Neap

Trial Examination 2022

# VCE Physics Units 1&2

Written Examination

## Suggested Solutions

### SECTION A – MULTIPLE-CHOICE QUESTIONS

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A | **B** | C | D | 11 | **A** | B | C | D |
| 2 | **A** | B | C | D | 12 | A | **B** | C | D |
| 3 | A | **B** | C | D | 13 | **A** | B | C | D |
| 4 | A | B | C | **D** | 14 | A | B | C | **D** |
| 5 | A | B | **C** | D | 15 | A | B | **C** | D |
| 6 | A | B | **C** | D | 16 | A | B | C | **D** |
| 7 | A | B | **C** | D | 17 | A | **B** | C | D |
| 8 | A | B | **C** | D | 18 | A | **B** | C | D |
| 9 | A | **B** | C | D | 19 | A | B | **C** | D |
| 10 | A | **B** | C | D | 20 | 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**

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

**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 $R_{total} = 2R$. 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 $R_{total} = 1.5R$. 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 $\alpha$-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 $\beta$-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.

**Question 11 A**

$\Delta v =$ $\uparrow 10 \text{ m s}^{-1}$ $-$ $\rightarrow 20 \text{ m s}^{-1}$

$=$ $\uparrow 10 \text{ m s}^{-1}$ $+$ $\leftarrow 20 \text{ m s}^{-1}$

$=$ $20 \text{ m s}^{-1}$ $\leftarrow$, $\uparrow 10 \text{ m s}^{-1}$

$\Delta v = v - u$

$= \sqrt{10^2 + 20^2}$

$= 22 \text{ m s}^{-1}$

$\tan\theta = \dfrac{20}{10}$

$\theta = 63°$

Therefore, the car's change in velocity is 22 m s$^{-1}$ N63°W.

**Question 12 B**

$$v_{\text{average}} = \frac{\text{total displacement}}{\text{total time}}$$

$$= \frac{\left(\left(\frac{1}{2}\times 3.0\times 6.0\right) + \left(4.0\times 6.0\right) + \left(\frac{1}{2}\times 3.0\times 6.0\right) - \left(\frac{1}{2}\times 2.0\times 5.0\right)\right)}{15.0}$$

$$= 2.4666$$

$$\approx 2.5 \text{ m s}^{-1}$$

**Question 13 A**

$$u = \frac{144}{3.6}$$

$$= 40 \text{ m s}^{-1}$$

$$v = \frac{252}{3.6}$$

$$= 70 \text{ m s}^{-1}$$

$$t = 10 \text{ s}$$

$$v = u + at$$

$$70 = 40 + 10a$$

$$a = 3 \text{ m s}^{-2}$$

**Question 14 D**

$$F_{\text{W}} = mg$$
$$= 80.0 \times 9.8$$
$$= 784 \text{ N}$$

**Question 15 C**

Taking up as positive gives:

$$F_{\text{net}} = ma$$
$$N - W = ma$$
$$N = ms + W$$
$$N > W$$

Therefore, the force exerted by the floor of the elevator on Sung-Hoon is more than Sung-Hoon's weight.

**Question 16 D**

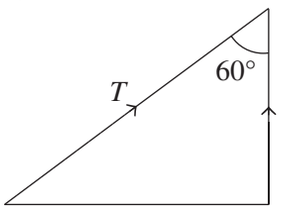
The work done on an object is equal to the area under an *s* versus *F* graph representing its movement.

$$\text{work done} = \left(0.150 \times 80.0\right) + \left(\frac{1}{2} \times 0.05 \times 80.0\right)$$
$$= 140 \text{ J}$$
$$\Delta E_k = \text{work done} = 140 \text{ J}$$
$$\frac{1}{2} \times 5.0 \times v^2 - \frac{1}{2} \times 5.0 \times 10.0^2 = 140$$
$$2.5v^2 = 390$$
$$v = \sqrt{\frac{390}{2.5}}$$
$$= 12.5 \text{ m s}^{-1}$$

**Question 17 B**

$$P = F \times v$$
$$v = \frac{230}{3.6}$$
$$= 100 \text{ m s}^{-1}$$
$$P = 2500 \times 100$$
$$= 2.5 \times 10^5 \text{ W}$$

**Question 18 B**




$$F_{\text{up}} \text{ for one wire} = \frac{10.0 \times 9.8}{2}$$

$$\cos 60 = \frac{\left(\frac{10.0 \times 9.8}{2}\right)}{T}$$

$$T = 98.0 \text{ N}$$

**Question 19 C**

$$F_{\text{net}} = ma$$

$$12 = 6.0 \times a$$

$$a = 2.0 \text{ m s}^{-2}$$

$$\sum \text{forces}_{\text{horizontally on B}} = m_B \times a$$

$$12 - F_{\text{A on B}} = 1.0 \times 2.0$$

$$F_{\text{A on B}} = 10 \text{ N}$$

**Question 20 B**

**B** is correct. An independent variable is the variable varied by the experimenter and it is assumed to directly affect the dependent variable.

**A** is incorrect. This option would not be relevant to the investigation.

**C** is incorrect. This option refers to a controlled variable.

**D** is incorrect. This option refers to the dependent variable.

## SECTION B

**Question 1** (8 marks)

**a.** 200 K (*read from graph*) 1 mark

$200 - 273 = -73°\text{C}$ 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.** $Q = mL_{\text{fusion}}$

$L_{\text{fusion}} = \dfrac{8.0 \times 10^4 - 2.0 \times 10^4}{0.25}$ 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.** $\Delta Q = mL_{\text{v}}$

$= 0.50 \times 8.5 \times 10^5$ 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)

$Q = mc\Delta T$

$0.2 \times 4200 \times (26.6 - 25.0) = m \times 450 \times (85.0 - 26.6)$ 1 mark

$1344 = 26\,280m$ 1 mark

$m = 0.05114 \text{ kg}$ 1 mark

$\approx 51 \text{ g}$ 1 mark

**Question 4** (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.** $$R_{total} = \frac{V_{total}}{I_{total}}$$ — 1 mark

$$= \frac{2.0}{0.6}$$ — 1 mark

$$= 3.3\ \Omega$$ — 1 mark

**Question 5** (7 marks)

**a.** $$\text{energy} = 1.6 \times 1.5 \times 5$$ — 1 mark

$$= 12.0 \text{ kWh}$$ — 1 mark

**b.** $$\text{cost} = \text{energy} \times \text{tariff}$$

$$32.51 = 12.0 \times n \times 0.25$$ — 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 6** (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 7** (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 7a**.*

**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

$E = mc^2$

$m = \dfrac{2.56 \times 10^{-11}}{\left(3.0 \times 10^8\right)^2}$ 1 mark

$= 2.84 \times 10^{-28} \text{ kg}$ 1 mark

**Question 8** (8 marks)

**a.** **i.** arrow D 1 mark

$13.1 - 10.2 = 2.9$ eV upwards 1 mark

**ii.** arrow A 1 mark

$13.1 - 10.2 = 2.9$ eV 1 mark

$2.9 \times 1.6 \times 10^{-19} = 4.64 \times 10^{-19}$ 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

**Question 9** (9 marks)

**a.** $\text{displacement} = 4.0 + 4.0 + 4.0 + 4.0$ 1 mark

$= 16.0 \text{ m}$ 1 mark

**b.** Reading from the graph gives:

2.0 to 3.0 seconds 1 mark

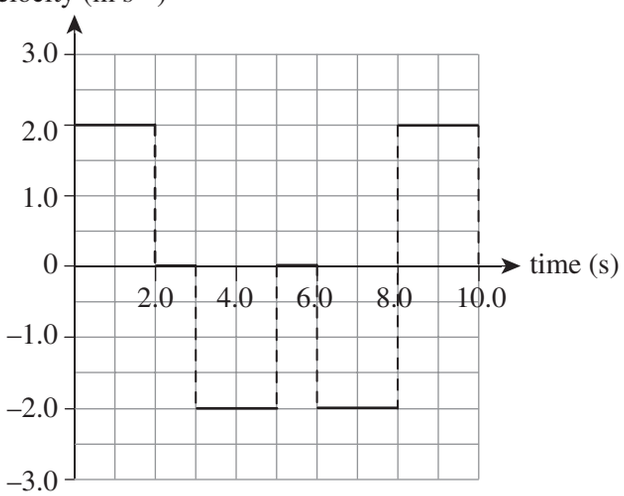
5.0 to 6.0 seconds 1 mark

**c.** Reading from the graph gives:

3.0 to 5.0 seconds 1 mark

8.0 to 10.0 seconds 1 mark

**d.** velocity (m $s^{-1}$)




3 marks

*1 mark for providing the correct scales.*
*1 mark for showing the correct plotted points.*
*1 mark for sketching the correct shape of the graph.*

**Question 10** (6 marks)

$F_{\text{net (vertical)}} = 12.0 \text{ N north}$ 1 mark

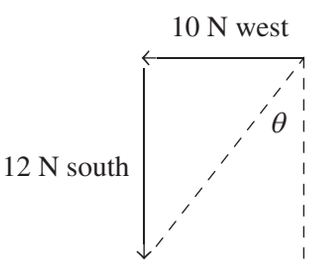
$F_{\text{net (horizontal)}} = 10.0 \text{ N west}$ 1 mark

$F_{\text{net}} = \sqrt{(12.0)^2 + (10.0)^2}$ 1 mark

$= 15.6 \text{ N}$ 1 mark

$\tan\theta = \dfrac{10.0}{12.0}$ 1 mark

$\theta = 39.8°$




S39.8°W 1 mark

**Question 11** (5 marks)

**a.** Let to the right be positive for velocity.

$$m_1\boldsymbol{u}_1 + m_2\boldsymbol{u}_2 = m_1\boldsymbol{v}_1 + m_2\boldsymbol{v}_2$$

$$3.0 \times 4.0 + 10 \times -2.5 = 3.0 \times 1.0 + 1.0v$$ 1 mark

$$v = 6.5 \text{ m s}^{-1}$$ 1 mark

**b.** $$F_{\text{by cart B on cart A}} = \frac{mv - mu}{t}$$

$$= \frac{3.0 \times 1.0 - 3.0 \times 4.0}{0.05}$$ 1 mark

$$= -180 \text{ N}$$

magnitude of $F_{\text{by cart B on cart A}} = 180$ N 1 mark

direction = left 1 mark

**Question 12** (6 marks)

**a.** Finding the acceleration of the 5.0 kg box gives:

$$F_{\text{net}} = ma$$

$$T = 5a$$ 1 mark

Finding the acceleration of the 3.0 kg box gives:

$$F_{\text{net}} = ma$$

$$W - T = 3a$$ 1 mark

$$3 \times 9.8 - T = 3a$$

$$29.4 - 5a = 3a$$ 1 mark

$$a = 3.7 \text{ m s}^{-2}$$ 1 mark

**b.** $u = 0.0$, $s = 1.0$ m, $a = 3.7$, $t = ?$

$$s = ut + \frac{1}{2}at^2$$

$$1.0 = 0 + \frac{1}{2} \times 3.7t^2$$ 1 mark

$$t = 0.74 \text{ s}$$ 1 mark

*Note: Consequential on answer to* ***Question 12a.***

**Question 13** (8 marks)

**a.** $E_K = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 1000.0 \times 5.00^2$ 1 mark

$= 1.25 \times 10^4$ J 1 mark

**b.** $E_X = E_Y$

$1.25 \times 10^4 + 1000.0 \times 9.8 \times 10.0 = \frac{1}{2} \times 1000 \times v^2$

*1 mark for LHS substitution.*
*1 mark for RHS substitution.*

$v = 14.9$ m s$^{-1}$ 1 mark

*Note: Consequential on answer to **Question 13a.***

**c.** $E_X = E_Z$

$1.11 \times 10^5 = 1000 \times 9.8 \times h$

*1 mark for LHS substitution.*
*1 mark for RHS substitution.*

$h = 11.3$ m 1 mark

**Question 14** (6 marks)

**a.** $E_K = \frac{1}{2}mv^2$

$2.0 = \frac{1}{2} \times 1.0 \times v^2$ 1 mark

$v = 2.0$ m s$^{-1}$ 1 mark

**b.** work done $= \Delta E_K$

$= 2.0$ J 1 mark

**c.** $U_s = 2.0$ J 1 mark

$= \frac{1}{2}kx^2$

$2.0 = \frac{1}{2} \times k \times (0.1)^2$ 1 mark

$k = 400.0$ or $4.0 \times 10^2$ N m$^{-1}$ 1 mark

**Question 15** (5 marks)

**a.** $\tau_{\text{clockwise}} = \tau_{\text{anticlockwise}}$

$F \times 0.800 = 10.0 \times 9.8 \times 0.200$ 1 mark

$F = 24.5 \text{ N}$ 1 mark

**b.** Taking up as positive gives:

$\Sigma F_{\text{vertical}} = 0$

$F + 10.0 \times 9.8 - F_{\text{R}} = 0$ 1 mark

$F_{\text{R}} = 123 \text{ N}$ 1 mark

direction = up 1 mark

*Note: Consequential on answer to **Question 15a.***

**Question 16** (10 marks)

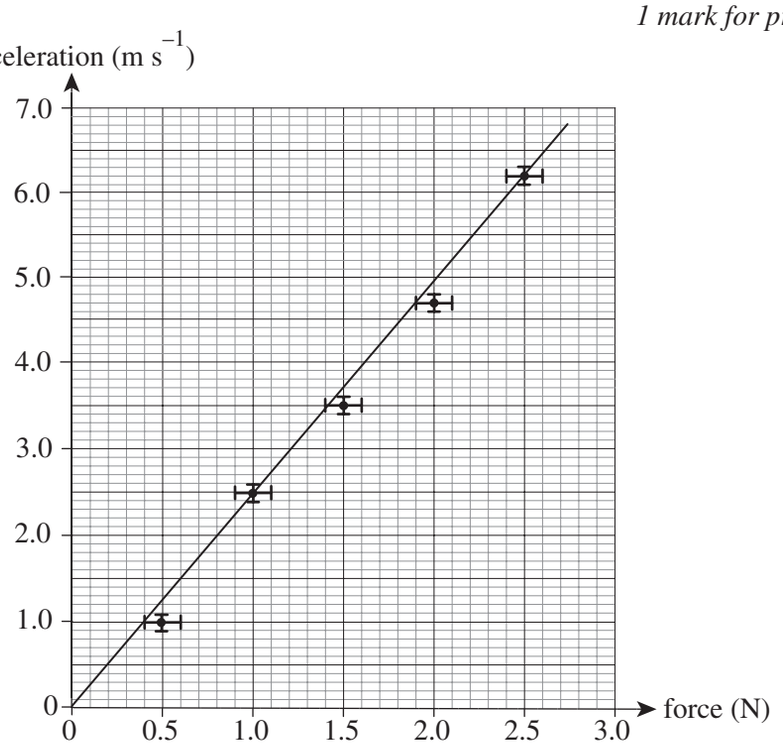
**a.**

| Classification | Variable |
|---|---|
| independent | force applied |
| dependent | acceleration |
| controlled | mass of the glider |

3 marks

*1 mark for providing each correct variable.*

**b.**




5 marks

*1 mark for using the correct axes labels.*

*1 mark for using correct scales. (At least half of the provided grid must be used.)*

*1 mark for showing the correct plotted points.*

*1 mark for showing the correct line of best fit.*

*1 mark for showing the correct uncertainty bars.*

**c.** $\text{gradient} = \dfrac{6.2}{2.5}$

$= 2.48$ 1 mark

$\text{mass} = \dfrac{1}{\text{gradient}}$

$= \dfrac{1}{2.48}$

$= 0.40 \text{ kg}$ 1 mark

*Note: Consequential on answer to **Question 16b.***