



**DESIGN TECHNOLOGY
HIGHER LEVEL
PAPER 2**

Monday 20 May 2002 (afternoon)

1 hour 30 minutes

Name

--

Number

--	--	--	--	--	--	--	--

INSTRUCTIONS TO CANDIDATES

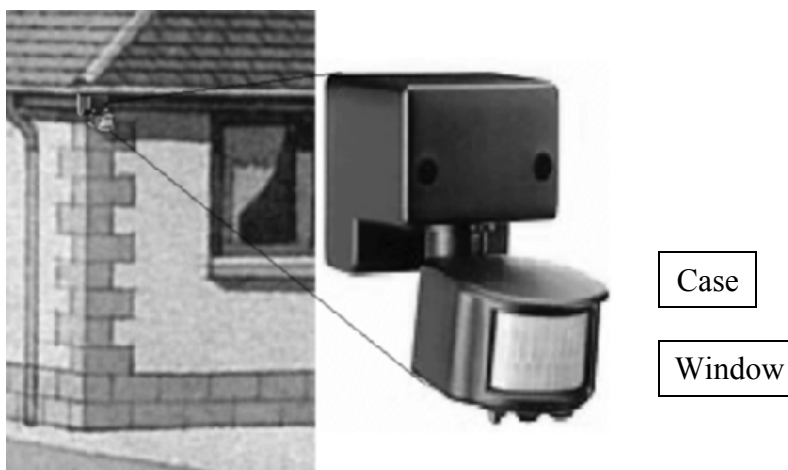
- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: Answer all of Section A in the spaces provided.
- Section B: Answer one question from Section B. Write your answers in a continuation answer booklet, and indicate the number of booklets used in the box below. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.
- At the end of the examination, indicate the number of the Section B question answered in the boxes below.

QUESTIONS ANSWERED		EXAMINER	TEAM LEADER	IBCA
SECTION A	ALL	/32	/32	/32
SECTION B	/20	/20	/20
NUMBER OF CONTINUATION BOOKLETS USED	TOTAL /52	TOTAL /52	TOTAL /52

SECTION A

Candidates must answer **all** questions in the spaces provided.

1. Home security has become easier and less intrusive with the development of Passive Infrared Detectors (PIR) as shown below. PIRs use the natural emission of infrared radiation from humans and other animals to generate signals which can open locks or trigger alarms. Large animals emit more infra-red radiation which can be detected by lower sensitivity PIRs.



The table shows data for a range of PIRs.

Model	Operating Voltage (V)	Sensitivity			Response Time (m sec ⁻¹)	Preferred Location	
		High	Medium	Low		Interior	Exterior
PIR40	12-15	*			0.3		*
PIR50	6-14		*		0.91	*	
PIR55	10-20			*	0.6 - 1.2 adjustable	*	*
PIR60	8-24	*			0.8 - 2.3 adjustable	*	*

(a) State the: -

- (i) Preferred Location of PIR40; [1]

.....

- (ii) The least sensitive model; [1]

.....

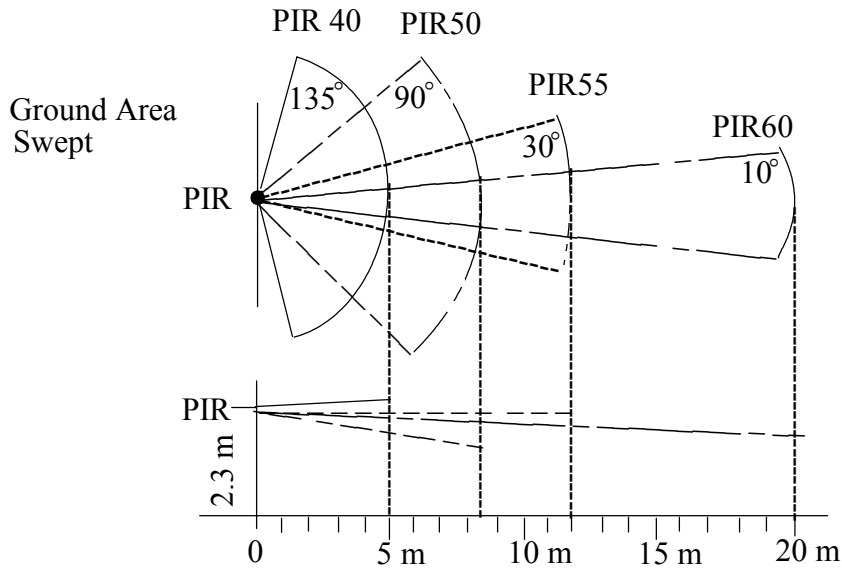
- (iii) Identify the operating voltage range that would allow any of the detectors to operate. [1]

.....

(This question continues on the following page)

(Question 1 continued)

Range and field of view chart.



- (b) (i) Calculate the area swept by PIR55 at ground level with the PIR at 2.3 m above the ground. [2]

.....

.....

.....

(This question continues on the following page)

(Question 1 continued)

A family pet cat requires to access a pet door. The door is secured by a solenoid bolt released when the system is activated. The door must only be released by the cat, not by a human or larger animal. The pet door is positioned within the main house door.



- (ii) Select a sensor (A) to detect a human but not a small animal at a distance of 10 m. [1]

.....

- (iii) Select a sensor (B) to detect a small animal and a human at a distance of 2.5 m. [1]

.....

- (iv) Annotate the diagram to show the positions of sensors A and B to be most effective. [2]

- (c) (i) Complete the truth table to operate the solenoid lock (Logic = 1) to allow the cat to enter only when alone. [1]

Sensor A (Human)	Sensor B (Cat)	Solenoid

(This question continues on the following page)

(Question 1(c) continued)

- (ii) Design a logic circuit to satisfy the conditions of the truth table. [3]

- (d) (i) List **two** criteria for the specifications of the material for the window of PIR40. [2]

.....
.....
.....

The case of the PIR is manufactured from a thermoset.

- (ii) Outline the structure and bonding of a thermoset suitable for this application. [2]

.....
.....
.....
.....

- (iii) Outline how the properties of a thermoset affect its ability to be recycled. [2]

.....
.....
.....
.....

2. (a) Outline the need to season natural timber. [3]

.....
.....
.....
.....

(b) Outline the need for large amounts of energy to manufacture glass. [2]

.....
.....
.....
.....

(c) State why scrap glass is added to new raw materials to manufacture glass. [2]

.....
.....

3. (a) Define an *alloy*. [1]

.....
.....

(b) Describe the difference between an alloy and a composite material. [2]

.....
.....
.....
.....

4. (a) Define *ductility*. [1]

.....
.....

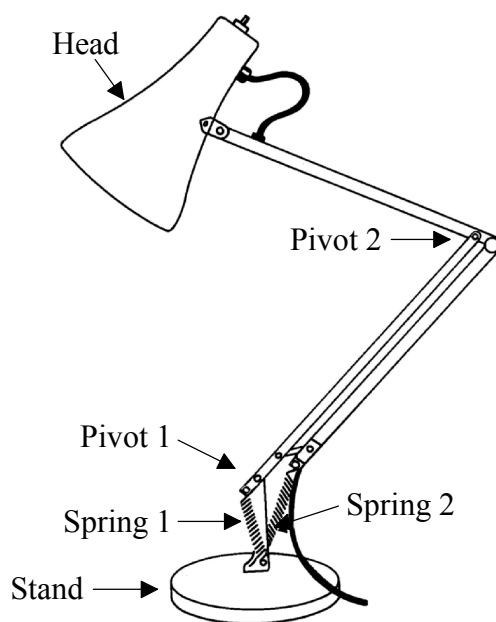
(b) Outline a manufacturing context where ductility is an important consideration. [2]

.....
.....
.....
.....

SECTION B

Answer **one** question. Up to three additional marks are available for the construction of your answer. Write your answers in a continuation answer booklet. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.

5. The ‘angle poise’ lamp shown below is a classic design for a desk lamp.



(a) (i) List **two** criteria for the specification for a material for the head. [2]

(ii) Identify **two** suitable materials for the head. [2]

(b) The velocity ratio (VR) of the lamp mechanisms is 10:1. The head moves 10 times to 1 unit extension of the spring.

(i) Calculate the mechanical advantage and the percentage efficiency if the lamp remains in equilibrium when the head has a mass of 40 g and the spring exerts a force equivalent to 100 g. [3]

$$MA = \frac{\text{Load}}{\text{Effort}}$$

$$\% \text{ efficiency} = \frac{MA}{VR} \times 100$$

(ii) Outline **two** reasons for the efficiency as calculated. [2]

(c) Describe **three** criteria for evaluating the desk lamp justifying your reasons for choice. [8]

6. An automated warehouse stores items for a volume production plant assembling cars. On arrival, the components, in containers, are weighed and logged to be stored in a vertical matrix automated storage system.



- (a) (i) Outline the need for a ‘factor of safety’ in structural design. [2]
- (ii) The factor of safety for the storage system described is 5.8. The normal maximum load is 200 tonnes. Calculate the design load. [2]
- $$\text{Factor of safety} = \frac{\text{Design Load}}{\text{Normal max Load}}$$
- (b) (i) List **three** functions that a robotic system must have. [3]
- (ii) Outline the advantage of using a robotic system in this context. [2]
- (c) The vertical storage system has 64 cells arranged in a 8×8 matrix. The storage/retrieval device has to be able to store and retrieve from any cell.
- Describe a specification for a control system that would allow this to function automatically. [8]

7. African villagers in remote rural areas spend as much as 50 % of their time collecting fuel for cooking fires. As their local reserves are depleted so a larger amount of time is needed to find more fuel. A new, more efficient form of cooking device is required.



- (a) (i) Describe the difference between a resource and a reserve. [2]
- (ii) List **two** renewable energy sources. [2]
- (b) (i) Outline **three** appropriate means of collecting data on this subject to help designers generate ideas. [3]
- (ii) Identify an appropriate form of modelling in this context. [2]
- (c) Two solutions have been proposed:
- I A solar powered cooking device using concave mirrors on a tripod focussing on hot plate.
- II A ceramic, fuel efficient, multi-solid fuel cooker. [8]
- Evaluate the proposed solutions and discuss their appropriateness to the needs of the villagers.
-