Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2025

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.

In considering this marking scheme the following points should be noted.

1. In many instances only key words are given – words that must appear in the correct context in the candidate's answer in order to merit the assigned marks.

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

3. Answers that are separated by a double solidus, //, are answers which are mutually exclusive. A partial answer from one side of the // may not be taken in conjunction with a partial answer from the other side.

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

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

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

7. A zero should only be recorded when the candidate has attempted the question item but does not merit marks. If a candidate does not attempt a question item examiners should record NR.

8. Examiners are expected to annotate parts of the responses as directed at the marking conference. (See below.)

Symbol	Name	Use
	Cross	Incorrect element
	Tick	Correct element (0 marks)
	Tick_n	Correct element (n marks)
	Horizontal wavy line	To be noticed
	Vertical wavy line	Additional page
n	Partial	Partially correct element (n marks)
-1	−1	−1
^	^	Missing element

9. Bonus marks at the rate of 10% of the marks obtained will be given to a candidate who answers entirely through Irish and who obtains 75% or less of the total mark available (i.e. 300 marks or less). In calculating the bonus to be applied decimals are always rounded down, not up ¬ e.g., 4.5 becomes 4; 4.9 becomes 4, etc. See below for when a candidate is awarded more than 300 marks.

Marcanna Breise as ucht freagairt trí Ghaeilge

Léiríonn an tábla thíos an méid marcanna breise ba chóir a bhronnadh ar iarrthóirí a ghnóthaíonn níos mó ná 75% d'iomlán na marcanna.

N.B. Ba chóir marcanna de réir an ghnáthráta a bhronnadh ar iarrthóirí nach ngnóthaíonn níos mó ná 75% d'iomlán na marcanna don scrúdú. Ba chóir freisin an marc bónais sin **a shlánú síos**.

Tábla 400 @ 10%
Bain úsáid as an tábla seo i gcás na n-ábhar a bhfuil 400 marc san iomlán ag gabháil leo agus inarb é 10% gnáthráta an bhónais.

Bain úsáid as an ngnáthráta i gcás 300 marc agus faoina bhun sin. Os cionn an mharc sin, féach an tábla thíos.

Bunmharc	Marc Bónais
301 - 303	29
304 - 306	28
307 - 310	27
311 - 313	26
314 - 316	25
317 - 320	24
321 - 323	23
324 - 326	22
327 - 330	21
331 - 333	20
334 - 336	19
337 - 340	18
341 - 343	17
344 - 346	16
347 - 350	15

Bunmharc	Marc Bónais
351 - 353	14
354 - 356	13
357 - 360	12
361 - 363	11
364 - 366	10
367 - 370	9
371 - 373	8
374 - 376	7
377 - 380	6
381 - 383	5
384 - 386	4
387 - 390	3
391 - 393	2
394 - 396	1
397 - 400	0

1. A student carried out an experiment to verify the principle of conservation of momentum between two trolleys, A and B. Trolley A travelled at a constant velocity down a track and then collided with Trolley B which was at rest. Trolleys A and B then moved together with the same velocity, v_{final}.

She measured the mass of each trolley and took further measurements to determine the velocities of the trolleys.

The following data were recorded.

mass of trolley A, m_A	0.34 kg
mass of trolley B, m_B	0.36 kg
velocity of trolley A before the collision, u_A	1.85 m s^{-1}
velocity of trolley B before the collision, u_B	0 m s^{-1}
velocity of trolley A and trolley B after the collision, v_{final}	0.90 m s^{-1}

(*i*) Draw a labelled diagram of the arrangement of the apparatus used in this experiment.

runway // airtrack **[3]**
two trolleys // two riders **[3]**
timer / metre stick / mass balance **[3]**
means of coalescence **[3]**

[-1 if no label is present on diagram}

(*ii*) Describe how the student measured the mass of each trolley.

(put on) mass balance **[3]**

(*iii*) State the formula used to calculate the velocity.

$v = \frac{s}{t}$ **[6]**

[accept partial answer for 3]

She used the recorded data and the following formula to verify the principle of conservation of momentum.

$$\text{total momentum before} = \text{total momentum after}$$

$$(m_A \times u_A) + (m_B \times u_B) = (m_A + m_B) \times v_{final}$$

(*iv*) Calculate

(*a*) the total momentum before the collision
momentum before = 0.63 kg m s^{-1} **[6]**

[accept partial answer for 3]

(*b*) the total momentum after the collision.
momentum after = 0.63 kg m s^{-1} **[6]**

[accept partial answer for 3]

(*v*) Explain how your calculations can be used to verify the principle of conversation of momentum.
momentum before ≈ momentum after **[3]**

(*vi*) How could the student have minimised the effect of friction?
using *an* air track, aerodynamic trolleys, etc. **[4]**

[accept partial answer for 2]

2. In an experiment to verify Boyle's law, a student measured the pressure *p* of a gas at different volumes *V*. The student recorded the following results.

V (cm^3)	5	10	15	20	25	30
P (MPa)	0.203	0.108	0.073	0.054	0.043	0.035
$\frac{1}{P}$ (MPa^{-1})	4.93	9.26	13.70			

(*i*) Draw a labelled diagram of the arrangement of the apparatus used in this experiment.

any two of; enclosed volume of gas, pressure gauge, volume scale, means of altering the pressure/volume **[6 + 3]**

[-1 if no label is present on diagram]

(*ii*) Describe how the student measured both the pressure and the volume.

(read) pressure gauge **[3]**
(read) volume scale **[3]**

(*iii*) State one quantity that must be kept constant during the experiment.

temperature / mass of gas **[3]**

(*iv*) Copy and complete the table above into your answer book by calculating the value of $\frac{1}{P}$ to 2 decimal places.

$\frac{1}{P}$ **(MPa^{-1})**	4.93	9.26	13.70	**18.52**	**23.26**	**28.57**

calculations of $\frac{1}{P}$ values **[3 x 2]**

(*v*) Plot a graph, on graph paper, of $\frac{1}{p}$ against *V.*

labelled axis **[3]**
points plotted **[6 x 1]**
line of best fit **[3]**

(*vi*) Explain how your graph verifies Boyle's Law.

straight line graph through the origin / *P* is inversely proportional to *V* **[4]**

[accept partial answer for 2]

3. In an experiment to calculate the refractive index *n* of glass, a student passed a ray of light through a rectangular glass block. He measured the angle of incidence *i* and the corresponding angle of refraction *r*. He repeated this for different values of the angle *i*.

(*i*) Draw a labelled diagram of the arrangement of the apparatus used in this experiment.

block **[3]**
ray box / laser / pins **[3]**
detail: ruler, protractor, paper, etc. **[3]**
[-1 if no label is present on diagram]

(ii) On your diagram, draw and label the incident ray, the refracted ray and the normal to the surface of the glass block.

incident ray **[3]**
refracted ray **[3]**
normal **[3]**
[-1 if no label is present on diagram]

(iii) What piece of equipment did the student use to measure the angles?

protractor **[3]**

The student recorded the following results.

i (degrees)	*r* (degrees)	sin *i*	sin *r*	$\frac{\sin i}{\sin r}$
20	13	0.34	0.22	**1.52**
46	28	**0.72**	**0.47**	**1.53**
61	35	**0.87**	**0.57**	**1.52**

(iv) Copy and complete the table above into your answerbook by calculating the missing values to 2 decimal places.

calculations of sin *i* values **[2 x 1]**
calculations of sin *r* values **[2 x 1]**
calculations of $\frac{\sin i}{\sin r}$ values **[3 x 1]**

(v) Use the data to calculate an average value for the refractive index *n* of the glass.

average calculation, $n \approx 1.5$ **[6]**
[accept partial answer for 3]

(vi) State one precaution the student should take when carrying out the experiment.

any valid precaution: use large angle values, etc. **[6]**
[accept partial answer for 3]

4. A student carried out an experiment to measure the specific latent heat of vaporisation of water. She added steam to cold water in a copper calorimeter. When the steam had condensed, she recorded a number of measurements and calculated the specific latent heat of vaporisation of water.

The following results were recorded.

mass of calorimeter + cold water	0.196 kg
mass of calorimeter + water + steam	0.198 kg
final temperature of calorimeter, water and added steam	42 ˚C

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

calorimeter **[3]**

water **[3]**

steam generator **[3]**

thermometer / mass balance **[3]**

detail: lagging, lid, stirrer, steam trap, tubing, etc. **[2]**

[-1 if no label is present on diagram]

(*ii*) The initial temperature of the steam was 100 ˚C. Calculate the change in temperature of the steam.

100 – 42 = 58 ˚C **[5]**

[accept partial answer for 2]

(*iii*) Calculate the mass m of the steam added.

0.198 – 0.196 = 0.002 kg **[5]**

[accept partial answer for 2]

She calculated the latent heat released ΔE when the steam condensed to be 4600 J.

(*iv*) Calculate, l, the specific latent heat of vaporisation of the water.

$\boldsymbol{l = 2.3 \times 10^6\ J\ kg^{-1}}$ **[6]**

[accept partial answer for 3]

(*v*) Suggest a reason why the student used cold water in the calorimeter at the start of the experiment.

so that the energy gained = energy lost or steam condenses quicker **[6]**

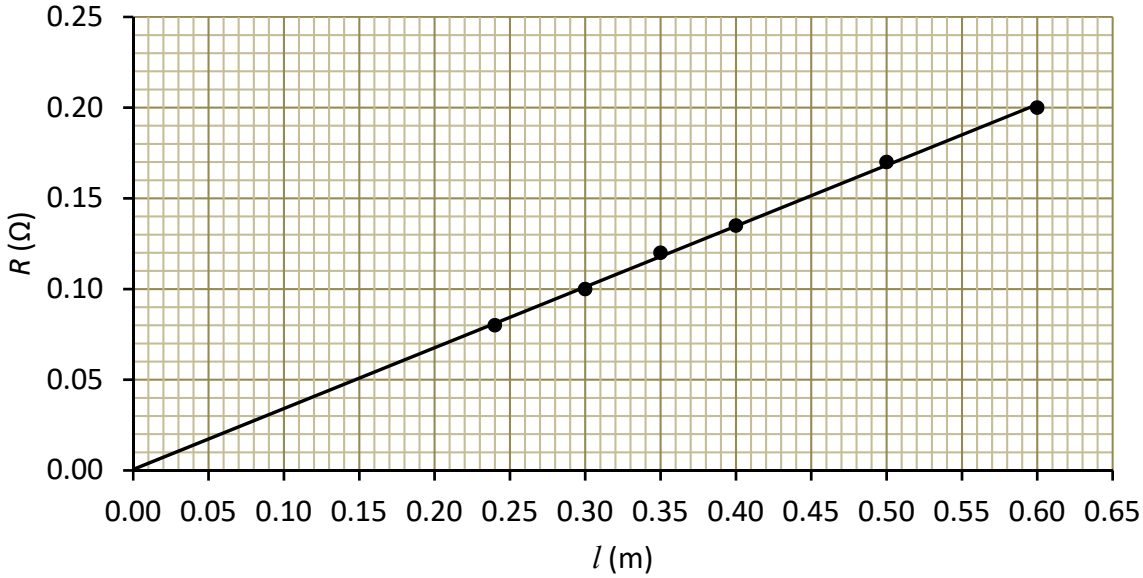
[accept partial answer for 3]

(*vi*) State one safety precaution the student should take when carrying out the experiment..

wear heat proof gloves, safety glasses, etc. **[4]**

[accept partial answer for 2]

5. In an experiment to measure the resistivity ρ of the material of a wire, a student measured the length l and the resistance R of the wire. He repeated this for six different lengths of the same wire. The student completed the following graph to show the relationship between l and R. He also measured the diameter d of the wire.



(*i*) Describe how the student measured

(*a*) the length l of the wire

metre stick **[6]**

[accept partial answer for 3]

(b) the resistance R of the wire.

ohmmeter **[6]**

[accept partial answer for 3]

(*ii*) Describe the steps the student used to find the diameter of the wire.

measure diameter at several points along the wire using a micrometer/digital callipers [6]

[accept partial answer for 3]

(*iii*) The radius of the wire is 0.00124 m. Calculate the circular cross-sectional area A of the wire.

$A = 4.83 \times 10^{-6}$ m^2 **[6]**

[accept partial answer for 3]

(*iv*) Describe the relationship between l and R shown in the graph.

(directly) proportional **[4]**

[accept partial answer for 2]

(*v*) Calculate the slope of the graph.

m ≈ 0.33 Ω m^{-1} **[6]**

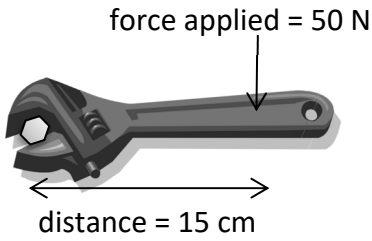
[accept partial answer for 3]

(*vi*) Using the formula, ρ = slope × A, calculate the resistivity ρ of the wire.

$\rho \approx 1.6 \times 10^{-6}$ Ω m **[6]**

[accept partial answer for 3]

6. (*a*) The diagram shows a force of 50 N applied to a wrench. Calculate the moment of the force about the fulcrum at the centre of the nut.



moment = 7.5 N m **[7]**

[accept partial answer for 4]

(*b*) State one condition necessary for equilibrium.

forces up = forces down or clockwise moments = anticlockwise moments **[7]**

[accept partial answer for 4]

(*c*) State the three primary colours of light.

red, green, blue **[3 + 2 + 2]**

(*d*) Choose, from the following list of apparatus, an instrument used to measure

(i) atmospheric pressure,

(ii) potential difference.

barometer joulemeter sound level meter voltmeter

(*i*) barometer

(*ii*) voltmeter **[4 + 3]**

[accept partial answer for 4]

(*e*) Two resistors 5 Ω and 10 Ω are connected in parallel. Calculate the total resistance of the two resistors.

***R* = 3.3 Ω** **[7]**

[accept partial answer for 4]

(*f*) State two characteristics of a musical note.

any two of; loudness, pitch, quality **[4 + 3]**

(*g*) Why does the north pole of a magnet, that is free to rotate, point north?

due to Earth's magnetic field **[7]**

[accept partial answer for 4]

(*h*) Sketch the electric field lines due to a positive point charge.

correct shape

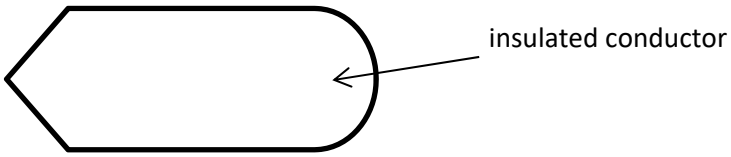
correct direction **[4 + 3]**

(*i*) Explain what is meant by a semiconductor.

material whose resistivity lies between that of a good insulator or conductor **[7]**

[accept partial answer for 4]

(*j*) The insulated conductor shown below is positively charged. Copy the diagram into your answer book and show the distribution of charge on it.



(charge throughout with) concentration at pointed end **[7]**

[accept partial answer for 4]

(*k*) Draw a labelled diagram of an atom. Include in your diagram the names and locations of the subatomic particles of the atom.

diagram of nucleus containing protons and neutrons with electrons orbiting in shells **[7]**

[accept partial answer for 4]

(*l*) Explain what is meant by the photoelectric effect.

emission of electrons from the surface of a metal when light of a suitable frequency shines on it **[7]**

[accept partial answer for 4]

7. In 1867, Isaac Newton published his ideas on motion in a book called *The Principia*. In it Newton developed an understanding of the idea of 'force'.

(*i*) Explain what is meant by force.

(force) causes acceleration **[6]**

[accept partial answer for 3]

(*ii*) State the SI unit for force.

newton **[3]**

(*iii*) Force is a vector quantity. Explain what is meant by a vector quantity.

(magnitude and) direction **[6]**

[accept partial answer for 3]

(*iv*) State another example of a vector quantity.

any valid example **[3]**

A person wishes to go skydiving. She boards an airplane at rest on a horizontal runway. The airplane reaches a velocity of 24 m s^{-1} in 8 s before take-off.

(*v*) Calculate the horizontal acceleration of the airplane.

***a* = 3 m s^{-2}** **[6]**

[accept partial answer for 3]

Some time after take-off, the skydiver jumps out of the plane. The total mass of the skydiver is 70 kg, including the parachute.

(*vi*) Calculate the total weight of the skydiver.

***F* = 686 N** **[6]**

[accept partial answer for 3]

(*vii*) What happens to the force of air resistance when the parachute is opened?

it increases **[3]**

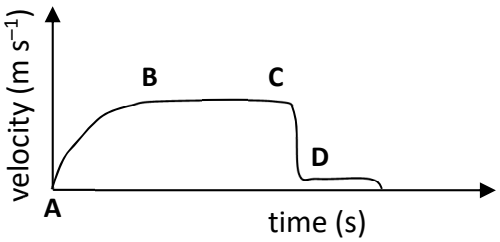
(*viii*) After the parachute has opened, the skydiver travels at constant velocity. Draw a labelled diagram to show the forces now acting on the skydiver.

arrow up **[2]**

arrow down **[2]**

equal and opposite **[2]**

The graph shows how the velocity of the skydiver changes with respect to time once she leaves the airplane.



(*ix*) How can we tell from the graph that the skydiver is accelerating between A and B?

positive slope **[6]**

[accept partial answer for 3]

(*x*) Describe the skydiver's velocity between **B** and **C**.

it is constant **[5]**

(*xi*) Identify the point that represents when the skydiver opens her parachute.

C **[3]**

(*xii*) Why is it safe for the skydiver to land after D?

as they have a small velocity **[3]**

8. Sound is produced when an object vibrates, causing the particles in the surrounding medium to have vibrational energy. As the particles vibrate, they cause nearby particles to vibrate thus transmitting the sound until it is detected by the ear of a nearby person.

(*i*) Describe an experiment to show that sound requires a medium to travel through.

apparatus **[4]**
method **[4]**
observation **[4]**

[accept partial answers for 2 in each case]

(*ii*) Explain what is meant by the frequency of a wave.

number of waves passing a point per second **[6]**

[accept partial answer for 3]

(*iii*) State the relationship between the frequency and the period of a wave.

inversely proportional **[3]**

A speaker emits a sound wave with a frequency *f* of 220 Hz. It has a wavelength λ of 1.5 m.

(*iv*) Calculate the speed of the sound wave produced.

c **= 330 m s^{-1}** **[7]**

[accept partial answer for 4]

(*v*) Does a sound wave travel faster in a solid or in air?

solid **[6]**

Sound waves can undergo diffraction and interference.

(*vi*) Explain what is meant by diffraction.

the (sideways) spreading out of a wave through a narrow gap/around an obstacle. **[6]**

[accept partial answer for 3]

(*vii*) Explain why a sound wave diffracts after passing through a doorway but a light wave does not.

reference to wavelength **[4]**

[accept partial answer for 2]

(*viii*) Describe an experiment to show that sound is a wave by showing that it can undergo interference.

apparatus **[4]**
method **[4]**
observation **[4]**

[accept partial answers for 2 in each case]

9. A concave mirror can be used to form real or virtual images.

(*i*) Distinguish between a real and a virtual image.

real image is formed by the actual intersection of light rays / virtual image is formed by the apparent intersection of light rays **[6]**

[accept partial answer for 3]

(*ii*) In your answer book, copy and complete the ray diagram below to show the formation of a real image in a concave mirror.

first incident ray **[3]**

first reflected ray **[3]**

second reflected ray **[3]**

image formed at intersection of rays **[2]**

(*iii*) A concave mirror has a focal length *f* of 8 cm. An object is placed with an object distance *u* of 20 cm in front of the mirror. Using the formula $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$, calculate the image distance *v*.

correct substitution of *u* or *f* **[3]**

$\mathbf{\frac{1}{v}=\frac{1}{f}-\frac{1}{u}}$ **[3]**

***v* = 13.3 cm** **[3]**

(*iv*) Calculate the magnification of the image produced.

magnification = 0.67 **[6]**

[accept partial answer for 3]

(*v*) The concave mirror in the ray diagram is replaced with a convex lens. Describe one difference between the ray diagram for the lens and the ray diagram for the concave mirror.

refraction will occur / ray will pass through lens **[4]**

[accept partial answer for 2]

Fibre broadband uses fibre optic cables to deliver data to homes and businesses across Ireland. A fibre optic cable is a thin flexible fibre with a glass core that can transmit light from one end to the other by total internal reflection.

(*vi*) Draw a labelled diagram to show how a ray of light is transmitted through a fibre optic cable by total internal reflection.

two materials of the differing refractive index **[2]**

ray of light **[2]**

multiple internal reflections **[2]**

[-1 if no label is present on diagram]

(*vii*) The critical angle *C* of the glass in a fibre optic cable is 42.8˚.
Calculate the refractive index *n* of the glass.

***n* = 1.47** **[6]**

[accept partial answer for 3]

(*viii*) State one advantage of using fibre optic cables instead of copper conductor cables.

greater bandwidth, etc. **[4]**

(*ix*) State one other use of fibre optic cables. .

endoscopy, broadband, Christmas decorations, etc. **[4]**

10. (*i*) Explain what is meant by a magnetic field.

a region in space in which a magnetic force can be felt **[6]**

[accept partial answer for 3]

(*ii*) Draw a sketch of the magnetic field around a bar magnet.

magnetic field lines shown above and below a bar magnet **[4]**

travelling from north to south **[4]**

(*iii*) Explain what is meant by an electric current.

flow of electrons **[6]**

[accept partial answer for 3]

(*iv*) Name an instrument used to measure electric current.

ammeter / galvanometer **[3]**

(*v*) State one effect of an electric current.

heating / chemical / magnetic **[3]**

An electrical generator is based on the principle of electromagnetic induction. It can be demonstrated by moving a magnet towards a coil as shown.

(*vi*) Explain what is meant by electromagnetic induction.

the production of an (induced) e.m.f. due to a changing magnetic field **[6]**

[accept partial answer for 3]

(*vii*) What is observed on the meter when the magnet is moved in and out of the coil?

non-zero reading on meter **[4]**

[accept partial answer for 2]

(*viii*) What is observed on the meter when the magnet is stationary within the coil?

constant 0 A reading **[4]**

[accept partial answer for 2]

A transformer is also based on the principle of electromagnetic induction. An a.c. source is connected to the primary coil of a transformer to provide an input voltage.

(*ix*) The primary coil of a transformer has 200 turns of wire and the secondary coil has 50 turns. The input voltage is 230 V a.c.
Calculate the output voltage across the secondary coil.

voltage output = 57.5 V **[6]**

[accept partial answer for 3]

(*x*) Draw a sketch of a graph to show how an a.c. voltage *V* changes with time *t*.

labelled axis and curve shown **[6]**

[accept partial answer for 3]

(*xi*) State one use of a transformer.

charger, substations, etc. **[4]**

11. An air to water system is one of the most common ways to heat modern homes.

(*i*) Distinguish between heat and temperature.
heat is a form of energy / temperature is a measure of the hotness (of a body) **[6]**
[accept partial answer for 3]

(*ii*) State two methods by which heat can be transferred throughout a home.
any two: conduction, convection, radiation **[6]**
[accept partial answer for 3]

Internal temperature monitors are used to record the indoor temperature. The temperature of a living room is 292 K.

(*iii*) Calculate the temperature of the living room in degrees celsius (°C).

292 – 273 = 19 °C **[6]**
[accept partial answer for 3]

(*iv*) The internal temperature monitors are based on a thermometric property. State one example of a thermometric property.
any valid named thermometric property **[7]**
[accept partial answer for 4]

A U-value is the measure of the rate of heat loss in a house.

(*v*) State two ways in which the U-value of a house can be reduced.
any two of: glazing, insulation, etc. **[6]**
[accept partial answer for 3]

In addition to air to water systems, modern homes can also have solar panels installed as a source of electricity. Solar energy is a renewable energy source.

(*vi*) Explain what is meant by the term renewable energy source.
(an energy source) that doesn't run out **[6]**
[accept partial answer for 3]

(*vii*) State one advantage and one disadvantage of using solar energy.
one advantage and one disadvantage **[7]**
[accept partial answer for 4]

(*viii*) State one other renewable source of energy.
wind, geothermal, biomass, etc. **[6]**
[accept partial answer for 3]

(*ix*) A solar cell can be used to charge a mobile phone. The power output from the solar cell is 3 W. The mobile phone requires 3.6 kJ of energy to charge.
Calculate the time taken for the mobile phone to charge.

time = 1200 s **[6]**
[accept partial answer for 3]

12(a) Radon is a naturally occurring radioactive gas which can pose a health risk if it is found in high concentrations in indoor environments. Radon is produced from natural radioactive decay and is found in rocks and soils.

(*i*) Explain what is meant by radioactivity.

decay of a nucleus / nucleus emitting alpha, beta or gamma radiation **[6]**

[accept partial answer for 3]

Rn_{86}^{222} is a radon atom.

(ii) How many protons in an atom of radon?

86 **[4]**

(*iii*) Calculate how many neutrons are in an atom of radon-222.

136 **[4]**

Rn_{86}^{222} emits an alpha particle.

(*iv*) Determine what element is formed after an alpha particle, α_2^4, is emitted from Rn_{86}^{222}.

Po **[6]**

[accept 84 for 2] & [accept 218 for 2]

(b) Nuclear fission reactors are used to generate electricity.

(*i*) Explain what is meant by nuclear fission.

splitting of a (large) nucleus **[6]**

[accept partial answer for 3]

(*ii*) Explain what is meant by a chain reaction.

the products of the reaction continue the reaction **[6]**

[accept partial answer for 3]

(*iii*) State a suitable fuel used in a nuclear fission reactor.

uranium / plutonium **[3]**

(*iv*) State the function of

(*a*) moderator,

(*b*) the shielding in a nuclear reactor.

(*a*) slows down (fast-moving) neutrons **[3]**

(*b*) prevents escape of radiation **[3]**

Einstein's equation $E = mc^2$ is used to explain the energy conversion taking place in a nuclear reactor.

(*v*) Identify what the letters *m* and *c* stand for.

***m* = mass of object & *c* = speed of light** **[6]**

[accept partial answer for 3]

The Sun's energy is produced by nuclear fusion.

(*vi*) Explain what is meant by nuclear fusion.

joining of two (small) nuclei **(6)**

[accept partial answer for 3]

(*vii*) State one advantage of using nuclear fusion over nuclear fission as a source of energy.

any valid reference to fuel/products **[3]**

13. Read the following passage and answer the questions below.

Domestic electricity refers to electrical circuits and safety devices around the home, like circuit breakers (e.g. fuses and RCDs), the ring mains circuit and the functions of the live, neutral and earth wires.

Circuit breakers are automatically operated electrical switches that protect the home. A fuse breaks the circuit if a fault causes too much current to flow.

The copper wiring in a house connects appliances together in parallel. This is so that each appliance (e.g. an electric kettle) has 230 V across it.

Electricity meters measure the number of units, kilowatt-hours (kW h), of electricity used in the home.

adapted from www.bbc.co.uk/bitesize

(*i*) Name a common material used to conduct electricity in an electrical cable.
copper **[7]**

[accept partial answer for 4]

(*ii*) Explain the function of an earth wire
provides a (low resistance) path to earth / safety feature **[7]**

[accept partial answer for 4]

(*iii*) A fuse is a type of circuit breaker. Explain how a fuse works.
melts / breaks if current is too high **[7)**

[accept partial answer for 4]

(*iv*) An electric kettle has a power rating of 2300 W. Identify, from the list below, which is the most appropriate fuse that should be used, 3 A, 5 A or 13 A.
13 A **[7]**

[accept partial answer for 4]

(*v*) In an electric plug, state the colour of (*a*) the live wire and (*b*) the neutral wire.
(*a*) live - brown
(*b*) neutral - blue **[4 + 3]**

[accept partial answer for 4]

(*vi*) The cost of electricity is calculated using the following equation.

$$\text{units (kW h)} = \text{power (kW)} \times \text{time (h)}$$

The price of a unit is 30 cent.
Calculate the cost of using a 1.2 kW electric heater for 3 hours.
€1.08 **[7]**

[accept partial answer for 4]

(*vii*) Explain why appliances in the home are connected in parallel.
each appliance has 230 V across it / even if one appliance is off the rest of the appliances can still work **[7]**

[accept partial answer for 4]

(*viii*) Another device used in domestic circuits is a residual current device (RCD). Explain the function of an RCD.
detects a current difference between the outgoing and incoming current / safety device / circuit breaker **[7]**

[accept partial answer for 4]

14(a) A crane lifts large objects from the ground.

(*i*) Explain what is meant by energy.

the ability to do work **[6]**

[accept partial answer for 3]

(*ii*) State the principle of conservation of energy.

energy cannot be created or destroyed **[6]**

[accept partial answer for 3]

(*iii*) Calculate the work done in lifting a weight of 12 000 N to a height of 3.5 m.

W = 42 000 J **[6]**

[accept partial answer for 3]

(*iv*) Calculate the power output required by the crane to raise the weight to this height in a time of 12 seconds..

P = 3500 W **[6]**

[accept partial answer for 3]

(*v*) The input power of the crane is 5000 W. Calculate the percentage efficiency of the crane.

% efficiency = 70 % **[4]**

[accept partial answer for 2]

(b) A moving train's whistle emits a note with a constant frequency of 2.4 kHz. The frequency of the sound emitted appears different to a stationary observer. This phenomenon is described by the Doppler effect.

(*i*) Explain what is meant by the Doppler effect.

(apparent) change in frequency due to the change in motion between the source producing it and the observer **[6]**

[accept partial answer for 3]

(*ii*) Describe a laboratory experiment to demonstrate the Doppler effect.

apparatus **[4]**

method **[4]**

observation **[4]**

[accept partial answers for 2 in each case]

To the observer, the frequency of the note appears to be higher than 2.4 kHz.

(*iii*) Is the train moving towards or moving away from the observer?

towards **[3]**

(*iv*) Describe the frequency that the train driver hears.

hears the same note / 2.4 kHz **[3]**

(*v*) State one an application of the Doppler effect.

speed gun, measuring red shift, ultrasonic scanners, weather forecasting, used to study heartbeat, blood flow, etc. **[4]**

[accept partial answer for 2]

(c) A gold leaf electroscope has many uses in the field of electrostatics.

(*i*) Identify the part labelled **X** on the electroscope in the diagram.

gold / leaf **[6]**

(*ii*) Describe how to charge an electroscope negatively

contact with negative conductor / brought close to positive charge and earthed **[6]**

[accept partial answer for 3]

(*iii*) State one use of an electroscope.

detecting or measuring charge / potential difference / capacitance **[6]**

[accept partial answer for 3]

(*iv*) State Coulomb's law.

force proportional to product of charges **// $F \propto q_1 q_2$** **[3]**

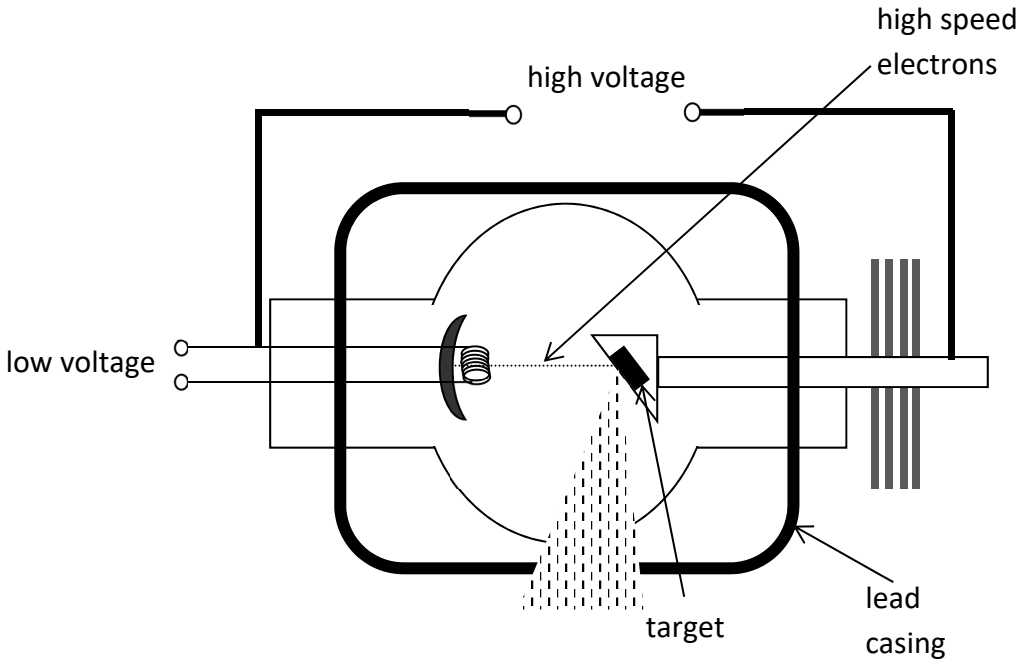
inversely proportional to the square of the distance between them **// $\propto \frac{1}{d^2}$** **[3]**

(*v*) Describe a method used to remove the charge from an electroscope.

connect metal cap of an electroscope to an earth **[4]**

[accept partial answer for 2]

(d) X-rays are produced when high speed electrons collide with a target in an X-ray tube as shown in the diagram.



(*i*) What are X-rays?

high energy rays / electromagnetic radiation **[6]**

[accept partial answer for 3]

(*ii*) Identify a suitable material that could be used for the target.

material with a high melting point **[6]**

[accept partial answer for 3]

(*iii*) Describe how electrons are produced in the X-ray tube.

thermionic emission **[6]**

[accept partial answer for 3]

(*iv*) Why is a lead casing put around an X-ray tube?

for safety / to prevent radiation being released to surroundings **[6]**

[accept partial answer for 3]

(*v*) State one use of X-rays.

check for broken bones, check for defects in parts, food irradiation, etc. **[4]**

[accept partial answer for 2]