Neap

Trial Examination 2020

Suggested solutions

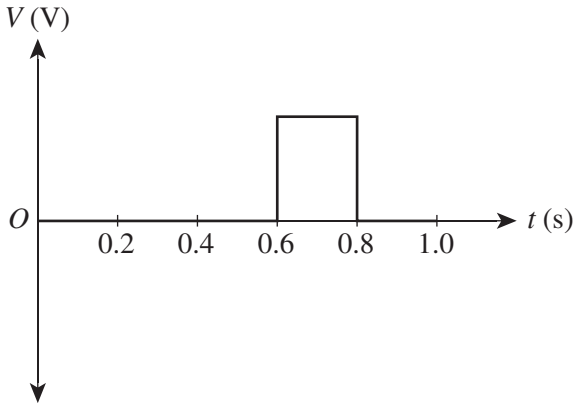
QCE Physics Units 3&4

Paper 2

SECTION 1

QUESTION 1 (8 marks)

a)



[2 marks]
1 mark for horizontal line along x-axis from 0.0 to 0.6.
1 mark for horizontal line above the x-axis from 0.6 to 0.8.

b) $\text{emf} = \dfrac{n\Delta\phi}{\Delta t}$

$= \dfrac{1(0 - 0.8 \times 0.05 \times 0.05)}{0.2}$ *[1 mark]*

$= 0.01$ V *[1 mark]*

c) As the coil is removed vertically upwards, there is a decrease in the external flux to the left. *[1 mark]*

The coil opposes this change in flux by providing its own induced flux to the left, which compensates for the loss of external flux. *[1 mark]*

Using the right hand grip rule, the fingers (induced flux) are aligned to the left through the coil. The thumb points from *A* to *B*, so the direction of the current is *B* to *A*. *[1 mark]*

d) The induced emf could be increased by removing the coil at a faster rate (in less than 0.2 s). *[1 mark]*

QUESTION 2 (8 marks)

a) $\text{speed} = \dfrac{\text{distance}}{\text{time}}$

$\text{time} = \dfrac{216}{50\cos 30}$ *[1 mark]*

$= 4.99$ s *[1 mark]*

b) $s = ut + \dfrac{1}{2}at^2$

$= (50\sin 30 \times 4.99) + \dfrac{1}{2}(-9.8)(4.99)^2$ *[1 mark]*

$= 2.8$ m *[1 mark]*

c) $v_v = u_v + a_v t$

$= 25.0 - 9.8(4.99)$

$= -23.9 \text{ m s}^{-1}$ *[1 mark]*

$v = \sqrt{(-23.9)^2 + (50\cos 30.0)^2}$ *[1 mark]*

$= 49.5 \text{ m s}^{-1}$ *[1 mark]*

$\tan(\theta) = \dfrac{23.9}{43.3}$

$\theta = 29.0°$ to the horizontal *[1 mark]*

QUESTION 3 (9 marks)

a) $\gamma = \dfrac{1}{\sqrt{1 - \dfrac{v^2}{c^2}}}$

$= \dfrac{1}{\sqrt{1 - \dfrac{(0.995c)^2}{c^2}}}$ *[1 mark]*

$= 10.01$ *[1 mark]*

b) $t = t_0 \gamma$

$= 2.2 \times 10.01$ *[1 mark]*

$= 22 \ \mu\text{s}$ *[1 mark]*

c) $l = \dfrac{l_0}{\gamma}$

$= \dfrac{1.200}{10.01}$ *[1 mark]*

$= 0.12 \text{ km}$ *[1 mark]*

d) $E_k = (\gamma - 1) m_0 c^2$ *[1 mark]*

$= (10.01 - 1) \times 105.66 \times c^2$ *[1 mark]*

$= 952.00 \text{ MeV}$ *[1 mark]*

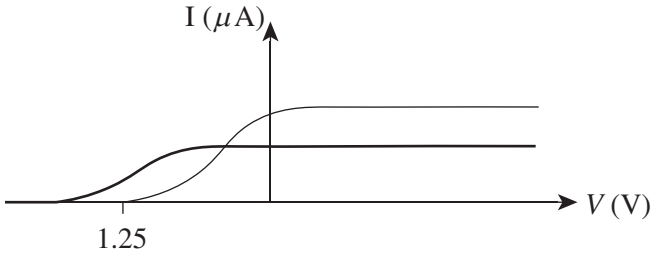
QUESTION 4 (4 marks)

a) $qV = \dfrac{1}{2} m v^2$

$1.25 \times 1.6 \times 10^{-19} = \dfrac{1}{2} \times 9.1 \times 10^{-31} v^2$ *[1 mark]*

$v = 6.6 \times 10^5 \text{ m s}^{-1}$ *[1 mark]*

b)



[2 marks]

1 mark for higher magnitude stopping voltage (x-intercept left of existing curve).
1 mark for lower current (y-intercept lower than existing curve).

QUESTION 5 (4 marks)

$\text{gradient} = \dfrac{F}{Q^2}$ *[1 mark]*

$= \dfrac{5.2 \times 10^{6}}{5.8 \times 10^{-6}}$

$= 9.0 \times 10^{11}$ *[1 mark]*

$F = \dfrac{kQ^2}{r^2}$

$r^2 = \dfrac{kQ^2}{F}$

$r^2 = 9.0 \times 10^{9} \times \dfrac{1}{\text{gradient}}$ *[1 mark]*

$r^2 = 1.0 \times 10^{-2} r$

$r = 1.0 \times 10^{-1}$ m *[1 mark]*

QUESTION 6 (5 marks)

a) $255 \text{ pm} = 255 \times 10^{-12}$ m

$= 2.55 \times 10^{-10}$ m *[1 mark]*

b) $n\lambda = 2\pi r$

$\lambda = \dfrac{2\pi r}{n}$

$= \dfrac{2\pi \times 2.55 \times 10^{-10}}{1}$ *[1 mark]*

$= 1.60 \times 10^{-9}$ m *[1 mark]*

c) $mvr = \frac{nh}{2\pi}$

$$v = \frac{nh}{2\pi mr}$$

$$= \frac{1 \times 6.63 \times 10^{-34}}{2 \times \pi \times 9.11 \times 10^{-31} \times 2.55 \times 10^{-10}}$$ *[1 mark]*

$$= 4.54 \times 10^{5} \text{ m s}^{-1}$$ *[1 mark]*

QUESTION 7 (2 marks)

$$E = \frac{hc}{\lambda}$$

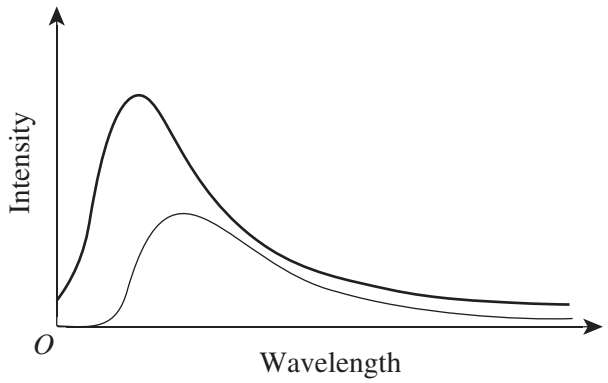
$$= \frac{6.63 \times 10^{-31} \times 3.0 \times 10^{8}}{200 \times 10^{-12}}$$ *[1 mark]*

$$= 9.95 \times 10^{-16} \text{ J}$$ *[1 mark]*

QUESTION 8 (5 marks)

a) Black-body radiation is the electromagnetic radiation emitted by a perfect emitter/absorber of electromagnetic radiation. *[1 mark]*

b)



[2 marks]
1 mark for peak shifted to the left.
1 mark for amplitude of peak increased.

c) $T = \frac{2.898 \times 10^{-3}}{\lambda}$

$$= \frac{2.898 \times 10^{-3}}{970 \times 10^{-9}}$$ *[1 mark]*

$$= 2987 \text{ K}$$ *[1 mark]*