of reflection // $i = r$ two lines correct 9
one line correct (6)
partial answer e.g. they are all in the same plane (3)

(*iii*) Give an application of reflection of light. **5 or 3**
mirror images, optic fibres, binoculars, endoscope, specific toys, etc 5
partial answer e.g. toys, etc (3)

(*iv*) Describe an experiment to demonstrate one of the laws of reflection of light. **4 × 3**
apparatus; raybox /laser // drawing pins 3
mirror 3
procedure; mark position of rays / pins // measure *i* and *r* 3
observation/conclusion; incident ray, reflected ray and normal in same plane // $i = r$ 3
accept valid alternatives
full marks may be merited by a labelled diagram
partial answer e.g. incomplete description (3)

The diagram shows a ray of light travelling from glass to air. The ray of light undergoes refraction at B.



(*v*) Explain what is meant by the refraction of light **6 or 3**
bending of light at the boundary when going from one medium to another 6
full marks may be merited by a labelled diagram
partial answer e.g. bending, example (3)

(*vi*) What special name is given to the angle of incidence, *i*, when the effect shown in the diagram occurs? **6 or 3**
critical angle / *C* 6
partial answer e.g. total internal reflection (3)

In the diagram the value of the angle *i* is 38°.

(*vii*) Calculate the value of the refractive index of the glass. **6 or 3**
$n = \frac{1}{\sin C} = \frac{1}{\sin 38} = 1.62$ 6
(*C* in grad. *n* =) 1.8 // (*C* in rad. *n* =) 3.4 (6-1)
partial answer e.g. correct equation, sin 38°, 0.62 (3)

(*viii*) Draw a diagram to show what happens to the ray of light when the angle of incidence is increased to 40°. **6 or 3**

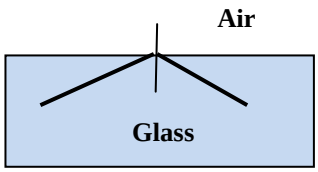


diagram to show
reflection at boundary 6
partial answer e.g. shows refraction (3)

Question 9 56 marks

A magnetic field exists around a current-carrying conductor.

(*i*) What is a magnetic field? **2 × 3**

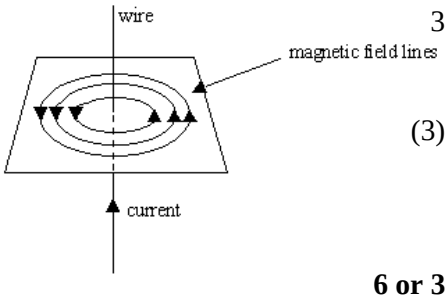
region (where) / space 3
magnetism is experienced // force is detected 3
partial answer e.g. incomplete diagram (3)

(*ii*) How does a compass indicate the direction of a magnetic field? **6 or 3**

(experiences a force in a magnetic field and) points in the direction of the field lines 6
partial answer (3)

(*iii*) Describe an experiment to show that there is a magnetic field around a current-carrying conductor and sketch the field lines around the conductor **4 × 3**

apparatus; power supply/ battery / voltage, conductor, compass any two 3
procedure; set up the circuit / turn on the power supply / current 3
observation/conclusion; compass deflects 3
field lines; circular lines (with correct direction) 3



diagrams may merit full marks
accept valid alternatives e.g. iron filings
partial answer e.g. incomplete description (3)
incorrect experiment maximum mark 2 × 3

(*iv*) Sketch the magnetic field around a bar magnet. **6 or 3**

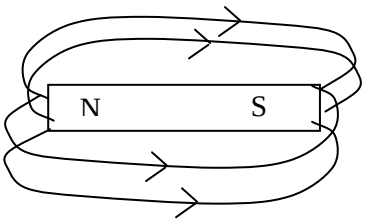
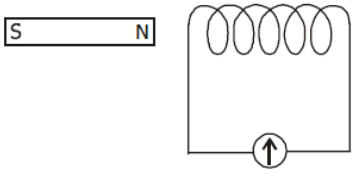


diagram to show
magnet, field lines and correct direction 6
partial answer (3)

A coil of wire is connected as shown in the diagram to a galvanometer. A bar magnet is placed near the coil.



(*v*) What is observed when the magnet is moved towards the coil? **2 × 3**

needle / pointer / galvanometer // current 3
deflects // induced 3
partial answer e.g. unqualified reference to force (3)

(*vi*) What is observed when the magnet is stationary? **6 or 3**

needle / pointer / galvanometer does not deflect // no current, etc 6
partial answer (3)

(*vii*) Explain these observations. **6 + 3**

emf / voltage / current / electromagnetic induction 6
due to changing magnetic field (around the coil) 3
partial answer (3)

(*viii*) How would increasing the speed of movement of the magnet alter the observations? **5 or 3**

greater deflection/ emf // current is greater 5
partial answer (3)

Question 10 56 marks

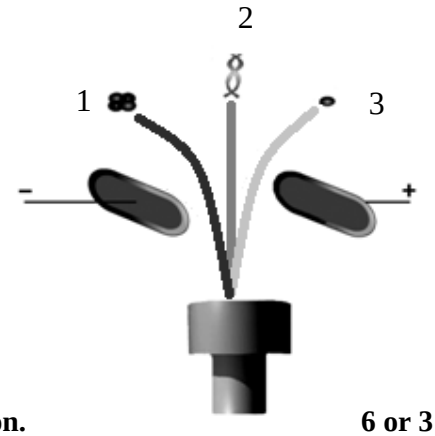
(*i*) What is meant by radioactivity? **2 × 3**

(spontaneous) emission of (one or more types of) particles/energy / α / β / γ 3

from the nuclei (of atoms) 3

partial answer e.g. definition of fusion / fission (3)

In an experiment, the radiation from a radioactive source is passed through an electric field, as shown in the diagram.



(*ii*) What does this experiment indicate about radiation. **6 or 3**

there are three different types // there is positive, negative and neutral radiation 6

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

State which type of radiation (1, 2 or 3)

(*iii*) is unaffected by electric fields **3**

2 / gamma / γ

(*iv*) is positively charged **3**

1 / alpha / α 3

(*v*) is negatively charged **3**

3 / beta / β 3

(*vi*) Give the name of radiation types 1, 2 and 3, in that order. **9 or 6 or 3**

alpha, gamma, beta 9

correct names in incorrect order (6)

partial answer e.g. any one correct (3)

Nuclear fission occurs in a nuclear power station such as the one shown in the photograph.

(*vii*) Name a suitable fuel for nuclear fission. **6 or 3**

(enriched) uranium/ U, plutonium / Pu, thorium / Th one correct 6

partial answer e.g. named reactor part such as (boron) steel, graphite (3)

(v*iii*) Explain the role of neutrons in nuclear fission. **6 or 3**

hit nucleus, are absorbed, cause fission / chain reaction 6

partial answer (3)

(*ix*) Explain how the control rods can control the rate of fission, or stop the reaction completely **6 or 3**

absorb neutrons // raise to increase // lower to decrease/stop 6

partial answer e.g. slow the neutrons, reference to movement (3)

(*x*) Iodine–131 is a product of nuclear fission. The half-life of iodine–131 is 8 days. What fraction of iodine–131 remains after 24 days? **8 or 4**

$\frac{1}{8}$ 8

partial answer e.g. indication of three half lives, $\frac{7}{8}$ (4)

Question 11 56 marks

Read this passage and answer the questions below

Lightning is one of the most deadly natural phenomena known to man. Lightning begins with the water cycle. To understand the water cycle we must first understand the principles of *evaporation* and *condensation*.

Evaporation is the process by which a liquid absorbs heat and changes to a gas. When a liquid is heated its molecules move around faster. Some of the molecules may move quickly enough to break away from the surface of the liquid and carry heat away in the form of a gas. Once free the gas begins to rise into the atmosphere due to *convection*.

Condensation is the process by which a gas loses heat and turns into a liquid. As the gas rises higher, the temperature of the surrounding air drops. Eventually the gas cools and turns back into a liquid. Earth's gravitational pull then causes the liquid to fall back down to the earth, thereby completing the cycle.

In an electrical storm, the storm clouds become charged due to convection in the cloud. The upper portion of the cloud becomes positively charged and the lower portion becomes negatively charged. The cloud's strong electric field creates a conductive path between the cloud and the earth's surface. This allows a current to flow which we see as the 'spark' of lightning.

The lightning causes air to heat up and expand rapidly, creating a sound wave that travels through the surrounding air. Sound travels much slower than light, so we see the flash before we hear the thunder.

(Adapted from '*howstuffworks.com*')

(*a*) Explain the term *evaporation*. **7 or 4**
process by which a liquid absorbs heat and changes to a gas 7
partial answer e.g. changing from a liquid to a gas, water to steam (4)

(*b*) Why effect does the addition of heat have on the molecules of a liquid? **7 or 4**
they move around faster 7
partial answer (4)

(*c*) What happens to the temperature of a gas rising through the atmosphere? **7 or 4**
it drops 7
partial answer (4)

(*d*) What part does gravity play in the water cycle? **7 or 4**
causes the liquid to fall back down to the earth 7
partial answer e.g. incomplete answer (4)

(*e*) Explain the term *convection*. **7 or 4**
transfer of heat/energy by the movement of atoms/molecules / currents 7
partial answer (4)

(*f*) What helps create the conductive path needed for lightning to occur? **7 or 4**
cloud's (strong) electric field 7
partial answer e.g. transfer of heat / gas rising (4)

(*g*) Name an instrument used in the laboratory to study static electricity. **7 or 4**
electroscope / GLE // Van De Graaff generator // capacitor, etc 7
partial answer e.g. refers to gold leaf, generator (4)

(*h*) Why do we see the flash of lightning before we hear the thunder? **7 or 4**
sound travels (much) slower than light 7
partial answer (4)

Question 12 **56 marks**

Part (a) Explain the distinction between speed and velocity. **6 or 3**

velocity is speed in a given direction // velocity is a vector // sound is a scalar 6

partial answer e.g. refers to distance per unit time, etc. (3)

A bus leaves a bus stop and accelerates from rest at 0.5 m s^{-2} to reach a speed of 15 m s^{-1}. It then maintains this speed for 100 seconds. When it approaches the next stop, the driver applies the brakes uniformly to bring the bus to a stop in 20 seconds. Calculate

(*i*) the time it took the bus to reach its top speed **5 or 3**

($t = (v-u)/a$ = (15 – 0) / 0.5 =) 30 (s) 5

partial answer e.g. any valid equation / $v = u + at$ (3)

(*ii*) the distance it travelled while at its top speed **5 or 3**

($s = vt$ = (15)(100)=) 1500 (m) 5

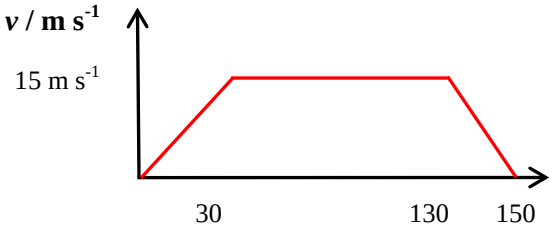
partial answer e.g. any valid equation / $s = vt$ / $s = ut + ½ at^2$ (3)

(*iii*) the acceleration required to bring the bus to a stop. **5 or 3**

($a = (v – u) / t$ = (0– 15) / 20 =) (–) 0.75 (m s^{-2}) 5

partial answer e.g. any valid equation / $a = (v – u) / t$ (3)

Sketch a velocity-time graph of the bus journey. **7 or 4**



graph showing
v increasing, *v* constant, *v* decreasing 7

partial answer (4)

Part (*b*) State the unit of pressure. **5 or 3**

Pa / N m^{-2} / bar 5

partial answer e.g. N m^2 (3)

Describe an experiment to demonstrate that the atmosphere exerts pressure **3 × 3**

apparatus: glass of water and cardboard // can of water and heat source 3

procedure: place cardboard over glass and invert // boil water and put on lid 3

observation/conclusion: water remains in glass // can collapses 3

accept valid alternatives e.g. sucking out air methods

marks may be obtained from a diagram

State Archimedes' principle **6 or 3**

The upthrust (on a body immersed in a liquid) is equal to the weight of the liquid displaced 6

partial answer e.g. incomplete answer (3)

(*i*) What is the upthrust (buoyancy force) on the object caused by the liquid? **4 or 2**

3 (N) 4

partial answer e.g. the upward force exerted by the liquid (2)

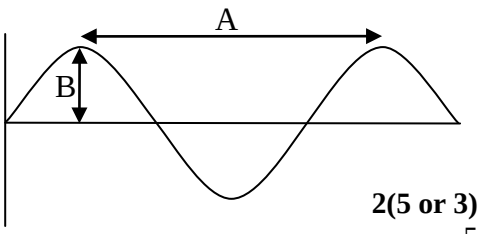
(*ii*) Will the object float in the liquid if released? Explain your answer. **2 × 2**

no / it won't / it will sink 2

the upthrust is less than the weight, it is more dense, diagram shows it immersed 2

partial answer (2)

Part (*c*) The diagram shows a transverse wave.



(*i*) Name the distances labelled A and B. **2(5 or 3)**

A = wavelength / λ 5

partial answer e.g. refers to distance between crests, wave/length (3)

B = amplitude / height of wave 5

partial answer e.g. loudness (3)

(*ii*) 20 waves pass a fixed point every second. What is the frequency of the wave? **6 or 3**

20 (Hz) 6

partial answer e.g. definition of frequency (3)

(*iii*) Calculate the velocity of the wave if distance A = 1.5 m. **6 or 3**

(*v* = *f* λ = (20)(1.5) =) 30 (m s^{-1}) 6

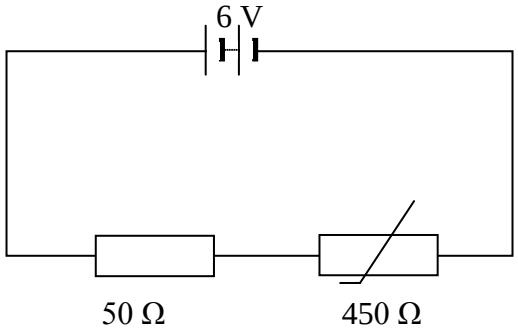
partial answer e.g. correct equation (3)

(*iv*) Transverse waves can be polarised. Name a type of wave that cannot be polarised. **6 or 3**

longitudinal // sound // pressure 6

partial answer e.g. stationary/mechanical/standing (3)

Part (*d*) The circuit diagram shows a resistor and a thermistor connected in series with a 6 V battery. At a certain temperature the resistance of the thermistor is 450 Ω.



(*i*) State Ohm's law. **6 or 3**

*V*α *I* // *V* = *IR* 6

partial answer e.g. *V* / *I* / *R* / α / at constant temperature (3)

(*ii*) What is the total resistance of the circuit? **4 or 2**

500 (Ω) 4

partial answer (2)

(*iii*) What is the current in the circuit? **6 or 3**

($I = \frac{V}{R} = \frac{6}{500}$ =) 1.2×10^{-3} (A) // answer consistent with (*ii*) 6

partial answer e.g. correct equation (3)

(*iv*) What is the potential difference across the 50 Ω resistor? **6 or 3**

(*V* = *IR* = $(1.2 \times 10^{-3})(50)$ =) 0.6 (V) // answer consistent with (*iii*) 6

partial answer e.g. correct equation (3)

(*v*) What would happen to the resistance of the circuit if the temperature were increased? **6 or 3**

it would decrease // depends on the thermistor 6

partial answer e.g. it would change (3)

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