GCSE

Science: Physics

Summer 2009

Mark Schemes

Issued: October 2009

NORTHERN IRELAND GENERAL CERTIFICATE OF SECONDARY EDUCATION (GCSE)
AND NORTHERN IRELAND GENERAL CERTIFICATE OF EDUCATION (GCE)

MARK SCHEMES (2009)

Foreword

Introduction

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16- and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

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Rewarding Learning

General Certificate of Secondary Education
2009

Science: Physics

Paper 1
Foundation Tier

[G7602]

WEDNESDAY 10 JUNE, AFTERNOON

MARK SCHEME

Subject-specific instructions

1 In numerical problems, the marks for intermediate steps shown in the mark scheme are for the benefit of candidates who do not obtain the correct final answer. A correct answer and unit, if obtained from a valid starting-point, gets full credit, even if all the intermediate steps are not shown. It is not necessary to quote correct units for intermediate numerical quantities.

Note that this "correct answer" rule does not apply to formal proofs and derivations, which must be valid in all the stages shown in the mark scheme to obtain full credit.

2 Do not reward wrong physics. No credit is given for substitution of numerical data, or subsequent arithmetic, in a physically incorrect equation.

However, answers to later parts of questions that are consistent with an earlier incorrect numerical answer, and are based on a physically correct equation, must gain full credit. Annotate this by writing **ECF** (Error Carried Forward) by your text marks.

3 The normal penalty for an arithmetical and/or unit error is to lose the mark(s) for the answer/unit line. Substitution errors lose both the substitution and answer mark, but 10^n errors (e.g. writing 550 nm as 550×10^{-6} m) count only as arithmetical slips and lose the answer/unit mark.

					AVAILABLE MARKS
1	**(a)**	**(i)**	a force [1] newtons [1]	[2]	
		(ii)	Tick at forces are equal	[1]	
		(iii)	$W = mg$ [1] $= 750 \times 10 = 7500$ [1] N [1]	[3]	
		(iv)	Gravity attracts it	[1]	
	(b)	**(i)**	Twice	[1]	
		(ii)	200 m	[1]	
		(iii)	Average speed = distance/time [1] = 1200/160 [1] = 7.5 [1] m/s [1]	no mark for km/hr unless correct numerical answer [4]	
		(iv)	Straight line starting at 0, 0 [2] ending at 160, 1200 [1] Any other line give [0]	[3]	
	(c)		Speed – Increases [1] Icy – Increases [1] Alcohol – Increases [1] Braking force – Decreases [1]	[4]	20

AVAILABLE MARKS

2 **(a)** **(i)** Efficiency = useful output energy/total input energy
Must be energy/work/power [1]

$\frac{\text{output}}{\text{input}}$ give [0]

(ii) Input energy = 150 + 450 [1]
= 600 (kJ) [1] [2]

(iii) Efficiency = 150/600 (e.c.f. from **(ii)** for total energy input) [1]
= 0.25 [1] [2]
0.25% give [2]/[3]
25 give [2]/[3]

(iv) Heat **or** sound [1]

(b) **(i)**

Renewable and dependent on the energy of the Sun	**Renewable and independent of the energy of the Sun**	**Non-renewable**
Biomass Hydroelectric Wind	Geothermal	Coal Gas Nuclear

[$\frac{1}{2}$] each **round up** [4]

(ii) Chemical [1]

(iii) Sunlight is converted to chemical energy by plants/photosynthesis [2]
Sun is a source of limitless energy [1]
Replacement plants can be grown [1] in a lifetime [1]
Sun allows plants to grow [1] [3]

(c) **(i)** Work = Force × Distance moved [1]

(ii) Work = 450 × 400 [1]
= 180 000 (J) [1] [2]

(iii) Power = work done/time taken [1]
Power = 18 000/500 [1] (e.c.f. from **(ii)** for work)
Power = 360 W [1] [3]

20

AVAILABLE MARKS

3 **(a)** **(i)** Same distance behind mirror as object in front [1]

(ii) Mirror Y [1]

(iii) Image correct distance behind Y [1]
Line joining image and object perpendicular to mirror [1] [2]

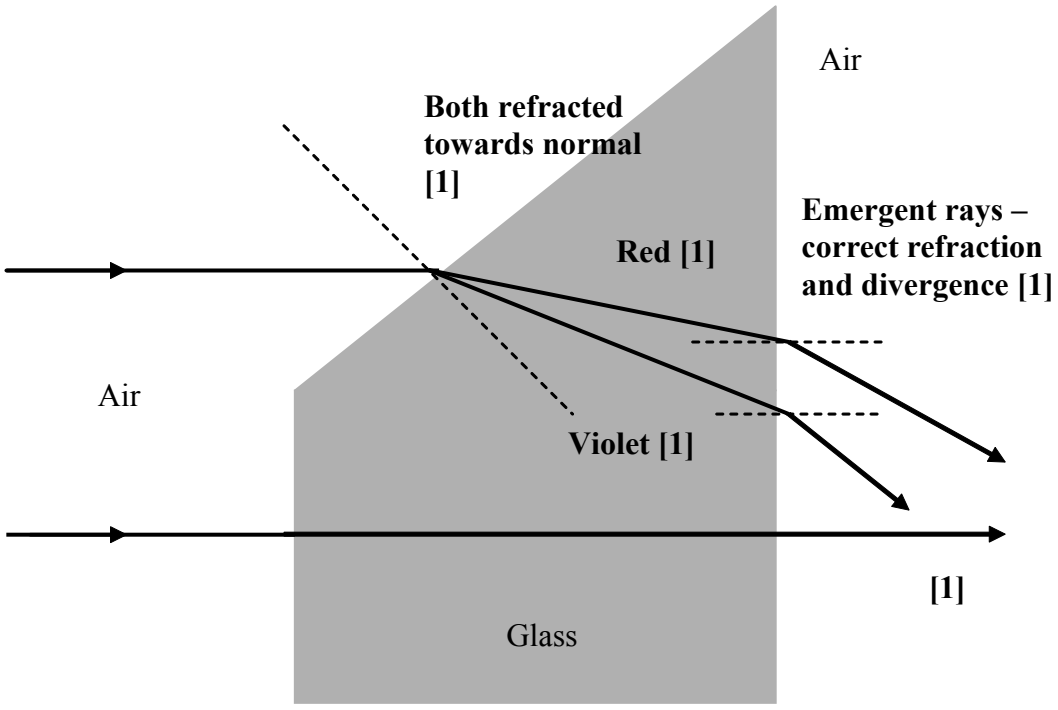
(iv) Ray marked with $i = r$ judged by eye [1]
Ray to eye appears to come from image (e.c.f.) [1]
Arrow from Z/towards A [1] (conflicting arrows [0]) [3]

(v) To enable driver to see down left-hand road [1]

(b) **(i)** Rays bend towards normal [1]
Ray passes out without any deviation [1]
Rays bend away from the normal [1] [3]

(ii) Ray P decreases in speed
Ray Q increases in speed
Both must be correct [1]

(c) Lower ray passes through without dispersion [1]
Top ray – dispersion with two rays refracted correctly [1]
Least refracted correctly labelled with colour [1]
Most refracted correctly labelled with colour [1]
Emergent ray – correct refraction and divergence of both [1] [5]



(d) **(i)** Diffraction – spreading of waves as they pass through a gap/around an obstacle
spreading in an area where a wave would not normally be [1]

(ii) Object correctly drawn – barrier with gap [1]
Waves spreading out on right-hand side of gap [1] [2]

20

AVAILABLE MARKS

4 **(a)** **(i)** Electrons move [1]
Move from duster to rod [1]
Giving a surplus of electrons on rod [1] [3]

(ii) There are many more free moving charged particles in electrical conductors than there are in electrical insulators (3rd point in table) [1]

(b) **(i)** Positive [1]

(ii) Negative smoke particles are attracted to positive plate [1]

(iii) Reduces atmospheric pollution [1]

(c) **(i)** —Ⓐ— placed between points W and X [1]

(ii) Anti-clockwise [1]

(iii) Resistance decreases [1]

(iv) Voltage [1]

(v) Voltmeter —Ⓥ— [1] across thermistor [1] [2]

(vi) $R = V/I$ [1]
$R = 0.75/0.015$ [2]
$R = 50\ (\Omega)$ [1] [4]

(d)

Switch S_1	Switch S_2	Lamp L_1	Lamp L_2
OPEN	CLOSED	**Out**	**Out**
CLOSED	OPEN	**Dimmer**	**Dimmer**
CLOSED	CLOSED	**Normal**	**Out**

[½] each **round down** [3]

20

			AVAILABLE MARKS
5	**(a)**	Top right – Neutron [1] Bottom right – Proton [1] Top left – Electron [1] Bottom left – Electron [1] Accept N, P, e [4]	
	(b) **(i)**	24 [1]	
	(ii)	Total of neutrons and protons [1]	
	(iii)	Same number of protons – if electrons also given award [0] [1]	
	(c) **(i)**	Radioactive [1]	
	(ii)	Gamma [1] Beta [1] Alpha [1] [3]	
	(iii)	Place aluminium between source and detector [1] Add more sheets [1] Until count rate falls to zero/background [1] measure background Any **three** [3]	
	(d) **(i)**	Tick statement two [1]	
	(ii)	30 minutes [1] Long enough to mix with the blood/short enough to avoid damage or without causing tissue damage [1] Five seconds too short to mix with blood **or** activity too small to detect [1] One year would cause tissue damage **or** damage body cells [1] [4]	
		Quality of written communication [1]	20
		Total	**100**

Rewarding Learning

General Certificate of Secondary Education
2009

Science: Physics

Paper 2
Foundation Tier

[G7603]

FRIDAY 19 JUNE, MORNING

MARK SCHEME

Subject-specific instructions

1 In numerical problems, the marks for intermediate steps shown in the mark scheme are for the benefit of candidates who do not obtain the correct final answer. A correct answer and unit, if obtained from a valid starting-point, gets full credit, even if all the intermediate steps are not shown. It is not necessary to quote correct units for intermediate numerical quantities.

Note that this "correct answer" rule does not apply to formal proofs and derivations, which must be valid in all the stages shown in the mark scheme to obtain full credit.

2 Do not reward wrong physics. No credit is given for substitution of numerical data, or subsequent arithmetic, in a physically incorrect equation.

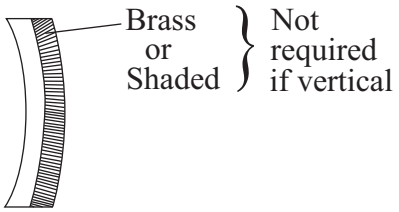
However, answers to later parts of questions that are consistent with an earlier incorrect numerical answer, and are based on a physically correct equation, must gain full credit. Annotate this by writing **ECF** (Error Carried Forward) by your text marks.

3 The normal penalty for an arithmetical and/or unit error is to lose the mark(s) for the answer/unit line. Substitution errors lose both the substitution and answer mark, but 10^n errors (e.g. writing 550 nm as 550×10^{-6} m) count only as arithmetical slips and lose the answer/unit mark.

		AVAILABLE MARKS
1	**(a)** B [1] Wide base [1] Low CoG [1] [3]	
	(b) **(i)** **Pivot** – centre of the wheel [1] **Effort** – at the handle, must touch or pass through handle [1] **Direction** – upwards, only if line of action when extended passes through handle [1] [3]	
	(ii) The effort is further from the pivot [1] So smaller force can produce same moment as the weight [1]/or larger moment (Moment is essential in the answer) [2] Also accept increases moment of (effort) Force multiplier [0] unless further explanation. Moving effort [0] Larger effort [0] Turning force [0]	
	(c) **(i)** Moment = force × distance from pivot [1] if perpendicular given [1] [2]	
	(ii) Moment = 5000 × 5 [2] = 25 000 (Nm) [1] [3]	
	(iii) Pressure = Force/Area [1] **or** equivalent = 30 000/120 [1] = 250 [1] Pa or N/m^2 [1] [4] **or** N/cm^2 [1] if no working present If working present, unit credit given for Pa or N/m^2	
	(d) **(i)** Tension in the string [1]	
	(ii) Move away in a straight line [1] at a tangent to the circle [1] [2]	20

AVAILABLE MARKS

2 **(a)** **(i)** Sketch showing:
Bending [1]
With brass on outside [1]



[2]

(ii) As the temperature increases [1] gets hot/warms up/
strip bends away (from the knob) or to the left [1] away from contact
strip bends and breaks contacts [2]
opening the contacts/breaking circuit [1] [3]

Quality of written communication [1]

(iii) To set the temperature (at which thermostat switches (off)) or on
control/change/raise or lower temperature [1]
Adjust the distance strip has to bend [1]
Reset heater [0] Sensitivity [0]

(iv) Substance:
Insulator or named insulator (e.g. polythene) [1] wood
Reason:
Otherwise heater permanently on **or**
Otherwise thermostat is short circuited [1] [2]
does not conduct **electricity**
does not conduct heat [0]

(b) Pin breaks (or bends) [1]
Force on pin due to contracting flat iron bar [1] [2]
It contracts [1] Increasing force/pressure on pin
Pin contracts [0] shrinks [1] shortens [1]

(c) **(i)** Conduction
Convection
Radiation
Evaporation
Any **three** [3]

(ii) Convection [1]
Atoms in solids are bound **or** unable to translate **or** unable to move
long distances [1] [2]

(iii) Polystyrene (beads) **or** urea formaldehyde **or** foam [1]

(iv) Feathers trap air [1]
Air is a good insulator [1] [2]

(d) **(i)** Electrons [1]

(ii) Atoms **or** molecules [1]

				AVAILABLE MARKS
	(iii)	Electrons absorb KE from flame/Electrons move faster Electrons collide with atoms/Passing KE to vibrating atoms in each collision Any **three**	[3]	
	(e)	Good absorbers of radiation more than one tick [0]	[1]	25
3	**(a)**	The number of vibrations per second	[1]	
	(b) **(i)**	Wavelength correctly marked and labelled	[1]	
	(ii)	Amplitude correctly marked	[1]	
	(c) **(i)**	Longitudinal or pressure wave	[1]	
	(ii)	Sound waves consist of vibrations of particles/molecules Needs particles to pass through/propagation	[1]	
	(iii)	Electric bell in a chamber (bell jar) Hammers seen striking gong Sound of the bell is audible Chamber/bell jar connected to vacuum pump Pump switched on/air removed from chamber/bell jar Loudness of sound decreases Sound becomes inaudible Even though the hammer is seen still striking gong Any **six**	[6]	
	(iv)	20 Hz [1] to 20 kHz [1]	[2]	
	(v)	Upper limit reduces [2] (Range reduces [1] lower limit changes [0])	[2]	
	(d) **(i)**	Speed = frequency × wavelength **or** $v = f\lambda$	[1]	
	(ii)	Speed = 200 × 1.7 [2] = 340 [1] = m/s [1]	[4]	20

					AVAILABLE MARKS
4	**(a)**	**(i)**	The electric current	[1]	
		(ii)	Inside the coil	[1]	
		(iii)	More cells/bigger current [1] More turns on the coil [1] Any magnetic core (any named magnetic substance) [1]	[3]	
	(b)	**(i)**	Coil	[1]	
		(ii)	The core	[1]	
		(iii)	Iron	[1]	
		(iv)	Iron is more easily/strongly magnetised [1] Iron loses its magnetism when current stops [1]	[2]	
		(v)	Conducts current/acts as part of the circuit [1] Pulls armature back to complete the circuit [1]	[2]	
		(vi)	Weaker field [1] **or** Insufficient force [1] The magnetic field would be too weak [1] To pull the armature over/break the circuit [2]	[3]	
		(vii)	Use weaker spring Adjust contact to press less strongly Move coil tighter to armature Increase number of turns Increase the current (more cells) Any **three**	[3]	
	(c)		It experiences a force/is pulled or pushed/movement [1] Up the page/down the page/perpendicular to field and current [1]	[2]	20

					AVAILABLE MARKS
5	**(a)**	**(i)**	A = Earth or a planet	[1]	
		(ii)	B = Moon	[1]	
		(iii)	C = Star	[1]	
	(b)	**(i)**	Orbit	[1]	
		(ii)	Communication Navigation (GPS) Weather monitoring } or similar Any **two**	[2]	
	(c)	**(i)**	Galaxy	[1]	
		(ii)	Star	[1]	
		(iii)	Gravity	[1]	
		(iv)	The distance [1] light travels in one year [1]	[2]	
		(v)	The distance is too great **or** spacecraft is too slow [1] Takes too long **or** time to get there greater than a human lifetime **or** too much fuel **or** equivalent (e.g. life resources) [1] Expense [0]	[2]	
	(d)	**(i)**	Hydrogen	[1]	
		(ii)	Nuclear fusion	[1]	15
				Total	**100**

Rewarding Learning

General Certificate of Secondary Education
2009

Science: Physics

Paper 1
Higher Tier

[G7604]

WEDNESDAY 10 JUNE, AFTERNOON

MARK SCHEME

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				AVAILABLE MARKS
1	(a)	(i)	A force/resistance [1] force of gravity [0] that opposes/preventing motion [1] [2]	
		(ii)	Zero [1]	
		(iii)	At rest [1] Moving with constant velocity or constant speed [1] [2]	
		(iv)	$F = ma$ [1] $= 750 \times 0.5$ $= 375$ [1] $F = A - B$ or $375 = 1200 - B$ $B = 825$ N [1] [3]	
		(v)	Force B is increasing [1]	
	(b)	(i)	Average speed = distance/time [1] $= 1200/160$ [1] $= 7.5$ [1] m/s [1] independent mark [4]	
		(ii)	Straight line [1] from 0, 0 [1] to 160, 1200 [1] [3]	
	(c)	(i)	8×1 [1] $= 8$ m [1] [2]	
		(ii)	Straight line [1] from 2, 8 to 5, 0 [1] [2]	
		(iii)	Deceleration = slope **or** 8/3 [1] **or** $a = \frac{v-u}{t}$ **or** $\frac{8}{3}$ $= 2.7$ m/s^2 [1] ignore minus sign [2]	
		(iv)	Area under the graph from [1] **or** $s = \frac{1}{2}(u+v)t$ $= 8 + \frac{1}{2} \times 3 \times 8$ [1] $= 20$ m [1] [3]	25

		AVAILABLE MARKS
2	**(a)** **(i)** Efficiency = useful energy or work output/total energy input or equivalent [1]	
	(ii) [1] [1] Efficiency = 150/(150 + 450) [2] = 150/600 = 0.25 [1] **or** 25% [3]	
	(b) **(i)**	

Renewable and dependent on the energy of the Sun	**Renewable and independent of the energy of the Sun**	**Non-renewable**
Biomass Hydroelectric Wind	Geothermal	Coal Gas Nuclear

[$\frac{1}{2}$] each **round up** [4]

(ii) Chemical [1]

(iii) Sun allows plants to grow [1]
Sunlight is converted energy by plants/photosynthesis [2]
Sun is a source of limitless/renewable energy [1] sun's energy never runs out [3]

(c) **(i)** Work = Force × Distance (moved) **or** W = f × d [1]

(ii) Work = 450 × 400 [1]
= 180 000 (J) [1] [2]

(iii) Power = work done/time taken [1] **or** W = P × t
Power = 180 000/500 [1] e.c.f. from **(ii)**
Power = 360 W [1] [3]

(d) **(i)** Heat from Sun is absorbed by land (and sea) or Earth
Heat is radiated back into atmosphere
Radiated heat is absorbed by carbon dioxide which re-radiates it back to earth
More carbon dioxide means more energy absorbed by atmosphere
Any **three** [3]

(ii) Solar and wind energy is unreliable [1]

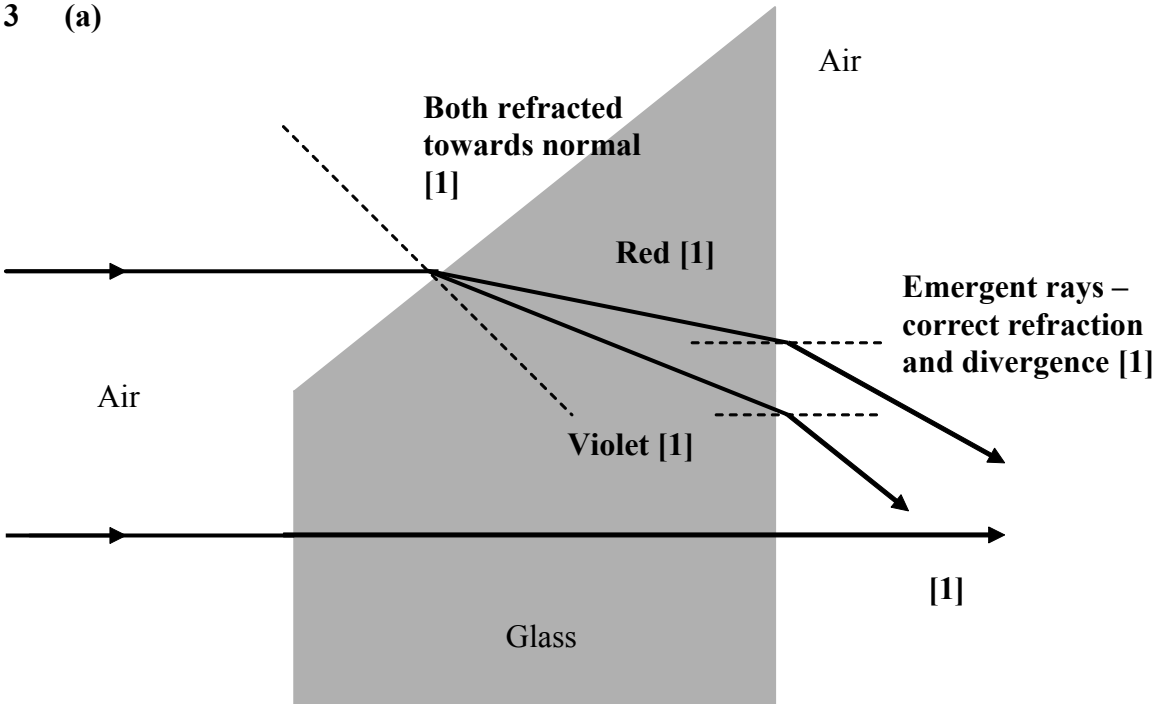
(e) **(i)** Reason for closing: dangerous radioactive waste/pollution **or** fear of being a terrorist target [1]
Reason for building: secure/reliable source of electricity **or** reduce carbon dioxide emissions **or** conserve fossil fuels [1] [2]

(ii) High costs of: Specialist personnel **or**
Specialist equipment **or**
Takes a very long time to do
Danger to personnel because of radioactivity [1]

25

AVAILABLE MARKS

3 (a)



Lower ray straight through without dispersion [1]
Top ray – divides with correct refraction for both [1]
Least refracted labelled with appropriate colour [1]
Most refracted labelled with appropriate colour [1]
Emergent rays – correct refraction and divergence [1] [5]

(b) (i) Spreading of a wave after passing through a gap [1]

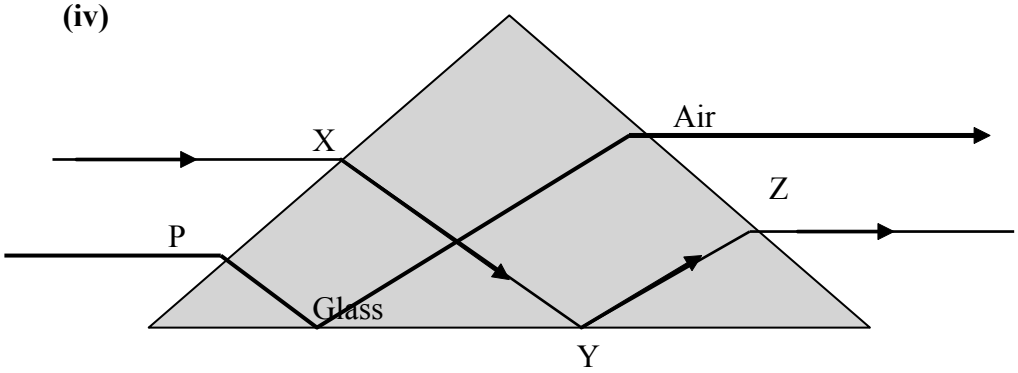
(ii) Obstacle correctly drawn – barrier with gap [1]
Curved wave fronts [1] [2]

(c) (i) Refraction [1]

(ii) Total internal reflection or T.I.R. [1]

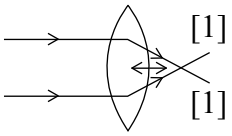
(iii) Y no change, Z an increase [1] each [2]

(iv)



New ray parallel to first ray in all parts [2]
(Parallel in only two sections [1]) [2]

(d) **(i)** Parallel rays converging, etc. [1]
Focal length marked [1] [2]



(ii) **Both** focal points marked and labelled 2 cm from lens [1]

(iii) Ray through centre of lens undeviated [1]
Ray parallel to p axis then through F or converse [1] e.c.f. for position of F from **(ii)**
Rays produced to meet [1]
Full image marked where rays meet [1] accept vertical line labelled I or vertical arrow
Arrow from object on at least one ray [1] [5]

(iv) Real Image [1]

(v) Image distance from candidate's diagram ±2 mm [1]

(vi) Height from candidate's diagram ±2 mm [1]

AVAILABLE MARKS

25

					AVAILABLE MARKS
4	**(a)**	**(i)**	Live – C Neutral – A Earth – B **All** must be correct	[1]	
		(ii)	D: fuse [1] E: cable/cord grip [1] flex, cord, cable clamp	[2]	
		(iii)	Current flows to earth Earth wire has low resistance Current exceeds fuse rating Fuse wire melts/blows/breaks Disconnects/breaks the circuit Any **four**	[4]	
	(b)	**(i)**	Week 6 meter reading = 12 681 + 144 = 12 825 [1] Units used in week 3 = 12 556 – 12 399 = 157 [1]	[2]	
		(ii)	Electrical energy	[1]	
		(iii)	11 (pence)	[1]	
		(iv)	[1] Cost = 129 × 11 = 1419 p e.c.f. for part **(iii)** = £14.19 [1] **or** 1419 p ignore £ sign if p present	[2]	
	(c)	**(i)**	Voltage and current are proportional to each other	[1]	
		(ii)	Ensure wire is at room/constant temperature **or** prevent wire heating up	[1]	
		(iii)	Straight line of twice the gradient [2] starting at 0, 0 (if just steeper [1])	[2]	
	(d)	**(i)**	Increases	[1]	
		(ii)	Decreases	[1]	
		(iii)	Smaller than that of the cotton thread	[1]	
	(e)	**(i)**	20 and 30 in parallel gives 12 Ω [1] 24 and 12 in series gives 36 Ω [1]	[2]	
		(ii)	[1] [1] $I = V/R = 12/36 = 0.33$ [2] e.c.f. for total resistance at **(i)** $V = IR = 24 \times 0.33 = 8$ V [1]	[3]	25

			AVAILABLE MARKS
5	**(a)**	Top right – Neutron [1] (N) Bottom right – Proton [1] (P) Top left – Electron [1] (e) Bottom left – Electron [1] (e) [4]	
	(b)	**(i)** 24 [1]	
		(ii) Total of neutrons and protons [1]	
		(iii) Same number of protons [1]	
		(iv) $^{24}_{12}\text{Mg} + {}^{0}_{-1}\text{e}(\beta)$ [5]	
	(c)	**(i)** Measure background reading Place aluminium between source and detector Add more sheets Until count rate falls to zero/background Any **three** [1] each [3]	
		(ii) Beta [1] Only beta can pass through the paper **or** alpha cannot pass through paper [1] [2]	
		(iii) Both parts **or** top and bottom both affected [1] Gamma can pass through paper and the aluminium [1] [2]	
	(d)	**(i)** Time for the activity to fall to half its original value Time for half of the atoms to decay [1]	
		(ii) 30 minutes [1] Long enough to mix with the blood/short enough to avoid damage without causing tissue damage [1] Five seconds too short to mix with blood [1] One year would cause tissue damage [1]/damage to body/cells [4]	
		Quality of written communication [1]	25
		Total	**125**

Rewarding Learning

General Certificate of Secondary Education
2009

Science: Physics

Paper 2
Higher Tier

[G7605]

FRIDAY 19 JUNE, MORNING

MARK SCHEME

Subject-specific instructions

1 In numerical problems, the marks for intermediate steps shown in the mark scheme are for the benefit of candidates who do not obtain the correct final answer. A correct answer and unit, if obtained from a valid starting-point, gets full credit, even if all the intermediate steps are not shown. It is not necessary to quote correct units for intermediate numerical quantities.

Note that this "correct answer" rule does not apply to formal proofs and derivations, which must be valid in all the stages shown in the mark scheme to obtain full credit.

2 Do not reward wrong physics. No credit is given for substitution of numerical data, or subsequent arithmetic, in a physically incorrect equation.

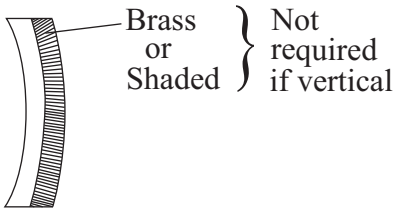
However, answers to later parts of questions that are consistent with an earlier incorrect numerical answer, and are based on a physically correct equation, must gain full credit. Annotate this by writing **ECF** (Error Carried Forward) by your text marks.

3 The normal penalty for an arithmetical and/or unit error is to lose the mark(s) for the answer/unit line. Substitution errors lose both the substitution and answer mark, but 10^n errors (e.g. writing 550 nm as 550×10^{-6} m) count only as arithmetical slips and lose the answer/unit mark.

				AVAILABLE MARKS
1	(a)	(i)	**Pivot** – centre of the wheel [1] **Effort** – at the handle, [1] must touch or pass through handle [1] **Direction** – upwards, [1] only if line of action when extended passes through handle [1] [3]	
		(ii)	The effort is further from the pivot [1] So smaller force can produce same moment as the weight [1]/or larger moment (Moment is essential in the answer) [2] Also accept increases moment of (effort) Force multiplier [0] unless further explanation. Moving effort [0] Larger effort [0] Turning force [0]	
	(b)	(i)	ACM = CM [1] [1] [1] F× 3 = 5000 × 5 [2] e.g. F × 3 = 500 × 5 give [2] F = 8333 N [1] accept 8300 [4]	
		(ii)	Pressure = Force/Area [1] **or** equivalent = 30 000/120 [1] = 250 [1] 0.025 N/cm^2 Pa or N/m^2 [1] **or** N/cm^2 [1] if no working present If working present, unit mark only given for Pa or N/m^2 [4]	
		(iii)	$v = u + at$ **or** $v = 0 + 10 \times 1.75$ [1] If 9.81ms^{-2}→ 17.1→17.2 v = 17.5 m/s [1] [2]	
		(iv)	Height = $\frac{1}{2}(u + v)t$ [1] = $\frac{1}{2}(0 + 17.5) \times 1.75$ [1] Also accept = 15.3 m [1] e.c.f. for v from **(iii)** mgh = $\frac{1}{2}$ mv^2 [3] s = $\frac{1}{2}$gt^2 [1] v^2 = 2as [1] s = ave. speed × time [1] = $\frac{1}{2} \times 10 \times 1.75^2$ [1] $17.5^2 = 2 \times 10$ [1] e.c.f. for v from **(iii)**	
	(c)	(i)	**Tension** (in the string) Must be tension [1]	
		(ii)	Decrease Increase No change Increase [$\frac{1}{2}$] each round down [2]	
	(d)		Momentum before = momentum after [1] [1] [1] $0.5 \times 3 = (0.5 + 0.75) \times V$ [2] [1] per side $(0.5 \times 3 + 0.75 \times 0)$ gets [1] V = 1.2 m/s [1] [4]	25

AVAILABLE MARKS

2 **(a)** **(i)** Sketch showing:
Bending [1]
With brass on outside [1]



[2]

(ii) As the temperature increases [1] gets hot/warms up/
strip bends away (from the knob) or to the left [1] away from contact
strip bends and breaks contacts [2]
opening the contacts/breaking circuit [1] [3]

Quality of written communication [1]

(iii) To set the temperature (at which thermostat switches (off)) or on
control/change/raise or lower temperature [1]
Adjust the distance strip has to bend [1]
Reset heater [0] Sensitivity [0]

(iv) Substance:
Insulator or named insulator (e.g. polythene) [1] wood
Reason:
Otherwise heater permanently on **or**
Otherwise thermostat is short circuited [1] [2]
does not conduct **electricity**
does not conduct heat [0]

(b) Pin breaks (or bends) [1]
Force on pin due to contracting flat iron bar [1] [2]
It contracts [1] Increasing force/pressure on pin
Pin contracts [0] shrinks [1] shortens [1]

(c) **(i)** GPE = mgh [1]
= 0.02 × 10 × 1.8 [2] 20 × 10 × 1.8 [1]
= 0.36 (J) [1] 360 [2] [4]

(ii) 0.36 (J) (**e.c.f. from (i)**) Mark to benefit of candidate [1]

(iii) KE = $\frac{1}{2}mv^2$ [1] $360 = \frac{1}{2} \times 20 \times v^2$ [2] or $360 = \frac{1}{2} \times 2 \times v^2$ [2]
$0.36 = \frac{1}{2} \times 0.02 \times v^2$ [2]
$v^2 = 36$ [1] $v^2 = u^2 + 2as$ wrong physics [0]
$v = 6$ (m/s) [1] All e.c.f. from **(i)** [5]

(iv) Speed: remains as before [1]
KE: remains as before [1] [2]

(v) Speed: remains as before [1]
KE: increases [1] [2]

25

				AVAILABLE MARKS
3	**(a)**	**(i)**	Passing energy from particles to particle Sound moves by **vibrations** of particles/molecules Needs particle to pass through/propagation [1] Sound produced by vibrations [0] needs moving particles [0]	
		(ii)	Electric bell in a chamber (bell jar) Hammer seen striking gong Sound of the bell is audible Chamber/bell jar connected to vacuum pump Pump switched on/air removed from chamber/bell jar Loudness of sound decreases Sound becomes inaudible Even though the hammer is seen still striking gong Any **six** [6]	
	(b)		$V = \frac{d}{t}$ [1] $340 = \frac{100}{t}$ [2] $340 = \frac{50}{t}$ [1] $t = 0.29$ [1] (0.294) 0.145 ← [0] unless work shown [4]	
	(c)		Speed = frequency × wavelength **or** $v = f\lambda$ [1] = 200 000 × 1500 or 200 000 × 1.5 [1] **or** 200 × 1.5 [0] – formula mark [1] = 300 000 000 (3×10^8) **or** 300 000 (3×10^5) [1] m/s [1] km/s [1] [4]	
	(d)	**(i)**	The wavelength should not have changed [1] **or** distance between waves The direction is wrong [1] **or** indicated by diagram [2]	
		(ii)	Straight wavefronts, unchanged wavelength (by eye) [1] not behind barrier Reflected so that $i = r$ (by eye) [1] Minimum is 2 wavefronts [2]	
	(e)	**(i)**	Observation . . . amplitude decreases [1] height – eventually str. line Explanation . . . sound gets quieter [1] lower/softer/loss of energy [2]	
		(ii)	Number of peaks or distance between peaks (doesn't change) [1] wavelength does not change [0] Frequency or pitch does not change [1] Tone [0] [2]	
		(iii)	It is louder or greater amplitude [1] It has the same pitch or frequency [1] [2]	25

AVAILABLE MARKS

4 **(a)** **(i)** Energised/electromagnet switched on/magnetic
Core coil becomes magnetised [1]
Pulls/attracts armature/hammer [1] [2]

(ii) Conducts current/acts as part of the circuit [1]
Pulls armature back to (complete the circuit) [1]
Allows armature/hammer to move [1]
} Allows armature to be attracted [0] flexible [2]

(iii) The magnetic field would be too weak [2]
Not able to pull the armature over/break the circuit [2]
Weaker magnetic field give [1]/insufficient force [1] [2]

(iv) Use weaker spring/adjust contact to press less strongly/move tighter coil closer to armature/Increase number of turns/Increase the current (more cells)
More magnetic [1]
Any **three** [3]
Thicker wire without explanation [0]

(b) **(i)** N Pole on the left or S on the right [1]

(ii) Join ends of lines with straight parallel lines in coil [1]
Arrows **inside** coil from S to N (e.c.f. from **(i)**) [1] [2]
outside N to S
Drawing lines to straight lines on diagram [0] but mark for direction

(iii) Complete loop or straight line down centre [1]

(c) It experiences a force/is pushed or/pulled [1] or movement
Up/down page/perpendicular to field and current [1] [2]

(d) **(i)** d.c. flows in a same/constant direction [1] constant value [0]
constant polarity [1]
a.c. changes direction + to – (**repeatedly**) [1] [2]

(ii) Electromagnetic induction [1]

(iii) D.C. **or** direct current **or** constant current [1]

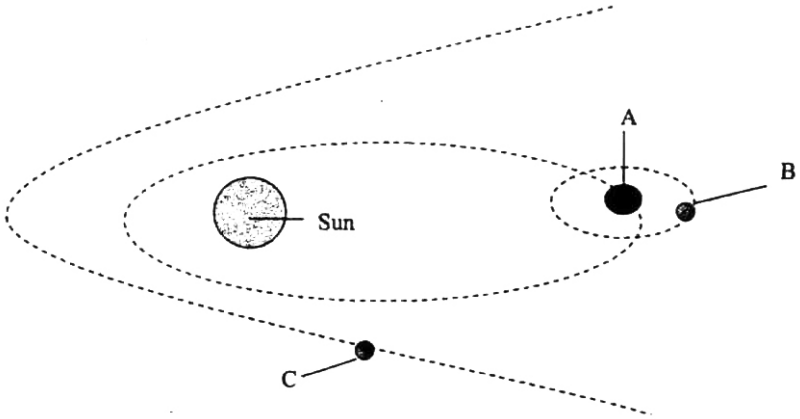
(iv) A complete iron core [1] which has a label [1]
Two coils of (insulated) wire [2] [4]

(v) At output of power station (any proper use) [1]
Any practical situation

(vi) To reduce energy loss in the grid or as appropriate depending on example given [1]

				AVAILABLE MARKS
(e)	**(i)**	Clockwise from the live terminal Fuse [1] Switch [1] Heater [1]	[3]	
	(ii)	If switch on neutral/wrong side: Appliance can be live/at a high voltage/dangerous to touch [1] Even when switch is off [1] Live side – Switch/fuse reversed – Then switch is dangerous to touch **or** switch is live if fuse blows	[2]	30

5 **(a)**



(i) A = planet orbit [1]

(ii) B = Moon orbit [1]

(iii) C = Comet path or an elliptical/circular path [1]

(b) **(i)** **24 hours** or **same time** as the Earth takes to make one rotation [1]
Same speed/rate [0]

(ii) Take photographs of large areas/spying/weather/sat nav/ any suitable use [1]

(c) **(i)** Stars/Suns – not **the** sun [1]

(ii) Gravity [1]

(iii) **Galaxies** are moving away from each other
Universe is expanding [1] but **not** expanding galaxies [1]

(iv) They are moving apart faster [1]

				AVAILABLE MARKS
(d)	**(i)**	Time = distance/speed [1] or t = *s*/*v* = 8.6/0.00004 [1] = 215 000 years [1]	[3]	
	(ii)	Spacecraft too slow **or** takes longer than a human lifetime **or** distance too great/too much fuel/takes too long resources for life [1] Any **two** expense [0]	[2]	
	(iii)	2 × 8.6 = 17.2 [1] years [1] **5.4 × 10^8 s**	[2]	
(e)	**(i)**	Hydrogen	[1]	
	(ii)	Fusion	[1]	
	(iii)	**(**Two) hydrogen [1]/helium **nuclei** join [1] fusing [1]	[2]	20
			Total	**125**