Practice Question Set For A-Level
Subject : Physics
Paper-3 Topic: Section B (Section 13_ Electronics)

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

Q1.

A telephone company transmits 15 speech channels across a single transmission link. The analogue information is first subjected to pulse code modulation (PCM) before transmission using time division multiplexing (TDM). The transmission system incorporates regenerators which remove noise from the signal.

Explain the basic principles of:

- pulse code modulation (PCM)
- time division multiplexing (TDM)
- a regenerator.

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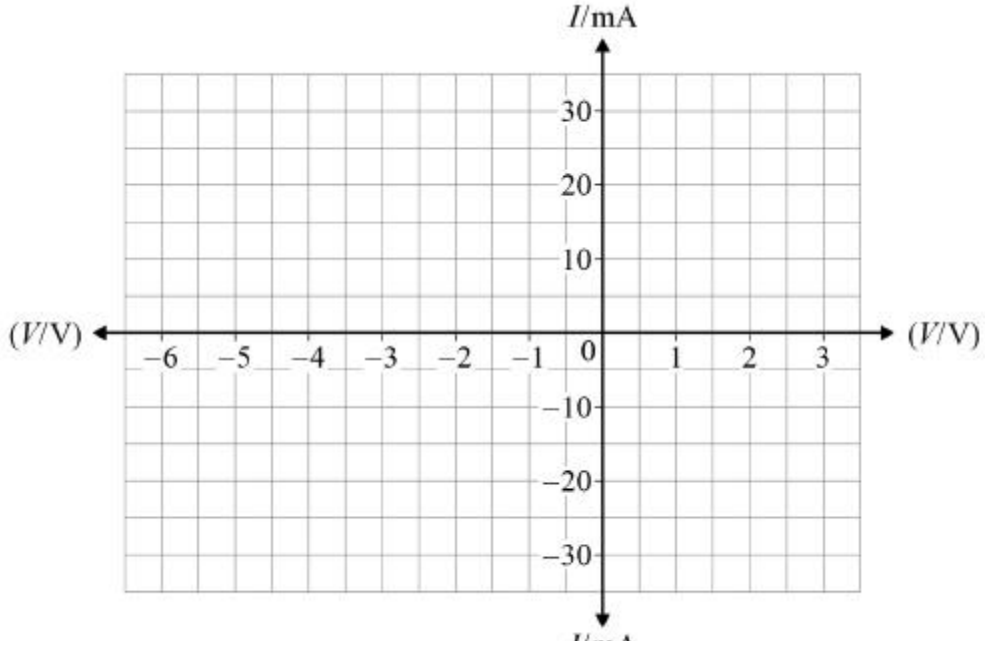
(Total 6 marks)

Q2.

A silicon-based 5.1 V Zener diode requires a minimum operating current I of 5.0 mA to maintain its Zener voltage V_z.

(a) Draw on **Figure 1** the general $I-V$ characteristic for this diode.

Figure 1

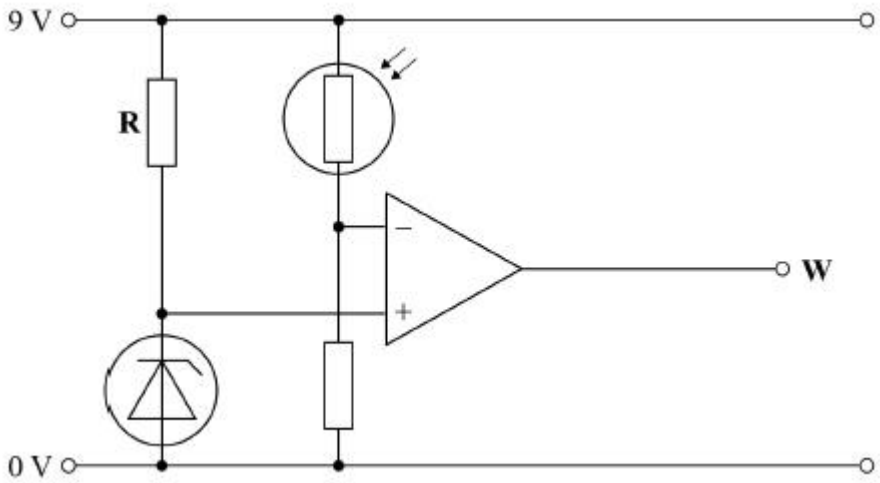


(2)

(b) **Figure 2** shows a circuit that uses a 5.1 V Zener diode.

The circuit causes the output **W** of the operational amplifier to change at a particular light intensity.

Figure 2



State the function of the Zener diode in this circuit.

_____

(1)

(c) Deduce whether a 100 Ω, 0.13 **W** resistor is suitable for **R** in **Figure 2**.

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(2)

(d) The circuit in **Figure 2** is rebuilt and the position of **R** is swapped with the position of the Zener diode.

Explain how this affects the light intensity at which **W** changes.

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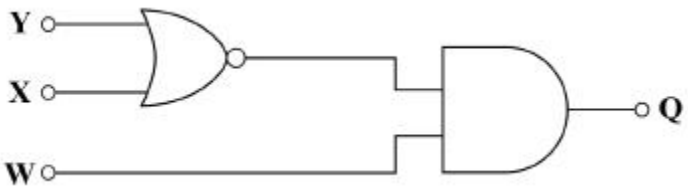
(2)

(e) The output **W** from the operational amplifier shown in **Figure 2** becomes one of three inputs to the combinational logic circuit shown in **Figure 3**.

Figure 3



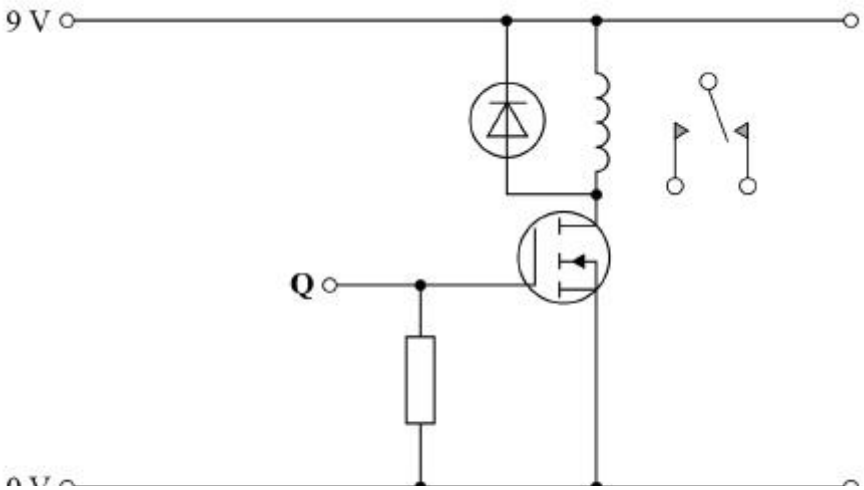
Write the Boolean algebra expression for the output **Q** in terms of **W**, **X** and **Y** based on the logic gates shown in **Figure 3**.

Q = _____

(1)

(f) Output **Q** from **Figure 3** becomes the input to the final part of the circuit shown in **Figure 4**.

Figure 4



The circuit uses a MOSFET to activate a relay.

State **one** property that makes the MOSFET suitable for interfacing with logic gates.

_____

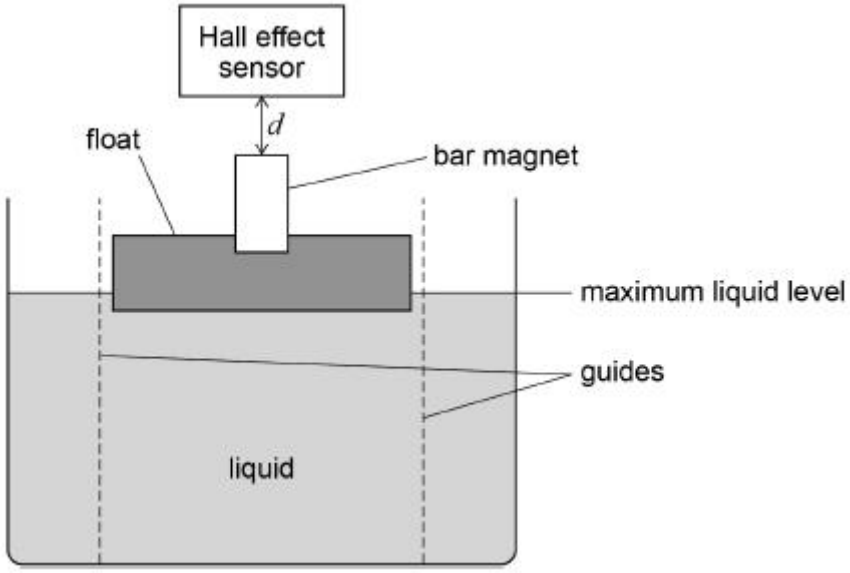
(1)

(Total 9 marks)

Q3.

Figure 1 shows a system to monitor a tank filling with liquid in which a magnet is mounted on a float.

Figure 1



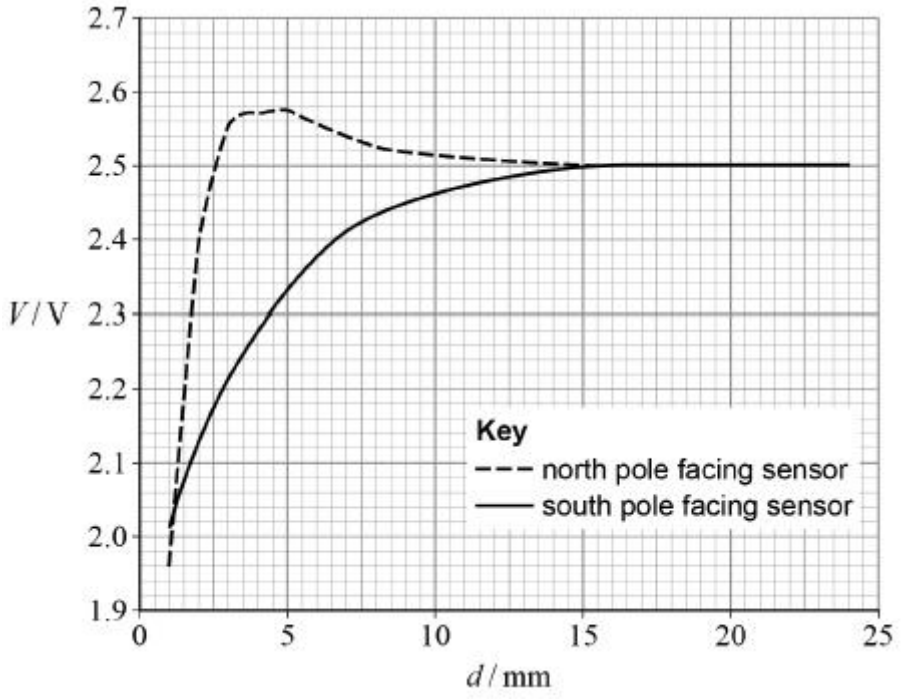
The Hall effect sensor produces an output voltage V. V depends on the distance d between the sensor and the magnet.

When V reaches a certain value, the flow of liquid to the tank is switched off.

The magnet may be arranged with either the north (N) or south (S) pole facing the sensor.

Figure 2 shows how the magnitude of V varies with d for the two possible arrangements of the magnet.

Figure 2



(a) Compare the advantages of the two arrangements for monitoring the movement of the magnet towards the Hall effect sensor.

In your answer you should compare:

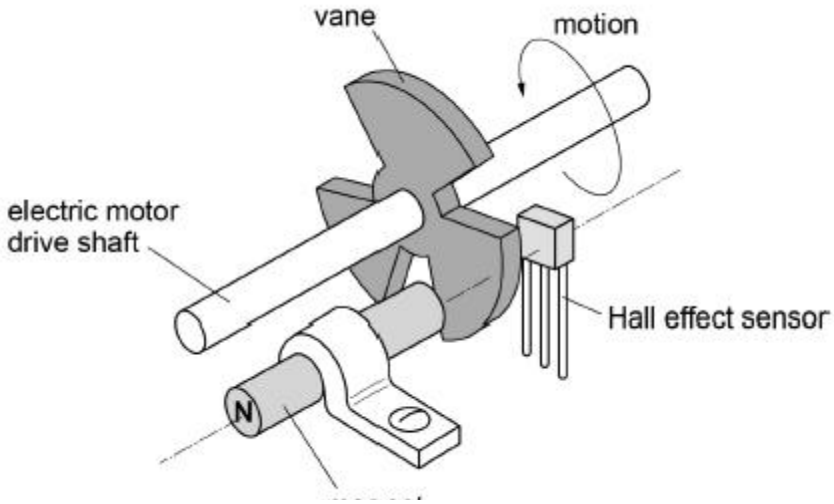
- the sensitivity of the system
- the range of d over which the system is useful.

You may ignore any effect from the Earth's magnetic field.

(3)

(b) **Figure 3** shows a Hall effect sensor being used as a tachometer to monitor the rotational speed of the drive shaft of an electric motor.

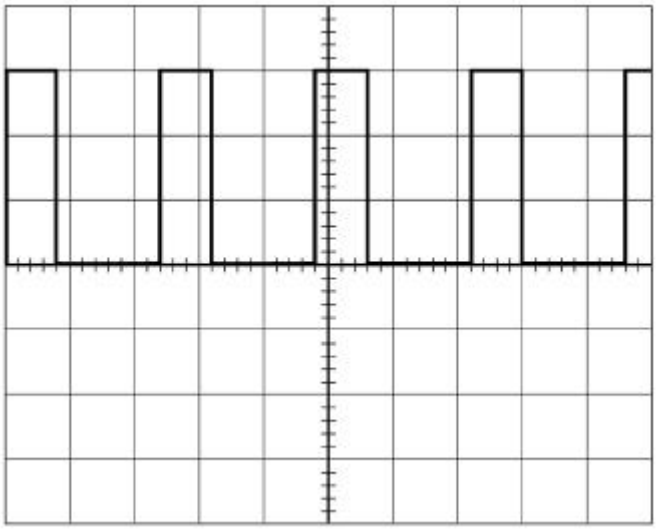
Figure 3



The output of the Hall effect sensor is connected to an oscilloscope. When the vane is between the magnet and the Hall effect sensor, the output of the Hall effect sensor is low.

The trace produced on the oscilloscope is shown in **Figure 4**.

Figure 4



The time-base on the oscilloscope is set to 5 ms / div.

Calculate the number of complete revolutions of the drive shaft in one second.

number of complete revolutions = _____ V

(3)

(Total 6 marks)