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MANA TOHU MĀTAURANGA O AOTEAROA

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Marking Schedule and Examination Commentary 1999

University Entrance, Bursaries and Scholarships Examination

PHYSICS

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University Entrance, Bursaries and Scholarships Examination
PHYSICS 1999

GENERAL

This was a similar paper to recent years but proved to be slightly harder than the 1998 paper and candidates found it difficult to score more than 140 points. Most questions were more demanding towards the end. As with recent years, the paper was contextual with a mixture of descriptive, algebraic and graphical questions. Almost all candidates finished the paper, apparently with sufficient time in hand. The paper was generally well answered with most candidates making a good attempt at each question.

There has been a recent trend for candidates to find it difficult to answer questions where descriptive answers are required. Questions requiring descriptive responses need to be practised far more extensively in order to be able to gain more success in the University Bursaries Physics examination. Also, there was an apparent erratic score distribution within individual candidates answers, suggesting that some parts of the course were less familiar to them or they found some areas more difficult than others.

This year it was very common for candidates to use rounded values in subsequent calculations within a question and this has been allowed in most cases in the marking process. An example from the marking schedule follows:

(c) $\theta = \omega_i + \frac{1}{2}\alpha t^2$
$= 0 + \frac{1}{2} \times 20.8 \times 2.5^2$
$= 65.0$
$= 65$ rad

However if 21 was used then **66** rad was accepted (since 21 was the 2 sf answer to (b)). Candidates should, however, use unrounded values in the next section of any question.

Significant figures and units were much improved on last year. The mean score for units was approximately 1.5/4, with the most common errors being in the rotational inertia question and simply leaving units off answers. The mean score for significant figures was approximately 0.9/4. Simple mistakes were made rather than a lack of understanding shown. Most candidates gave one significant figure in Q9 (c) instead of two. Many candidates lost marks through transcription errors from one part of a question to the next. Powers of ten in answers were often copied incorrectly.

Legibility was still a problem. Pencil was often used in diagrams. This is not advisable. Candidates must make their intended answers as clear as possible. Markers will take the last answer as the one candidates mean to be marked.

Spelling was overall very poor, especially some physics terms and in some cases words were just made up by candidates, eg 'impacedents', 'trinuchelium' and 'recipitator'. In Question 12 there were actually 20 different spellings of deuterium, only a few of which were accepted and only if the word could not be confused with tritium or lithium. Candidates must be advised to spell physics terms correctly or risk not gaining marks, especially if they are totally unclear.

COMMENTS ON SPECIFIC QUESTIONS

(Note: The mean mark in each case has been obtained from a sample of papers.)

Question 1: Rotational Motion (mean 7.3/10)

As with last years paper this question was relatively straightforward to settle candidates into the examination.

(a) Well done by all candidates.
(b) Generally well done but some candidates mixed radians and degrees.
(c) Many candidates did not change the diameter into radius before calculating.
(d) Well done by all candidates.
(e) Well done. Most candidates knew that the vector was towards the centre.
(f) An easy question but many failed to state a fraction and instead gave 3 as the answer, in the correct ratio, but did not gain the mark.

Question 2: Translational and Rotational Motion (mean 8.4/14)

(a)(b) Well done by most candidates.
(c) Not well done, for what was a simple question.
(d) Well done by most candidates.
(e) Some candidates remembered that for a disc $I = \frac{1}{2} MR^2$ which gives the correct answer and this was accepted but this is a risky strategy. The prescription does not require the rotational inertia formulae for different shaped objects to be remembered.

(f) This was very poorly done, making it perhaps the most difficult question in the entire paper. The lack of correct answers showed a surprisingly weak understanding of the principle of work done being change in **total** energy.
(g) Generally well done.
(h) Many candidates used impulse rather than the method suggested in the marking schedule.

Question 3: Simple Harmonic Motion (mean 8.3/15)

(a) Well done by most candidates.
(b) Many candidates used a rounded version of T and so did not conclusively **show** the result. In order to show seven significant figures, at least as many must be used in the calculation.
(c) Generally well done but some candidates treated A as though it was in metres.
(d) Well done by all candidates.
(e) Well done by most candidates.
(f) More candidates used sine than cosine, suggesting that they were unaware of the need to choose the correct formula relating to the position of the mass at t = 0. Most did not substitute 11.44155, which was required here to get the correct answer, since this unrounded value was given.
(g) This question was not done as well as expected. Using formulae gains no marks when candidates have been told to use a reference circle. The poor response to this question suggests that the graphical representation of SHM needs more emphasis and practice in teaching.

Question 4: Gravity (mean 6.8/14)

(a) Generally well done, with some candidates equating gravity to centripetal and getting a similar, and acceptable, answer.
(b) Generally well done.
(c) Only a few candidates were confident enough to just repeat the answer to (b).
(d) Well done by most candidates.
(e) Generally well done, but obviously many candidates had not done this calculation before.
(f) Many candidates forgot to add to the radius of the Earth or forgot to square on bottom line. Most wrote down the correct equation.
(g) Too many candidates referred to jumping to the same height with less energy, which was not what the question stated. Many simply assumed that there was less gravity on the moon because the moon has a smaller radius. There is a need for teachers to emphasise how questions like this should be answered – by selecting and exploring the relevant physical law to justify the answer fully.

Question 5: Sound (mean 8.2/11)

(a) Well done by all candidates.
(b) Well done but many lost a significant figure mark here.
(c) Well done by most, although it was labelling which was being marked, not the wave shape drawn in.
(d) Many candidates thought that plucking the string with more force changed the wavelength. If they did know or guess that tension was different most did not then say that this changed the wave velocity.
(e) Well done by most.
(f) Well done by most, with a few odd spellings of longitudinal.

Question 6: Electromagnetic Radiation (mean 11.8/19)

Too many candidates used the speed of sound instead of the speed of light in this question.

(a) Well done, apart from those using the speed of sound.
(b) Well done by most candidates.
(c) It seemed that many candidates simply guessed here.
(d) Most candidates wrote down the Doppler equation given in the formulae sheet. Many of those then chose the correct negative sign and so could get to the answer.
(e) This was well done by most candidates.
(f) Markers noted difficulties marking this question. Many candidates appeared to use a different favourite equation, rather than the equation provided in the equation sheet. If candidates use other equations, they must realise that those equations have been derived using a series expansion and so are valid only where v is very much smaller than c, and candidates needed to state this to gain full marks. The equation given in the marking schedule, although valid for sound, is only a low velocity approximation to the true relativistic equation. Nevertheless, it is suggested that if teachers ignore it and prefer to teach their own version they may disadvantage their candidates, if the candidates either do not remember or the examiner feels that the equation they use is not appropriate.
(g) Well done by most candidates. This question emphasised that most candidates are very proficient at selecting and using a formula when there is no doubt as to which one to use.
(h) This question was very poorly done. Some candidates referred to thin film interference – a topic not even in the prescription now. Candidates' answers suggested a very superficial understanding of interference. Teachers are referred to the following articles as a starting point for CD phenomena; *The Physics Teacher*, October 1990, p484 and Am. J. Phys., 59,4, p367, 1991.

Question 7: DC Electricity (mean 6.7/10)

(a)(b) Well done by all candidates.
(c) Well done by most candidates.
(d) Many candidates considered the second CD player to be identical and they simply halved the current. Obviously candidates did not read the question carefully.
(e) Poorly done. It was surprising that many candidates at this level could not connect batteries in parallel.

Question 8: AC Electricity (mean 6.6/19)

Approximately 10% of candidates scored 0 out of 19 for this question and many more did not attempt parts (e) – (h). There is a definite need for extra teaching effort in this topic.

(a) It was the **configuration** which was important here, not simply diodes.
(b) There was confusion between concept of current and voltage and several candidates thought the transformer changed AC to DC.
(c) Well done but many used $6 \times \sqrt{2}$, incorrectly, as the peak value.
(d) Some candidates knew it was smoothed but did not accurately draw the ripple. Too few knew the correct wave shape, suggesting that this common application of AC circuits has not been adequately covered in many courses of study.
(e) Too few candidates could establish or remember the formula, let alone rearrange it correctly. This is one of the few formulae not given and its derivation should be practised.
(f) Many thought the frequency was halved.
(g) Not well done at all, with many candidates drawing a straight, sloping line.
(h) Poorly done, indicating candidates have not had sufficient practice at drawing and calculating from phasor diagrams.

Question 9: Capacitors (mean 6.1/10)

(a) Well done by most candidates where there was no doubt as to which equation to use.
(b) Well done, but many errors occurred in rearranging the equation. Many candidates incorrectly assigned units to this factor.
(c) Well done in general.
(d) Generally well done, but drawing was often poorly done. Many candidates showed the curve asymptotic to the current axis, despite marking in 0.48 A as a starting value.
(e) Poorly done and most candidates lost a significant figure mark here.

Question 10: Inductors (mean 2.4/11)

A very poorly done question. It seems that candidates have a poor understanding of the finer details of inductance.

(a) Back EMF is not well understood by candidates. Many candidates even brought capacitors into their answers. Good candidates realised what was happening here but weaker candidates had no idea at all. Most candidates could not write an appropriate descriptive answer.
(b) Few candidates realised that it was now a closed loop and 6V was the maximum voltage available. Few candidates seem to have read the question carefully.
(c) Quite well done, but in order to gain full marks candidates needed to show that they understood when steady state was reached.

Question 11. Atomic Physics (mean 6.4/11)

(a) Well done by most candidates.
(b) Quite well done.
(c) Many seemed to guess.
(d)(e) Generally well done.
(f) Well done by most.

Question 12. Nuclear Physics (mean 5.6/12)

(a) Not very well done, with the beta speed the hardest part. Answers of < c were not accepted since that is too vague.
(b) In this question there were 20 different spellings for deuterium. Hydronium was a common answer, as was dilithium. Answers which could be, in any way related to tritium were not accepted. **Correct spelling of physics terms is essential.**
(c) Many candidates believed that no radiation results from fusion. Many had the ideas but not the facts, and only in a very superficial way.
(d) Well done.
(e) Not very well done, despite being clearly signalled in the new prescription.
(f) Generally well done, but only if they could do (e).

MARKING SCHEDULE

Question 1: Rotational Motion (10 marks)

(a) $\frac{52\times60}{2\pi} = 496.56$ (1 mark)

$= 500$ rev / min (1 mark)

(b) $\alpha = \frac{\Delta\omega}{\Delta t}$ (1 mark)

$= \frac{52}{2.5}$

$= 20.8$

$= 21$ rads^{-2} (1 mark)

(c) $\theta = \omega_i t + \frac{1}{2}\alpha t^2$ (1 mark)

$= 0 + \frac{1}{2}\times 20.8 \times 2.5^2$

$= 65.0$

$= 65$ rad

(or 64 if calculated with other kinematics equation, or 66 if 21 used in calculation, or 3724 degrees accepted) (1 mark)

(d) $v = r\times\omega$ (1 mark)

$= 0.060\times 52$

$= 3.12$

$= 3.1$ ms^{-1} (1 mark)

(e) Vector drawn towards centre (to left of P) (1 mark)

(f) $\frac{1}{3}$ (no marks for v_P is $3\times v_Q$) (1 mark)

Question 2: Translational and Rotational Motion (14 marks)

(a) GPE $= mgh$ (1 mark)

$= 0.016\times 9.8\times 0.3$

$= 0.04704$

$= 0.047$ J (1 mark)

(b) $KE = \frac{1}{2}mv^2$ (1 mark)

$= \frac{1}{2}\times 0.016\times 2^2$

$= 0.032$ J (1 mark)

(c) (a) − (b) $= 0.04704 - 0.032$

$= 0.015$ J (1 mark)

(d) $v = r\times\omega,\ \omega = \frac{v}{r}$ (1 mark)

$= \frac{2.0}{0.06}$

$= 33.333$

$= 33$ rads^{-1} (1 mark)

(e) $KE_{rot} = \frac{1}{2}I\omega^2$ (1 mark)

$I = \frac{2\times 0.015}{33.333^2}$

$= 2.75\times 10^{-5}$

$= 2.8\times 10^{-5}$ kgm^2

(accept 2.7×10^{-5}, accept $\frac{1}{2}MR^2$ calculation giving answer) (1 mark)

(f) $F = \frac{W}{d} = \frac{\Delta E}{d} = \frac{\text{total energy lost}}{\text{distance}}$ (1 mark)

$= \frac{(a)}{1.3}$ (1 mark)

$= \frac{0.047}{1.3}$

$= 0.03615$

$= 0.036$ N (1 mark)

(g) $p = m\times v$

$= 0.35\times 5.4$

$= 1.890$

$= 1.9$ kgms^{-1} (1 mark)

(h) $F = m\times a$

$= \frac{m\times\Delta v}{\Delta t}$

$= \frac{0.35\times 5.4}{0.040}$

$= 47.25$

$= 47$ (or 48) N (1 mark)

Question 3: Simple Harmonic Motion (15 marks)

(a) $T = 2\pi\sqrt{\frac{m}{k}}$ (1 mark)

$= 2\pi\sqrt{\frac{0.055}{7.2}}$

$= 0.549155$

$= 0.55$ s (1 mark)

(b) $\omega = \frac{2\pi}{T}$ (1 mark)

$= \frac{2\pi}{0.549155}$

$= 11.44155$

(must have all digits under 2π) (1 mark)

(c) $v_{max} = A\times\omega$ (1 mark)

$= 0.035\times 11.44155$

$= 0.40045$

$= 0.40$ ms^{-1} (1 mark)

(d) Passing through equilibrium point (middle). (1 mark)

(e) $KE = \frac{1}{2}mv^2$ (1 mark)

$= \frac{1}{2} \times 0.055 \times 0.40045^2$

$= 4.4 \times 10^{-3}$ J (1 mark)

(f) $a = -A\omega^2 . \cos \omega t$ (1 mark)

$= -0.035 \times 11.44155^2 \times \cos(11.44155 \times 0.7)$

(must use 11.44155) (1 mark)

$= 0.707809$

$= 0.71$ ms^{-2} (1 mark)

(g) A to horizontal : $\theta = \frac{\pi}{2}$ or 90°

Horizontal to B : $\theta = \frac{\pi}{6}$ or 30° (1 mark for both)

$\theta_{Total} = 120°$ or $\frac{2\pi}{3}$, which takes $\frac{T}{3}$

so time $= \frac{0.55}{3}$ (1 mark)

$= 0.18$ s (1 mark)

Note: no credit if used equations only
one mark only if 0.18 s given without working

Question 4: Gravity (14 marks)

(a) $v = \frac{\Delta x}{\Delta t}$ (1 mark)

$= \frac{2\pi R}{T}$

$= \frac{2\pi \times 8.1 \times 10^6}{7200}$ (1 mark)

$= 7068.58$

$= 7100$ ms^{-1} (1 mark)

Note: if gravity force equated to centripetal force then 7000 ms^{-1} accepted.

(b) $a = \frac{v^2}{R}$ (1 mark)

$= \frac{(a)^2}{8.1} \times 10^6$

$= 6.1685$

$= 6.2$ ms^{-1}

(or 6.1 if 7000 used) (1 mark)

(c) 6.2 (or 6.1) ms^{-2} (1 mark)
Note: 1.9 ms^{-2} accepted if height used was distance above surface.

(d) Decrease. (1 mark)

(e) 24 × 60 × 60 = 86 400 s (no significant figures marked here) (1 mark)

(f) $F = \frac{Gm_1m_2}{r^2}$ (1 mark)

$= \frac{6.67 \times 10^{-11} \times 0.220 \times 6.0 \times 10^{24}}{(6.37 \times 10^6 + 6100)^2}$ (1 mark)

$= 2.1659$

$= 2.2$ N (1 mark)

(g) W = ΔE (muscle strength is same)

= gain in GPE

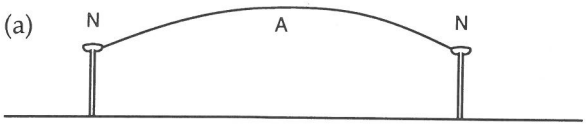
$= m \times g \times h$ (1 mark for energy argument)

m is same, g is less (this calculation by itself worth 1 mark) (1 mark)

so h must be greater (1 mark)

Question 5: Sound (11 marks)

(a)



both nodes labelled (1 mark)
antinode in centre labelled (1 mark)

(b) $v = f \times \lambda$ (1 mark)

$l = \frac{\lambda}{2}$ (1 mark)

$\lambda = 2 \times 1$

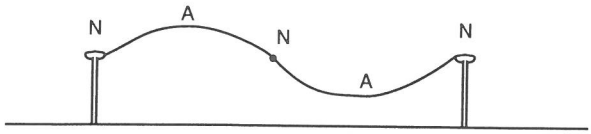
$= 0.50$ m

$v = 930 \times 0.50$

$= 465$

$= 470$ ms^{-1} (1 mark)

(c)



node in centre (1 mark)
rest labelled correctly (1 mark)

(d) Tension (1 mark)
Velocity of wave in wire is different (1 mark)

(e) 930 – 910 = 20 Hz (1 mark)

(f) Longitudinal (1 mark)

Question 6: Electromagnetic Radiation (19 marks)

(a) $\lambda = \frac{v}{f}$

$= \frac{3.00 \times 10^8}{9.9 \times 10^7}$ (must use c) (1 mark)

$= 3.0303$

$= 3.03$ m (1 mark)

(b) $t = \frac{d}{v}$

$= \frac{5.6 \times 10^6}{3.0 \times 10^8}$ (must use c) (1 mark)

$= 0.01866$

$= 0.019$ s (1 mark)

(c) Higher (1 mark)

(d) $f' = \frac{f \times c}{(c - v)}$ (must be negative sign) (1 mark)

$= \frac{9.90 \times 10^7 \times 3.00 \times 10^8}{\left(3.00 \times 10^8 - 5.400 \times 10^3\right)}$ (1 mark)

$= 9.9001782 \times 10^7$ (must be larger than 9.90)

$= 9.9(0) \times 10^7$ Hz (1 mark)

Note: zero marks for using a positive sign in equation.

(e) $f_1 = \frac{v}{\lambda}$

$= \frac{3.00 \times 10^8}{6.40 \times 10^{-7}}$

$= 4.6875 \times 10^{14}$

$= 4.69 \times 10^{14}$ Hz (1 mark)

$f_2 = 4.65 \times 10^{14}$ Hz (1 mark)

(f) $f' = \frac{f \times c}{c + v}$ (1 mark)

$v = \left(\frac{f \times c}{f'}\right) - c$ rearrange (1 mark)

$= \frac{4.875 \times 10^{14} \times 3 \times 10^8}{4.6512 \times 10^{14} - 3 \times 10^8}$ substitute (1 mark)

$= 2.34133125 \times 10^6$

$= 2.34 \times 10^6$ ms^{-1}

$\left(\text{or } 2.58 \times 10^6 \text{ ms}^{-1}\right)$ (1 mark)

Notes:

– if used $f' = \frac{c - v}{\lambda}$ then must say that only true if $v << c$.

– if used $v = \frac{c \times \Delta f}{f}$ then also only true if $v << c$.

- no credit for moving observer equation.

(g) $n\lambda = d \sin\theta$ (1 mark)

$d = \frac{n\lambda}{\sin\theta}$

$= \frac{6.3 \times 10^{-7}}{\sin(23)}$ (1 mark)

$= 1.612 \times 10^{-6}$

$= 1.6 \times 10^{-6}$ m (1 mark)

(h) At certain angles specific colours (wavelengths or frequencies) will constructively **interfere**. (1 mark)

At multiples of n the pattern will repeat giving multiple spectra. (1 mark)

Notes: - "different wavelengths diffract at different angles" **not** accepted.

- "white light made up of all wavelengths/ frequencies" insufficient for marks.

Question 7: DC Electricity (10 marks)

(a) $R = \frac{V}{I}$ (1 mark)

$= \frac{6.0}{0.098}$

$= 61.224$

$= 61\ \Omega$ (1 mark)

(b) $P = V \times I$ (1 mark)

$= 6.0 \times 0.098$

$= 0.588$

$= 0.59$ W (1 mark)

(c) $0.59\text{W} = 0.59\ \text{J s}^{-1}$

so time $= \frac{9.1 \times 10^3\ \text{J}}{0.59\ \text{J s}^{-1}}$ (1 mark)

$= 15424$ s

$= 257$ min

$= 4.28$ hr (1 mark)

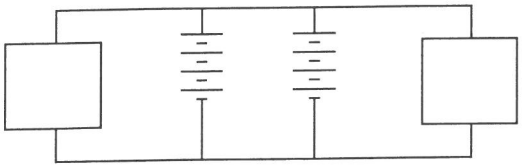
Note: significant figures not marked in this problem

(d) $0.23 - 0.098$ (1 mark)

$= 0.132$

$= 0.13$ A (1 mark)

(e)



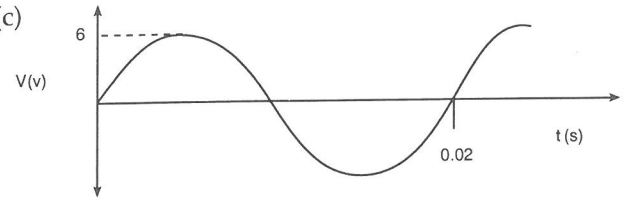
Parallel and same orientation (1 mark)
Correct voltage (1 mark)
Note: zero marks if batteries in series or of opposing polarities.

Question 8: AC Electricity (19 marks)

(a) Bridge/rectifier/full wave rectification (not simply diodes) (1 mark)

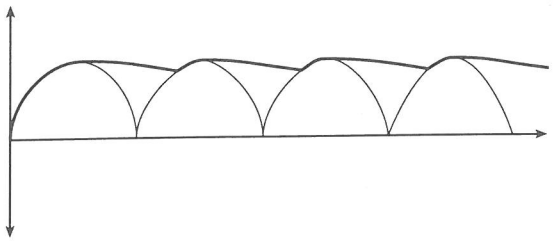
(b) transform/change (1 mark)
voltage to a lesser value (1 mark)
Note: marks also awarded to answers related to iron/laminated core and magnetic field/mutual inductance.

(c)



Peak at 6 to 7.5 V (not 8.5) (1 mark)
Sine or cosine shape (1 mark)
Calculation of period (1 mark)
Period marked in correct place (1 mark)

(d)



Full wave rectification shown (1 mark)
Smoothed DC shown (1 mark)
Note: 1 mark only for horizontal line.

(e) $f = \dfrac{1}{2\pi\sqrt{LC}}$ (derived or remembered, since not in formulae sheet) (1 mark)

$C = \dfrac{1}{L \times 4 \times \pi^2 \times f^2}$ rearrange (1 mark)

$= 4.3957 \times 10^{-12}$

$= 4.4 \times 10^{-12}$ F

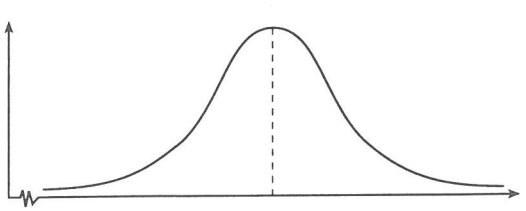
$= 4.4$ pF (1 mark)

(f) $f' = \dfrac{1}{\sqrt{2}} \times f$ or similar reasoning (1 mark)

$= 6.93 \times 10^7$

$= 6.9 \times 10^7$ Hz (1 mark)

(g)



Shape (peak near 9.8) (1 mark)
Symmetry and asymptote at I = 0 (1 mark)

(h) $X_L = \omega L$

$= 2\pi \times f \times L$

$= 518.36\ \Omega$ (1 mark)

$\theta = \tan^{-1}\left(\dfrac{518.36}{470}\right)$ (1 mark)

$= 0.834$

$= 0.83$ radians (accept 0.84) (1 mark)

Question 9: Capacitors (10 marks)

(a) $C = \dfrac{\varepsilon_r \varepsilon_0 A}{d}$ (1 mark)

$d = \dfrac{\varepsilon_r \varepsilon_0 A}{C}$

$= \dfrac{7.5 \times 8.85 \times 10^{12} \times (0.02 \times 1.6)}{1.0 \times 10^{-8}}$ (1 mark)

$= 2.124 \times 10^{-4}$

$= 2.1 \times 10^{-4}$ m (1 mark)

(b) $\varepsilon_r = \dfrac{C \times d}{A \times \varepsilon_0}$

$= \dfrac{1.0 \times 10^{-8} \times 5.5 \times 10^{-5}}{0.032 \times 8.85 \times 10^{-12}}$

$= 1.94$

$= 1.9$ (or 2.0) no units (1 mark)

(c) $\tau = RC$

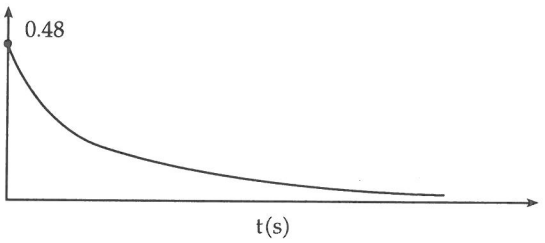
$= 25 \times 0.10$

$= 2.5$ s (1 mark)

$\dfrac{12}{e} = 4.4$ at one time constant, so time $= 2.5$ s (1 mark)

Note: both marks given for 2.5 s answer on assumption candidates knew one time constant was required.

(d)



$$I_{max} = \frac{V}{R}$$
$$= \frac{12}{2.5}$$
$$= 0.48 \text{ A}$$ (1 mark)

General shape (1 mark)

(e) $$\frac{1}{C_T} = \frac{1}{0.10} + \frac{1}{0.10}$$
$$= 20$$
$$C_T = 0.050 \text{ F}$$ (1 mark)

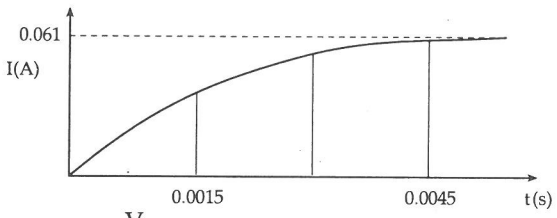
$$Q = C \times V$$
$$= 0.050 \times 12$$
$$= 0.60 \text{ C}$$ (1 mark)

Question 10: Inductance (7 marks)

(a) When I drops to zero a back e.m.f. is induced across L. (1 mark)
The switch is open so V_L is not constrained to 6V and so a **large** voltage causes a shock. (1 mark)

(b) No (or less severe) (1 mark)
Kirchoff's Law gives V_L to be less than or equal to 6V **or** no back e.m.f. is produced at constant current. (1 mark)

(c)



$$I_{max} = \frac{V}{R}$$
$$= \frac{6.0}{99}$$
$$= 0.061 \text{ A}$$ (1 mark)

General shape (1 mark)

$$\tau = \frac{L}{R}$$
$$= 0.0015 \text{ s}$$

time to reach steady state marked in as greater than 3 time constants or shown as infinity. (1 mark)

Question 11: Atomic Physics (11 marks)

(a) $$E = \frac{hcR}{n^2}$$ (1 mark)
$$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8 \times 1.097 \times 10^7}{4^2}$$ (1 mark)
$$= 1.3637 \times 10^{-19}$$
$$= (-)\ 1.4 \times 10^{-19} \text{ J}$$ (1 mark)

(b) $$\Delta E = E_4 - E_2$$
$$= 1.3637 \times 10^{-19} - 5.5 \times 10^{-19}$$
$$= 4.1363 \times 10^{-19} \text{ J}$$ (1 mark)
$$\lambda = \frac{hc}{\Delta E}$$
$$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{4.1363 \times 10^{-19}}$$
$$= 4.8086 \times 10^{-7}$$
$$= 4.8 \times 10^{-7} \text{ m}$$ (1 mark)

Note : $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right)$
gives 4.9×10^{-7} m and 2 marks.

(c) Visible (1 mark)

(d) Yes (1 mark)
U.V. has more **energy** (or hf) than blue (not just higher f or lower λ) (1 mark)

(e) $$E = hf$$
$$= \frac{hc}{\lambda}$$
$$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{4.4 \times 10^{-7}}$$ (1 mark)
$$= 4.52 \times 10^{-19}$$
$$= 4.5 \times 10^{-19} \text{ J}$$ (1 mark)

(f) 4.5×10^{-19} J (accept just less than 4.5×10^{-19} J) (1 mark)

Question 12: Nuclear Physics (12 marks)

(a) Beta particle or beta or electron or e^- (1 mark)
$0.1c < v < c$ or an answer between 0.5c and 0.999c (1 mark)
+2 (1 mark)
0 (1 mark)

(b) Deuterium (close spellings accepted) (1 mark)

(c) - fuel materials are easier to source and/or are cheaper
- no chain reaction problems
- fewer **long half-life** by-products
- larger energy release per kg of fuel.

(1 mark each for any two)

(d) 86 (1 mark)
136 (1 mark)

(e) $1.0\ \text{J} = \left(1.6\times10^{-19}\right)^{-1}\ \text{eV}$

$= 6.25\times10^{18}$

$= 6.3\times10^{18}\ \text{eV}$ (no unit needed) (1 mark)

(f) $E = mc^2$

$m = \dfrac{E}{c^2}$

$= \dfrac{1.7\times10^{6}\times1.6\times10^{-19}}{\left(3.0\times10^{8}\right)^2}$

(1 mark if energy calculated correctly)

$= 3.022\times10^{-30}$

$= 3.0\times10^{-30}\ \text{kg}$ (1 mark)