8225
Paper 2

Key messages

- Candidates are sometimes unable to gain full credit because their descriptions are not given with sufficient detail, and they would benefit from providing more detail. Often answers are made unclear through the omission of certain key words and inappropriate use of everyday language.
- Candidates should be encouraged to learn precisely certain definitions, laws and **principles**. The omission of a single key word can lead to marks not being awarded if it is an important part of a definition.
- It is important not to prematurely round values to two significant figures at intermediate stages within a calculation as this may lead to an incorrect final answer. Candidates should instead wait until they obtain a final answer before rounding to an appropriate number of significant figures. Never round to 1 significant figure.
- Candidates need to present clearly all of their working in extended mathematical questions. Well presented calculations show all the discrete steps in a logical order. This will often enable marks to be gained for the working even when a mistake has been made with the final answer. No marks are awarded for mentioning the formula, if not specifically asked.
- Many questions at AS Level require candidates to perform unit conversions, for example from mm^2 to m^2 or from g to kg. Errors due to incorrect unit conversions can add up over a number of different question parts and make a significant difference to the final mark for the paper. Candidates should continually practise converting between units when performing calculations.
- It is important that candidates practise answering questions that are of the same standard as those in the examination. Working through past papers is a way of achieving this.

GENERAL COMMENTS

A wide range of marks were awarded on this paper. There were some question parts that were deliberately very challenging in order to discriminate between stronger candidates. Other question parts were very straightforward to ensure that weaker candidates had opportunities to score marks.

Blank pages at the end of scripts may suggest that some candidates had insufficient time to complete the questions. However, these blank pages usually appeared in the scripts of weaker candidates and may have resulted from unfamiliarity with some subject content.

Many candidates had difficulty in calculating numerical values. Frequently, the method and substitution were correct but the final answer demonstrated a lack of calculator skills. Candidates should be encouraged to consider whether any answer is physically reasonable, rather than just accepting a calculator answer as being correct.

COMMENTS ON INDIVIDUAL QUESTIONS

1 (a) (i) The definition of mass was well known. The majority of candidates correctly referred to the quantity of matter. Some candidates used incorrect terms such as amount of substance or the number of molecules. A significant number described mass in terms of weight and gravitational field strength, whilst others expressed it in terms of density and volume. These expressions are used to define gravitational field strength and density respectively and are not appropriate here.

Mark scheme / expected answers
Mass is the property of a body that resists change in motion.

(a) (ii) The most common incorrect definition of force was 'the product of mass and acceleration'. Candidates would benefit from improving their knowledge of the definitions in the syllabus.

Mark scheme / expected answers
Force is the rate of change of momentum.

(b) (i) The majority of candidates could not recall the formula of the volume of a sphere. There were many answers which had been set out poorly, with all the working on a single line with the answer from one calculation running into the next. These answers are often so unclear that it is impossible to award credit. Candidates should be encouraged to lay out their working as clearly as possible.

Mark scheme / expected answers

$V = \frac{1}{2}\left(\frac{4}{3}\pi\left(\frac{d}{2}\right)^3\right)$ or $\frac{1}{2}\left(\frac{4}{3}\pi\left(\frac{0.05}{2}\right)^3\right)$ or 3.3 x 10^{-5}

$\rho = \frac{0.25}{\frac{1}{2}\left(\frac{4}{3}\pi\left(\frac{0.05}{2}\right)^3\right)}$ = 7600 (kg m^{-3})

(b) (ii) Candidates did not appreciate the fact that the unit for volume is to the power of 3. Power-of-ten errors caused by wrongly interpreting the prefixes of the units given was a common mistake.

Mark scheme / expected answers

$\left(\left(\frac{0.01}{0.25} + \frac{0.006}{0.050}\right) \times 100\right)$ = 16%

(c) When doing calculations no uncertainties should be included. Candidates did not square the value for speed when calculating the kinetic energy. When using the formula P = F $\bar{v}$, it should be stressed that the AVERAGE velocity should be used. The majority of candidates wrongly used 12 $m.s^{-1}$.

Mark scheme / expected answers

(i) $\left(\frac{3.5}{0.25}\right)$ = 14 ($m\,s^{-2}$)

(ii) $\left(\frac{1}{2} \times 0.25 \times 12^2\right)$ = 18 (J)

(iii) $\left(3.5 \times \frac{12}{2}\right)$ = 21 (W)

(iv) (12 = 0 + 14t) t = 0.86 (s)

2 It is evident that many centers did not do this topic in detail.

(a) Many answers did not contain enough detail to gain full credit. Candidates often did not make it clear that the object will return to its original shape after the force has been removed.

Mark scheme / expected answers
Elastic deformation is reversible when the stress is removed.

(b) (i) Many candidates used a small range for the change in the force or chose points that were difficult to read, and then obtained an inaccurate value for k. For the unit, candidates are advised to use units given on the graph and convert them to basic SI-units.

Mark scheme / expected answers
(21 N / 6 cm) = 3.5 N cm^{-1} **or** (21 N / 0.06 m) = 350 N m^{-1}

(b) (ii) A minority of candidates realised that SI-units have to be used for the answer to be in J.

Mark scheme / expected answers
Energy ($= \frac{1}{2} \times 20.0 \times 0.057$ in m) = 0.57 J

OR

Energy ($= \frac{1}{2} \times 350 \times (0.057)^2$) = 0.57 J

(c) This question was only accessible to the better candidate.

Mark scheme / expected answers
elastic potential energy = area under graph
Calculate area of 1 square / 1 block
Energy = number of squares / blocks × area of square / block

(d) Although clearly stated that the sketch graph should be on Figure 2.2, many candidates opted to draw a graph in the empty space at the bottom of the page. These graphs could not be awarded with any marks.

Mark scheme / expected answers
Graph starts at 23.0 N and 9.6 cm and decreases.
Graph ends at a non-zero value on x-axis less than 4.0 cm.

Question 3

(a) Answers were generally very good, with most candidates showing a clear calculation and answer. Weaker candidates did not convert the distance to m.

Mark scheme / expected answers
$\left(t_{west} = \left(\frac{6300}{1.4}\right)\right) = 4500$ (s)

(b) Only the minority of candidates realized that an expression has a variable and is not a value.

Mark scheme / expected answers
(distance due east =) 0.75 t

(c) There were very few correct answers. Only the strongest candidates were able to give the correct equation and calculate the time. The majority were not able to deduce the equation because their answer in **(b)** was incorrect.

Mark scheme / expected answers
Average speed = total distance travelled / (total) time

$$1.2 = \frac{6300 + 0.75\,t}{4500 + t} \qquad 1.2 = \frac{6300 + \text{distance due east}}{4500 + \frac{\text{distance due east}}{0.75}}$$

$$t = 2000 \qquad t = 2000$$

$$s = 1500 \text{ (m)} = 1.5 \text{ (km)}$$

Question 4

(a) (i) The minority of candidates scored 2 marks. Most candidates calculated the period by using all 9 blocks horizontally. Only the better candidate realized that only 1 wave has to be used to calculate the period.

Mark scheme / expected answers
$3 \text{ cm} \times 0.5 \text{ ms cm}^{-1} = 1.5 \text{ ms}$

$$f = \frac{1}{T} = \frac{1}{1.5 \times 10^{-3}} = 670 \text{ Hz}$$

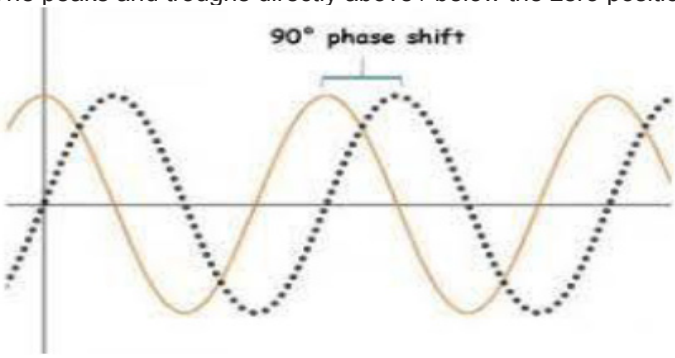
(a) (ii) Almost all the candidates could state the correct wave equation.

Mark scheme / expected answers

$$\lambda = \frac{v}{f} = \frac{340}{670} = 0.51 \text{ (m)}$$

(a) (iii) It is evident that candidates do not fully and clearly understand phase difference. The majority did draw a phase difference of 180°.

Mark scheme / expected answers
Same amplitude and same frequency with correct phase difference for at least two complete waves,
The peaks and troughs directly above / below the zero position of the original wave.



(b) (ii) Candidates needed to state the principle of superposition in precise terms. Some candidates only said that the waves 'superpose'. It was important to state that the waves must overlap and that the resultant displacement is the sum of the displacement of each wave. A common mistake was to say that the 'resultant wave is the sum of the individual waves' which was too vague as there was no mention of displacement. Another common mistake was to refer to amplitude instead of displacement.

$$\lambda = \frac{ax}{D}$$

Mark scheme / expected answers
for max order number θ = 90°

$$\Rightarrow \left(n = \frac{d\sin\theta}{\lambda}\right) = \frac{1.5 \times 10^{-6}(\times \sin 90)}{4.25 \times 10^{-7}}$$

n = 3

Question 5

The vast majority of the answers were correct. Candidates should however be sensitized to use the correct spelling for names of scientists.

Mark scheme / expected answers

(a) Doppler (effect)
The distance between wave fronts / wavelength changes / decreases / waves being pushed together (causing a change in frequency)

(b) $f_0 = \frac{f_s v}{(v - v_s)} = 1210\left(\frac{340}{340 - 30}\right) = 1330$ (Hz)

(c) The observed wavelength is longer/frequency is lower.
Greater velocity between earth and the star (so moving away).

Question 6

(a) The vast majority of the answers were correct.

Mark scheme / expected answers

(i) ((Q = I × t) = 5.0 × 4.0 =) 20 (C)

(ii) ((V = W/Q) = 760/20 =) 38 (V)

(b) Many candidates calculated volume instead of area of the conductor.

The majority of the candidates were able to recall and use the relevant symbol formula.

Mark scheme / expected answers

R= 38 / 5 or 7.6 Ω
$A = \pi (0.6 \times 10^{-3})^2$ or 1.13×10^{-6} m^2
$\rho = (38/5.0) \times \pi (0.6 \times 10^{-3})^2 / 45 =) = 1.9 \times 10^{-7}$ (Ω m)

(c) (i) The majority of the candidates were able to recall and use the relevant symbol formula. When substituting many candidates wrongly used the total charge and not the charge of one charge carrier. Candidates should understand the difference.

Mark scheme / expected answers

$$n = \frac{5.0}{1.13 \times 10^{-6} \text{x} 5.0 \times 10^{-4} \times 1.6 \text{x} 10^{-19}}$$

$= 5.5 \times 10^{28}$ m^{-3}

(d) (i) Candidates should be reminded constantly that these questions must be answered in detail and not in general.

Mark scheme / expected answers

The drift velocity is halved.

Question 7

(a) Most candidates gave the correct answer.

Mark scheme / expected answers

$$^{222}_{86}\text{X} + {}^{4}_{2}\alpha$$

(b) (i) Most candidates could recall the correct formula but forgot to convert the distance between the two plates to m.

Mark scheme / expected answers

$$\left(E = \frac{V}{d}\right) = \frac{3500}{50 \times 10^{-3}} = 70\ 000$$

Unit: V m^{-1} or N C^{-1}

(b) (ii) Candidates did not realize that alpha particles have two protons and omitted to multiply the elementary charge by 2.

Mark scheme / expected answers
(F = EQ =) $70\ 000 \times 2 \times 1.6 \times 10^{-19} = 2.2 \times 10^{-14}$ (N)

(b) (iii) The majority of candidates only were awarded 1 mark as the drawings were done hastily. As soon as the line shows an upward trend somewhere the second mark was not awarded.

Mark scheme / expected answers
Path moves towards the negative plate,
Starts to curve downwards (in the shape of a parabola) towards the negative plate between the plates.

(c) Most candidates gave the correct answer. Great care should be taken to correctly spell particles.

Mark scheme / expected answers

(i) Down down up / ddu

(ii) An up quark changes into down quark
emission of positron
and (electron) neutrino.