CHEMISTRY 2021

Unit 4

Key Topic Test 6 – Energy Content of Food

Recommended writing time*: 50 minutes

Total number of marks available: 50 marks

SOLUTIONS

SECTION A: Multiple-choice questions (1 mark each)

Question 1

Answer: C

Explanation:

Fat has the highest energy per gram so less mass needs to be carried.

Question 2

Answer: A

Explanation:

A lot of protein cannot be metabolised by the body as the energy available is less than the heat of combustion.

Question 3

Answer: B

Explanation:

A bomb calorimeter contains oxygen and this has to be under pressure so there is enough energy to completely oxidise the food or fuel.

Question 4

Answer: B

Explanation:

When a calorimeter is calibrated, the heat absorbed by the water as well as the container and its components are taken into account. A is incorrect as during the calibration, heat is released.

Question 5

Answer: D

Explanation:

Fats and oils contain a higher percentage of carbon than carbohydrates. These results in a higher energy density.

Question 6

Answer: D

Explanation:

During respiration, carbon is oxidised and oxygen is reduced. The products have less energy that the reactants and the reaction is exothermic.

Question 7

Answer: B

Explanation:

The calibration factor of a calorimeter that has been calibrated by an electrical method is higher as for each 1 degree of temperature rise, energy is absorbed by the water as well as the components of the calorimeter. The energy absorbed by just the water is less.

Question 8

Answer: B

Explanation:

Apples contain a high percentage of water and water has no energy value. Grains contain some fat but have a low water content.

Question 9

Answer: D

Explanation:

10/(15+15+10) = (10/40)*100= 25%. Fat makes up 25% of the snack food.

Question 10

Answer: B

Explanation:

The temperature can be an increase for an exothermic reaction of a decrease for an endothermic reaction. It does not record an energy change.

SECTION B: Short-answer questions

Question 1

a. $C_6H_{12}O_{6(aq)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)}$ $\Delta H = -2560$ kJmol^{-1}
(1 mark for correct formulae, 1 for balancing and 1 for correct ΔH)

3 marks

b. As well as glucose, other nutrients provide energy to humans. Place an X against the nutrients would NOT be expected to provide significant amounts of energy,

- o Starch
- X Cellulose
- o Fat
- o Protein
- X Vitamins
- X Salt

3 marks

c. Refer VCAA chemistry data booklet for the heat of combustion values in KJ/g of Carbohydrates (16), Protein (17), and Fat (37).
Carbohydrates – 3.10g x 16 = 49.6 kJ *
Protein – 0.55g x 17 = 9.35 kJ *
Fat – 0.80g x 37 = 29.6 kJ *
Total Energy of 5.0 g biscuit = 49.6 + 9.35 + 29.6 = 88.55 kJ *
Energy per gram = 88.55 ÷ 5 = 17.71 = 18 kJg^{-1} *

5marks
Total 11 marks

Question 2

a. Mass of water = Volume of water X density of water = 100 mL X 0.997 g/mL = 99.7 g
$q = m_{water}c\Delta T$ = 99.7 x 4.18 x 8.0 * = 3334 J = 3.334 kJ *

2 marks

b. $q = m_{water}c\Delta T$ = 99.7 x 4.18 x 21.0 * = 8752 J = 8.752 kJ*
Energy per gram = $E/\Delta T$ = 8.752/(1.030 – 0.290) = 11.83 kJg^{-1} *

3 marks

c. The technique is not accurate * as heat is lost to the thermometer, container, air and stirrer.***(any 3)

4 marks
Total 9 marks

Question 3

a. E = VIt = 5.50 x 1.50 x 5.0 x 60* = 2475 J*
CF = $E/\Delta T$ = 2475/5.7 = 434 $J°C^{-1}$ *

3 marks

b. n = m/M = 0.124/122 = 0.001016 mol*
E = n X ΔH = 0.001016 x 3228 = 3.281 kJ*
CF = 3.281/3.02 = 1.09 $kJ°C^{-1}$ *

3 marks

c. A bomb calorimeter has a combustion container *containing oxygen under pressure* and a heater to ignite the sample.*

3 marks

d. **i.** Read from the graph. 38°C - 21°C = 17°C
ii. The calorimeter is poorly insulated.

1 + 1 = 2 marks
Total 11 marks

Question 4

a. E = CF x ΔT = 6.80 x 10.7 = 72.76 kJ*
Energy per gram = 72.76 / 1.50 = 48.5 kJg^{-1} *

2 marks

b. E = VIt = 6.15 x 1.40 x 9.00 x 60* = 4649 J*
CF = $E/\Delta T$ = 4649/10.41 = 446.6 $J°C^{-1}$ *
$E_{(sucrose)}$ = CF x ΔT = 446.6 x 1.45 = 647.6 J*
Energy/gram = 647.6/44.60 = 14.5 Jg^{-1}*
Energy/mol = 14.5 x 342* = 4970 $Jmol^{-1}$* 7 marks

Total 9 marks