advancing learning, changing lives

Mark Scheme (Results)

January 2007

GCE

GCE Physics (6734/01)

Edexcel Limited. Registered in England and Wales No. 4496750
Registered Office: One90 High Holborn, London WC1V 7BH

A PEARSON COMPANY

Mark scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

For example:

(iii) <u>Horizontal force of hinge on table top</u>

66.3 (N) or 66 (N) **and** correct indication of direction [no ue] ✓ **1**
[Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific words that must be present. Such words will be indicated by underlining e.g. '<u>resonance</u>'
1.2 Bold lower case will be used for emphasis.
1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally cause the final calculation mark to be lost.
2.2 Incorrect use of case e.g. 'Watt' or 'w' will **not** be penalised.
2.3 There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given.
2.4 The same missing or incorrect unit will not be penalised more than once within one question but may be penalised again in another question.
2.5 Occasionally, it may be decided not to penalise a missing or incorrect unit e.g. the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.
2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. Significant figures

3.1 Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.
3.2 Use of an inappropriate number of significant figures will normally be penalised in the practical examinations or coursework.
3.3 Using $g = 10\ \text{m s}^{-2}$ will **not** be penalised.

4. Calculations

4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
4.2 If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.
4.3 **use** of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.
4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.
4.5 The mark scheme will show a correctly worked answer for illustration only.
4.6 Example of mark scheme for a calculation:

<u>'Show that' calculation of weight</u>

Use of L × W × H ✓

Substitution into density equation with a volume and density ✓

Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] ✓
[Allow 50.4(N) for answer if 10 N/kg used for g.]
[If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark] **3**
[Bald answer scores 0, reverse calculation 2/3]

Example of answer:

$80 \text{ cm} \times 50 \text{ cm} \times 1.8 \text{ cm} = 7200 \text{ cm}^3$

$7200 \text{ cm}^3 \times 0.70 \text{ g cm}^{-3} = 5040 \text{ g}$

$5040 \times 10^{-3} \text{ kg} \times 9.81 \text{ N/kg}$

$= 49.4 \text{ N}$

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme, placed as first mark.
5.2 Usually it is part of a max mark.
5.3 In SHAP marks for this are allocated in coursework only but this does not negate the need for candidates to express themselves clearly, using appropriate physics terms. Likewise in the Edexcel A papers.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.
6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.
6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.
6.4 Points should be plotted to within 1 mm.
- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

6.5 For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

6734 Unit Test PHY4

1.(a)	Why transverse waves can be polarised but not longitudinal waves [Marks can be earned in diagram or text] Transverse waves have * perpendicular to direction of **	✓	
	* = vibration/displacement/oscillation/motion of particles		
	** = travel/propagation/motion of wave/energy transfer/wave		
	In a transverse wave, * can be in different planes but polarisation restricts it to one plane	✓	
	Longitudinal waves have * parallel to **	✓	
			3
	[Don't accept "motion" for ** Diagrams to earn marks must be clearly labelled, but don't insist on a label "looking along direction of travel" in the usual diagrams to illustrate polarised and unpolarised waves]		
(b)(i)	Effect of Polaroid on intensity Intensity is reduced (OR halved) [not zero]	✓	
	[Accept slightly reduced and greatly reduced] Polaroid stops (OR absorbs) vibrations (OR waves OR light) in one plane/	✓	
	Polaroid only lets through vibrations (OR waves OR light)in one plane/ Light has been polarised		
			2
(ii)	Effect of rotating Polaroid No effect	✓	
	[ignore incorrect reasons accompanying statements of effect]		**1**
			6

2.(a) <u>Calculation of efficiency</u>

Use of incident power = intensity x area ✓

Use of efficiency = electrical power/incident power ✓

[Or ratio of powers per unit area, or powers per cell]

Correct answer [0.18 or 18%] ✓

3

e.g. Incident power = $1.4 \text{ kW m}^{-2} \times 20000 \times 10 \times 10^{-4} \text{ m}^2$

= 28 kW

Efficiency = 5 kW / 28 kW

= 0.18

[Omission of 20000 loses marks 1 and 3]

(b)(i) <u>Calculation of intensity</u>

Use of $I = P / 4 \pi r^2$ ✓

Correct answer [3.1×10^{-13} W m^{-2} OR 3.1 x 10^{-16} kW m^{-2} ✓

OR 3.1 x 10^{-7} W km^{-2} OR 3.1 x 10^{-10} kW km^{-2}]

2

e.g. $I = 5 \times 10^3 \text{ W} / (4\pi(3.6 \times 10^7\text{m})^2)$

$= 3.1 \times 10^{-13} \text{ W m}^{-2}$

[Failure to square r when substituting loses both marks]

[Omission of 4 loses both marks]

(ii) <u>Calculation of intensity of focused beam</u>

Use of area = πr^2 ✓

Correct answer [6.4×10^{-9} W m^{-2} OR 6.4 x 10^{-12} kW m^{-2} ✓

OR 6.4 x 10^{-3} W km^{-2} OR 6.4 x 10^{-6} kW km^{-2}]

2

e.g. $I = 5 \times 10^3 \text{ W} / (\pi(500 \times 10^3 \text{ m})^2)$

$= 6.4 \times 10^{-9} \text{ W m}^{-2}$

[Failure to square r when substituting loses both marks

Use of diameter instead of radius loses both marks]

7

[Inclusion of 4 or any other number loses both marks]

[Missing or incorrect unit should be penalised only once in part (b)]

3.(a) Definition of SHM

Acceleration (OR force) is proportional to displacement/allow distance from point (from a fixed point) / a (OR F) = (-)constant x with symbols defined ✓

Acceleration (OR force) is in opposite direction to displacement/ Acceleration is towards equilibrium point [Allow "towards a fixed point" if they have said the displacement is measured from this fixed point] / Signs in equation unambiguously correct, e.g. a (OR F) = $-\omega^2 x$ ✓

[Above scheme is the only way to earn 2 marks, but allow 1 mark for motion whose period is independent of amplitude OR motion whose displacement/time graph is sinusoidal]

2

(b)(i) Calculation of period

Use of $T = 2\pi\sqrt{m/k}$ ✓

Correct answer [1.1 s] ✓

2

e.g. $T = 2\pi\sqrt{(0.120 \text{ kg} / 3.9 \text{ N m}^{-1})}$

$= 1.10$ s

(ii) Calculation of maximum speed

Use of $v_{max} = 2\pi f x_o$ and $f = 1/T$ ✓

Correct answer [0.86 m s^{-1}] ✓

2

e.g. $f = 1/(1.10 \text{ s})$

$= 0.91$ Hz

$v_{max} = 2\pi\,(0.91 \text{ Hz})(0.15 \text{ m})$

$= 0.86 \text{ m s}^{-1}$

(iii) Calculation of maximum acceleration

Use of $a_{max} = (-)(2\pi f)^2 x_0$ ✓

Correct answer [4.9 ms^{-2}] ✓

2

e.g. $a_{max} = (2\pi \times 0.91 \text{ Hz})^2(0.15 \text{ m})$

$= 4.9 \text{ m s}^{-2}$

(iv) Calculation of mass of block

Use of $T \;\alpha\; \sqrt{m}$ / Use of $T = 2\pi\sqrt{m/k}$ ✓

Correct answer [0.19 kg] ✓

2

e.g. $m = (0.12 \text{ kg})(1.4 \text{ s} / 1.1 \text{ s})^2$

$= 0.19$ kg

OR $m = (3.9 \text{ N m}^{-1})(1.4 \text{ s} / 2\pi)^2$

$= 0.19$ kg

10

[Apply ecf throughout]

4.(a)(i) <u>How the bow causes the wave pattern</u>

EITHER

Bow alternately pulls and releases string (or sticks and slips) ✓

Creates travelling wave (OR travelling vibration) (on string) ✓

Wave reflects at the end (OR bounces back) ✓

Incident and reflected waves (OR waves travelling in opposite directions) superpose (OR interfere OR combine) ✓

[Don't accept collide]

max 3

OR

Bow alternately pulls and releases string (or sticks and slips) ✓

Produces forced oscillation/acts as a driver/exerts periodic force ✓

[Don't accept makes it vibrate]

At a natural frequency of the string ✓

Causing resonance (OR large amplitude oscillation) ✓

max 3

(ii) <u>Determination of wavelength</u>

Use of node to node distance = λ/2 / recognise diagram shows 2λ] ✓

Correct answer [0.4 m] ✓

2

e.g. $\lambda = 2 \times 0.2$ m

$= 0.4$ m

(iii) <u>Differences between string wave and sound wave</u>

Any TWO points from:

- String wave is transverse, sound wave is longitudinal / …can be polarised, … can't
- String wave is stationary (OR standing), sound wave is travelling (OR progressive) / … has nodes and antinodes, …doesn't / …doesn't transmit energy, …does…
- The waves have different wavelengths
- Sound wave is a vibration of the air, not the string

✓✓

2

[Don't accept travel in different directions / can be seen, can't be seen / can't be heard, can be heard / travel at different speeds

The first two marking points require statements about both waves, e.g. not just "sound waves are longitudinal"]

(b) <u>Sketch of the waveform</u>

Sinusoidal wave with T = 1 ms ✓

[Zero crossings correct to within half a small square

Accept a single cycle]

Amplitude 1.6 cm ✓

[Correct to within half a small square]

2

9

5.(a) Conditions for observable interference

Any THREE of:

- Same type of wave / must overlap (OR superpose) / amplitude large enough to detect / fringes sufficiently far apart to distinguish [Only one of these points should be credited]

- (Approximately) same amplitude (OR intensity)
- Same frequency (OR wavelength)
- Constant phase difference (OR coherent OR must come from the same source)

✓✓✓

3

[Accept two or more points appearing on the same line in the answer book

Don't accept
- must be in phase
- must be monochromatic
- must have same speed
- no other waves present
- must have similar frequencies
- answers specific to a particular experimental situation, e.g. comments on slit width or separation]

(b)(i) Experiment description

[Marks may be scored on diagram or in text]

(Microwave) transmitter, 2 slit barrier and receiver ✓

[Inclusion of a screen loses this mark, but ignore a single slit in front of the transmitter]

Barrier, metal sheets ✓

[Labels indicating confusion with the light experiment, e.g. slit separations or widths marked as less than 1 mm, lose this mark]

Appropriate movement of receiver relevant to diagram [i.e. move in plane perpendicular to slits along a line parallel to the plane of the slits, or round an arc centred between them] ✓

3

(ii) Finding the wavelength

Locate position P of identified maximum/minimum 1st/2nd/3rd etc. away from centre ✓

Measure distance from each slit to P ✓

Difference = λ OR $\lambda/2$ (consistent with point 1) ✓

3

[Accept use of other maxima and corresponding multiple of λ]

9

6.(a) [Treat parts (i) and (ii) together. Look for any FIVE of the following points. Each point may appear and be credited in either part (i) or part (ii)]

(i)

- Light (OR radiation OR photons) releases electrons from cathode
- Photon energy is greater than work function / frequency of light > threshold frequency / $f_{light} > f_0$ / wavelength of light is shorter than threshold wavelength / $\lambda < \lambda_0$
- PD slows down the electrons (OR opposes their motion OR creates a potential barrier OR means they need energy to cross the gap)
- Electrons have a range of energies / With the PD, fewer (OR not all) have enough (kinetic) energy (OR are fast enough) to cross gap
- Fewer electrons reach anode / cross the gap

(ii)

- (At or above V_s) no electrons reach the anode / cross the gap
- Electrons have a maximum kinetic energy / no electrons have enough energy (OR are fast enough) to cross

ANY FIVE ✓✓✓ ✓✓

[Don't worry about whether the candidate is describing the effect of increasing the reverse p.d. (as the question actually asks), or simply the effect of having a reverse p.d.]

5

(b) Effects on the stopping potential

(i) No change ✓

(ii) Increases ✓

2

[Ignore incorrect reasons accompanying correct statements of the effect]

7

7.(a)(i) <u>Calculation of de Broglie wavelength</u>

Use of $E = ½ mv^2$ ✓

Use of $p = mv$ ✓

Use of $\lambda = h / p$ ✓

$\lambda = 3.1 \times 10^{-10}$ (minimum 2 s.f.) ✓✓

[Use of $E = p^2/2m$ earns the first two marks
If the last two marks are not earned, allow 1 mark for $v = 2.3 \times 10^6$ or $p = 2.1 \times 10^{-24}$]

5

e.g. $v = \sqrt{(2 \times 2.46 \times 10^{-18} \text{ J} / 9.11 \times 10^{-31} \text{ kg})}$
$= 2.32 \times 10^6 \text{ m s}^{-1}$
$p = 9.11 \times 10^{-31} \text{ kg} \times 2.32 \times 10^6 \text{ m s}^{-1}$
$= 2.12 \times 10^{-24} \text{ kg m s}^{-1}$
$\lambda = 6.63 \times 10^{-34} \text{ J s} / 2.12 \times 10^{-24} \text{ kg m s}^{-1}$
$= 3.13 \times 10^{-10} \text{ m}$

[Reverse argument, calculating the KE from the given wavelength, can earn 4 max: the first three marks, and 1 (only) for the answer 2.7×10^{-18} J, 2 sig fig minimum]

(ii) <u>Region of electromagnetic spectrum</u>

X rays ✓

1

(iii) <u>Why the electron is suitable</u>

Diffraction occurs ✓

Wavelength approximately equal to atomic spacing ✓

[Don't accept atomic size]

2

(b) <u>Meaning of wave-particle duality</u>

QOWC ✓

When a particle exhibits wave properties / When a wave exhibits particle properties [Accept statement about a specific wave/particle, e.g. light or electrons] ✓

Electrons behave like particles …….. [example] ✓

Possible examples:
In electric circuits / Can be accelerated in a vacuum tube / Can be deflected by electric (OR magnetic) fields / Can collide / During ionisation / When beta rays are detected in a GM tube

Electrons behave as waves ……….. [example] ✓

Possible examples:
Can be diffracted / interfere / As stationary waves inside an atom / in tunnelling microscope

4

[The examples given should indicate behaviour in which particle/wave properties are displayed, rather than just mentioning generic properties (e.g. electrons have mass, electrons have charge)]

12