



SURNAME: Groom

FORENAME(S): LAWRENCE

12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

1	Student Number	1810351
2	Title of Examination Paper	Electromagnetic Radiation
3	Module Code	ACDA 5009
4	Date and Time of Examination	3/05/22 10:00
5	Examination Venue	1Q 002
6	Seat Number	
7	Number of Answer Books handed in	

[illegible]

1

A

Radio ✓

Microwave ✓

IR - Infrared ✓

Visible ✓

Ultra violet ✓

X-ray ✓

Gamma. ✓

7

B

Radio - can induce current in conductors ✓

microwave - can induce current in conductors and heating non conductors ✓

IR - induces heat in both conductors and non conductors does not induce current. ✓

visible - can be seen by the human eye ✓

Ultra violet - cannot be seen by the human eye, is harmful to biological material ✓

X-ray - ionising radiation produced by electrons ✓

gamma - ionising radiation produced by nuclei ✓

7

C

Refraction - the bending of a wave form as it moves between ~~at~~ materials of different properties 1

D

Diffraction - the bending of a wave form over or around an obstacle or through an aperture. 1

E

Dispersion - the break up of a wavelength into its ~~own~~ frequencies ~~DI~~ 1

F

Specular - angles are equal, reflected angle is equal to incoming angle - mirror as example. 1

G

Diffuse - scattering of outgoing wave form from a rough surface 1

H

Transmission - The movement of a wave form through a material without absorption. 1

1

I Absorption - The transfer of energy from a wave from ~~medium~~ to a medium as it passes through.

Q1 = 21

2

a FSK, 433 MHz, 40 Kbit/s, 10 mW

$$\lambda = \frac{c}{f} \quad \lambda = \frac{0.01 \text{ W}}{433 \text{ MHz}} = \lambda = \frac{0.01}{433,000,000}$$

~~λ~~ ≠ divide answer by 4 as quarter wave length antenna

(-2)

b background noise (radio interference)
grounding conditions
line of site from RPA to Antenna
ionising combustion products from RPA motor

c Inverse Square Law. 270m, 10mW gets to 90.

$$90 \times 3 = 270 \text{ so } \sqrt{(90 \times 3)^2} = 270 \text{ so}$$

90mW gets to 270m due to inverse square law.

d high gain antenna/directional antenna such as yagi style.

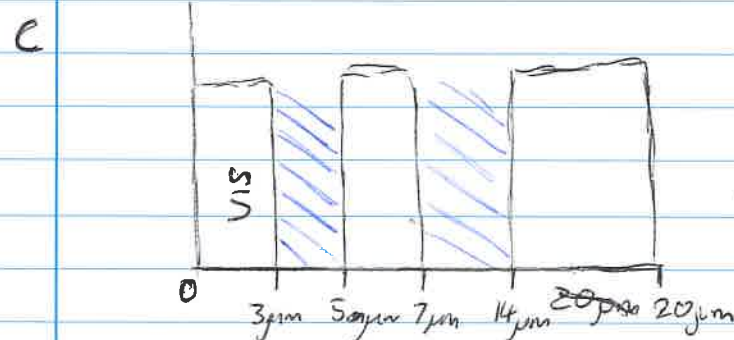
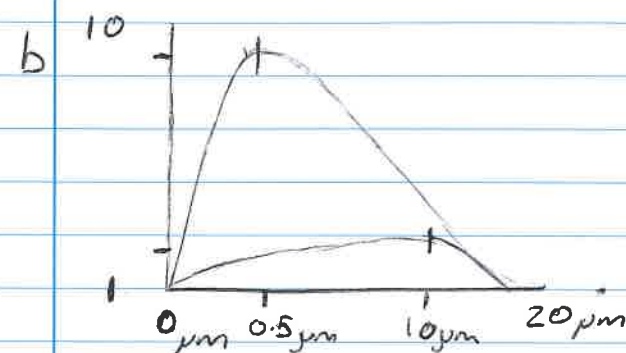
e 6 degrees, 8 bit each, 40 Kbits/sec $\frac{40000}{48} = 833.3$

$$6 \times 8 = 48 - \text{total bits} \quad \frac{48}{40000} = 1.2 \times 10^{-3}$$

Q2 = 8

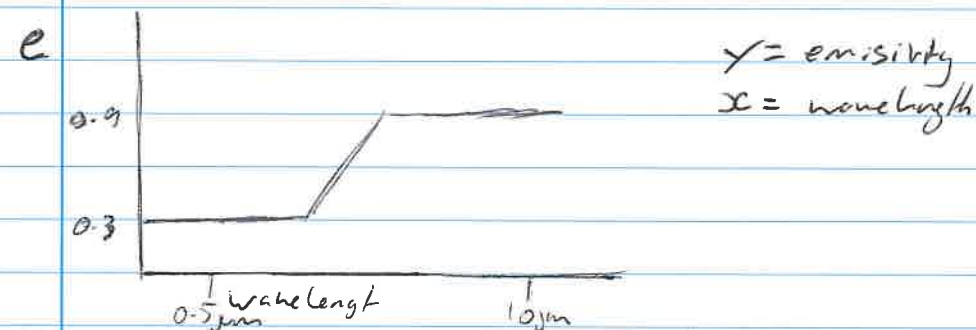
3

A Black body is something ^{that} ~~that~~ absorbs all wavelengths, frequencies ~~and~~ at all angles



IR is Absorbed due to H₂O molecules in atmosphere.
3-5 and 7-14 μm are the IR regions.

d ratio of emittance from a medium and emittance from a perfect emitter (Black body) when both are at the same temperature. temperature. (-2)



f The pigment in the white paint allows good reflection of solar energy at the correct wavelength (0.5 μm) whilst allowing incidence of energy at the correct wavelength of the ~~not~~ medium painted. Best of both worlds. (-1)

Q3 = 13

3

4

1

2

1

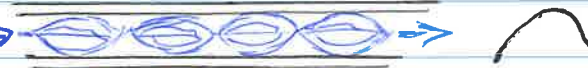
4

a Advantages of Fiber over copper.

- | | |
|------------------------------|-------------------------|
| 1. more secure | 5. lower noise |
| 2. higher bandwidth | 6. cheaper |
| 3. duplex operation possible | 7. more robust/rigidity |
| 4. Smaller | 8. greater range. |

b Step index 

Transmitted signal is reflected from wall and "bounces" down cable, loss of peak results in reduced bandwidth, lower sig strength means less range (1km)

graded index 

Signal is refracted at known angles, sig is more constructed gives slightly high bandwidth as sig is not broken up entirely, greater range as a result (10km)

mono mode 

Signal travels straight, does not impact side walls high bandwidth (Gbit) and extreme range (100km)

Step index ~~dis~~ advantages are cheap and robust

graded index is comparatively cheaper than mono mode and relatively robust

mono mode is ~~very~~ very expensive and fragile.

4

- c
1. robustness/rigidity of fibre
 2. Transmission distance
 3. bandwidth
 4. Cost

Recommended graded index fibre specified for distance element as it is capable of 10 km range. If less range is required then step index is more suitable due to robustness. data rate as will be low as direction control adjustment is not heavy in automation.

Q4 = 22

8

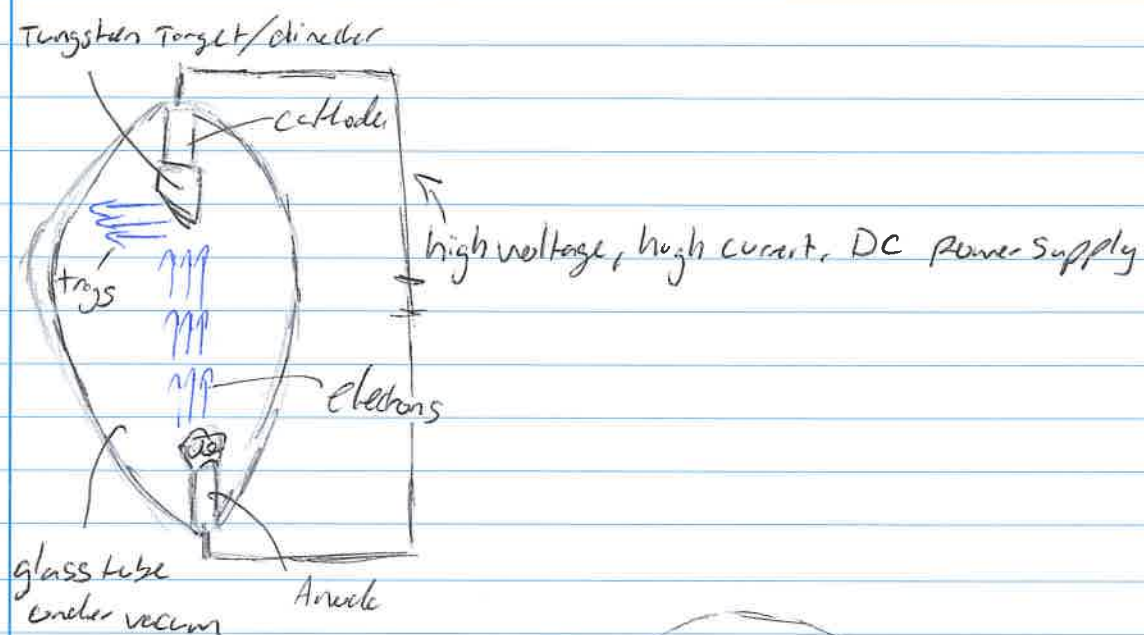
9

5

- a inspection - Airport scanner
 detection - Ecd
 Crystallography - Crystal structure of explosives
 EXR - measurement.

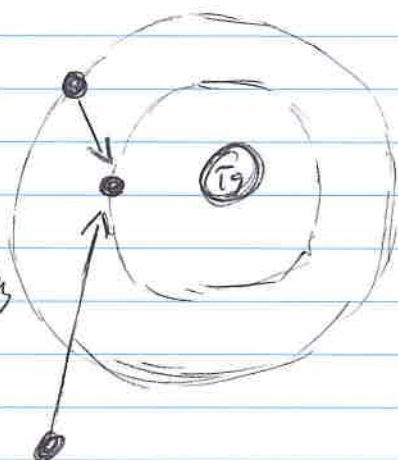
Ce

b



c

high energy electron
 knocks off electron from
 inner shell which is immediately
 replaced by electron in
 outer shell. The outer
 electron moving produces
 an x-ray. The outer
 electron's position is taken up by an electron produced
 by the high voltage, high current circuit.



d

Compton effect.
 charged particles produced by energy imparted on them when
 moving through a field.
 charged particles induce energy onto electrons as they move through the
 charged field

(-1)

5, e

4

1

f

4

6

4

1

density

Thickness

Atomic mass

Atomic number

x-ray energy

$$\mu = \frac{\rho Z^4}{AE^3}$$

where

 $\rho =$ density $Z =$ Atomic number $A =$ Atomic mass $E =$ x-ray energy

$\mu =$ coefficient with distance
 so equates to thickness.

- g highly charged electrons produce an electric field
 that induces current in conductors.
 charged electrons are from the Compton effect.

(-1)

Q5 = 24

- a) directly proportional to current

directly proportional to length of wire

directly proportional to angle of wire and magnetic field.

(-1)

Inversely proportional to distance.

(-2)

- b 1m wire, 1A flows. field of 1T what is force acting on wire.

1T, one Tesla = 1N, one newton

5

4

2

2

2

2

1

5

6

d

$$L = \frac{\mu N^2 A}{l}$$

 $L = \text{Inductance (H)}$
 $\mu = \text{Permeability}$
 $N = \text{No of coils}$
 $A = \text{area enclosed}$
 $l = \text{length of coil}$

$$L = 40 \mu\text{H}$$

$$\mu = 4\pi \times 10^{-7} \text{ Hm}^{-1}$$

$$l = 10 \text{ cm}$$

$$A = 2 \text{ cm} \times 10 \text{ cm (area of cylinder)}$$

Solve for N so transposition of formula.

$$L = \frac{\mu N^2 A}{l} \Rightarrow L l = \mu N^2 A \Rightarrow \frac{L l}{\mu A} = N^2$$

$$\frac{L l}{\mu A} = N^2 \Rightarrow \sqrt{\frac{L l}{\mu A}} = \sqrt{N^2}$$

(-5)

$$\frac{L l}{\mu A} = N^2 \Rightarrow \sqrt{\frac{L l}{\mu A}} = \sqrt{N^2}$$

$$Q6 = 12$$