Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2012

Marking Scheme

Physics

Ordinary Level

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. One mark is allocated for the appropriate units in answers after calculation.

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

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

Section A (120 marks)

Three questions to be answered.

Question 1 40 marks

A student carried out an experiment to measure the acceleration of a moving trolley. The student measured the initial velocity of the trolley and the final velocity of the trolley, along with another measurement. The student used these measurements to find the acceleration of the trolley.

(i) Draw a diagram to show how the student got the trolley to accelerate. **6 +3 + 3**

diagram to show:

trolley and runway // air track and glider 6 + 3

one correct (6)

detail e.g. tilt runway, apply force, ticker timer, motion sensor 3

accept valid alternatives e.g. data logging methods, which fit the scheme

(ii) Describe how the student measured the final velocity of the trolley. **2 × 3**

using a motion sensor // distance between (eleven) dots over time

// (velocity=) $\frac{\text{distance}}{\text{time}}$ / $\frac{s}{t}$ 2 × 3

measure the distance between (eleven) dots (3)

divide by time (taken) / details how the time was measured (3)

(iii) What other measurement did the student take? **6 or 3**

distance / time 6

partial answer e.g. force / mass (3)

(iv) How did the student use the measurements to calculate the acceleration of the trolley? **10 or 7 or 4**

(acceleration =) $\frac{\text{change in velocity}}{\text{change in time}}$ / $\frac{v_2 - v_1}{t_2 - t_1}$ // $v^2 = u^2 + 2as$ 10

one error in the equation (7)

partial answer (4)

(v) Give a precaution the student took to ensure an accurate result. **6 or 3**

oil the wheels, clean the runway, ignore the initial tickertape dots, reduce the friction, etc. 6

partial answer e.g. repeat and take an average, (3)

Question 2 40 marks

You carried out an experiment to establish the calibration curve of a thermometer.

(i) Describe, with the aid of a diagram, the procedure you used in the experiment. 4× 3

diagram to show:

container and water

thermometer (in water) // temperature sensor

heat source; hot plate / Bunsen

record at least two thermometric property measurements

detail e.g. stirrer, ruler, 2nd thermometer, means of recording thermometric property, datalogger, etc.

any 4 lines 4× 3

if there is no diagram maximum mark 3× 3

a labelled diagram may merit full marks

(ii) Name the thermometric property of the thermometer you calibrated and describe how the value of this property was measured? 7 + 3

length of column of mercury – measure length with ruler //

resistance (of thermistor) – measure resistance with ohmmeter etc. 7 + 3

correct thermometric property (7)

partial answer (3)

The following table shows the data obtained in an experiment to establish the calibration curve of a thermometer.

Temperature /°C	0	20	40	60	80	100
Value of thermometric property	5	14	29	48	80	130

(iii) Using the data in the table, draw a graph on graph paper to establish the calibration curve. Put temperature on the horizontal axis 4× 3

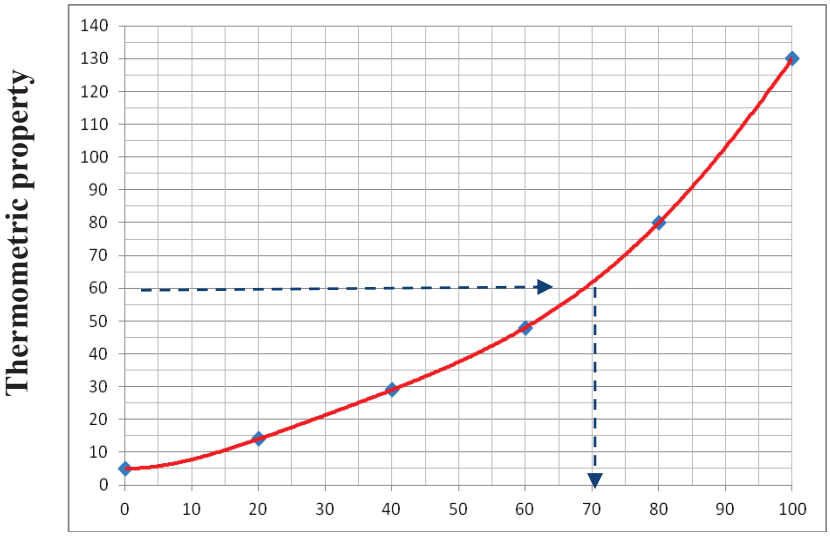
temp on the horizontal axis 3

plot three points correctly 3

plot another three points correctly 3

plot (smooth) curve 3

if graph paper is not used maximum mark 3×3



(iv) Use your graph to estimate the temperature when the value of the thermometric property is 60. 6 or 3

70 ± 3 °C or value consistent with graph 6

partial answer e.g. evidence of using the graph (3)

Question 3 40 marks

A student carried out an experiment to verify Snell's law of refraction. The student measured the angle of incidence *i* and the corresponding angle of refraction *r* for a ray of light passing through a glass block. The student repeated this procedure for different values of the angle *i*. The data recorded by the student are shown in the table.

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

labelled diagram to show:

glass block 3
laser / ray box / pins 3
protractor / ruler / sheet of paper 3

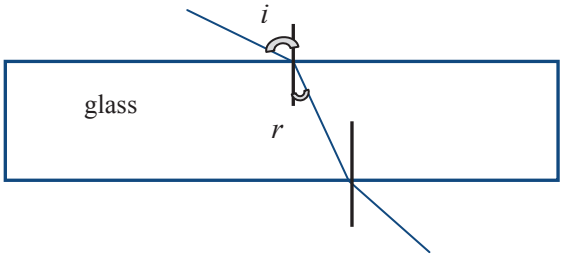
NOTE: no labels, deduct 2
accept valid alternatives

(ii) Describe how the student found the path of the ray of light passing through the glass block. **6 + 3**

refracted ray described or drawn 6
detail e.g. refers to the incident ray / emerging ray 3
a diagram may merit full marks

partial answer (3)

(iii) Indicate on the diagram the angles *i* and *r*. **2 × 3**



correct angle *i* 3
correct angle *r* 3
partial answer e.g. angle labels mismatched (3)
The angles may be shown on the diagram in (i)

(iv) Copy this table into your answerbook and complete it. **(9 or 6 or 3)**

angle of incidence *i*	angle of refraction *r*	sin *i*	sin *r*	$\frac{\sin i}{\sin r}$
25°	16°	**0.423**	**0.276**	**1.533**
35°	22°	**0.574**	**0.375**	**1.531**
50°	30°	**0.766**	**0.500**	**1.532**
60°	34°	**0.866**	**0.559**	**1.549**

> 9 calculations correct 9
any 6 calculations correct (6)
any 3 calculations correct (3)

(v) How does the data in the completed table verify Snell's law of refraction **7 or 4**

$\frac{\sin i}{\sin r}$ is constant /1.536 7

partial answer (4)

Question 4 **40 marks**

In an experiment to investigate the variation of current *I* with potential difference *V* for a copper sulfate solution, the following apparatus was used.

(i) Name the instrument X. **6 or 3**

milliammeter / ammeter /galvanometer / multimeter 6

partial answer e.g. meter (3)

(ii) Name the apparatus Y and give its function in the experiment **2 × 3**

rheostat / (variable) resistor / potential divider / potentiometer 3

change in one of: resistance, voltage, potential, current, power, /
answer consistent with named apparatus 3

Y is a resistor and limits the current (2 × 3)

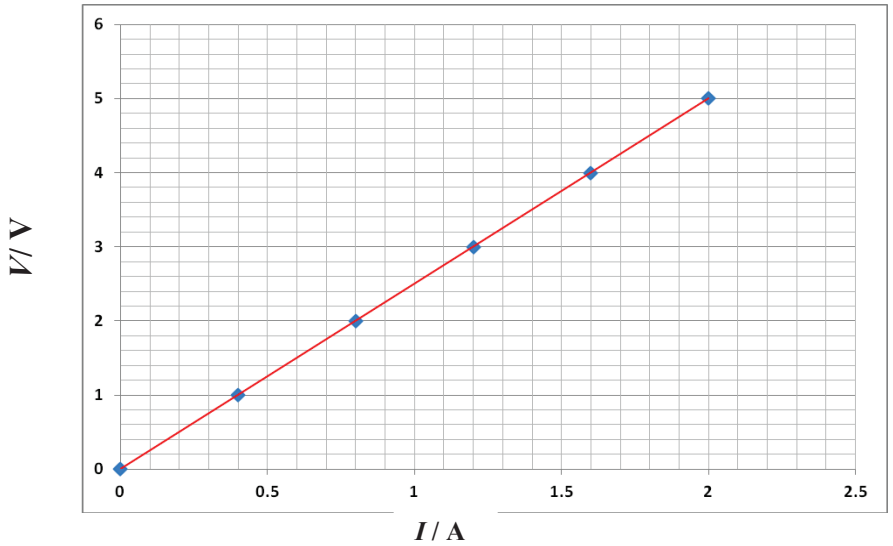
(iii) How was the potential difference measured in the experiment? **6 or 3**

using a voltmeter/ with Z 6

partial answer e.g. using a multimeter, $V = IR$, (3)

The following table shows the values recorded for the current *I* and the corresponding potential difference *V* during the experiment. Using the data in the table, draw a graph on graph paper to show the variation of current with potential difference. **4 × 3**

***V* /V**	**0**	**1.0**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**
***I* /A**	**0**	**0.4**	**0.8**	**1.2**	**1.6**	**2.0**	**2.4**



label one axis correctly- name/symbol/unit acceptable 3

plot three points correctly 3

plot another three points correctly 3

draw line of best fit 3

if graph paper is not used maximum mark 3×3

Calculate the slope of your graph.

Use this value to determine the resistance of the copper sulfate solution. **7 + 3**

$\left(\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5-0}{2-0} =\right)$ 2.5 // answer consistent with graph e.g. 0.4 7

$\left(R = \frac{V}{I} =\right)$ 2.5 Ω 3

partial answer e.g. $V = I\,R$, evidence of using the graph (3)

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 tow-truck pulls a car with a net horizontal force of 500 N. Calculate the work done in towing the car a distance of 2 km to a garage. **7 or 4**

(500)(2000) = 10^6 J 7

partial answer e.g. $W = Fs$ / incomplete answer (4)

(*b*) Give one factor on which the potential energy of a body depends **7 or 4**

$m/g/h$, etc. one correct 7

partial answer (4)

(*c*) Which of the following instruments can be used to measure atmospheric pressure? **7**

barometer 7

(*d*) The Tacoma Narrows Bridge collapsed, soon after construction, due to resonance. What is resonance? **7 or 4**

(the tendency of a body to oscillate at a) greater amplitude at some (forced) frequencies // refers to energy transfer at certain frequencies 7

partial answer e.g. refers to natural frequency, valid example (4)

(*e*) A building has a low U-value. What is the advantage of this? **7 or 4**

low energy loss, etc. 7

partial answer (4)

(*f*) Why is a lightning conductor made of copper? **7 or 4**

good conductor, doesn't corrode, cheaper than silver, etc. 7

partial answer (4)

(*g*) Why does a magnet that is free to rotate point north? **7 or 4**

earth's magnetic field 7

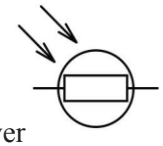
partial answer (4)

(*h*) A transformer is used to change the voltage of an electrical supply. What is the principle of operation of a transformer? **7 or 4**

change in magnetic flux induces an emf // correct reference to coils // e.m. induction 7

partial answer e.g. refers to Faraday / magnetic field /emf (4)

(*i*) The photo shows an LDR. Draw the electrical circuit symbol for an LDR. **7 or 4**



7

partial answer (4)

(*j*) What is the main source of energy in the sun? **7 or 4**

hydrogen /nuclear / fusion 7

partial answer e.g. fission (4)

Question 6 56 marks

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

(acceleration) caused by the (gravitational pull of the) earth /moon /planet 6

partial answer e.g. refers to earth / refers to falling / 9.8 (3)

A spacecraft of mass 800 kg is on the surface of the moon, here the acceleration due to gravity is 1.6 m s^{-2}.
Compare the weight of the spacecraft on the surface of the moon with its weight on earth where the acceleration due to gravity is 9.8 m s^{-2} **6 + 3**

weight on moon = mg_m = (800)(1.6) = 1280 N

weight on earth = mg_e = (800)(9.8) = 7840 N two lines correct 6 + 3

one line correct (6)

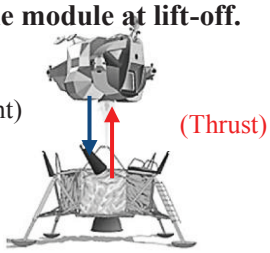
($\frac{9.8}{1.6}$ =) 6.1 / " six times heavier" (6)

partial answer e.g. correct equation / mg (3)

The module of the spacecraft has a mass of 600 kg, when it is launched vertically from the surface of the moon with its engine exerting an upward force of 2000 N.

(i) Draw a diagram showing the forces acting on the module at lift-off. **2 × 3**

diagram to show



3

3

(ii) What is the resultant force on the module? **6 or 3**

$F - mg_m$ = 2000 – (600)(1.6) = 1040 N 6

partial answer (3)

(iii) Calculate the acceleration of the module during lift-off. **6 or 3**

(F=ma) 1040 = (600)(a) a = 1.73 m s^{-2} 6

answer consistent with (ii) (6)

partial answer e.g. $F = ma$ (3)

(iv) Calculate the velocity of the module, 20 seconds after lift-off. **6 or 3**

($v = u + at$) i.e. v = 0 + (1.73)(20) = 34.6 m s^{-1} 6

answer consistent with (iii) (6)

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

(v) Would the engine of the module be able to lift it off the earth's surface? Justify your answer in terms of the forces acting on the module. **3 + 6**

no 3

force required to overcome the earth's gravity (5880 N) is greater than the upward force (2000) // 5880 > 2000 6

partial answer (3)

(vi) Why is the acceleration due to gravity on the moon less than the acceleration due to gravity on the earth? **5 or 3**

because the mass of the moon is less than the mass of the earth 5

partial answer e. g. refers to mass / distance (3)

(vii) Suggest a reason why the module of the spacecraft when launched from the moon does not need a streamlined shape like those that are launched from earth. **3**

no atmosphere // no drag // no friction 3

Question 7 56 marks

Under certain conditions, light can undergo <u>diffraction</u> and <u>interference</u>.

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

<u>diffraction</u> is the spreading out of waves around a barrier / the edges of an opening // correct diagram 6

partial answer e.g. light spreads out, bending (3)

<u>interference</u> occurs when two waves meet and add // correct diagram 6

partial answer (3)

reversed explanations (6)

(ii) Describe an experiment to demonstrate the wave nature of light **4 × 3**

apparatus: (light) source, (diffraction) grating / slits, screen

three pieces 2×3

one piece (3)

procedure: shine the (narrow beam of) light through the grating 3

observation/conclusion; pattern on screen 3

incorrect experiment maximum mark 2×3

marks may be obtained from a diagram

accept valid alternatives

The photograph shows Polaroid sunglasses which reduce glare caused by sunlight.

(iii) Explain the term polarisation **6 or 3**

polarisation is the restriction of (vibrating electromagnetic) waves to a single plane 6

marks may be obtained from a diagram

partial answer (3)

(iv) Describe an experiment to demonstrate the polarisation of light **4 × 3**

apparatus: (two pieces of a) polaroid sheet 3

procedure: look at the light through the two pieces of polaroid 3

cross/rotate one of the polaroid pieces 3

observation/conclusion; the crossed pieces stops the light 3

marks may be obtained from a diagram

accept valid alternatives

(v) What type of wave motion does light have as indicated by the experiment in part (iv)? **9 or 6 or 3**

transverse 9

electromagnetic (6)

partial answer e.g. refers to longitudinal (3)

(vi) Why are Polaroid sunglasses more effective than non-Polaroid sunglasses at reducing glare? **5 or 3**

polaroid sunglasses remove most of the polarised reflected light (which causes the glare) while ordinary sunglasses doesn't // reflected light is polarised 5

partial answer e.g. reduces intensity (3)

Question 8 56 marks

A plug is used to connect an electrical appliance in the home to the 230 volt mains supply. Modern plugs contain a small fuse which comes with a rating of 1A, 2A, 3A, 5A or 13A. The electrical energy supplied to the home is measured in kW h (*kilowatt-hour*).

(i) What is the colour of the wire that should be connected to the fuse in a plug? **6 or 3**

brown 6

partial answer e.g. blue, black, red, green-yellow (3)

(ii) Why is there a fuse in a plug? **6 or 3**

protection // to prevent current overload // prevent fire, etc. 6

partial answer (3)

(iii) Explain how a fuse works. **6 + 3**

when the current exceeds a certain value

the wire breaks / fuse burns out / circuit breaks — two lines correct 6 + 3; one line correct (6)

partial answer (3)

(iv) A vacuum cleaner has a power rating of 900 W. What is the most suitable fuse to use in the plug of the vacuum cleaner? **3 × 3**

5 A 3 × 3

($I = \frac{P}{V} = \frac{900}{230} = 3.9$) // fuse consistent with calculated current (2 × 3)

partial answer e.g. 13 A (3)

(v) Why is a fuse of a lower rating unsuitable? **6 or 3**

it might melt/break /blow / current will be too big 6

partial answer e.g. appliance won't work (3)

(vi) Name a device found in modern domestic circuits that has the same function as a fuse. **6 or 3**

(miniature) circuit breakers / MCBs // trip switches //
residual current devices / RCDs // trip switch / RCB / ELCB, etc. 6

partial answer (3)

If the vacuum cleaner is used for 90 minutes calculate;

(vii) the number of units of electricity used; **8 or 6 or 3**

$P \times t = (0.9)(1.5) = 1.35$ 8

$(900)(90) = 81000$ // $(900)(90 \times 60) = 4860000$ (2 × 3)

partial answer e.g. 0.9 kW / 1.5 hours (3)

(viii) cost of the energy used if the price of each unit of electricity is 22 cent **6 or 3**

((1.35)(22) =) 29.7 cent / 30 cent 6

consistent with (vii) (6)

partial answer e.g. (22)(900) (3)

Question 9 56 marks

The temperature of an object is a measure of its hotness or coldness.

(i) What is the SI unit of temperature? **6 or 3**

K 6

partial answer (3)

(ii) The Celsius scale is the practical temperature scale.
How is the degree Celsius (°C) related to the SI unit of temperature? **6 or 3**

$\theta/t = T - 273(.15)$ 6

partial answer e.g. $\theta/t = T + 273$ (3)

When heat is transferred to a substance, it causes a rise in temperature or a change in state of the substance, or both.

(iii) What is heat? **6 or 3**

(a form of) energy / $mc\Delta\theta$ /ml 6

partial answer (3)

(iv) Name the three methods of heat transfer. **6 or 3**

conduction, convection, radiation 6

partial answer e.g. incomplete answer (3)

(v) What is meant by the change in state of a substance? **3**

any change between solid, liquid or gas 3

(vi) Define specific latent heat. **6 or 3**

(amount of)energy required to change 1 kg of the substance from one state to another (without a change in temperature) 6

partial answer e.g. incomplete answer (3)

20 g of ice cubes at 0 °C are added to a glass of warm water. All the ice melts quickly and cools the water to 5 °C.
Assuming no heat transfer to the surroundings or to the glass, calculate:

(vii) The energy required to melt the ice **3 × 3**

($E = ml = (20\times10^{-3})(3.34\times10^{5})$ =) 6.68×10^{3} J 3×3

($E = ml = (20\times10^{-3})(3.34\times10^{5})$) (2×3)

partial answer e.g. ml (3)

(viii) The energy required to warm the melted ice to 5 °C. **3 × 3**

($E = mc\Delta\theta = (20\times10^{-3})(4.18\times10^{3})(5)$ =) 418 J 3×3

Two quantities correctly substituted into the equation (2×3)

partial answer e.g. $mc\Delta\theta$ (3)

(ix) Why is it important to stir the mixture? **5 or 3**

to ensure temperature equilibrium // to ensure the ice melts quickly 5

partial answer e.g. incomplete answer (3)

Question 10 56 marks

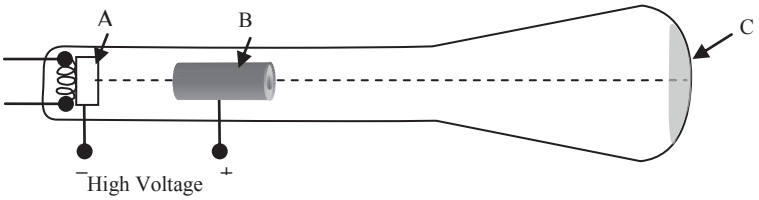
A cathode ray tube and an X-ray tube are practical applications of thermionic emission. In these tubes thermionic emission releases electrons, which are then accelerated into a beam.

An electron is a subatomic particle.
Name another subatomic particle and give two of its properties. **3 × 3**

	proton	**neutron etc.**
mass	1(amu)	1 (amu)
charge	+ 1	0
location	inside nucleus	inside nucleus

correct particle 3

any two properties 2×3



The diagram shows a simple cathode ray tube.

(i) Name the parts labelled A, B, and C in the diagram. **3 × 3**
A–cathode / hot metal 3
B– anode 3
C – screen 3
3 correct labels mismatched (2 × 3)
partial answer e.g. 2 correct labels in incorrect order (3)

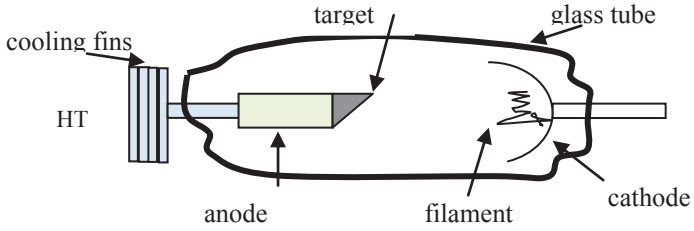
(ii) Give the function of any two of these labelled parts. **6 + 3**
cathode emits (electrons)
anode attracts/focuses /accelerates (electrons)
screen (lights up to) show presence (of electrons)
two correct 6 + 3
one correct (6)
partial answer (3)

(iii) How can the beam of electrons be deflected? **6 or 3**
electric field/electrode/magnetic field/magnet/X-Y plates 6
partial answer (3)

(iv) What happens at C when the electrons hit it? **6 or 3**
lights up / fluorescence / spot 6
partial answer (3)

(v) Why is a vacuum needed in a cathode ray tube? **3**
electrons not blocked / easier to pass through / electrons not absorbed 3

In an X-ray tube, a beam of electrons is used to produce X-rays.
Draw a sketch of an X-ray tube. **3 × 3 + 2**



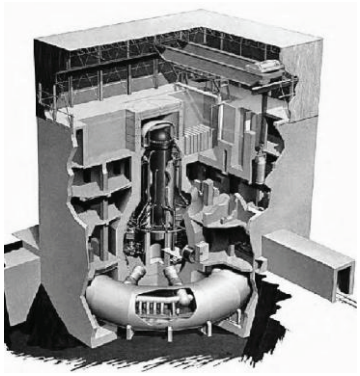
heater, cathode, anode, target, high voltage any three 3 × 3
detail e.g. correct arrangement / coolant / shielding/vacuum/extra item from previous line 2
partial answer (3)

Give one safety precaution taken by a radiographer when using an X-ray machine. **3**
use a lead shield, protective clothing, lead glass, monitor dosage, reduce dosage, etc. 3

Question 11 56 marks

Read this passage and answer the questions below

The Fukushima nuclear disaster



In March 2011, following a powerful earthquake, the Fukushima nuclear reactor in Japan was shut down automatically. A nuclear reactor generates heat by splitting atoms of uranium in a process known as nuclear fission. The uranium is contained in the reactor's fuel rods. A chain reaction is set up by the neutrons released during fission and these go on to split more atoms of uranium. The power output of the reactor is adjusted by controlling the number of neutrons that are present. Control rods made of a neutron absorber capture neutrons. Absorbing more neutrons in a control rod means that there are fewer neutrons available to cause fission. Therefore, pushing the control rods deeper into the reactor will reduce its power output, and extracting the control rods will increase it.

The Fukushima nuclear reactor continued to generate heat even after the chain reaction was stopped because of the radioactive decay of the isotopes created during nuclear fission. This decay cannot be stopped and the resulting heat must be removed by circulating cooling water through the reactor core.

When the reactor was shut down due to the earthquake, the pumps to keep the cooling water circulating should have been powered by electricity from the national grid or diesel generators. However, connections to the grid were damaged by the earthquake and the diesel generators were destroyed by the tsunami wave that followed the earthquake. As a result, no cooling was available for the reactor core and this resulted in the explosions and subsequent release of radiation, consisting of radioactive isotopes such as caesium and iodine, into the environment.

(Adapted from '*Wikipedia*', June 2011)

(*a*) What is meant by nuclear fission? **7 or 4**

splitting nuclei // splitting (large) atoms 7

partial answer e.g. release of neutrons /energy / particles (4)

(*b*) What is radioactivity? **7 or 4**

decay/splitting of a nucleus with the emission of particles/radiation 7

partial answer e.g. alpha/ beta / gamma / activity (4)

(*c*) What is a nuclear chain reaction? **7 or 4**

a chain reaction is when the neutrons released during fission go on to split more atoms / or produce more neutrons **7**

partial answer e.g. ongoing reaction (4)

(*d*) What is the function of the control rods? **7 or 4**

adjust the power output // absorb neutrons, etc. 7

partial answer (4)

(*e*) What type of material are control rods made of? **7 or 4**

boron / steel / silver / indium / cadmium, etc. // neutron absorber 7

partial answer e.g. other named metal (4)

(*f*) Why did the reactor still generate heat even though the chain reaction had stopped? **7 or 4**

because of the radioactive decay of the isotopes created during nuclear fission 7

partial answer (4)

(*g*) Why is it important to remove the heat generated? **7 or 4**

to avoid over heating/ explosions / release of radiation 7

partial answer e.g. to protect the environment (4)

(*h*) Give one advantage of nuclear energy. **7 or 4**

use less fuel for energy produced // does not pollute the air // fuel can be produced (in a breeder reactor) //no greenhouse gases, etc. 7

partial answer e.g. cheaper, plentiful (4)

Question 12 56 marks

Part (a) State the principle of conservation of momentum. **6 or 3**

momentum before = momentum after // $m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$ 6

partial answer e.g. incomplete equation // in a closed system (3)

A cannon of mass 1500 kg containing a cannonball of mass 80 kg was at rest on a horizontal surface as shown. The cannonball was fired from the cannon with an initial horizontal velocity of 60 m s^{-1} and the cannon recoiled.

Calculate **2(2 × 3)**

(i) the recoil velocity of the cannon

$v_1 = (-)\ 3.2$ m s^{-1} 2 × 3

$0 = m_1 v_1 + m_2 v_2$ / $0 = (1500)(v_1) + (80)(60)$) (3)

(ii) the kinetic energy of the cannon as it recoils.

(½(1500)$(3.2)^2$=) 7680 J / answer consistent with (i) 2 × 3

(*E* =) ½mv^2 (3)

Why did the cannon recoil? **4**

to conserve momentum / to balance the cannon ball going forward 4

Why will the cannon come to a stop in a shorter distance that the cannonball? **6 or 3**

bigger mass / resistance of ground bigger than that of air / small recoil velocity 6

partial answer (3)

Part (b) State the laws of reflection of light. **2 × 3**

the incident ray the normal and the reflected ray are all in the one plane 3

the angle of incidence is equal to the angle of reflection // $i = r$ 3

partial answer e.g. states the laws of refraction (3)

How would you estimate the focal length of a concave mirror? **3 × 3**

(reflect image of) distant object 3

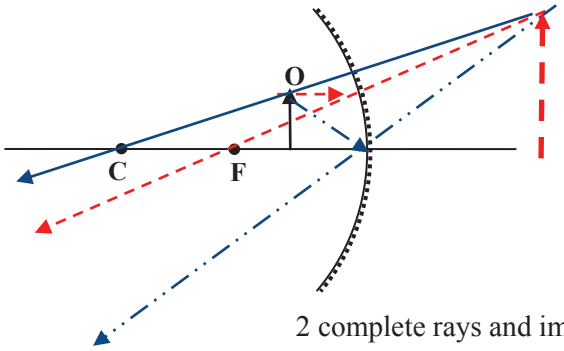
(onto) screen (and adjust screen until the image is sharp) 3

distance from screen to mirror is (approximate) focal length 3

partial answer e.g. $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ // half way between the centre of curvature and pole (3)

The diagram shows an object O in front of a concave mirror, whose focus is at F.

Copy and complete the diagram to show the formation of the image of the object O **3 × 3**



2 complete rays and image correctly drawn 3 × 3

at least one complete ray correctly drawn (2 × 3)

partial answer (3)

Give one use for a concave mirror. **4 or 2**

torch / headlights /searchlight, dentist mirror, cosmetic / shaving mirror,

solar furnace, (reflecting) telescopes, etc. one correct 4

partial answer e.g. use of a convex mirror / lens (2)

Part (c) The pitch of the sound emitted by the siren of a moving fire engine appears to change as it passes a stationary observer.

(i) Name this phenomenon. **6 or 3**

Doppler effect 6

partial answer (3)

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

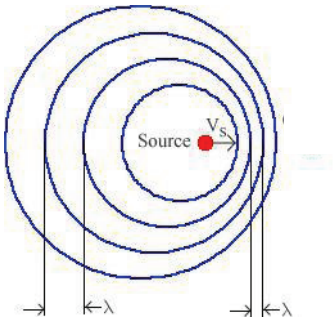


diagram to show;

moving wave source 3

wave fronts 3

as the moving wave source approaches the waves get closer together 2× 3

// conversely as the wave source moves away the waves are further apart

accept valid alternatives

a labelled diagram may merit full marks

partial answer (3)

no diagram maximum mark 3× 3

(iii) Will the crew in the fire engine notice this phenomenon? Give a reason for your answer. **4 or 2**

no as there is no relative motion between the sound source and the crew 4

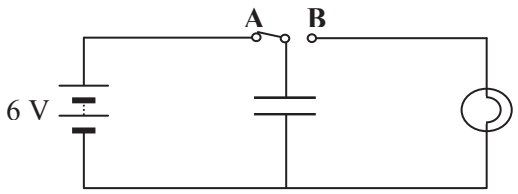
partial answer e.g. no (2)

(iv) Give an application of this phenomenon. **6 or 3**

measuring speed / speed gun, (measuring) red shift, ultrasonic scanners, imaging used to study blood flow, used to study heart beat, weather forecasting, etc. 6

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

Part (d) A capacitor is connected to a switch, a battery and a bulb as shown in the diagram. When the switch is changed from position A to position B, the bulb lights briefly.



(i) What happens to the capacitor when the switch is in position A? **6 or 3**

it charges / short-lived current flows / stores energy 6

partial answer e.g. current flows (3)

(ii) Why does the bulb light when the switch is in position B? **6 or 3**

capacitor discharges / current flows // (switch) closes the circuit 6

partial answer (3)

(iii) Why does the bulb light only briefly? **6 or 3**

capacitor discharges quickly / p.d. fades / current transient / capacitor only holds small charge / capacitor only stores a small amount of energy 6

partial answer (3)

(iv) The capacitor has a capacitance of 200 μF. Calculate its charge when connected to a 6 V battery. **6 or 3**

($Q = CV = (200\times10^{-6})(6) =$) 1.2×10^{-3} C 6

partial answer e.g. $Q = CV$ (3)

(v) Give a use for a capacitor. **4 or 2**

store charge / (radio) tuning / filtering / smoothing / timing / coupling / store energy / flash camera / phone charger, etc. one correct 4

partial answer e.g. storing electric current (2)