

Trial Examination 2022

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

B is correct. Convection is the transfer of thermal energy through liquids and gasses via currents that are set up in a fluid and that travel between different temperatures and, hence, different fluid densities.

A is incorrect. Conduction relies on vibrations passing between atoms, not on the atoms moving from a hot region to a cooler one.

C and **D** are incorrect. Radiation is the transfer of heat in the form of electromagnetic radiation, which can travel through a vacuum and does not require a medium.

Question 2 A

A is correct.

$$\begin{aligned} W &= Q - \Delta U \\ &= 840 - 1125 \\ &= -285 \text{ J} \end{aligned}$$

Therefore, 285 J of work is done on the system.

B and **D** are incorrect. Work is not done by the system.

C is incorrect. If 1965 J of work was done on the system, the increase in the system's internal energy would have been 2805 J.

Question 3 B

$$\begin{aligned} \lambda_{\max} &= \frac{0.0029 \text{ mK}}{T} \\ T &= \frac{0.0029}{0.5 \times 10^{-6}} \\ &= 5.8 \times 10^3 \text{ K} \\ &= 5.8 \times 10^3 - 273 \\ &= 5527^\circ\text{C} \\ &= 5.5 \times 10^3^\circ\text{C} \end{aligned}$$

Question 4 D

$$\begin{aligned} Q &= n_{\text{electrons}} \times q \\ n_{\text{electrons}} &= \frac{1}{1.6 \times 10^{-19}} \\ &\approx 6.3 \times 10^{18} \end{aligned}$$

Question 5 C

$$\begin{aligned} V &= \frac{E}{It} \\ &= \frac{2.88 \times 10^4}{4.0 \times 120} \\ &= 60 \text{ V} \end{aligned}$$

Question 6 C

When the switch is open, the circuit is a simple series circuit where $R_{\text{total}} = 2R$. Therefore, the voltage across each resistor is half the voltage of the battery. When the switch is closed, the circuit is a combination circuit where $R_{\text{total}} = 1.5R$. The voltage across the parallel combination is half the voltage across the single resistor. Therefore, the parallel combination takes a third of the voltage of the battery.

Question 7 C

There is 3.0 V across the LED. Therefore, there is 9.0 V across the variable resistor. A current of 150 mA is required for full brightness.

$$\begin{aligned} R &= \frac{V}{I} \\ &= \frac{9.0}{0.15} \\ &= 60 \, \Omega \\ &= 6.0 \times 10^1 \, \Omega \end{aligned}$$

Question 8 C

If $\frac{7}{8}$ of the source has decayed, there is $\frac{1}{8}$ remaining. The number of half-lives is, therefore, $3 \times 25 = 75$ s.

Question 9 B

B is correct. When uranium-238 undergoes α -decay, the atomic number goes down by two and the mass number goes down by four. Hence, it becomes thorium-230.

A is incorrect. The number of neutrons is 140, not the mass number.

C and **D** are incorrect. The final type of decay is not β -decay.

Question 10 B

The inflationary epoch (event 4) was followed by the formation of elementary particles (event 3). Next, nuclear fusion began (event 2) and nucleosynthesis occurred. This was followed by a recombination period where neutral atoms began to form (event 1). The correct order of events is, therefore, 4, 3, 2, 1.

SECTION B**Question 1** (8 marks)

- a. 200 K (*read from graph*) 1 mark
 $200 - 273 = -73^{\circ}\text{C}$ 1 mark
- b. When it reached 360 K, the sample changed state. 1 mark
It changed from a liquid into a gas via vaporisation. 1 mark
- c. $Q = mL_{\text{fusion}}$
 $L_{\text{fusion}} = \frac{8.0 \times 10^4 - 2.0 \times 10^4}{0.25}$ 1 mark
 $= 2.4 \times 10^5 \text{ J kg}^{-1}$ 1 mark
- d. $Q = mc\Delta T$
 $1.4 \times 10^5 - 8.0 \times 10^4 = 0.25 \times c \times (360 - 200)$ 1 mark
 $c = 1.5 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$ 1 mark

Question 2 (6 marks)

- a. $\Delta Q = mc\Delta T$
 $= 0.50 \times 2500(78 - 25)$ 1 mark
 $= 6.63 \times 10^4 \text{ J}$ 1 mark
- b. $\Delta Q = mL_v$
 $= 0.50 \times 8.5 \times 10^5$ 1 mark
 $= 4.25 \times 10^5 \text{ J}$ 1 mark
- c. $\Delta Q = 6.63 \times 10^4 + 4.25 \times 10^5$
 $= 4.91 \times 10^5 \text{ J}$ 1 mark
 $= 4.9 \times 10^5 \text{ J}$ 1 mark

Question 3 (4 marks)

$$Q = mc\Delta T$$
$$0.2 \times 4200 \times (26.6 - 25.0) = m \times 450 \times (85.0 - 26.6)$$
$$1344 = 26\,280m$$
$$m = 0.05114 \text{ kg}$$
$$\approx 51 \text{ g}$$

1 mark
1 mark
1 mark
1 mark

Question 4 (3 marks)

- a. shorter 1 mark
lower 1 mark
- b. The majority of the radiation emitted by Earth is absorbed by greenhouse gases and re-emitted. 1 mark

Question 5 (10 marks)

- a. resistor A 1 mark
The graph for resistor A shows a proportional relationship between voltage and current, which, therefore, shows a constant resistance. 1 mark
- b. 200 mA 1 mark
When the voltage across resistor A is 2.0 V, the current flowing through resistor A is 200 mA. Because the two resistors are in series, the current is the same when it flows through resistor B. 1 mark
- c. The current flowing through resistor A is 400 mA. 1 mark
The current flowing through resistor B is 200 mA. 1 mark
Total current flowing through the variable supply:
$$I_T = I_1 + I_2$$
$$= 400 + 200$$
$$= 600 \text{ mA}$$
 1 mark
- d.
$$R_{\text{total}} = \frac{V_{\text{total}}}{I_{\text{total}}}$$
 1 mark
$$= \frac{2.0}{0.6}$$
 1 mark
$$= 3.3 \, \Omega$$
 1 mark

Question 6 (4 marks)

$$V_{\text{total}} = I_{\text{total}} R_{\text{total}}$$

$$12.0 = 1.0 \times R_{\text{total}}$$

$$R_{\text{total}} = 12.0 \, \Omega$$

1 mark

Total resistance of the parallel branch:

$$R_{\text{parallel}} = 12.0 - 4.0 - 4.0$$

$$= 4.0 \, \Omega$$

1 mark

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{4.0} = \frac{1}{8.0} + \frac{1}{R_x}$$

1 mark

$$\frac{1}{R_x} = \frac{1}{4.0} - \frac{1}{8.0}$$

$$= \frac{2.0 - 1.0}{8.0}$$

$$= 8.0 \, \Omega$$

1 mark

Question 7 (6 marks)

- a. The resistance of the light-dependent resistor (LDR) is $3.0 \, \text{k}\Omega$.

1 mark

$$V_{\text{out}} = \frac{R_2}{R_1 + R_2} \times V_{\text{in}}$$

$$3.0 = \frac{3.0}{3.0 + R_2} \times 12.0$$

1 mark

$$R_2 = 9.0 \, \text{k}\Omega$$

1 mark

- b. $1.2 = \frac{R}{9.0 + R_1} \times 12.0$

1 mark

$$R_1 = 1.0 \, \text{k}\Omega$$

1 mark

$$\text{light intensity} = 25.0 \, \text{lux}$$

1 mark

*Note: Consequential on answer to **Question 7a**. Accept responses in the range of 23.0–27.0 lux.*

Question 8 (7 marks)

- a. energy = $1.6 \times 1.5 \times 5$

1 mark

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

1 mark

- b. cost = energy $\times$ tariff

$$32.51 = 12.0 \times n \times 0.25$$

1 mark

$$n = 10.8$$

1 mark

$$\approx 11 \, \text{weeks}$$

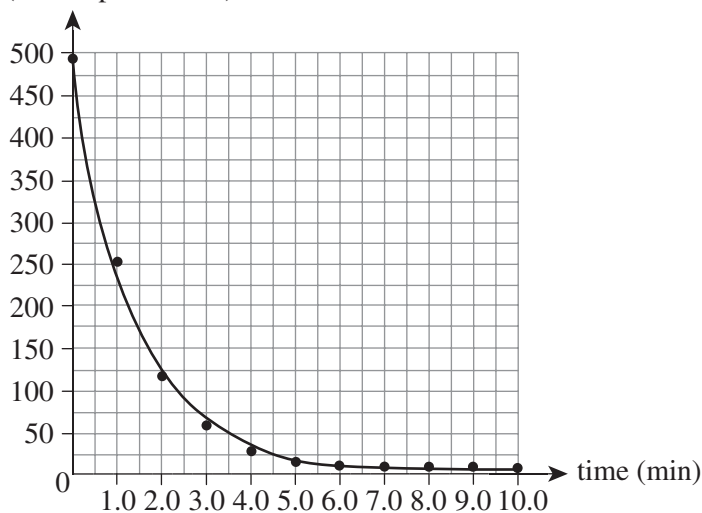
- c. $I = \frac{P}{V}$
 $= \frac{1700}{240}$ 1 mark
 $= 7.1 \text{ A}$ 1 mark
 The fuse will not blow because 7.1 A is below 10.0 A. 1 mark

Question 9 (3 marks)

- a. $A = 239 + 0$
 $= 239$ 1 mark
 $Z = 94 - 1$
 $= 93$ 1 mark
- b. neptunium (*as found on the periodic table*) 1 mark

Question 10 (8 marks)

- a. activity (counts per minute)



4 marks

1 mark for including appropriate scales.
1 mark for including appropriate axis labels.
1 mark for correctly plotting the data.
1 mark for including a correct line of best fit.

- b. The term half-life refers to the time it takes for half of a radioactive sample to decay. 1 mark
OR

The term half-life refers to the time after which there is a 50% chance that an unstable nucleus will have decayed. 1 mark

- c. $t_{\frac{1}{2}} = 1.0 \text{ min}$ 1 mark

Note: Consequential on answer to Question 10a. Accept responses in the range of 0.9–1.1 min.

- d. 150 s = 2.5 min 1 mark
 85 counts per minute 1 mark

Note: Accept responses in the range of 80–90 counts per minute.

Question 11 (4 marks)

Radiation	Mass (amu)	Charge (C)	Speed	Ionising ability
α	1	+2	10% of c	high
β^-	$\frac{1}{1800}$	-1	90% of c	medium
γ	0	none	c	low

4 marks

1 mark for every two correct cells of the table completed.

Question 12 (9 marks)

- a. LHS = RHS
 $235 + 1 = 144 + 89 + Y$ 1 mark
 $Y = 3$ 1 mark
 $92 = 56 + Z$ 1 mark
 $Z = 36$ 1 mark
- b. krypton (*as found on the periodic table*) 1 mark

Note: Consequential on answer to Question 12a.

- c. $168 \text{ MeV} = 1.68 \times 10^8 \text{ eV}$ 1 mark
 $1.60 \times 10^7 \times 1.6 \times 10^{-19} = 2.56 \times 10^{-11} \text{ J}$ 1 mark
 $E = mc^2$
 $m = \frac{2.56 \times 10^{-11}}{(3.0 \times 10^8)^2}$ 1 mark
 $= 2.84 \times 10^{-28} \text{ kg}$ 1 mark

Question 13 (8 marks)

- a. i. arrow A 1 mark
 $12.8 - 10.2 = 2.6 \text{ eV upwards}$ 1 mark
- ii. arrow D 1 mark
 $13.1 - 10.2 = 2.9 \text{ eV}$ 1 mark
 $2.9 \times 1.6 \times 10^{-19} = 4.64 \times 10^{-19} \text{ J}$ 1 mark
- b. No. 1 mark
 Photon emissions and absorptions can only happen 1 mark
 as electrons move from one level to another. 1 mark