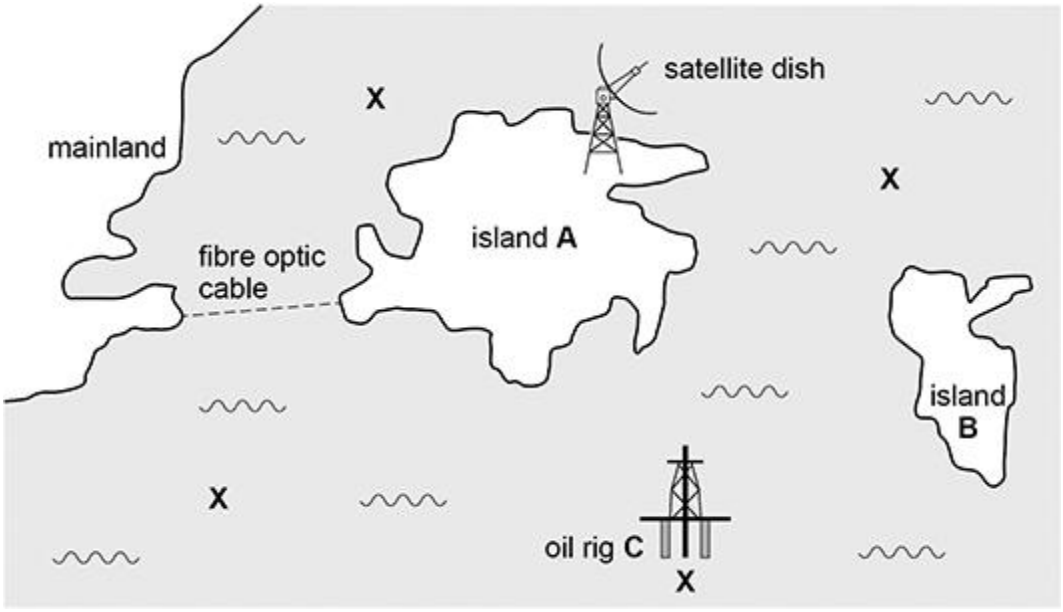
Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

The figure below shows island **A**, a fully developed island off the mainland coast. The island is connected to the mainland by a fibre optic cable lying along the seabed and it also has a satellite link.

Nobody lives on island **B**, but it is due to be developed as a major holiday resort over the next 5 years.

Moveable oil rig **C** is due to explore the four sites marked '**X**' for oil and gas over a 9-month period.



A communications company has been asked to provide solutions for island **B** which will allow the development to begin immediately and then later to support a fully developed holiday resort.

A communications solution is also required for oil rig **C** during the 9-month exploration period.

Describe appropriate solutions involving fibre optic cabling and satellite communication systems for each of the two clients, island **B** and oil rig **C**.

In your answer you should:

- outline the way each communications system operates
- suggest, with reasons, your choice of system for each solution.

_____

_____

_____

(Total 6 marks)

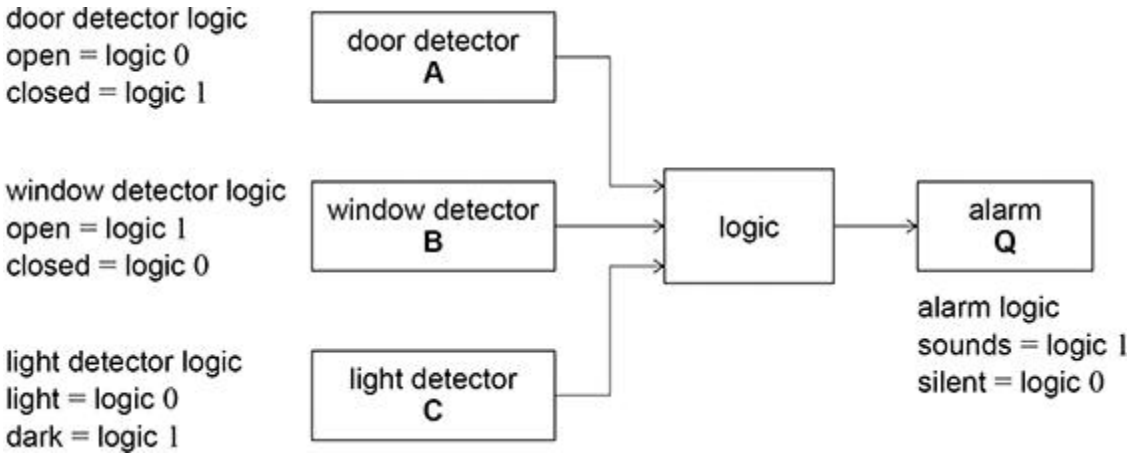
Q2.

A burglar-alarm system in a house sounds an alarm during the hours of darkness when **one** of the following conditions is met:

- the door is opened
- the window is opened
- both the door and the window are opened.

Figure 1 shows the main burglar-alarm subsystems and the logic status for the inputs and output.

Figure 1



(a) The table below is a partially completed truth table for the logic subsystem.

Inputs			Output
C	**B**	**A**	**Q**
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0

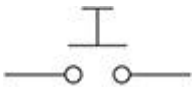
1	0	0	1
1	0	1	
1	1	0	
1	1	1	

Complete the table above.

(1)

Figure 2 shows the symbol of the push-to-make switch used in the door detector. When the door is closed, the switch button is pushed down onto the contacts. It automatically releases when the door opens.

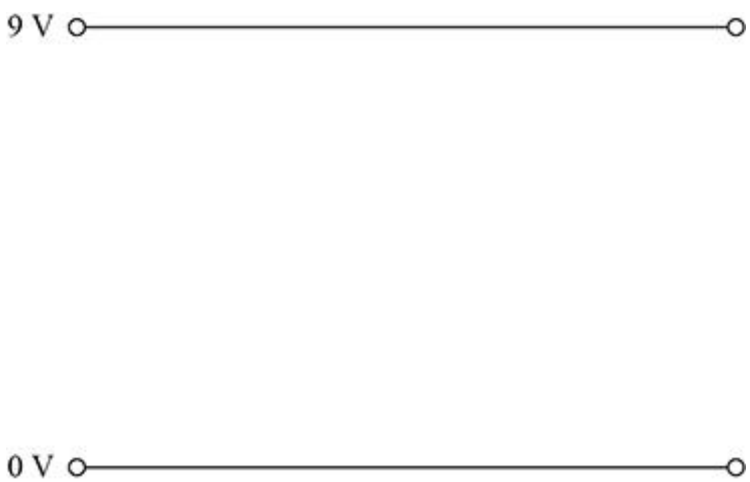
Figure 2



(b) Complete **Figure 3** to show how this switch, together with a 10 kΩ resistor, can be connected to create the door detector circuit in **Figure 1**.

Label the output of the circuit with an **X**.

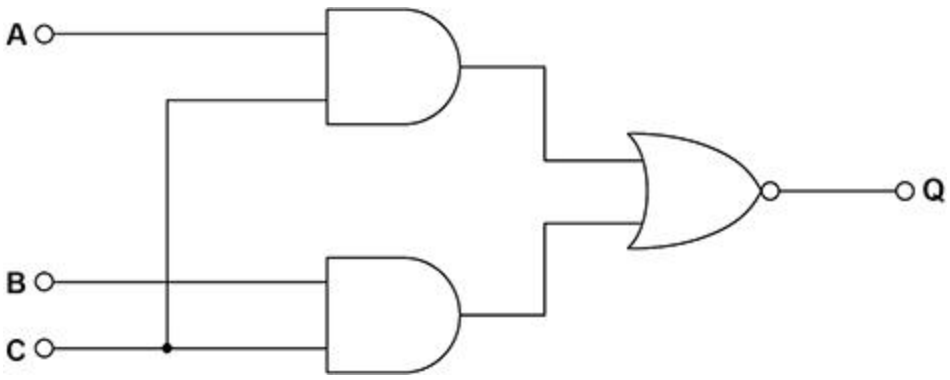
Figure 3



(2)

Figure 4 shows a logic circuit for a different alarm system.

Figure 4



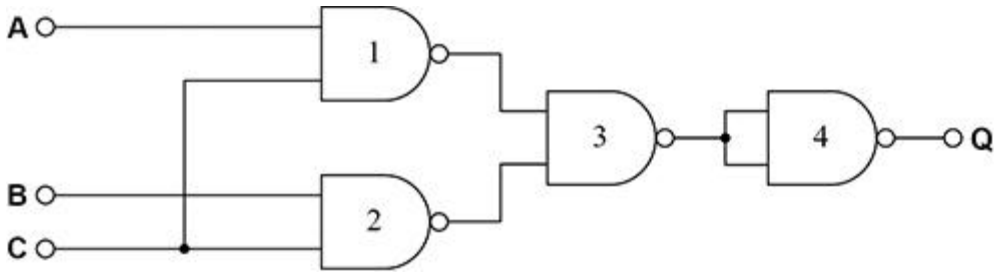
(c) Write the Boolean algebra expression for **Q** in terms of inputs **A**, **B** and **C**.
In your answer use only AND and NOR operators.

Q = _____

(2)

(d) **Figure 5** shows a logic circuit that has the same function as the circuit in **Figure 4**.
Only one type of gate is used in the circuit in **Figure 5**.

Figure 5



State the logic function performed by gate 4.

_____

(1)

(e) Microchips containing two-input logic gates are mass-produced. Each microchip contains four identical logic gates.

A manufacturer of the logic circuit used in the burglar alarm chooses to make the circuit in **Figure 5** rather than that in **Figure 4**.

Suggest why.

_____

_____

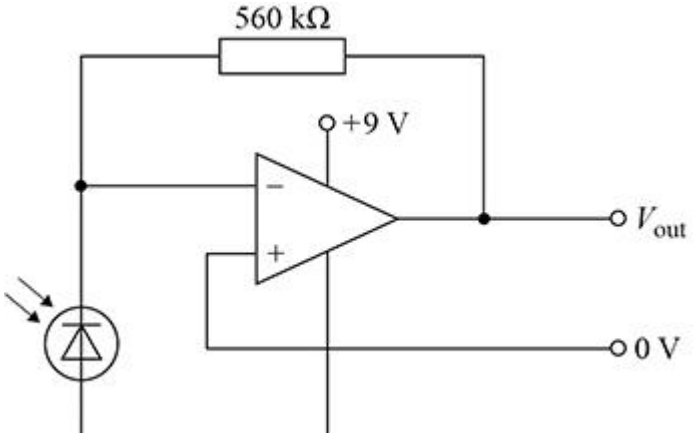
(1)

(Total 7 marks)

Q3.

Figure 1 shows the circuit for an infrared detector using a photodiode and an operational amplifier. In this application the operational amplifier uses a feedback resistor to give a voltage signal when the current in the photodiode changes.

Figure 1



(a) State the mode in which the photodiode is being used in **Figure 1**.

_____

(1)

(b) In the circuit shown in **Figure 1**, there is a current in the photodiode even when there is no light incident on it. This current is called the dark current.

In an optical communication system, the dark current needs to be very small in comparison to the photodiode current.

Explain why.

_____

_____

(1)

The responsivity R_λ of a silicon photodiode is a measure of its sensitivity to light at a given wavelength λ.

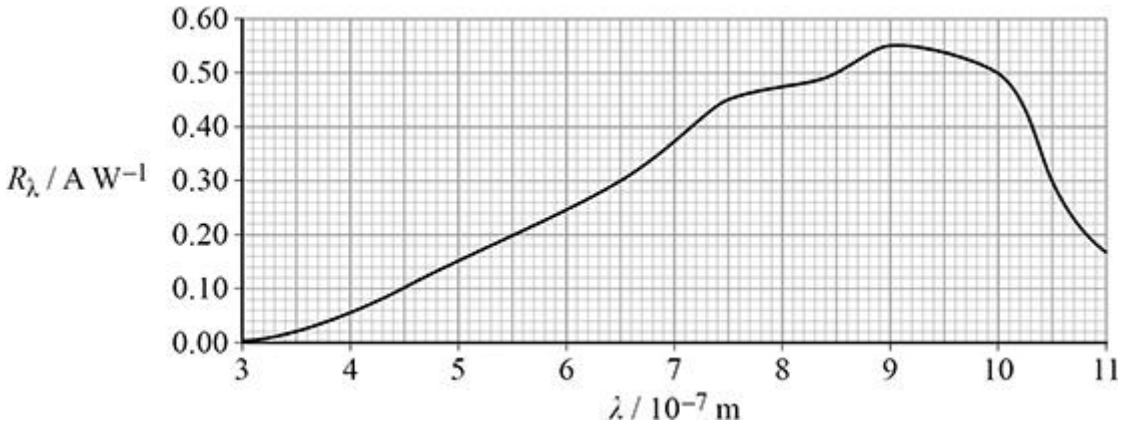
R_λ is defined as:

$$R_\lambda = \frac{I_p}{P}$$

where I_p is the current in the photodiode and P is the incident light power at the given wavelength.

Figure 2 shows the spectral response graph for this photodiode.

Figure 2



(c) Monochromatic radiation of wavelength 850 nm and power 4.0 μW is incident on the photodiode in **Figure 1**.

Calculate the output voltage of the detector circuit.

output voltage = _____ V

(3)

(d) The output from the detector circuit in **Figure 1** needs to be amplified by a factor of +4

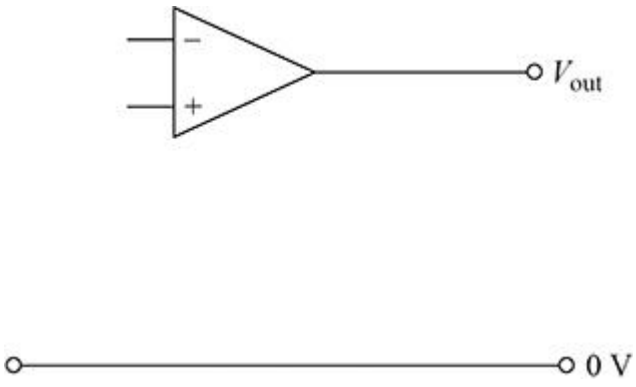
Complete **Figure 3** to show the amplifier circuit required.

In your completed circuit you should:

- label the input point as $\mathbf{V_{in}}$
- label your Figure with the values of resistance for any resistors used in your circuit. Any resistance values must lie within the range 1 kΩ to 100 kΩ.

Do **not** show the power supplies to the operational amplifier.

Figure 3



(3)
(Total 8 marks)