Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE 2008

MARKING SCHEME

PHYSICS

ORDINARY LEVEL

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Introduction

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

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

2. Marks shown in brackets represent marks awarded for partial answers as indicated in the scheme.

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

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

5. The descriptions, methods and definitions in the scheme are **not** exhaustive and alternative valid answers are acceptable. Marks for a description may be obtained from a relevant diagram, depending on the context.

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

Section A (120 marks)

Question 1 40 marks

(i) Describe, with the aid of a diagram, how the student measured the velocity of the trolley **5 × 3**

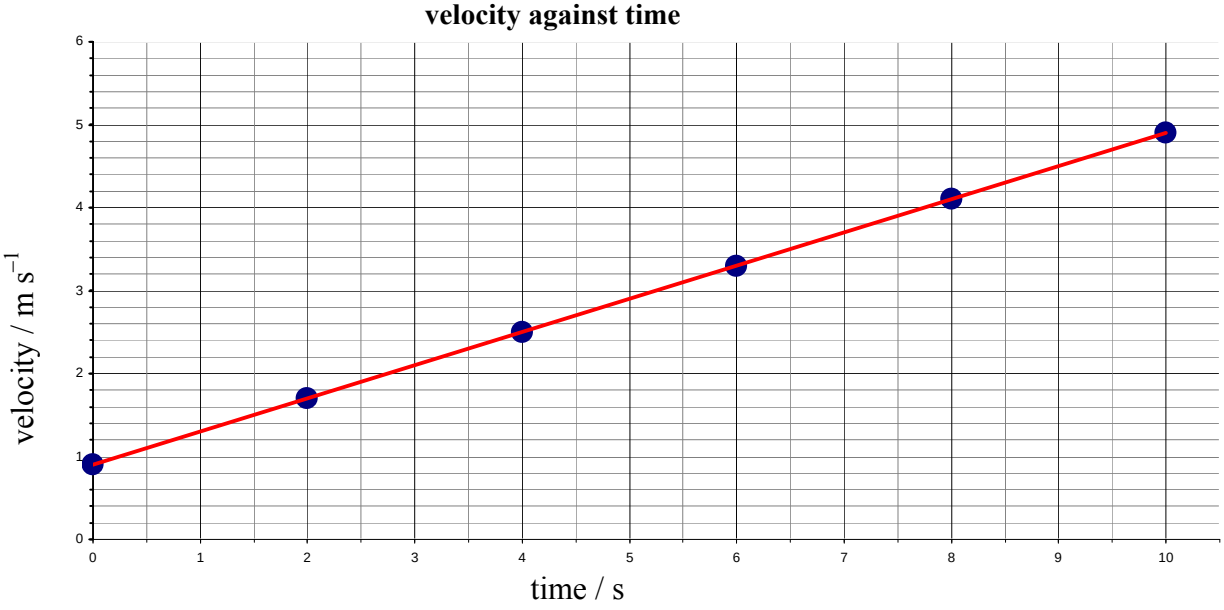
trolley (and runway)		3
timer e.g. ticker timer / photogates (and timer)	// motion sensor	3
detail e.g. ticker tape /air track / card	// connect datalogger to sensor	3
measure distance / measure time	// start program	3
velocity = distance ÷ time	// calculator / computer displays velocity	3

reference to a datalogger would merit at least 2 × 3

(ii) Using the data in the table, draw a graph on graph paper of the trolley's velocity against time. Put time on the horizontal axis (X-axis) **5 × 3**

label axes correctly, (name / symbol / unit acceptable)	3
plot three points correctly	3
plot another three points correctly	3
straight line	3
best fit	3

if graph paper is not used, maximum mark 4 × 3
if time is on the Y-axis, maximum mark 4 × 3



(iii) Find the slope of your graph and hence determine the acceleration of the trolley **10 or 7 or 4**

(a = velocity ÷ time =) 0.4 ± 0.05 (m s^{-2})	10
substituted equation $\left(m = \frac{y_2 - y_1}{x_2 - x_1}\right)$ e.g. $\frac{4.9 - 0.9}{10 - 0}$	(7)
evidence of using the graph to select a point on the line / slope formula	(4)

Question 2 40 marks

You carried out an experiment to find the speed of sound in air, in which you measured the frequency and the wavelength of a sound wave

(i) With the aid of a diagram describe the adjustments you carried out during the experiment **2 × 3 + 6**

diagram to show:
resonance tube / cylinder of water 3
tuning fork // speaker/signal generator 3
adjust the length of the air column // adjust frequency of signal generator
(until resonance / loud sound occurs) 6

(ii) How did you find the frequency of the sound wave? **6**
(read it) from the tuning fork / signal generator // used tuning forks
of known frequency 6

(iii) How did you measure the wavelength of the sound wave? **3 × 3**
measure length (of vibrating air) 3
measure diameter of tube // measure length for next resonance 3
detail e.g. equation $\lambda = 4(l + 0.3d)$ // $\lambda = 2(l_2 - l_1)$ 3
partial answer e.g. using a ruler (3)
measurements may be inferred from the diagram

(iv) How did you calculate the speed of sound in air? **3 × 3**
substituted 3
measurements / frequency and wavelength 3
(into the) formula 3
(c =) $f\lambda$ (3 × 3)

(v) Give one precaution you took to get an accurate result **4 or 2**
repeat using different frequencies, repeat and take an average, end-correction
(take measurements from the) sharpest resonance, clamp tube to take
measurements, etc. 4
partial answer e.g. repeat / average (2)

Question 3 40 marks

An experiment was carried out to measure the refractive index of a substance. The experiment was repeated a number of times.

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

substance e.g. glass block 6

light source / laser / raybox / pins 3

protractor / ruler / sheet of paper 3

NOTE: no labels, deduct 2

(ii) What measurements were taken during the experiment? **2 × 6**

angle of incidence / i // real depth 6

angle of refraction / r // apparent depth 6

critical angle (2 × 6)

partial answer e.g. angles / height (6)

measurements may be inferred from the diagram

(iii) How was the refractive index of the substance calculated? **10 or 7 or 4**

$(n=)\dfrac{\sin i}{\sin r}$ // $(n=)\dfrac{\text{real depth}}{\text{apparent depth}}$ 10

one error e.g. $n = \sin i \times \sin r$ (7)

partial answer e.g. from the equation (4)

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

to increase accuracy of result / reduce errors one correct 6

partial answer (3)

Question 4 40 marks

The diagram shows a circuit used to investigate the variation of current with potential difference for a semiconductor diode in forward bias.

(i) Name the apparatus X. What does it measure? **2 × 3**

milliammeter / ammeter /galvanometer / multimeter 3

current / *I* / amps // answer consistent with named apparatus 3

(ii) Name the apparatus Y. What does it do? **2 × 3**

rheostat / (variable) resistor / potential divider 3

change in one of: resistance, voltage, potential, current, power 3

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

(iii) What is the function of the 330 Ω resistor in this circuit? **6 or 3**

to protect the diode // limit the current 6

partial answer (3)

The table shows the values of the potential difference used and its corresponding current recorded during the experiment.

potential difference/V	0	0.2	0.4	0.6	0.8	1.0
current/mA	0	3	6	14	50	100

Using the data in the table, draw a graph on graph paper of the current against the potential difference. Put potential difference on the horizontal axis (X-axis) **4 × 3**

label axes correctly, (name / symbol / unit acceptable) 3

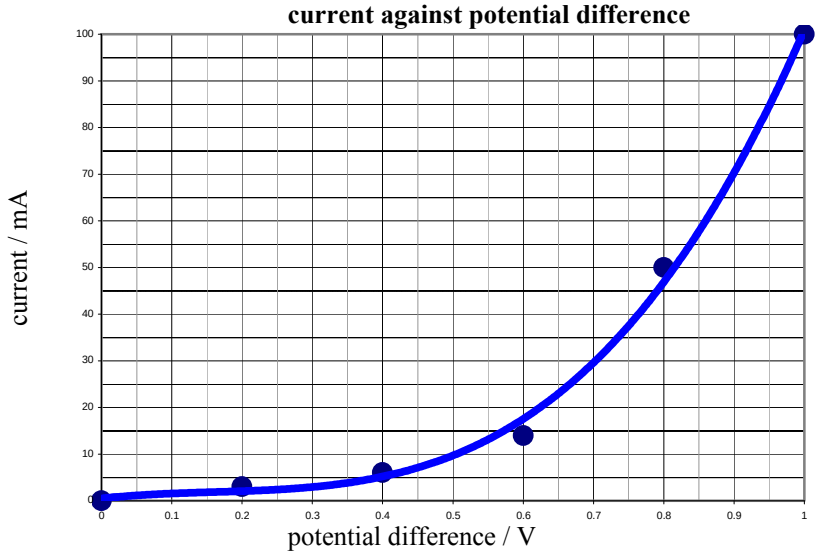
plot three points correctly 3

plot another three points correctly 3

(smooth) curve 3

if graph paper is not used, maximum mark 3 × 3

if current is on the Y-axis, maximum mark 3 × 3



What does the graph tell you about the variation of current with potential difference for a semiconductor diode? **10 or 7 or 4**

current rises rapidly after potential difference reaches 0.6 V // they are not (directly) proportional // the conduction is non-ohmic // not linear 10

current rises as potential rises (7)

partial answer e.g. 0.6 V, rises (4)

Section B (280 marks)

Question 5 56 marks

Take the best eight from ten parts.

(a) State the principle of conservation of momentum **7 or 4**

momentum before = momentum after // $m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$ 7

partial answer e.g. incomplete equation // in a closed system (4)

(b) A solid block in the shape of a cube of length 120 cm rests on a table. The weight of the block is 25 N. Calculate the pressure it exerts on the table **7 or 4**

$\left(\frac{25}{(1.2)^2} =\right)$ 17.4 (N m^{-1}), 1.74×10^{-3} (N cm^{-2}) 7

partial answer e.g. calculates the area $(1.2)^2$ (4)

(c) Which of the following is the unit of energy? **7**

kelvin watt newton joule

joule 7

(d) What physical quantity is measured in decibels? **7 or 4**

sound (level) / intensity 7

partial answer e.g. loudness (4)

(e) A concave lens has a power of 0.1 cm^{-1}. What is the focal length of the lens? **7 or 4**

10 (cm) 7

partial answer e.g. correct substitution (4)

(f) Give one effect of static electricity? **7 or 4**

lightning, static discharge, receive shock after walking across carpets, attracts objects, causes materials to repel, causes hair to stand on end, can damage electronics, causes sparks, etc. one correct 7

partial answer e.g. photocopying (4)

(g) Give two uses for the instrument shown. **7 or 4**

voltmeter, ammeter, ohmmeter, temperature, frequency, other known use of multimeter two correct 7

one correct (4)

(h) What is the colour of the live wire in an electric cable? **7 or 4**

brown 7

black, red, blue (4)

(i) State two properties of X-rays **7 or 4**

electromagnetic waves, have short wavelength, cause ionisation, penetrate materials, no mass, no charge, effect photographic film, etc. two correct 7

one correct (4)

(j) What is nuclear fusion? **7 or 4**

release of energy by joining of two (light) nuclei 7

partial answer e.g. release of energy /joining nuclei / explosions in sun (4)

diagram may merit full marks

Question 6 56 marks

The weight of an object is due to the gravitational force acting on it.
Newton investigated the factors which affect this force.

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

(force) causes / changes	// (rate of) change of	3
acceleration	// momentum	3
partial answer e.g. change shape		(3)

Unit: newton / N 3

State Newton's law of universal gravitation.

force proportional / $F \propto$	3
product of masses / $m_1 m_2$	3
inversely proportional to the square of the distance between them / $\propto \frac{1}{d^2}$	3
partial answer e.g. reference to G	(3)

Calculate the acceleration due to gravity on the moon.
The radius of the moon is 1.7×10^6 m and the mass of the moon is 7×10^{22} kg **4 × 3 + 4**

$$\left(g_m = \frac{GM}{R^2} = \frac{(6.7 \times 10^{-11})(7 \times 10^{22})}{(1.7 \times 10^6)^2} \right) = 1.6 \ (\mathrm{m\,s^{-2}})$$ 4 × 3 + 4

substitutes 3 quantities correctly into the equation	(4 × 3)
identifies 2 quantities correctly / substitutes 2 quantities correctly into the equation	(2 × 3)
identifies 1 quantity correctly / substitutes 1 quantity correctly into the equation	(3)

A lunar buggy designed to travel on the surface of the moon had a mass of 2000 kg when built on the earth **6 + 6 + 4**

(i) What is the weight of the buggy on earth? **6**
($W = mg = 2000 \times 9.8 =$) 19600 (N) 6

(ii) What is the mass of the buggy on the moon? **6**
2000 (kg) 6

(iii) What is the weight of the buggy on the moon? **4**
($W = mg = 2000 \times 1.6 =$) 3200 (N) 4

A powerful rocket is required to leave the surface of the earth.
A less powerful rocket is required to leave the surface of the moon. Explain why **6 or 3**

any reference to gravity less on moon // less force needed (to escape) // rocket does not need as high a velocity (to escape moon as its gravity is less)	6
partial answer e.g. moon is smaller	(3)

Question 7 56 marks

The temperature of an object is measured using a thermometer, which is based on the variation of its thermometric property **3(6 or 3)**

(i) What is meant by temperature? **6 or 3**
measure of hotness // measure of how hot / cold an object is 6
partial answer e.g. the heat in a body (3)

(ii) What is the unit of temperature? **6 or 3**
°C / K 6
partial answer e.g. degrees (3)

(iii) Give an example of a thermometric property **6 or 3**
resistance, length (of column of mercury), emf, pressure of gas (at constant volume), colour, etc. 6
partial answer e.g. definition (3)

The rise in temperature of an object depends on the amount of heat transferred to it and on its specific heat capacity **7 × 3**

(iv) What is heat? **2 × 3**
(form of) energy 2 × 3
partial answer e.g. work (3)

(v) Name three ways in which heat can be transferred **3 × 3**
conduction 3
convection 3
radiation 3

(vi) Define specific heat capacity **2 × 3**
energy required to change temperature 3
of 1 kg of material by 1 K (1 °C) 3
partial answer (3)
formula $c = \frac{Q}{m\Delta\theta}$ (2 × 3)

A saucepan containing 500 g of water at a temperature of 20 °C is left on a 2 kW ring of an electric cooker until it reaches a temperature of 100 °C. All the electrical energy supplied is used to heat the water. **5 × 3+2**

Calculate:
(i) the rise in temperature of the water; **3**
100 – 20 = 80 (°C) 3

(ii) the energy required to heat the water to 100 °C; **2 × 3**
$Q = m\,c\,\Delta\theta = 0.5 \times 4200 \times 80 = 168\,000$ (J) 2 × 3
partial answer e.g. one quantity substituted correctly into the equation (3)

(iii) the amount of energy the ring supplies every second; **3**
2000 (J) 3

(iv) the time it will take to heat the water to 100 °C **3 + 2**
$\left(P = \frac{W}{t} \Rightarrow t = \frac{W}{P} = \frac{168\,000}{2000}\right)$ 84 (s) // answer consistent with Q and P above 3 + 2
partial answer e.g. one quantity substituted correctly into the equation (3)

Question 8 56 marks

The diagram shows a signal generator connected to two loudspeakers emitting the same note.

A person walks slowly along the line AB **3(7 or 4)**

(i) What will the person notice? **7 or 4**

sound gets loud and weak (as they move from A to B) 7
partial answer e.g. sound gets loud (4)

(ii) Why does this effect occur? **7 or 4**

any mention of interference 7
partial answer (4)

(iii) What does this tell us about sound? **7 or 4**

wave (motion) 7
partial answer (4)

Describe an experiment to demonstrate that sound requires a medium to travel **4×3 + 2**

apparatus: bell jar with electric bell, battery, vacuum pump two correct 2×3
procedure: turn on pump 3
observation/conclusion: no sound heard when air removed / sound needs a medium 3
detail 2

The pitch of a note emitted by the siren of a fast moving ambulance appears to change as it passes a stationary observer. **3(7 or 4)**

(i) Name this phenomenon **7 or 4**

Doppler effect 7
partial answer e.g. frequency change (4)

(ii) Explain how this phenomenon occurs **7 or 4**

as sound source approaches (waves closer together) // sound source moves away
hence wavelength shorter / frequency higher // λ longer / *f* lower

two lines correct 7
one line correct (4)

suitable diagram(s) may merit full marks (7)

(iii) Give an application of this phenomenon **7 or 4**

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

Question 9 56 marks

An electric current flows in a conductor when there is a potential difference between its ends.

(i) What is an electric current? **2 × 3**

flow of / movement 3
charge / electrons / electricity 3
partial answer e.g. refers to amps (3)

(ii) Give two effects of electric current. **2 × 3**

heating / lighting, magnetic, chemical two correct 2×3
one correct (3)

(iii) Name a source of potential difference. **4 or 2**

battery / generator / thermocouple etc 4
partial answer (2)

Describe an experiment to investigate if a substance is a conductor or an insulator . **2×2 + 2×3**

apparatus: circuit to show power source, ammeter/ bulb, leads, contacts two correct 2×2
procedure: connect the circuit and place item between contacts 3
observation/conclusion: bulb lights / item conductor // bulb does not light / item is an insulator 3

The two headlights of a truck are connected in parallel to a 24 V supply.

(i) Draw a circuit diagram to show how the headlights are connected to the supply. **6 or 3**

circuit diagram showing battery, two bulbs, connected in parallel 6
partial answer. (3)

(ii) What is the advantage of connecting them in parallel? **6 or 3**

brighter / more current to each / if one goes the other still works, etc 6
partial answer (3)

(iii) Why should a fuse be included in such a circuit? **6 or 3**

safety / prevent overheating or fire / prevent too high a current flowing 6
partial answer (3)

The resistance of each headlight is 20 Ω.
Calculate:

(iv) the total resistance of the circuit **6 or 3**

$\left(\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{1}{20}+\frac{1}{20}=\frac{1}{10}\right)$ R=10 (Ω) 6

partial answer e.g. substitutes one quantity correctly into the equation (3)

(v) the current flowing in the circuit **6 or 3**

($V = IR$ $24 = (I)(10)$ $I =$) 2.4 (A) / answer consistent with R above 6
partial answer (3)

Question 10 56 marks

Give two properties of an electron **9 or 6**

(negatively) charged; deflected by electric fields; deflected by magnetic fields; fundamental particle; 1.6×10^{-19} ; small mass; outside nucleus; etc

two correct 9
one correct (6)

The diagram shows the arrangement used by Rutherford to investigate the structure of the atom. During the investigation he fired alpha-particles at a thin sheet of gold foil in a vacuum.

(i) What are alpha-particles? **9 or 6 or 3**

consist of two protons and two neutrons // helium (nucleus) 9
consist of protons and neutrons // radioactive particles (6)
partial answer e.g. any alpha property (3)

(ii) Describe what happened to the alpha-particles during the experiment **9 or 6 or 3**

most went straight through
some deflected by various amounts
some bounced back

two lines correct 9
one line correct (6)
partial answer e.g. reference to proton/neutron (3)

(iii) What conclusion did Rutherford make about the structure of the atom? **9 or 6 or 3**

mainly empty space
dense nucleus
central positive area (nucleus)

two lines correct 9
one line correct (6)
partial answer (3)

(iv) How are the electrons arranged in the atom? **9 or 6 or 3**

orbit nucleus 9
on outside // moving (6)
partial answer (3)

(v) Name a device used to detect alpha-particles **6 or 3**

GM tube, solid state detector, cloud chamber, ionisation tube, ZnS screen scintillation counter, gold leaf electroscope, photographic film, etc. one correct 6
partial answer e.g. monitor badge (3)

(vi) Why was it necessary to carry out this experiment in a vacuum? **5 or 3**

alpha particles would be stopped by a few cm of air 5
partial answer (3)

Question 11 56 marks

Read this passage and answer the questions below.

Energy is essential to the comfort of our homes. There are many ways of reducing energy needs and meeting those needs with renewable sources. The main sources of renewable energy are the sun (solar energy), the wind, moving water (hydropower, wave and tidal energy), heat below the surface of the earth (geothermal energy) and biomass (wood, waste, crops).

Solar heating systems are used in many homes. These systems have two main parts: a solar panel and a hot water storage cylinder. Typically, a panel is placed on the roof, facing directly south. However, a good output can still be achieved between south-east and south-west.

The sun heats a black metal plate in the panel, which, in turn, heats water in pipes in the panel. To move the heated water between the panel and the storage cylinder, a system either uses a pump or the tendency of water to naturally circulate as it is heated. The solar water heating system needs to be backed up by a conventional heat source.

(Adapted from '*Renewable energy in the home' a guide* by Sustainable Energy Ireland.)

(a) State two uses of energy in the home **7 or 4**

heating, cooking, lighting, TV etc — two correct 7; one correct (4)

(b) Give two ways to reduce energy needs in the home **7 or 4**

insulate, double glaze, reduce usage, use low energy appliances, turn off unused lights, etc

two correct 7; one correct (4)

(c) List the main sources of renewable energy **7 or 4**

solar, wind, wave, tidal, geothermal, biomass — two correct 7; one correct (4)

(d) What are the main parts of a solar heating system? **7 or 4**

solar panel, hot water storage cylinder — two correct 7; one correct (4)

(e) Why does a solar panel need to face south? **7 or 4**

to get most sunlight // face sun // better output 7

partial answer (4)

(f) What is the function of the backup heater? **7 or 4**

for use at night // in poor sunlight // to heat radiators 7

partial answer e.g. for more heat (4)

(g) Why are parts of the solar panel painted black? **7 or 4**

black is a good absorber of heat // black is a poor reflector of heat 7

partial answer e.g. black attracts heat (4)

(h) What is the name given to the tendency of water to circulate as it is heated? **7 or 4**

convection 7

partial answer (4)

Question 12 56 marks

Part (a)

Define (i) velocity, (ii) acceleration. **6 + 3**

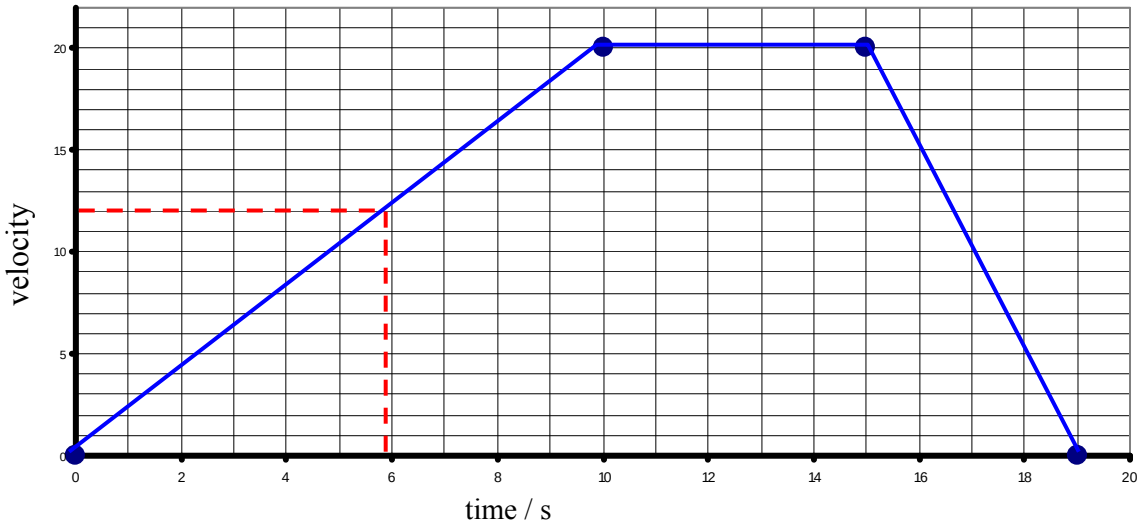
(i) change in displacement with respect to time // $v = \frac{s}{t}$

(ii) change in velocity with respect to time // $a = \frac{v - u}{t}$

two lines correct 6 + 3
one line correct (6)
partial e.g. change in velocity (3)

A speedboat starts from rest and reaches a velocity of 20 m s^{-1} in 10 seconds.
It continues at this velocity for a further 5 seconds.
The speedboat then comes to a stop in the next 4 seconds.

(i) Draw a velocity-time graph to show the variation of velocity of the boat during its journey. **6 or 3**



correct graph 6
partial answer (3)

(ii) Use your graph to estimate the velocity of the speedboat after 6 seconds. **3**
12 ± 1 (m s^{-1}) // answer consistent with graph 3

(iii) Calculate the acceleration of the boat during the first 10 seconds. **6 or 3**
($a = \frac{v}{t} = \frac{20}{10}$ =) 2 (m s^{-2}) 6

partial answer e.g. one quantity correctly substituted into the equation (3)

(iv) What was the distance travelled by the boat when it was moving at a constant velocity? **4 or 2**
($s = vt = 20 \times 5$ =) 100 (m) 4
partial answer e.g. $s = vt$ (2)

Part (b)

Sunlight is made up of different colours and invisible radiations.

(i) How would you show the presence of the different colours in light? **3 × 3**

apparatus: (glass) prism, (light source, slits, screen) // diffraction grating, (light source) 3

procedure: shine the light through the prism // allow light through the grating 3

observation/conclusion: light spreads out into different colours 3

accept valid alternatives e.g. reflection from CD / oil

(ii) Name two radiations in sunlight that the eye cannot detect. **2 × 3**

infra-red / IR 3

ultra-violet / UV 3

(iii) Describe how to detect one of these radiations. **3 × 3**

apparatus: thermometer / temperature sensor // fluorescent material / UV sensor 3

procedure: place in IR light // place in UV light source 3

observation / conclusion: temperature rises // material glows / sensor lights 3

(iv) Give a use for this radiation. **4 or 2**

heat source, hatch chickens, heat treatment of muscles etc // suntan, forensics detect forged currency, disco lights, used in insect removal device, sterilisation etc 4

partial answer e.g. use mismatched with description (2)

Part (c)

What is the photoelectric effect? **2 × 3**

emission of electrons 3

(when) light (hits a metal) 3

A photocell is connected to a sensitive galvanometer as shown in the diagram. When light from the torch falls on the photocell, a current is detected by the galvanometer.

(i) Name the parts of the photocell labelled A and B. **2 × 3**

A = (photo)cathode 3

B = (photo)anode 3

in reverse order –1

(ii) How can you vary the brightness of the light falling on the photocell? **6 or 3**

move it towards / away from the photocell // use a different torch 6

partial answer (3)

(iii) How does the brightness of the light effect the current? **4 or 2**

brighter the light the greater the current // dimmer the light the less the current 4

partial answer e.g. more current (2)

(iv) Give a use for a photocell. **6 or 3**

(burglar) alarms, automatic door, control burners in heating systems, safety switches, light meters, solar cells, sound track in film, etc one correct 6

partial answer e.g. non-specific use (3)

Part (d)

What is electromagnetic induction? **2 × 3**

emf / voltage / potential difference / current is induced 3

(due to) changing (magnetic) flux / field // moving magnet 3

a diagram or example may merit full marks

A magnet and a coil can be used to produce electricity.

How would you demonstrate this? **4 × 3 + 4**

apparatus: coil and magnet 3

(galvano)meter 3

procedure: (galvano)meter attached to coil 3

magnet moves relative to the coil 3

observation / conclusion: needle deflects / emf produced 4

The electricity produced is a.c. What is meant by a.c.? **2 × 3**

alternating 3

current 3

a relevant explanation may merit 2 × 3