

Trial Examination 2020

VCE Physics Unit 1

Written Examination

Suggested Solutions

SECTION A – MULTIPLE-CHOICE QUESTIONS

1	☐ A	☒ B	☐ C	☐ D
2	☐ A	☒ B	☐ C	☐ D
3	☒ A	☐ B	☐ C	☐ D
4	☐ A	☐ B	☒ C	☐ D
5	☐ A	☒ B	☐ C	☐ D
6	☐ A	☐ B	☒ C	☐ D
7	☐ A	☒ B	☐ C	☐ D
8	☐ A	☒ B	☐ C	☐ D
9	☐ A	☐ B	☐ C	☒ D
10	☐ A	☐ B	☒ C	☐ D

Question 1 B

The metal spoon is a solid, so the main method of heat transfer in the spoon is conduction.

Question 2 B

$$\Delta Q_{\text{water}} = \Delta Q_{\text{aluminium}}$$

$$5.0 \times 4200 (T - 20^\circ\text{C}) = 1.0 \times 880 (90 - T)$$

$$21\,000T - 420\,000 = 79\,200 - 880T$$

$$21\,880T = 499\,200$$

$$T = 22.82^\circ\text{C}$$

$$T = 23^\circ\text{C}$$

Question 3 A

$$Q = ml_{\text{f}}$$

$$= 0.00400 \times 1.05 \times 10^5$$

$$= 420 \text{ J}$$

Question 4 C

Hotter objects emit most of their radiation at shorter wavelengths. Shorter wavelengths have more energy and higher frequency than longer wavelengths; therefore, hotter objects will appear more blue than cooler objects.

Question 5 B

$$V = \frac{E}{Q}$$

$$= \frac{4.5}{3.0}$$

$$= 1.5 \text{ V}$$

Question 6 C

$150 + 150 = 300 \, \Omega$ (bottom of branch for parallel component)

resistance of parallel component of combined circuit:

$$\frac{1}{R_{\text{total}}} = \frac{1}{300} + \frac{1}{150}$$

$$R_T = 100 \, \Omega$$

total resistance of combined circuit:

$$R_{\text{effective}} = 100 + 150 = 250 \, \Omega$$

Question 7 B

3.0 V across the LED leaves 2.0 V across the $100\ \Omega$ resistor.

$$V = IR$$

$$2.0 = I \times 100$$

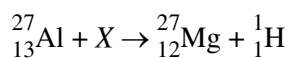
$$= 0.02\ \text{A}$$

$$= 20\ \text{mA}$$

Question 8 B

α decay: mass number decreases by 4; atomic number decreases by 2

β^- decay: no change to mass number; atomic number increases by 1

Question 9 D

$$27 + 1 = 27 + 1 \text{ (Mass numbers are equal on both sides of the equation.)}$$

$$13 + 0 = 12 + 1 \text{ (Atomic numbers are equal on both sides of the equation.)}$$

Question 10 C

The four observed fundamental forces are the weak nuclear force, strong nuclear force, electromagnetic force and gravitational force. Dark matter force is not an observed fundamental force because it is a theory.

SECTION B**Question 1** (3 marks)

A human has a greater average kinetic energy than the swimming pool water because they have a higher average temperature. 1 mark
1 mark

The swimming pool water has a greater total kinetic energy than a human because it has a greater volume of particles than the human. 1 mark

Note: For full marks, students must differentiate between average kinetic energy and total kinetic energy.

Question 2 (2 marks)

The evaporation of sweat causes sweat to change states from a liquid to a vapour. 1 mark
This takes away energy from the body as latent heat, giving a cooling effect. 1 mark

Question 3 (5 marks)

a. The substance changes state from a liquid to a solid. 1 mark

b. $Q = ml_{\text{fusion}}$
 $300\,000 = 0.20 \times l_{\text{fusion}}$ 1 mark
 $l_{\text{fusion}} = 1\,500\,000 \text{ J kg}^{-1}$ 1 mark

c. $Q = mc\Delta T$
 $100\,000 = 0.2 \times c \times (90 - 70)$ 1 mark
 $c = 25\,000 \text{ J kg}^{-1} \text{ K}^{-1}$ 1 mark

Question 4 (4 marks)

a. Step 1:
 $\Delta U = Q - W$
 $= 70 - (-35)$
 $= 105 \text{ J}$ 1 mark

Step 2:

$\Delta U = Q - W$
 $= 35 - 70$
 $= -35 \text{ J}$ 1 mark

Overall:

$\Delta U = Q - W$
 $= 105 - 35$
 $= 70 \text{ J}$ 1 mark

b. increase 1 mark

Question 5 (2 marks)

$$\lambda_{\max} = \frac{0.0028}{3900}$$

$$= 7.2 \times 10^{-7}$$

$$= 720 \text{ nm}$$

1 mark

1 mark

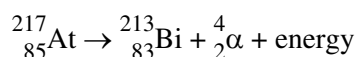
Question 6 (4 marks)

- a. The greenhouse gases absorb the infrared radiation emitted by Earth and re-emit it in all directions, heating up both Earth's atmosphere and Earth itself, therefore making Earth warm enough to sustain life. 1 mark
- The infrared radiation emitted by Earth would radiate straight out of Earth's atmosphere if there were no greenhouse gases in the atmosphere. 1 mark
- b. Human activities such as burning fossil fuels increase the amount of greenhouse gases released in the atmosphere. 1 mark
- The increase in greenhouse gases in the atmosphere results in extra heat being trapped, causing Earth's temperature to rise, which contributes to the enhanced greenhouse effect. 1 mark

Question 7 (4 marks)

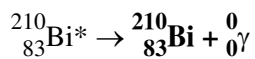
	α particle	β^- particle	γ particle
mass	heavy	light	none
speed	~10% of c	~90% of c	speed of light
charge	+2	-1	no charge
penetration ability	low	medium	high

4 marks

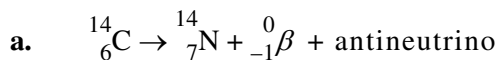
*Award 4 marks for 8 correct answers.**Award 3 marks for 6–7 correct answers.**Award 2 marks for 4–5 correct answers.**Award 1 marks for 1–3 correct answers.**Award no marks for 0 correct answers.***Question 8** (3 marks)

3 marks

*1 mark for parent atom on LHS of equation and daughter atom on RHS of equation.**1 mark for alpha particle on RHS side of equation.**1 mark for ${}_{83}^{213}\text{Bi}$.*

Question 9 (2 marks)

2 marks

1 mark for ${}_{83}^{210}\text{Bi}$.1 mark for ${}_0^0\gamma$.**Question 10** (11 marks)

3 marks

1 mark for the correct elements.

1 mark for the correct mass numbers.

1 mark for the correct atomic numbers.

b.

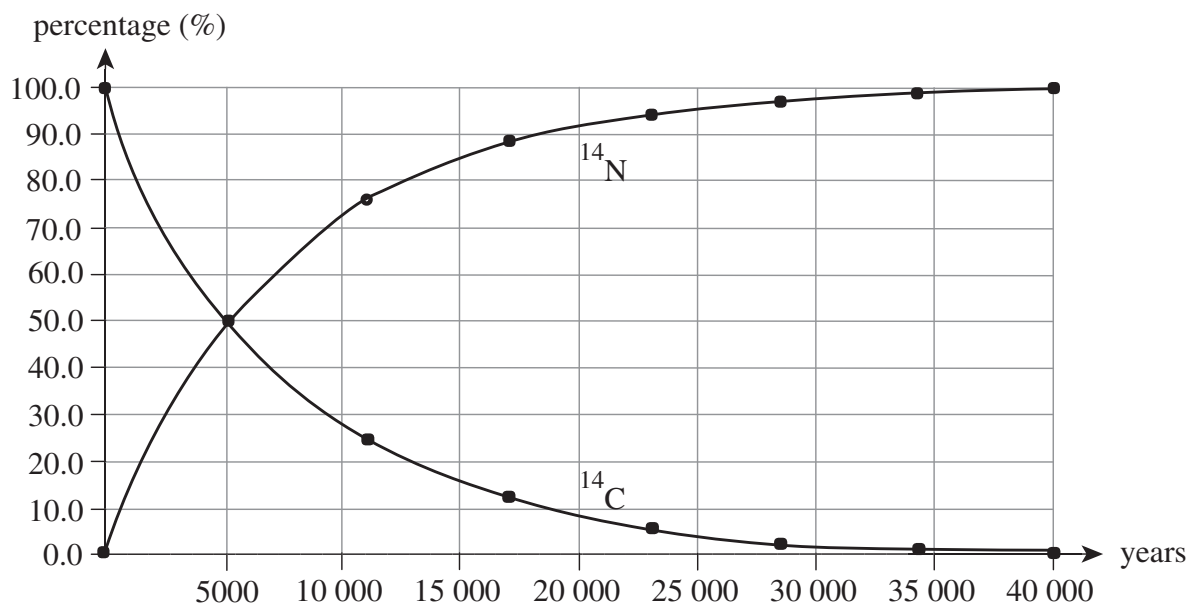
Years from present	0	5700	11 400	17 100	22 800	28 500	34 200	39 900
% ${}^{14}\text{C}$	100.0	50.0	25.0	12.5	6.3	3.1	1.6	0.8
% ${}^{14}\text{N}$	0.0	50.0	75.0	87.5	93.8	96.9	98.4	99.2

3 marks

1 mark for the correct years.

1 mark for correct percentages for ${}^{14}\text{C}$.1 mark for correct percentages for ${}^{14}\text{N}$.

c.



4 marks

1 mark for correct ^{14}C plotting.1 mark for ^{14}C line of best fit.1 mark for correct ^{14}N plotting.1 mark for ^{14}N line of best fit.

d. $\frac{1}{2^{10}} = 9.8 \times 10^{-4}$

$\therefore n = 10$

The carbon-14 in an organic material will become difficult to detect after approximately 10 half-lives (9.8×10^{-4}).

1 mark

Question 11 (7 marks)

- a. weight of three protons:

$$3 \times 1.6726 \times 10^{-27} = 5.0178 \times 10^{-27} \text{ kg}$$

weight of four neutrons:

$$4 \times 1.6749 \times 10^{-27} = 6.996 \times 10^{-27} \text{ kg}$$

The total weight of 3 protons and neutrons is $1.1717 \times 10^{-26} \text{ kg}$.

difference from the lithium-7 nucleus:

$$1.1717 \times 10^{-26} - 1.1650 \times 10^{-26} = 6.7400 \times 10^{-29} \text{ kg}$$

3 marks

1 mark for weights of protons and weights of neutrons.

1 mark for total weight of protons and neutrons.

1 mark for difference in weight from the lithium-7 nucleus.

- b. The difference of mass is converted to energy released by the seven nucleons. 1 mark

c. $E = mc^2$

$$= 6.7400 \times 10^{-29} \times (3 \times 10^8)^2$$

$$= 6.0660 \times 10^{-12} \text{ J} \quad 1 \text{ mark}$$

$$= \frac{6.0660 \times 10^{-12}}{1.6 \times 10^{-13}} \quad 1 \text{ mark}$$

$$= 37.91 \text{ MeV} \quad 1 \text{ mark}$$

Question 12 (6 marks)

a. $R_T = 100 + 200 + 300$

$$= 600 \, \Omega \quad 1 \text{ mark}$$

$$V_T = I_T \times R_T$$

$$6.0 = I_T \times 600$$

$$I_T = 0.010 \text{ A}$$

$$= 10 \text{ mA} \quad 1 \text{ mark}$$

$$V_{\text{drop/voltmeter}} = 0.010 \times 300$$

$$= 3.0 \text{ V} \quad 1 \text{ mark}$$

b. $\frac{1}{R_T} = \frac{1}{200} + \frac{1}{300}$

$$R_T = 120 \, \Omega$$

1 mark

$$V_T = I_T \times R_T$$

$$6.0 = I_T \times 120$$

$$I_T = 0.050 \, \text{A}$$

$$I_T = 50 \, \text{mA}$$

1 mark

$$V_{\text{voltmeter}} = 6.0 \, \text{V (same as the supply)}$$

1 mark

Question 13 (11 marks)

- a. i.** maximum resistance:

$$R_T = 1000.0 + 1000.0$$

$$= 2000.0 \, \Omega$$

1 mark

minimum current:

$$I = \frac{12.0}{2000.0}$$

$$= 6.0 \times 10^{-3} \, \text{A}$$

$$= 6.0 \, \text{mA}$$

1 mark

- ii.** minimum resistance:

$$R_T = 1000.0 + 0.0$$

$$= 1000.0 \, \Omega$$

1 mark

maximum current:

$$I = \frac{12.0}{1000.0}$$

$$= 12.0 \times 10^{-3} \, \text{A}$$

$$= 12.0 \, \text{mA}$$

1 mark

- b. i.** $V = I \times R$

Minimum voltage is 0.0 V when the resistor is set to zero.

1 mark

- ii.** $V = I \times R$

maximum voltage when set to 1000 Ω :

$$V_{\text{out}} = \frac{1000}{1000 + 1000} \times 12$$

1 mark

$$= 6.0 \, \text{V}$$

1 mark

- c. resistance of parallel:

$$\frac{1}{R_T} = \frac{1}{1000} + \frac{1}{1000}$$

$$R_T = 500 \, \Omega$$

1 mark

$$R_{\text{eff}} = 1500 \, \Omega$$

1 mark

$$I = \frac{12.0}{1500}$$

1 mark

$$= 0.008 \, \text{A}$$

$$= 8.0 \, \text{mA}$$

1 mark

Question 14 (8 marks)

- a. component X

1 mark

Component X is ohmic because its resistance is constant for all current–voltage pairs, as shown by the straight line through the origin.

1 mark

- b. i. 30 mA

1 mark

- ii. 80 mA

1 mark

- iii. resistance of component X:

$$R = \frac{8.0}{0.08}$$

$$= 1000 \, \Omega$$

1 mark

resistance of component Y:

$$R = \frac{8.0}{0.03}$$

$$= 2667 \, \Omega$$

1 mark

effective resistance:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_T} = \frac{1}{1000} + \frac{1}{2667}$$

1 mark

$$R_T = 727 \, \Omega$$

1 mark

Question 15 (3 marks)

- a. A person could get an electric shock.

1 mark

- b. If an active wire comes into contact with the metal case, the outer casing could become live.

1 mark

There is a 240 V AC potential difference between the person's hand and the ground, and a current may flow.

1 mark

Question 16 (5 marks)

- a.** $E = 1000 \times 3600$
 $= 3.6 \times 10^6 \text{ J}$ 1 mark
- b. i.** $P = VI$
 $3000 = 240 \times I$ 1 mark
 $I = 12.5 \text{ A}$ 1 mark
- ii.** cost (\$) = power (kW) $\times$ time (hours) $\times$ number of days $\times$ \$0.28/kWh
cost = $3.0 \text{ kW} \times 2 \text{ hours} \times 14 \text{ days} \times 0.28$ 1 mark
 $= \$23.52$ 1 mark