

In this examination, you may find the following information useful:

Constants:

$$\begin{aligned} g &= 9.8 \text{ m s}^{-2} \\ c &= 3.00 \times 10^8 \text{ m s}^{-1} \\ k &= 1.38 \times 10^{-23} \text{ J K}^{-1} \\ \epsilon_0 &= 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2} \\ 1/(4\pi\epsilon_0) &= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2} \\ \mu_0 &= 4\pi \times 10^{-7} \text{ T m A}^{-1} \\ h &= 6.63 \times 10^{-34} \text{ J s} \\ \hbar = h/2\pi &= 1.06 \times 10^{-34} \text{ J s} \\ e &= 1.60 \times 10^{-19} \text{ C} \\ -e/m_e &= -1.76 \times 10^{11} \text{ C kg}^{-1} \\ m_p &= 1.67 \times 10^{-27} \text{ kg} \\ m_e &= 9.11 \times 10^{-31} \text{ kg} \\ a_0 &= 5.29 \times 10^{-11} \text{ m} \end{aligned}$$

$$\begin{aligned} e &= 2.72 \\ \pi &= 3.14 \end{aligned}$$

Conversion factor:

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$$

Equations:

$$\begin{aligned} T &= 2\pi\sqrt{L/g} \\ p &= \frac{mv}{\sqrt{1-v^2/c^2}} \\ E &= \frac{mc^2}{\sqrt{1-v^2/c^2}} \\ E^2 &= c^2p^2 + m^2c^4 \end{aligned}$$

Derivatives ( $A$ ,  $n$  and  $k$  are constants):

$x$	$dx/dr$
$A$	$0$
$At^n$	$Anr^{n-1}$
$\sin kr$	$k \cos kr$
$\cos kr$	$-k \sin kr$
$e^{kr}$	$ke^{kr}$
$Ay$	$A \frac{dy}{dr}$
$y+z$	$\frac{dy}{dr} + \frac{dz}{dr}$

### Instructions for completing the CME form for Part I of the exam

You will find one CME form provided with this paper.

The general instructions are the same as for the computer-marked assignments that you have been doing during the year. You should use an HB pencil to make entries on the CME form. Use horizontal lines to mark CME cells. If you make any smudges or other marks on the form which you cannot cancel out clearly, you should ask the invigilator for a new form, and transfer your entries to it.

If you do not wish to answer a question, pencil across the 'don't know' cell ('?').

If you think that a question is unsound in any way, pencil across the 'unsound' cell ('U'), in addition to pencilling across either an answer cell or the 'don't know' cell.

For each question, you **must** pencil across **either** the required number of cells **or** the 'don't know' cell.

We suggest that, in the first instance, you answer by writing your answer(s) alongside each question. Check your answers before transferring them to your CME form. **YOU SHOULD NOTE THAT NO ADDITIONAL TIME WILL BE ALLOWED AT THE END OF THE THREE-HOUR PERIOD FOR TRANSFERRING YOUR ANSWERS TO THE CME FORM.**

On Part I of the CME form, you must write in your name, personal identifier (not examination number) and the 'assignment number' for this examination (S271 99). You should also pencil across the cells in the two blocks in Part I of the form corresponding to your personal identifier and the assignment number given.

Failure to follow the above instructions may mean that we shall be unable to award you a mark for this part of the paper.

THREE AND A HALF HOURS

A	A	A	A	0	0	0	0
D	D	D	D	1	1	1	1
E	E	E	E	2	2	2	2
M	M	M	M	3	3	3	3
P	P	P	P	4	4	4	4
S	S	S	S	5	5	5	5
T	T	T	T	6	6	6	6
U	U	U	U	7	7	7	7
H	H	H	H	8	8	8	8
				9	9	9	9