Neap

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**

$$\Delta Q_{\text{water}} = \Delta Q_{\text{aluminium}}$$
$$5.0 \times 4200\,(T - 20°C) = 1.0 \times 880(90 - T)$$
$$21\,000T - 420\,000 = 79\,200 - 880T$$
$$21\,880T = 499\,200$$
$$T = 22.82°C$$
$$T = 23°C$$

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 Ω resistor.

$$V = IR$$
$$2.0 = 1 \times 100$$
$$= 0.02 \text{ A}$$
$$= 20 \text{ mA}$$

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

$${}^{27}_{13}\text{Al} + X \rightarrow {}^{27}_{12}\text{Mg} + {}^{1}_{1}\text{H}$$

27 + 1 = 27 + 1 (Mass numbers are equal on both sides of the equation.)

13 + 0 = 12 + 1 (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
$$c = 25000 \text{ J kg}^{-1}\text{K}^{-1}$$ 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)

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

$= 7.2 \times 10^{-7}$ 1 mark

$= 720$ nm 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)

$${}^{217}_{85}\text{At} \rightarrow {}^{213}_{83}\text{Bi} + {}^{4}_{2}\alpha + \text{energy}$$

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 ${}^{213}_{83}Bi$.

Question 9 (2 marks)

$^{210}_{83}\text{Bi}^* \rightarrow \mathbf{^{210}_{83}Bi} + \mathbf{^{0}_{0}\gamma}$

2 marks

1 mark for $^{210}_{83}Bi$.

1 mark for $^{0}_{0}\gamma$.

Question 10 (11 marks)

a. $^{14}_{6}\text{C} \rightarrow {}^{14}_{7}\text{N} + {}^{0}_{-1}\beta$ + antineutrino

3 marks

1 mark for the correct elements.
1 mark for the correct mass numbers.
1 mark for the correct atomic numbers.

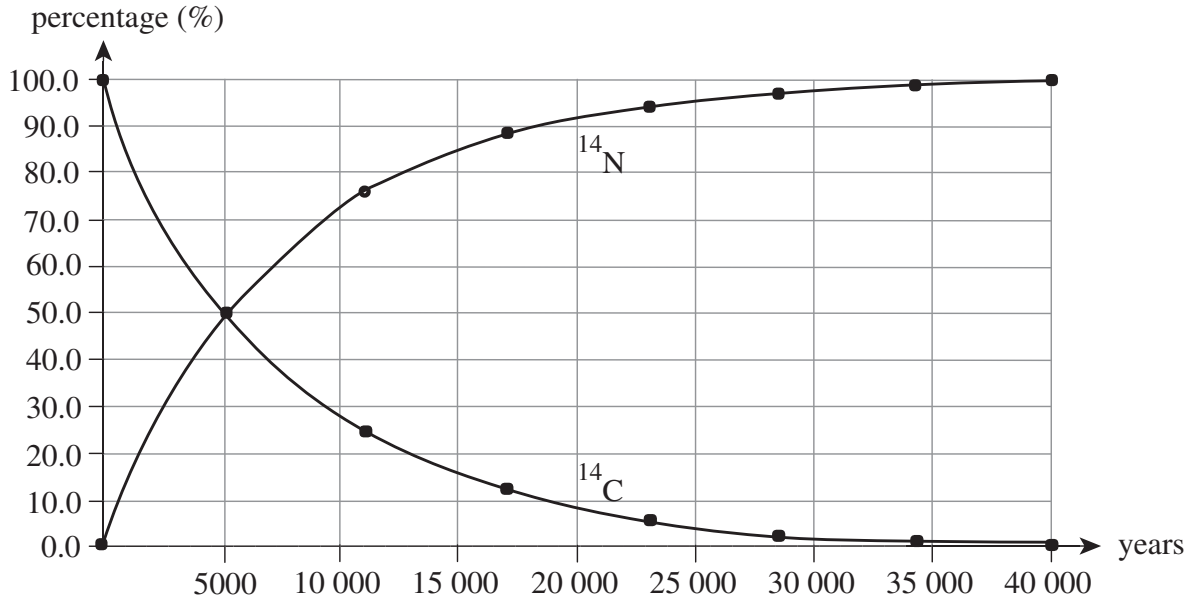
b.

Years from present	0	5700	11 400	**17 100**	**22 800**	**28 500**	**34 200**	39 900
% ^{14}C	100.0	**50.0**	**25.0**	**12.5**	**6.3**	**3.1**	**1.6**	**0.8**
% ^{14}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}C.
1 mark for correct percentages for ^{14}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:

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

weight of four neutrons:

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

The total weight of 3 protons and neutrons is 1.1717×10^{-26} kg.

difference from the lithium-7 nucleus:

$1.1717 \times 10^{-26} - 1.1650 \times 10^{-26} = 6.7400 \times 10^{-29}$ 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. $E = mc^2$

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

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

$= \dfrac{6.0660 \times 10^{-12}}{1.6 \times 10^{-13}}$ 1 mark

$= 37.91$ MeV 1 mark

Question 12 (6 marks)

a. $R_T = 100 + 200 + 300$

$= 600\ \Omega$ 1 mark

$V_T = I_T \times R_T$

$6.0 = I_T \times 600$

$I_T = 0.010$ A

$= 10$ mA 1 mark

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

$= 3.0$ V 1 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:

$R_T = 1000.0 + 0.0$

$= 2000.0\ \Omega$ 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

$R_{eff} = 1500\ \Omega$ 1 mark

$I = \frac{12.0}{1500}$ 1 mark

$= 0.008$ A

$= 8.0$ 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. $E = 1000 \times 3600$

$= 3.6 \times 10^6$ J 1 mark

b. **i.** $P = VI$

$3000 = 240 \times I$ 1 mark

$I = 12.5$ A 1 mark

ii. cost ($) = power (kW) × time (hours) × number of days × $0.28/kWh

cost = 3.0 kW × 2 hours × 14 days × 0.28 1 mark

= $23.52 1 mark