Unit 16 · Fundamentals of Applied Chemistry

ANSWER KEY · FOR TEACHERS

Full marks 35

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. applied chemistry
2. commodity chemicals
3. prototype
4. pilot plant
5. productivity
6. capital-intensive
7. batch processing
8. continuous processing

Each carries 0.5 mark. **K · 4**

2 Label the diagram

1. launch
2. growth
3. decline
4. maturity

Each carries 0.5 mark. **K · 2**

3 Multiple choice

i. **c.** a dealer carrying and selling cement **U · 1**

Tertiary production provides services, including selling finished goods. Quarrying and farming are primary; making cement is secondary.

ii. **b.** chlorine, sodium hydroxide and hydrogen **K · 1**

Electrolysis of sodium chloride solution gives chlorine, caustic soda (NaOH) and hydrogen.

iii. **c.** the kiln **U · 1**

Fixed factors, such as the plant and the land, can't be changed quickly; raw materials, fuel and energy are variable.

iv. **c.** a cough syrup **A · 1**

Medicines are made in modest amounts, many products in the same equipment: batch processing. The others are bulk products made continuously.

v. **a.** carbon dioxide **K · 1**

$CaCO_3 \rightarrow CaO + CO_2$: heating limestone releases carbon dioxide.

4 Short answers

a. **MARKING SCHEME** **K · 2**

- ✓ Pure chemistry seeks knowledge for its own sake (why reactions happen); applied chemistry uses that knowledge to solve real problems and make products.
- ✓ An example, e.g. learning how acids react with bases (pure) and designing an antacid tablet (applied).

b. **MARKING SCHEME** **U · 2**

- ✓ To keep only the ideas most likely to make a profit, asking whether customers want it, what competition it faces, and whether the company can make and sell it.
- ✓ A bad idea dropped now costs almost nothing; dropped after the product is made, it costs a lot (managing risk).

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c. MARKING SCHEME U · 2

- ✓ Any two, e.g. relief valves and automatic shut-down; protective clothing; training and drills; safe storage and labeling; emergency plans.
- ✓ Inspection and maintenance find leaks, corrosion and worn parts before they cause an explosion, fire or poisoning.

d. MARKING SCHEME U · 3

- ✓ One harm with its prevention.
- ✓ A second harm with its prevention.
- ✓ A third harm with its prevention.

5 Long answer

ANSWER U · 4

Designing a chemical plant means using the principles of engineering and chemistry to plan a plant that turns raw materials into valuable products efficiently, safely and cheaply. It is the work of chemical engineers, with chemists, other engineers and safety experts.

Any three, for example: process and site selection (which chemical route, and where to build: near raw materials, market, water, power and transport); equipment selection and sizing, resting on material and energy balances (how much of each substance goes in and out of every unit, and how much heat is added or removed); safety and environmental considerations (keeping hazards in and emissions down); cost estimation; risk assessment; operation and maintenance.

MARKING SCHEME

- ✓ The meaning, with chemical engineers as the designers.
- ✓ A first thing the design covers, explained.
- ✓ A second, explained.
- ✓ A third, explained.

6 Numerical problems

a. ANSWER A · 4

i. Before: $4800 \div 40 =$ **120 bars per worker a day**; after: $6300 \div 42 =$ **150**. Rise $= (150 - 120) \div 120 \times 100 =$ **25%**.

ii. Cycle $= 35 + 20 - 30 =$ **25 days**; with 20 days of stock: $20 + 20 - 30 =$ **10 days**, so its money comes back 15 days sooner.

MARKING SCHEME

- ✓ 120 and 150 bars per worker a day.
- ✓ A 25% rise.
- ✓ 25 days.
- ✓ 10 days.

b. ANSWER A · 4

Urea, M = 60: 600 t $= 600 \times 10^6$ g $\div 60 = 1.0 \times 10^7$ mol a day.

i. Ammonia $= 2 \times 1.0 \times 10^7 = 2.0 \times 10^7$ mol $\times$ 17 g = **340 t**.

ii. $CO_2 = 1.0 \times 10^7$ mol $\times$ 44 g = **440 t**.

iii. Hydrogen $= 3/2 \times 2.0 \times 10^7 = 3.0 \times 10^7$ mol $\times$ 2 g = **60 t**.

MARKING SCHEME

- ✓ 1.0×10^7 mol of urea.
- ✓ 340 t of ammonia.
- ✓ 440 t of CO_2.
- ✓ 60 t of hydrogen.

7 Think

ANSWER

Profit is not cash. The company paid out cash for raw materials and wages long before its customers paid for the paint, so its money is tied up in stock and in bills its customers have not paid yet: its cash conversion cycle is long, and in that month its cash outflow was more than its inflow. It could keep less

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stock, collect customers' payments sooner, or arrange to pay its suppliers later, so that its money comes back sooner.

MARKING SCHEME

- ✓ Cash is tied up in stock and unpaid bills; outflow comes before inflow (a long cash cycle).
- ✓ A first way, e.g. keep less stock or collect payments sooner.
- ✓ A second way, e.g. pay suppliers as late as they allow.

8 Activity: Industries at home

(not marked)

WHAT STUDENTS SHOULD FIND

Answers depend on the products. Cement is made continuously, in a kiln fed with limestone and clay day and night, and Nepal has its own limestone and many cement plants; medicines are made in batches, many products in the same equipment.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	10	13	9	3	**35**

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