Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2017

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**

An experiment was set up to measure *g*, the acceleration due to gravity.

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

labelled diagram to show:

(falling) object/ball	// pendulum bob	// picket fence	6
timer: timer shown in diagram	// stop-watch	// photogate (and timer)	3
detail: stop/start mechanism	// fixed point/retort stand	// calculator/computer	3

NOTE: no labels, deduct 2
incorrect experiment, maximum mark 2 × 3
all valid methods are acceptable e.g. data logging methods, which fit the scheme

(*ii*) What measurements were taken to calculate *g*?
How were these measurements taken? **4 × 3**

distance /*s*	// length (of pendulum)	// selected *v* versus *t*	3
time /*t*	//period /time	// slope of graph	3
measure length using a metre stick		// start program / datagate	3
measure the time using a stop watch /timer		// drop picket fence	3

partial answer (3)

(*iii*) How were these measurements used to calculate *g*? **3 × 3**

substitute (for *t* and *s*) into the equation

$g = \frac{2s}{t^2} / s = \frac{1}{2} g t^2$ // $g = \frac{4\pi^2 l}{T^2} / T = 2\pi\sqrt{\frac{l}{g}}$ 3×3

one error e.g. $g = \frac{2s}{t}$ // $g = \frac{4\pi l}{T^2}$ (2×3)

partial answer e.g. substitute into the equation, gives a detail (3)

(*iv*) State two precautions which the student might have taken to get an accurate result. **7 or 6 or 4 or 2**

avoid parallax error, etc. // swing through small angle, etc.
partial answer (2)
use the smallest time value recorded for *t*, etc. // use accurate digital timer, etc.
partial answer (2)

1st and 3rd lines 7
1st or 3rd line (4)

Question 2 40 marks

An experiment was set up to measure the specific heat capacity of a substance.

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

labelled diagram to show
liquid / water in a calorimeter // block of metal 6

method of heating
stirrer
thermometer
joulemeter
insulation any two 2×3

incorrect experiment, maximum mark 6 + 3
NOTE: no labels, deduct 2

(ii) **What measurements were taken during the experiment.** **3 × 3**

mass 3
accept weight 3-1 marks
temperature 3
detail e.g. specific mass / temperature // energy 3

inconsistency between the apparatus and the measurements maximum mark 3

partial answer (3)

(iii) **How was the mass of the substance determined?** **6 or 3**

mass of calorimeter and water - mass of calorimeter //
(using an electronic) balance plus detail e.g. tare 6

partial answer e.g. weigh it, by subtraction (3)

(*iv*) How was the specific heat capacity of the substance determined? **3 × 3**

any formula consistent with method e.g. $m_1c_1\Delta\theta_1 = m_2c_2\Delta\theta_2$ // $\Delta E = mc\Delta\theta$ 3 × 3

one error (2 × 3)

partial answer e.g. one part correct // attempts word version of the formula (3)

(*v*) State one precaution which the student might have taken to get an accurate result **4 or 2**

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, no parallax when reading the thermometer etc.
any one 4

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

partial answer e.g. repeat / average / no parallax (2)

Question 3 40 marks

A student carried out an experiment to measure the focal length of a concave mirror. The table shows the data recorded during the experiment.

***u* (cm)**	**15**	**25**	**45**
***v* (cm)**	**30**	**17**	**13**

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

labelled diagram to show:

concave mirror
object e.g. crosswire
image / screen
correct arrangement
detail e.g. optical bench, metre-stick, ray-box, etc.

any 4 lines correct 4×3

approximate method maximum mark 3×3
NOTE: no labels, deduct 2

accept valid alternatives

(*ii*) How did the observer know that the apparatus was correctly arranged to record the data? **6 or 3**

the (inverted) image was in (sharp) focus (on the screen) // inverted image 6

partial answer e.g. mentions screen (3)

(*iii*) Indicate on your diagram the measurements that were taken? **2 × 3**

distance from the object/crosswire to the mirror 3
distance from the image/screen to the mirror 3
partial answer (3)

(*iv*) Calculate the value for the focal length *f* of the mirror, using the data data above **4 × 3**

$(f = \frac{f_1 + f_2 + f_3}{3} = \frac{30.21}{3} =) 10.07 \text{ cm}$ 4 × 3

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ (2 × 3)

$\frac{1}{15} + \frac{1}{30} = \frac{2}{30} + \frac{1}{30} = \frac{3}{30} \quad (\Rightarrow f_1 = 10)$ (2 × 3 + 2)

each further calculation +1

$\frac{1}{25} + \frac{1}{17} = \frac{17 + 25}{(17)(25)0} = \frac{42}{425} \quad (\Rightarrow f_2 = 10.12)$

$\frac{1}{45} + \frac{1}{13} = \frac{13 + 45}{(45)(13)} = \frac{58}{585} \quad (\Rightarrow f_3 = 10.086)$

inverting + 1 mark
averaging +1 mark

partial answer (3)

(v) Why might it be an advantage to use a darkened room when carrying out this experiment. **4 or 2**

greater accuracy, more reliable result, minimise errors, the image might be clearer, helps to get a sharp image etc. any one 4

partial answer (2)

Question 4 40 marks

An experiment was set up to investigate the variation of the resistance *R* of a metallic conductor with its temperature *Θ*.

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

ohmmeter/multimeter, heating-source, conductor/resistor each one (3) all three 3 × 3
detail e.g. insulation, container, thermometer 3
partial answer (3)

NOTE: no labels deduct 2
accept valid alternatives methods

(*ii*) How was the value of the resistance of the metallic conductor measured? **6 or 3**

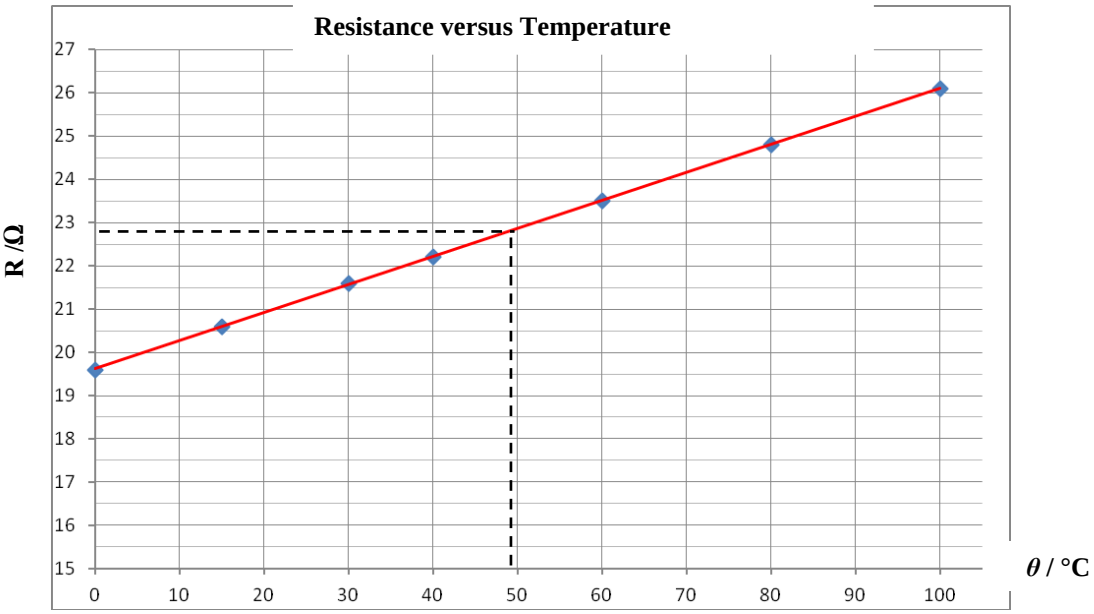
ohmmeter / multimeter (set to read ohms) 6
partial answer e.g. reference to measuring voltage or current / resistance meter (3)

The table shows the measurements obtained during the experiment.

Θ (°C)	0	15	30	40	60	80	100
R (Ω)	19.6	20.6	21.6	22.2	23.5	24.8	26.1

***(iii)* Using the data in the table, draw a graph on graph paper to show the variation of resistance of the metallic conductor with temperature.** **3 + 6 + 3**

label axes correctly, (name / symbol / unit acceptable) 3
plot six points correctly 6
-1 for each error thereafter
straight line 3
if graph paper is not used, maximum mark 3 × 3



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

resistance increases with temperature // linear // ∝ (on kelvin scale) 6
partial (3)

***(v)* Use your graph to find the temperature of the metallic conductor when it has a resistance of 22.8 Ω.** **4 or 2**

47 – 50 (°C) // answer consistent with graph 4
evidence of using the graph at 22.8 Ω (2)

SECTION B (280 Marks)

Five questions to be answered

Question 5 **any *eight* parts** **56 marks**

Take the best 8 from 10 parts

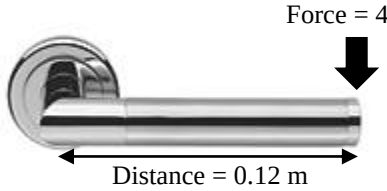
(*a*) Name an example of (i) a vector quantity (ii) a scalar quantity. **7 or 4**

correct examples of each 4 + 3

partial answer e.g. examples in reverse order, definitions given (4)

(*b*) A door handle is used to open a door.

Calculate the moment of the force applied in the diagram. **7 or 4**



($M = Fd$ = 40 ×0.12 = 40 × 0.12 =) 4.8 N m 7

partial answer (4)

(*c*) Choose from the list below the instrument used to measure

(*i*) electrical current and (*ii*) length. **7 or 4**

(i) ammeter protractor **(ii) metre stick** barometer 7

one correct (4)

(*d*) Conduction is one method of heat transfer. Name the other two methods. **7 or 4**

convection, radiation two correct 7

one correct (4)

(*e*) Name the instrument shown **7 or 4**

micrometer /screw gauge 7

partial answer (4)

(*f*) State one common use of a convex lens. **7 or 4**

magnification, (eye) glasses, binoculars, contact lenses, camera, etc. 7

partial answer e.g. use of convex mirror (4)

(*g*) Resonance can cause a wine glass to shatter. What is resonance? **7 or 4**

transfer of energy

between bodies at the same frequency // at natural frequency

two lines 7

partial answer e.g. refers to natural frequency one line (4)

(*h*) Name one source of voltage. **7 or 4**

cell, battery, power supply,(charged) capacitor, etc. 7

partial answer (4)

(*i*) What sub-atomic particle is released by the photoelectric effect? **7 or 4**

electron 7

partial answer (4)

(*j*) Name one method of detecting radiation? **7 or 4**

Geiger-Muller tube, Geiger counter, solid state detector, cloud chamber, bubble chamber, GLE, photographic film, radiometer, radiation sensor, etc. 7

partial answer (4)

Question 6 56 marks

A fairground sling-shot is shown below. Springs attached to the pod are used to store a form of potential energy. When the pod and springs are released, this potential energy is used to exert a force which gives the pod an upward acceleration. At the pod's highest point, the occupants experience apparent weightlessness for a short time, before gravity causes the pod to fall back towards the ground.

(*i*) Explain the underlined terms. **3(6 or 3)**

force: causes an object to accelerate // $F = ma$ 6

partial answer (3)

acceleration: rate of change of velocity // $a = \frac{v-u}{t}$ 6

partial answer (3)

gravity: force of attraction between masses // $g = G\frac{M}{d^2}$ 6

partial answer (3)

(*ii*) What form of energy does the pod have due to its motion? **6 or 3**

kinetic (energy) 6

partial answer (3)

(*iii*) What form of energy does the pod have at its highest point? **6 or 3**

potential (energy) 6

partial answer (3)

(*iv*) Why do the occupants experience apparent weightlessness at the pod's highest point? **3**

freefall / no reaction force / no support force 3

The mass of the pod is 400 kg.
It reaches a maximum height of 50 m above its point of release.

(*v*) Calculate the potential energy stored in the springs before the pod is released. **6 or 3**

(PE = *mgh* = 400 × 9.8 × 50 =) 196 000 J 6

partial answer e.g. correct equation (3)

(*vi*) Draw a diagram to show the forces acting on the pod when it is released. **6 or 3**

diagram to show: downward force/ weight, upward force / tension 6

partial answer e.g. any one (3)

(*vii*) Calculate the momentum of the pod when it has a speed of 8 m s^{-1}. **6 or 3**

(*p* = *mv* = 400 × 8 =) 3200 kg m s^{-1} 6

partial answer e.g. correct equation (3)

(*viii*) State one energy loss that might prevent the pod from reaching its maximum height. **5 or 3**

friction / air resistance 5

partial answer (3)

Question 7 **56 marks**

A ray of light can undergo both reflection and refraction.

(*i*) What is meant by reflection of light? **6 or 3**

rebounding / bouncing of light from a surface 6

partial answer (3)

(*ii*) State the laws of reflection. **9 or 6 or 3**

angle of incidence is equal to the angle of reflection

incident ray, the normal, and the reflected ray are coplanar two lines correct 9

one line correct (6)

partial answer (3)

The periscope, like the one in the diagram, is an application of the reflection of light that allows a person to see over objects.

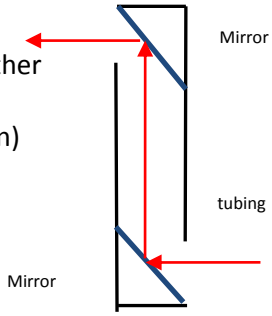
(*iii*) Draw a diagram to show how a periscope works. **3 × 3**

two mirrors/ prisms facing each other

mirrors at 45°

correct ray path (in either direction)

tubing



any 3 lines 3 × 3

any 2 lines (2 × 3)

any line (3)

The diagram shows the word AMBULANCE written so that a driver can read it correctly in a car mirror.

(*iv*) Explain why the driver can read the word correctly in the mirror. **6 or 3**

(the mirror causes an apparent) left to right reversal // lateral inversion 6

partial answer (3)

Total internal reflection of light occurs in optical fibres which are used to transmit information.

(*v*) Draw a labelled diagram to show how total internal reflection occurs. **6 + 3**

diagram showing indication of 2 media, $i > C$ / $i = r$, internal reflection 6 + 3

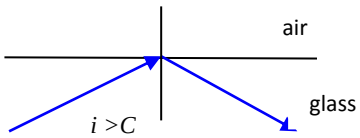


diagram with one omission (6)

partial answer (3)

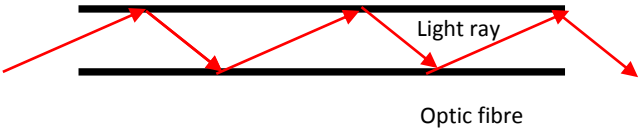
Note: no labels deduct 2

(*vi*) Draw a labelled diagram to show how an optical fibre transmits light along its length. **9 or 6 or 3**

diagram showing fibre, multiple internal reflections 9

diagram with one omission (6)

partial answer (3)



Note: no labels deduct 2

(*vii*) An optical fibre cable has a refractive index of 1.5.
Calculate the angle at which total internal reflection occurs. **8 or 6 or 4**

$(n = \frac{1}{\sin C} = 1.5 \qquad \sin C = 0.6666) \qquad C = 41.8°$ 8

one error (6)

partial answer e.g. correct equation (4)

Question 8 56 marks

Frequency and wavelength are properties associated with waves.

(*i*) What is meant by the frequency of a wave? **6 or 3**

number of waves passing per second 6

partial answer (3)

(*ii*) State the relationship between the frequency of a wave and its wavelength. **6 or 3**

$f = \frac{v}{\lambda}$ // $f \propto \frac{1}{\lambda}$ // $c = f\lambda$ 6

partial answer (3)

The diagram shows a person standing near an ambulance as it approaches with its siren on. As the ambulance passes, the person observes a change in the frequency of the siren.

(*iii*) What name is given to this effect? **6 or 3**

Doppler 6

partial answer e.g. example (3)

(*iv*) Explain, with the aid of a labelled diagram, how this phenomenon occurs. **4 × 3**

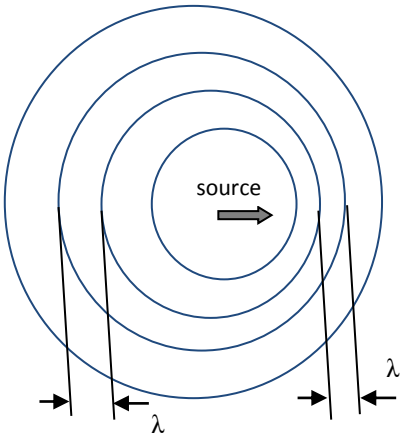


diagram to show:

moving wave source 3

wave fronts 3

as the moving wave source approaches 3

the waves get closer together 3

// conversely as the wave

source moves away the waves are further apart (2× 3)

accept valid alternatives

a labelled diagram may merit full marks

partial answer e.g. the Doppler wave equation (3)

Note: no labels deduct 2, no diagram maximum mark 3 × 3

(*v*) Name one practical application of this phenomenon. **5 or 3**

speed gun, (measuring) red shift, ultrasonic scanners, imaging

used to study blood flow, used to study heart beat, weather forecasting, etc. 5

partial answer e.g. general application such as medicine, radar, sonar (3)

(*vi*) An electrical storm is seen before it is heard. What does this indicate about the difference between sound waves and light waves? **6 or 3**

light travels faster than sound 6

partial answer e.g. reversed (3)

(*vii*) State one other difference between sound waves and light waves. **6 or 3**

sound waves are longitudinal // light waves are transverse //

sound waves need a medium // light waves may be polarised any one 6

partial answer (3)

When timing a 100 m sprint, a person stands at the finishing line and starts the stopwatch when he hears the starting gun fired at the starting line.

(*viii*) Calculate the difference in time the runner would receive if the stopwatch was started at *exactly* the same time as the starting gun was fired, i.e. without any delay caused by the time taken for the sound to travel 100 m . **9 or 6 or 3**

$(t = \frac{s}{v} = \frac{100}{330} =)\ 0.3$ s 9

one error (6)

partial answer (3)

Question 9 56 marks

Magnetic fields can be detected near a magnet or a current-carrying conductor.

(*i*) What is a magnetic field? **6 or 3**

a region/space where a magnetic force is felt / it effects a compass 6

partial answer e.g. draws magnetic field (3)

(*ii*) State one example of a good conductor and one example of a good insulator. **2 × 3**

one example of a good conductor 3

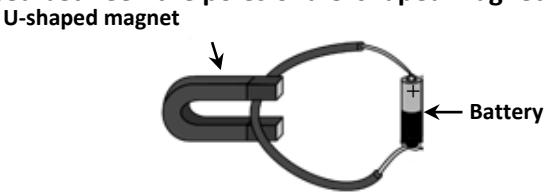
one example of a good insulator 3

(*iii*) Name the unit of voltage. **6**

volt / V 6

partial answer (3)

The diagram below shows a wire placed between the poles of a U-shaped magnet.



(*iv*) What happens to the wire when current flows through it? **6 or 3**

it moves // it experiences a force // gets hot 6

partial answer (3)

(*v*) What happens when the direction of the current is reversed? **6 or 3**

wire moves in the other direction 6

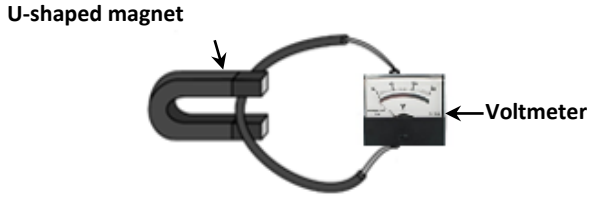
partial answer e.g. wire moves (3)

(*vi*) Name one device based on this effect. **6 or 3**

electric motor, speaker, (moving coil) galvanometer, etc. 6

partial answer (3)

The wire is then disconnected from the battery and connected to a sensitive voltmeter.



(*vii*) What is observed on the voltmeter when neither the wire nor the magnet move? **4**

no reading / no deflection / nothing 4

(*viii*) What is observed on the voltmeter when either the wire or the magnet is moved? **4**

deflection / pointer moves / reading 4

(*ix*) Name a scientist whose law is associated with this phenomenon? **6 or 3**

Faraday / Lenz 6

partial answer (3)

(*x*) Magnetism is one effect associated with an electric current. Name one other effect. **6 or 3**

heating // chemical 6

partial answer (3)

Question 10 56 marks

Radiation is released when radioactive elements decay.

(*i*) Name three types of radiation. **3 × 3**

alpha / α, beta / β, gamma / γ 3 × 3

(*ii*) Which type of radiation has no charge? **3**

gamma / γ 3

(*iii*) Which type of radiation is the least penetrating? **3**

alpha / α 3

(*iv*) Which type of radiation is not deflected by magnetic fields? **3**

gamma / γ 3

(*v*) State one danger associated with nuclear radiation. **6 or 3**

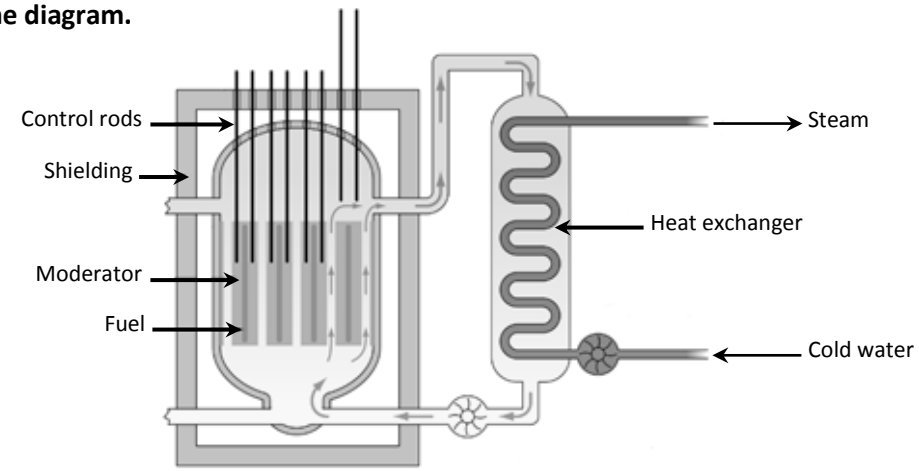
leukaemia, cancer, skin burns, hair loss, kills cells, damage DNA, etc. 6

partial answer (3)

(*vi*) State one precaution that should be taken when handling radioactive substances. **3**

protective clothing, tongs, etc. 3

Radioactive fuels are used to generate power in a nuclear fission reactor like the one shown in the diagram.



(*vii*) What is nuclear fission? **2 × 3**

splitting (of a large nucleus) 3

into two (smaller nuclei) // with release of energy / neutrons 3

partial answer e.g. defines fusion (3)

(*viii*) Name a fuel used in nuclear reactors. **5 or 3**

plutonium / Pu, (enriched) uranium / U, thorium / Th 5

partial answer (3)

(*ix*) State the function of (*a*) the control rods and (*b*) the shielding in a reactor. **2(6 or 3)**

(*a*) control rate of reaction // absorbs neutrons 6

partial answer e.g. refers to boron rods (3)

(*b*) prevents escape of radiation 6

partial answer e.g. protection / safety (3)

(*x*) What is the purpose of the heat exchanger? **6 or 3**

converts (kinetic energy) energy to heat // brings energy to the generator 6

partial answer (3)

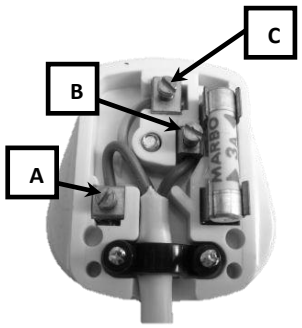
Question 11 56 marks

The Electricity Connection to your Home

The electricity connection to your home is an a.c. supply and comes through ESB Networks' main fuse and meter. The ordinary fuses or miniature circuit breakers in the distribution board respond to overloaded circuits by 'blowing' and switching off the flow of electricity in the circuit. Additional protection against electric shock or fire is provided by a Residual Current Device, RCD. In simple terms, an RCD detects an abnormal flow of electricity out of a circuit when, for instance, a cable is damaged or a fault develops in an appliance allowing electricity to 'leak' out. The RCD responds instantaneously to such 'leakage' and disconnects the supply from the circuit. All RCDs have a test button to check that the mechanism is working properly.

Making the Connection – Plugs and Cable Colours

Almost all new electric appliances now come complete with a fitted 13 A 3-pin plug. The first thing to know is the colour code for connecting the cables to the appropriate pin/terminal in the plug. When you connect each wire to the appropriate terminal, it is most important that no loose strands of wire are exposed and that all the screw connections are fully tightened. You should also leave a little extra slack on the green/yellow wire within the plug in order to avoid strain on this vital connection. The ordinary 13 A plug suits most of the commonly used 'non-fixed' appliances in the home – heaters, washing machines, dryers, microwave ovens, tools, entertainment equipment, etc. Appliances with a higher loading should be permanently connected to their own circuit through a switch. The most vulnerable parts of many appliances are the connecting flex and the plug. Most electrical accidents associated with electric appliances are caused either by damaged flexes or wrongly-wired plugs. For your own safety, keep electric appliances well maintained and don't abuse them.



(Adapted from *The Safe Use of Electricity in the Home*, ESB Networks)

(a) **What is the function of the electricity meter?** **7 or 4**

to measure the (electrical) energy used 7

partial answer (4)

(b) **What is meant by the term a.c.?** **7 or 4**

alternating current 7

partial answer (4)

(c) **Name three safety devices found in domestic circuits.** **7 or 4**

fuse, earth, miniature circuit breaker/ (trip) switch, residual current device any 3 7

partial answer (4)

(d) **What is the cause of most accidents associated with electrical appliances?** **7 or 4**

damaged flexes // wrongly-wired plugs 7

partial answer (4)

(*e*) **What is the function of the test button on an RCD?** **7 or 4**

to check that the mechanism is working properly 7

partial answer (4)

(*f*) **Name the pins labelled A, B and C in the diagram.** **7**

A – neutral; B – live; C – earth 7

1st named pin matched correctly 3 marks, others matched correctly 2 marks each

1st named mismatched pin by label/ colour 2 marks, others 1 mark each

(*g*) **State one precaution that should be taken when wiring a plug.** **7 or 4**

no loose strands of wire are exposed // all the screw connections are tightened // leave a little extra slack on the green/yellow wire within the plug. 7

partial answer (4)

(*h*) **What is the maximum power that an appliance with a 13 A plug can use when connected to a 220 V supply?** **7 or 4**

($P=IV$= 13 × 220=) 2860 W 7

partial answer (4)

Question 12 56 marks

Answer any **two** of the following parts, (*a*), (*b*), (*c*), (*d*).

Part (*a*) Define (*i*) velocity and (*ii*) friction. **6 + 3**

(*i*) rate of change of displacement // distance over time (in a given direction)

(*ii*) force (between 2 bodies in contact) which opposes motion two correct 6 + 3

one correct (6)

partial (3)

A car started from rest and accelerated at 0.4 m s^{-2} to reach a top speed of 28 m s^{-1}. It maintained this speed for 200 seconds.
When the car approached its destination, the driver applied the brakes uniformly to bring it to a stop in 30 s.

(*iii*) Draw a diagram indicating the main forces acting on the car when it was accelerating. **6 or 3**

Weight/*W*, reaction force/*R*, force from engine/F_e, friction/F_r two correct 6

one correct (3)

(*iv*) Calculate how long it took the car to reach its top speed. **6 or 3**

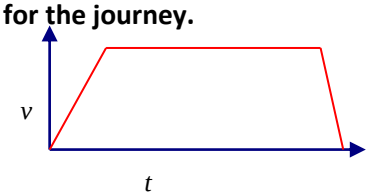
$(v = u + at \Rightarrow 28 = 0 + 0.4t \Rightarrow t = \frac{28}{0.4} =)$ 70 s 6

partial answer e.g. $v = u + at$ (3)

(*v*) Sketch the velocity-time graph for the journey. **7 or 4**

correct velocity-time graph 7

partial (4)



Part (*b*) The heat pump in a fridge uses a fluid with a high specific latent heat.

(*i*) Explain the underlined terms. **2(6 or 3)**

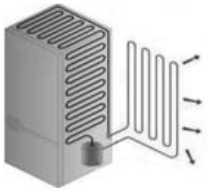
heat pump: means of transferring heat from a cold region to a warm region 6

partial answer e.g. device to transfer heat (3)

specific latent heat : heat needed to change the state of 1 kg of a substance 6

partial answer e.g. refers to no change in temperature (3)

A fridge lowers the temperature of 2 kg of water from 30 °C to 5 °C in 840 s.



Calculate

(*ii*) the energy removed from the water **4 × 3**

($E = mc\Delta\theta = 2 \times 4200 \times 25 =$) 210 000 J 4 × 3

one error (3 × 3)

two errors (2 × 3)

partial answer e.g. incomplete formula (3)

(*iii*) the power of the fridge. **4 or 2**

$(P = \frac{W}{t} = \frac{210000}{840} =)$ 250 W // answer consistent with (*ii*) 4

partial answer e.g. correct formula (2)

Part (*c*) Mountain climbers encounter large changes in atmospheric pressure.

(*i*) Define pressure and state its unit. **2 × 3 + 4**

force 3

per unit area 3

partial e.g. $P = \rho gh$ (3)

pascal / N m^{-2} 4

(*ii*) Describe an experiment to demonstrate that the atmosphere exerts pressure. **3 × 3**

apparatus: e.g. can of water and heat source 3

procedure: e.g. boil water and put on lid 3

observation: e.g. can collapses 3

partial (3)

accept valid alternatives e.g. sucking out air methods

marks may be obtained from a diagram

A weather balloon is released to test the weather at the height of Mount Everest, where atmospheric pressure is only 3.0 × 10^4 Pa.

The balloon has a volume of 2 litres when it is released from sea level.

(*iii*) Calculate the volume of the balloon when it reaches the height of Mount Everest. **9 or 6 or 3**

$(P_1V_1 = P_2V_2 \quad \Rightarrow (10.1\times10^4)(2) = (3.0\times10^4)(V_2) \Rightarrow V_2 = \frac{20.2}{3})$ = 6.7 L 9

one error (6)

partial answer e.g. $P_1V_1 = P_2V_2$ / PV=k / Boyle's law (3)

Part (*d*)

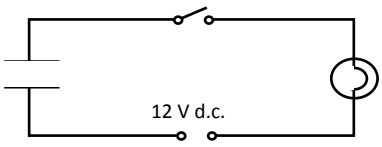
(*i*) State Coulomb's law of force between electric charges. **2 × 3**

force proportional to the product of charges / $F \propto q_1q_2$ 3

inversely proportional to the distance between the charges squared / $\propto \frac{1}{d^2}$ 3

A capacitor can be used to store electric charge.

A discharged capacitor with a capacitance of 6 × 10^{-2} F is connected in a circuit with a bulb, a switch and a 12 V d.c. power supply as shown.



(*ii*) What is observed when the switch is closed? **6 or 3**

bulb flashes 6

partial e.g. bulb lights, current flows, etc. (3)

(*iii*) What would be observed if a 12 V a.c. power supply had been used instead? **4 or 2**

bulb lights (continuously) 4

partial e.g. bulb flashes (2)

(*iv*) Calculate the charge stored on the capacitor when it is connected to the 12 V d.c. power supply. **9 or 6 or 3**

$(C = \frac{Q}{V} \Rightarrow Q = CV = (6\times10^{-2})(12) =$) 0.72 C 9

one error (6)

partial answer (3)

(*v*) State one application of a capacitor. **3**

store charge / conducts a.c. /(radio) tuning / filtering / smoothing / timing / store energy / flash camera / phone charger, etc. 3

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