



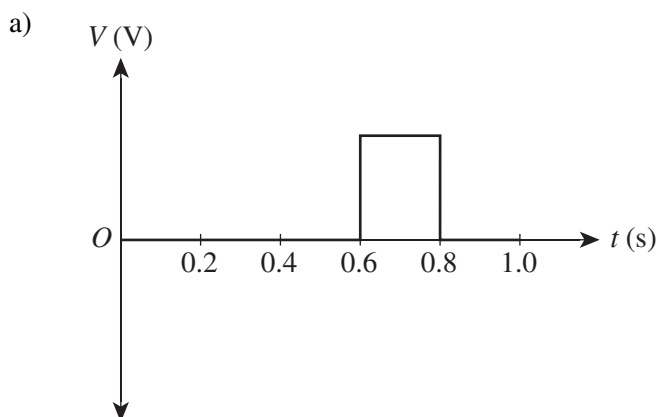
Trial Examination 2020

Suggested solutions

QCE Physics Units 3&4

Paper 2

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SECTION 1**QUESTION 1 (8 marks)**

[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)
$$\text{emf} = \frac{n\Delta\phi}{\Delta t}$$

$$= \frac{1(0 - 0.8 \times 0.05 \times 0.05)}{0.2}$$

$$= 0.01 \text{ V}$$
[1 mark]
[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)
$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{time} = \frac{216}{50 \cos 30}$$

$$= 4.99 \text{ s}$$
[1 mark]
[1 mark]
- b)
$$s = ut + \frac{1}{2}at^2$$

$$= (50 \sin 30 \times 4.99) + \frac{1}{2}(-9.8)(4.99)^2$$

$$= 2.8 \text{ m}$$
[1 mark]
[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]
- $\tan(\theta) = \frac{23.9}{43.3}$
 $\theta = 29.0^\circ$ to the horizontal [1 mark]

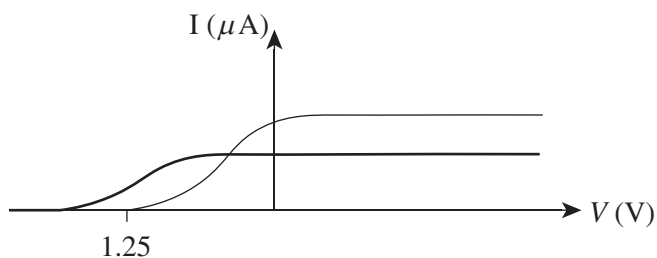
QUESTION 3 (9 marks)

- a) $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$
 $= \frac{1}{\sqrt{1 - \frac{(0.995c)^2}{c^2}}}$ [1 mark]
 $= 10.01$ [1 mark]
- b) $t = t_0 \gamma$
 $= 2.2 \times 10.01$ [1 mark]
 $= 22 \text{ } \mu\text{s}$ [1 mark]
- c) $l = \frac{l_0}{\gamma}$
 $= \frac{1.200}{10.01}$ [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) $qV = \frac{1}{2}mv^2$
 $1.25 \times 1.6 \times 10^{-19} = \frac{1}{2} \times 9.1 \times 10^{-31} v^2$ [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)

$$\text{gradient} = \frac{F}{Q^2} \quad [1 \text{ mark}]$$

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

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

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

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

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

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

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

QUESTION 6 (5 marks)

$$\begin{aligned} \text{a) } 255 \text{ pm} &= 255 \times 10^{-12} \text{ m} \\ &= 2.55 \times 10^{-10} \text{ m} \end{aligned} \quad [1 \text{ mark}]$$

$$\text{b) } n\lambda = 2\pi r$$

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

$$= \frac{2\pi \times 2.55 \times 10^{-10}}{1} \quad [1 \text{ mark}]$$

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

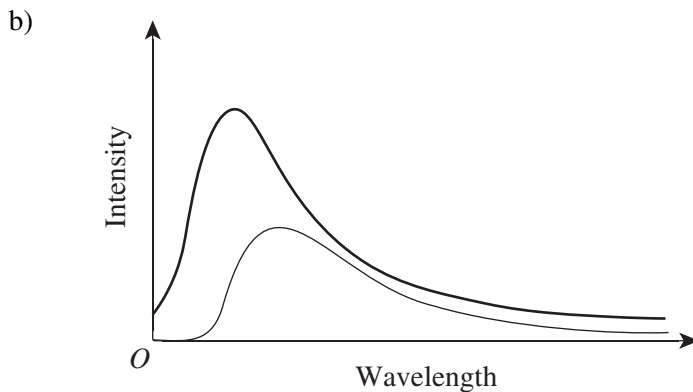
$$\begin{aligned}
 \text{c) } mvr &= \frac{nh}{2\pi} \\
 v &= \frac{nh}{2\pi mr} \\
 &= \frac{1 \times 6.63 \times 10^{-34}}{2 \times \pi \times 9.11 \times 10^{-31} \times 2.55 \times 10^{-10}} && [1 \text{ mark}] \\
 &= 4.54 \times 10^5 \text{ m s}^{-1} && [1 \text{ mark}]
 \end{aligned}$$

QUESTION 7 (2 marks)

$$\begin{aligned}
 E &= \frac{hc}{\lambda} \\
 &= \frac{6.63 \times 10^{-31} \times 3.0 \times 10^8}{200 \times 10^{-12}} && [1 \text{ mark}] \\
 &= 9.95 \times 10^{-16} \text{ J} && [1 \text{ mark}]
 \end{aligned}$$

QUESTION 8 (5 marks)

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



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

$$\begin{aligned}
 \text{c) } T &= \frac{2.898 \times 10^{-3}}{\lambda} \\
 &= \frac{2.898 \times 10^{-3}}{970 \times 10^{-9}} && [1 \text{ mark}] \\
 &= 2987 \text{ K} && [1 \text{ mark}]
 \end{aligned}$$