



PIABC LEVEL 5 DIPLOMA IN PACKAGING TECHNOLOGY
(Qualification No. 610/0740/7)

**SAMPLE EXAMINATION PAPER
(WITH SUGGESTED SOLUTIONS)**

K/650/2134 UNIT 2 (PAPER A)

UNDERSTANDING PACKAGING MATERIALS AND COMPONENTS

INSTRUCTIONS TO CANDIDATES

Write your answers in the answer book provided.

Wherever possible, use diagrams to illustrate your answer.

This is a closed book examination.

100 marks are available in total for this examination.

The number of marks is given in brackets () at the end of each question or part question.

Leave time at the end to check your answers.

This examination paper is worth 50% of the total marks for Unit 2

Examination Time: 2 Hours

Issued under the authority of the
PACKAGING ASSESSMENT BOARD
14 September 2023

SECTION 1

TWO QUESTIONS - 20 MARKS EACH

Question 1

- A) Identify the FOUR main ingredients (excluding cullet) in a batch of container glass (Type III) and describe the function of each ingredient in the mix. (4 x 1 mark)
- B) Cullet is often added to the mix. How can this affect the glass making process? (2 marks)
- C) Explain why hot and cold end coatings are used on glass; describe where they are applied, and the typical materials used. (4 marks)
- D) A bottle can be made by one of two blowing processes. Briefly describe the difference between these processes and discuss the benefits/drawbacks of each process. (2 x 5 marks)

Suggested Solution

- A) For example, silica sand is the main ingredient, making up around 70% of the batch. It provides the structure for the glass.
- B) Cullet (recycled glass) content varies can be anything from 0% to over 90%. It reduces the use of raw materials, lowers energy needs (every 10% cullet reduces energy requirement by 2.5%), however it can add undesirable contaminants, (stones, borosilicate, colour) which can increase rejects. Reduce CO2 emissions.
- C) Main aim is to prevent scuffing / scratching.
Hot end: applied before the Lehr. Primer or bonding agent coat (Tin or Titanium tetrachloride). Strengthens glass.
Cold end: applied after the Lehr. Friction reducing coat (Oleic acid, monostearates, waxes, silicones, polyethylenes)
- D) A description of the difference between blow & blow and narrow neck press & blow processes is required. Followed by a discussion about the narrow neck press and blow process having better control than the blow and blow process and has enabled glass manufacturers to increase overall productivity and reduce weight and variations in the thickness/glass distribution of beer and beverage bottles. Tooling costs of NNPB are generally higher compared to B&B.

Question 2

A carbonated orange fruit drink can be packed in plastic, metal and glass containers.

- A) For each of these materials; identify suitable pack types to contain the drink. (3 marks)
- B) With reference to the properties of the drink, explain how each of these containers are able to provide a shelf life of at least 12 months. (3 x 3 marks)
- C) Discuss the advantages and disadvantages of using plastic to contain this product from a functional, environmental, commercial and aesthetic perspective. (8 marks)

Suggested Solution

A & B)

Properties of the Product

Include it is a liquid containing orange juice which is acidic, CO₂, sugar/sweetener.
Packaging must contain the CO₂, prevent ingress of O₂, not react to the fruit acid, reduce effect of UV light on colour.

Properties of Plastic

ISBM PET container with a HDPE or PP screw closure

- For this product, bottle usually clear so product can be seen but UV light can affect product
- Good barrier to CO₂ and moisture
- Poor O₂ barrier
- Does not react to product acidity

Properties of Metal

Draw and wall iron, steel or aluminium can and easy open lid

- Absolute moisture, odour, CO₂ and O₂ gas barrier, subject to integrity of closure
- Opaque - UV light barrier
- Subject to corrosion, needs lacquer to stop reaction with acid.

Properties of Glass

Type III glass, Narrow neck, press and blow bottle (or blow and blow) with crown closure.

- For this product, the bottle usually clear so product can be seen but UV light can affect product.
- Absolute barrier to CO₂ and odour egress, O₂ ingress, subject to closure.
- Inert – no leaching of or interaction with glass by product

C)

Functional

Advantages - Can be reclosed, Lightweight components, lower transportation costs, could be refilled.

Disadvantages - Barrier variables

Environmental

Advantages - Easy to identify for recycling, Lightweight, lower transportation costs, could be refilled

Disadvantages - Negative perception of use

PIABC Level 5 Diploma in Packaging Technology
Unit 2 (Paper A) – Understanding Packaging Materials and Components
Sample Examination Paper with Suggested Solutions

Commercial

Advantages - Closure, standard neck finishes – high speed application, Lightweight, lower transportation costs

Disadvantages - High initial cost of tooling

Aesthetic

Advantages - Bespoke or custom tooling - Unique shape for selling function. Bottles could be labelled or shrink sleeved

Disadvantages - Could be perceived as lower quality compared to glass

SECTION 2

SIX QUESTIONS - 10 MARKS EACH

Question 3

Discuss how the selection of raw materials (3 marks), additives (3 marks) and pulp processing (4 marks) can influence the characteristics of paper.

Suggested Solution

Raw Material selection

- Hardwood: Shorter fibres (1 – 1.5 mm) which will produce weaker papers
- Softwood: Longer fibres (3 – 4mm) which produce stronger papers
- Recycled: Variable fibre length and strength. Will contain contaminants which may discolour paper and introduce lumps of foreign material.

Additives

- Bleach: increase whiteness
- Fillers (e.g. chalk: improved print surface, reduced cost)
- Whitening and brightening
- Binders (e.g. starch to increase strength)
- Size to control water penetration
- Wet strength resins (e.g. urea)
- Grease resistance (e.g. fluorocarbons)

Pulp Processing

- Mechanical: Quick process, damages the fibres reducing strength. High yield contains lignin which may discolour over time.
- Chemical: Chemical separation produces little damage to fibres increasing strength. Removal of lignin and other materials reduced yield. Can provide strong and bright white papers
- Semi chemical: Varying properties depending on balance of process. Reduced fibre damage and some lignin removal.
- The amount of processing requires careful control as papers can be over processed.
- Increased beating will increase tensile strength, burst strength, and uniformity. Reduces air porosity, moisture absorbency. Tear and folding resistance initially increase and then decrease. Provides smoother print surface.

Question 4

Identify TEN properties of aluminium foil when used as a packaging material. Using examples, discuss the advantages and disadvantages of these properties when using this packaging material. (10 x 1 mark)

Suggested Solution

It is important that the properties must be related to the use of aluminium foil as a packaging material and the importance should be demonstrated using examples of the application.

For example, it is a total (absolute) barrier to moisture vapour and gases at thicknesses greater than 20 micron when used as a blister foil for tablets. However, aluminium foil less than 20 microns is affected by pin holing, so it is not an absolute barrier.

Question 5

- A) Provide a definition of a polymer (2 marks)
- B) Explain how each of the following affects the properties of a polymer:
- Copolymerisation (2 marks)
 - Chain branching (2 marks)
 - Orientation (2 marks)
 - Glass Transition Temperature (2 marks)

Suggested Solution

Poly means many, Mer means a unit, Polymer: many units. They are large, complex structures made by adding smaller molecules (mers) together.

Copolymerisation

Gives different properties to the polymer eg addition of octene or butene to LDPE produces LLDPE which is much stronger and stretches.

Can have random, alternating and block copolymers

Chain branching

Polymer chains exhibit varying degrees of side branching. Linear chains with very little side branching can be packed together closely in a dense structure, while steric hindrance prevents highly branched hydrocarbons from being closely packed.

Polyethylenes, having similar molecular weights, can have different properties, depending on the degree and nature of side branching. The most immediate difference is density. Highly branched molecular chains cannot pack closely together and hence produce a low-density polyethylene (LDPE). Highly linear polyethylene molecules can be closely packed and result in a high-density polyethylene (HDPE).

Orientation

Orientation is alignment of polymer molecules either in melted state or from warm solid. Alignment increases tensile strength in orientation direction but reduces tear strength. Improves barrier properties, and clarity

Glass Transition Temperature T_g

The point at which the amorphous polymeric material freezes. No chain movement is possible below T_g. Mechanical behaviour becomes glass like – brittle. Note: a frozen polymer may not be cold.

Question 6

- A) Describe TWO common quality issues with corrugated board. What are their causes and what impact do they have? (2 x 3 marks)
- B) Discuss TWO important properties of a sheet of corrugated board, typically found in a board specification, and briefly describe how the board would be tested. (2 x 2 marks)

Suggested Solution

Quality issues could include:

- Warping of board, caused by moisture movement as board dries is one liner shrinks more than the other the board can warp. This can cause difficulties in folding up cases.
- Wash boarding is a corrugated surface appearing on the outside of the board liner. This is caused by too much adhesive. The rough surface will be difficult to print on and may detract from the board appearance.
- Compression damage to the fluting can be caused by excessive pressure on the rollers and conveyors. Compression of the fluting will reduce the stiffness and compression strength of any case made from the material.

Properties and Testing could include:

- Burst Strength: General strength test. Board is clamped over rubber diaphragm which is inflated with hydraulic oil until it bursts through board. Max pressure recorded.
- Puncture Resistance: Resistance to puncture with sharp object. Triangular pyramid punched through board and amount of energy required is recorded.
- Flat Crush: Ability of flat corrugated board to withstand compression. Flat sample subjected to compression force until max force is recorded.
- Edge Crush: Is indicative of compression strength of case made from material. Sample set on its edge and compressed until max force is achieved.
- Stiffness: Is indicative of the compression strength of the case. Corrugated beam is supported on 2 supports. A force is applied through 1 or 2 points and the deflection/force is measured.

Question 7

Explain, with the use of a diagram, how the construction and material properties of a 3-piece steel can help to protect and preserve a can of beans over its shelf life. (10 marks)

Suggested Solution

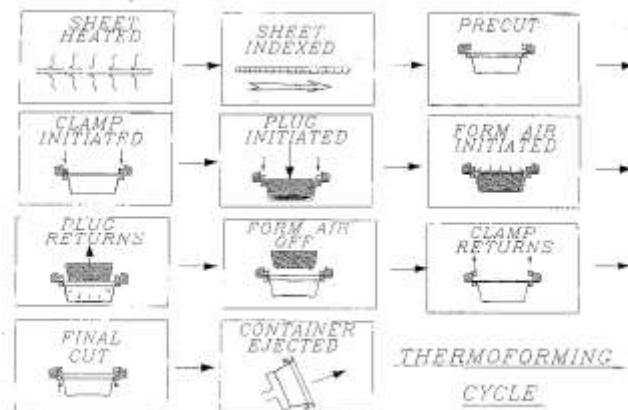
- The construction of a 3-piece can involve the use of tin-plated steel which may be lacquered on the inside.
- Body and lid of steel will have expansion rings which allows product to be retorted and sterilised. The can will resume correct shape for labelling.
- Can lid and base will be double seamed onto the body to produce a hermetic seal.
- The tin and epoxy lacquer coatings prevent rusting and product contamination.
- The material is light, gas and moisture proof ensuring the beans does not deteriorate through exposure to UV light and oxygen.
- Rigidity of container reduces secondary packaging requirements and allows stacking on a pallet.

Question 8

- A) Describe, with the aid of diagrams, the manufacturing process for a thermoformed container to hold a soft spread product such as margarine or butter. In your answer describe the process from receipt of a reel of material to despatch of finished container to the filler. (9 marks)
- B) Justify a suitable material for the container. (1 mark)

Suggested Solution

- Reeled materials are received wrapped and labelled on a pallet. QC checks as required.
- Reel placed on thermoforming machine and fed into the take-off rollers to ensure an even take off and feed in tension.
- Material heated in oven
- Then fed into the forming station where the material is indexed into position and clamps the sheet to the female cavity below.
- The forming punch travels down into the female cavity assisted by air pressure.
- Material cools
- At bottom of the stroke, the outer cutting ring cuts the formed article from the sheet.
- The punch retracts with air pressure maintained on the formed article.
- The outer cutting ring is withdrawn and the skeletal scrap is separated from the article
- As the punch is now retracted, the air pressure is turned off, the clamp ring is released and ejects the article to the packing station.
- The finished article is collated and quality checks carried out before being placed inside a clean PE bag and placed in a labelled corrugated outer.
- The material most likely to be used is a cast polypropylene as it has good moisture barrier and a fair oxygen barrier with good forming characteristics. It has good strength at a lower weight, compared to polystyrene, which is an alternative for these containers.



END OF EXAMINATION PAPER