



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Complete, fold and seal
(see note 2 below)

SURNAME:

JAMES

FORENAME(S):

STEVEN

Examination Answer Books

12 Pages

Instructions to Candidates

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	1810370
2	Title of Examination Paper	Electromagnetic radiation
3	Module Code	ACDA5009
4	Date and Time of Examination	3-5-2022 10:00
5	Examination Venue	IQ 002
6	Seat Number	
7	Number of Answer Books handed in	1 of 1

List the numbers of the questions you have attempted	Office Use
1	21
2	10
3	15
4	22
5	25
6	15
~~7~~	
~~8~~	
Total	

(Gweler yr ochr arall am y fersiwn Cymraeg)

- ① a. Radio wave - Can induce current in a conductor ✓
 + b. Microwave - Can induce current in a conductor + heat in a non conductor ✓
 Infra Red - Can't induce current, can induce heat in a conductor + non conductor ✓
 Visible - Can be seen with human eye ✓
 Ultra Violet - Can't be seen but is biologically harmful ✓
 X Ray - ionising - produced by electrons ✓
 Gamma Ray - ionising - produced by nuclei ✓
- b. Refraction - The bending of angle of wave as it passes from one medium to another ✓
 c. Diffraction - The bending of a wave round a corner, obstacle or through an aperture ✓
 e. Dispersion - The separation of frequencies within a wave ✓
- f. Specular reflection - The reflection of a wave at the same angle of incidence in the opposite plane - A Mirror ✓
 g. Diffuse reflection - The scattering of a wave in all directions due to a rough surface ✓
 h. Transmission - The energy of a wave passing through a medium without absorption ✓
 i. Absorption - The energy of a wave given to a medium as the wave passes through it. ✓

40kb/s 433MHz 10mW

Question No.

2a

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{433 \text{ MHz}} = 0.6928$$

$$0.6928 \div 4 = 0.1732 = \underline{17.32 \text{ cm}}$$

b. Line of sight
Orientation of Antenna
Good ground plane

$$c. I_1 \times D_2^2 = I_2 \times D_1^2$$

$$\therefore \frac{I_1 \times D_2^2}{D_1^2} = \frac{10 \text{ mW} \times 270^2}{90^2} = 90 \text{ mW}$$

d. Use a high gain directional antenna such as a Yagi.

$$e. 8 \text{ bits} \times 6 \text{ degrees} = 48 \text{ bits}$$

$$\frac{48 \text{ bits}}{48 \text{ bits}} \times 40 \text{ kb/s} = 833.3$$

$$\frac{1}{833.3} = \underline{1.2 \text{ ms}} \quad (\text{in reality could be up to } 2 \text{ ms})$$

Examiner Only

2

3

2

1

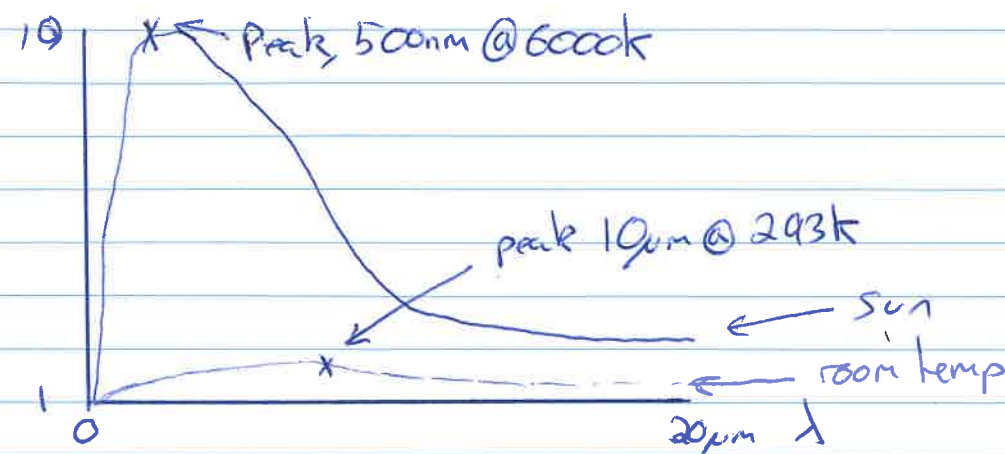
2

Question No.

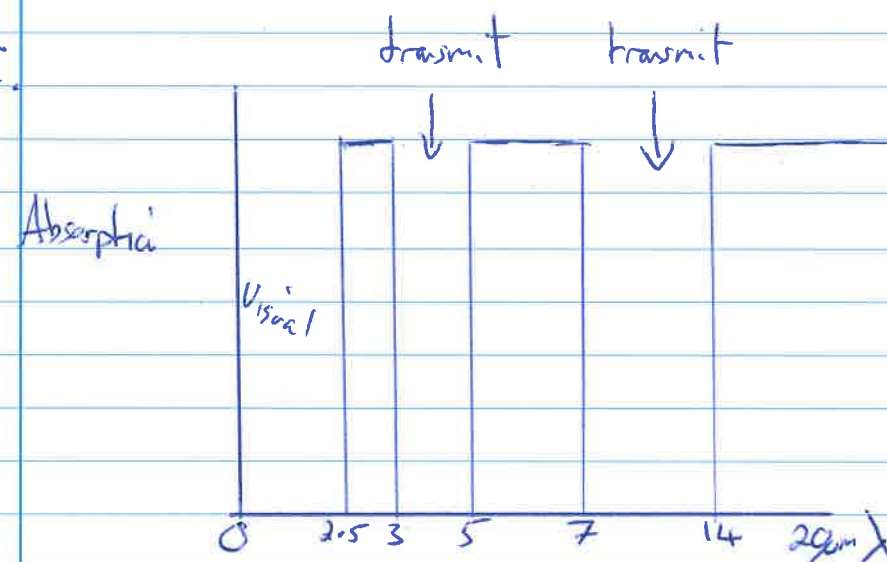
3 a

A black body radiator absorbs all kinds of EMR at all frequencies/wavelength and all angles of incidence

b.



c.

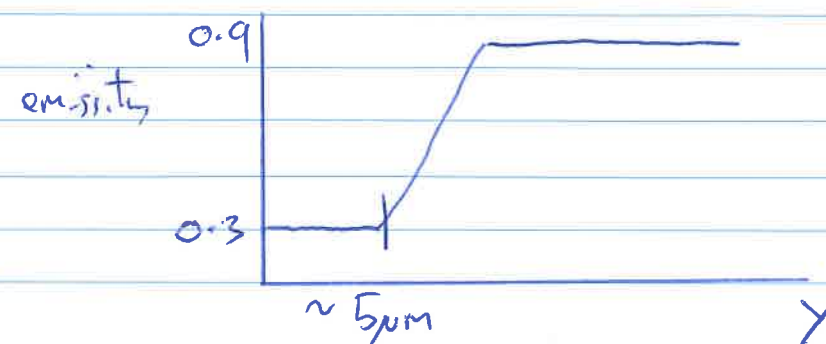


Free Wavelets/frequencies exist bands in the gasses and vapors in the atmosphere which absorb the waves. This absorption makes the atmosphere opaque at those frequencies.

d.

Emmissivity is a ratio of the ^{energy of} body radiating from its surface, compared to that of a perfect radiator. Polished surface ~ 0.02, black paint ~ 0.98

e.



Examiner Only

2

3

4

3

2

3 f. Olive green absorbs lots of wavelengths. White paint absorbs waves from the sun, but also radiates at its own frequencies

1

-1

Q3 = 15

④

- a. Cost - relatively cheap ✓
 Reliable ✓
 2 way communication (Duplex mode) ✓
 Long distance ✓
 high bandwidth / fast data rate ✓
 Secure ✓
 Less susceptible to interference ✓
 Less susceptible to corrosion ✓
 Light weight ✓

8

b. Step index multimode - light refracts from where the core meets the sheath. Multiple angles of refraction disperse the signal. It is robust and cheap works to 1km @ 1Mb/s

3

b. Graded index multimode - the refractive index of the core changes from edge to the centre. This means some light will travel down the centre, other light takes a longer path, but higher velocity reducing dispersion of the wave. works to 10km @ 100Mb/s

3

④ b. chnd.

Single mode - the light travels straight down the core of the cable. The cables are delicate and expensive the work to 100km @ 1Gb/s

3

- c. Cost ⑤ ✓
 bandwidth ④ ✓
 Durability ② ✓
 Length of transmission ① ✓
 Reliable ③ ✓

5

The torpedo will travel ~80knts, and only requires minimal inputs, up/down, left/right, go. It must be a durable cable to survive stresses of use.

Step index multimode would be a good choice. However the torpedo may travel 10km, therefore Graded index is best to carry the signal over the long distance.

Q4 = 22

⑤ a. Security

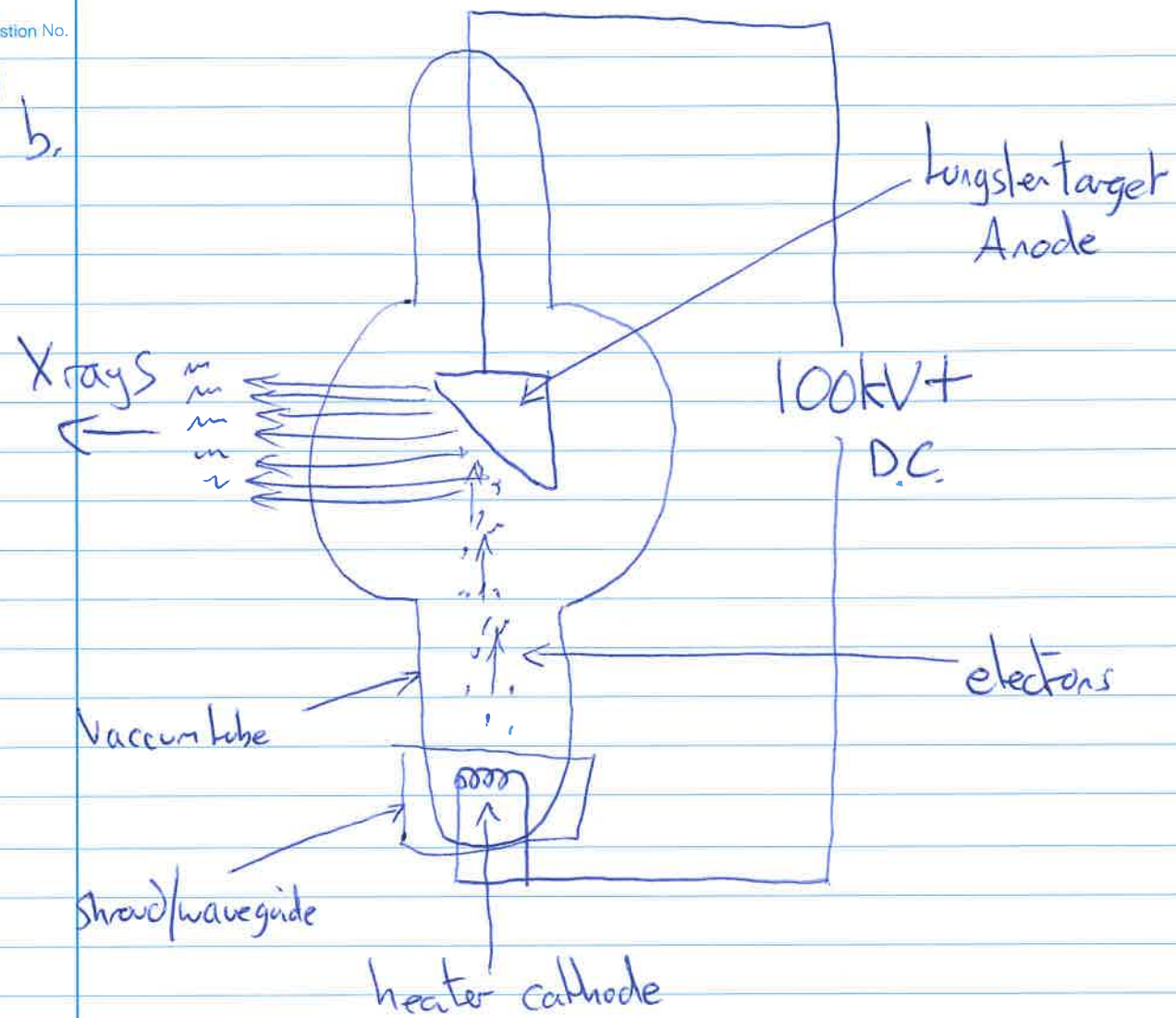
Crystallography
 flash X-ray

Non destructive testing (NDT)

Triggering the secondary in a 2 stage nuclear warhead.

4

Question No.
5 b.



c. Electrons pass from the cathode and hit the tungsten target anode. As they hit the tungsten, an electron from the inner orbital of the tungsten is 'knocked off'. This electron is replaced by an electron from the outer orbital "jumping down" the orbitals. The energy produced from the electron jumping down is emitted as a high energy photon of X-rays.

d. As a photon interacts with a charged particle, it is scattered. This interaction reduces the energy of the photon.

(-1)

Examiner Only

Question No.

5 e. Atomic Mass A
Atomic Number Z
Thickness
Density ρ
Energy of X-ray E

4

f. absorption α
(μ) $\frac{\rho Z^4}{A E^3}$

g. Nuclear fission releases gamma rays into the atmosphere. These gamma rays interact with the particles in the atmosphere. Due to Compton effect, the interaction produces varying electric fields. These varying electric fields induce currents into conductors.

6

a. Directly proportional to - Current $\propto I^2$
- length of conductor $\propto L^2$
- Angle $\propto \theta^2$
Inversely proportional to - distance from conductor

QS = 25

(-3)

4

b. 1 Newton

1

P.T.O.

Examiner Only

5

4

3

6

1

5

⑥

d.

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

$$l = 10 \text{ cm} \quad 0.1 \text{ m}$$

$$\text{diameter} = 2 \text{ cm} \quad 0.02 \text{ m}$$

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

$$\mu = 4\pi \times 10^{-7} \\ = 1.256637 \times 10^{-6} \quad \checkmark$$

$$A = \pi r^2 \quad 2\pi r$$

$$A = \pi \times 0.01^2 \quad 2 \times \pi \times 0.01$$

$$= 314159 \mu\text{m}^2 = 0.000314159 \text{ m}^2 \\ \times 10^{-6} = 3.14159 \times 10^{-7} \text{ m}^2$$

$$L \times l = \mu N^2 A$$

$$A = \pi D \times L$$

$$= \pi \times 0.02 \times 0.1$$

$$= 6.28 \times 10^{-3}$$

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

$$\therefore \sqrt{\frac{L \times l}{\mu \times A}} = N$$

$$\therefore \sqrt{\frac{40 \mu\text{H} \times 0.1 \text{ m}}{(3.14159 \times 10^{-7}) \times (1.2566 \times 10^{-6})}} = \frac{4 \times 10^{-6}}{3.9 \times 10^{-10}}$$

$$4 \times 10^{-6}$$

$$7.89 \times 10^{-9}$$

$$3.14 \times 10^{-3}$$

$$\sqrt{\frac{40 \mu\text{H} \times 0.1 \text{ m}}{1.256 \times 10^{-6} \times 6.283 \times 10^{-3}}} = 22.5 \text{ turns}$$

②

3