Question 8 (10 marks)

Electric power from the Yallourn W power station is delivered to consumers in Melbourne as shown in Figure 7. The electric power has different voltages at different stages of transmission. The generator produces energy at a rate of 200 MW_{RMS} and an AC voltage of 20 kV_{RMS}. In the adjacent switchyard transformer, 20 kV_{RMS} is stepped up to 500 kV_{RMS} for transmission. The terminal station is 100 km away.

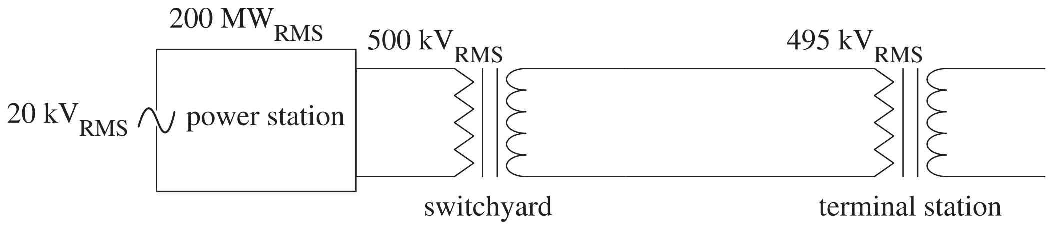

Figure 7

a. Calculate the value of $\frac{\text{number of turns on the secondary}}{\text{number of turns on the primary}}$ for the switchyard transformer. 2 marks

b. Show that the RMS current flowing in the transmission lines is 400 A. 2 marks

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Neap

Trial Examination 2020

VCE Physics Unit 3

Written Examination

Suggested Solutions

SECTION A – MULTIPLE-CHOICE QUESTIONS

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

Question 1 **D**

The field lines travel from North to South, and so the direction of the field is to the left.

Question 2 **B**

If the speed is decreased, the radius of the path will decrease, as shown by $r = \frac{mv}{q_e B}$. If the velocity has decreased, then the force acting on the proton will decrease, as shown by $F_c = qvB$.

Question 3 **D**

$$F_{\text{new}} = \frac{k2Q2Q}{\left(\frac{r}{2}\right)^2}$$

$$= 4 \times (2)^2 \times F_{\text{original}}$$

$$= 16 \times F_{\text{original}}$$

Question 4 **B**

$$\frac{r^3_{\text{Rhea}}}{t^2_{\text{Rhea}}} = \frac{r^3_{\text{Helene}}}{t^2_{\text{Helene}}}$$

$$\frac{(527.1)^3}{(4.5)^2} = \frac{(377.4)^3}{t^2}$$

$$t = \sqrt{\frac{(527.1)^3 \times (4.5)^2}{(527.1)^3}}$$

$$= 2.7\,\text{days}$$

Question 5 **B**

Because of the orientation, the primary side is on the right and the secondary side is on the left.

$$\frac{N_{\text{primary}}}{N_{\text{secondary}}} = \frac{V_{\text{primary}}}{V_{\text{secondary}}}$$

$$\frac{6}{12} = \frac{12}{V_{\text{secondary}}}$$

$$V_{\text{secondary}} = 24.0 \text{ V}$$

Question 6 **C**

Graph **C** best represents the induced EMF, as EMF is proportional to the rate of change of flux.

Question 7 **C**

The vertical component of speed is 0.0 m s^{-1} and the horizontal component is 70.0cos30 = 60.6 m s^{-1}.
Speed at P is therefore 70.0cos30 = 60.6 m s^{-1}.

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b. $E_{K(\text{before})} = \frac{1}{2}m_1(\boldsymbol{u}_1)^2 + \frac{1}{2}m_2(\boldsymbol{u}_2)^2$

$= \frac{1}{2}0.2(20.0)^2 + 0.0 = 40\text{ J}$ 1 mark

$E_{K(\text{after})} = \frac{1}{2}0.2(\mathbf{5.0})^2 + \frac{1}{2}0.6(\mathbf{5.0})^2 = 10\text{ J}$ 1 mark

$\frac{1}{2}m_1(\boldsymbol{u}_1)^2 + \frac{1}{2}m_2(\boldsymbol{u}_2)^2 > \frac{1}{2}m_1(\boldsymbol{v}_1)^2 + \frac{1}{2}m_2(\boldsymbol{v}_2)^2$

inelastic 1 mark

Question 11 (7 marks)

a. $U_s = \frac{1}{2} \times 200.0(2.00 - 1.5)^2$ 1 mark

$= 25.0\text{ J}$ as required 1 mark

b. The ball reaches maximum speed when the net force is zero and the ball has stopped accelerating.

$mg = kx$

$2.0 \times 9.8 = 200.0x$ 1 mark

$x = 0.098 = 0.10\text{ m}$ 1 mark

c. $E_T = 25.0\text{ J}$

When launched, the ball has $U_g + E_K$. 1 mark

$25.0 = 2 \times 9.8 \times 0.5 + \frac{1}{2}2 \times v^2$ 1 mark

$v = 3.9\text{ m s}^{-1}$ 1 mark

Question 12 (5 marks)

a. minimum speed needed to maintain contact:

$g = \frac{v^2}{r}$

$v = \sqrt{9.8 \times 6}$ 1 mark

$= 7.7\text{ m s}^{-1}$ 1 mark

If the car is travelling at less than 7.7 m s^{-1} when it reaches the top of the loop it will not remain in contact with the track. At 8.0 m s^{-1}, it will remain in contact. 1 mark

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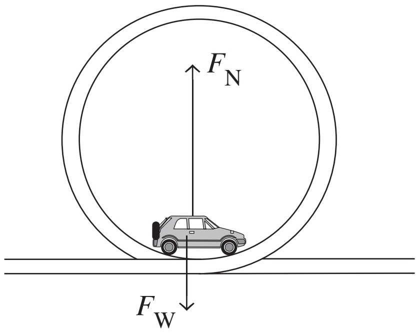
b.



2 marks
1 mark for labelled force vectors.
1 mark for relative length of force vectors.

Question 13 (4 marks)

a. time dilation — 1 mark

b. $l = \frac{l_o}{\gamma}$

$\gamma = \frac{5.0}{2.2} = 2.27$ — 1 mark

$v = c\sqrt{1 - \frac{1}{\gamma^2}}$

$= 3.0 \times 10^8 \sqrt{1 - \frac{1}{2.27^2}}$ — 1 mark

$= 2.7 \times 10^8 \text{ m s}^{-1}$ — 1 mark

Question 14 (2 marks)

The work done is equal to the change in kinetic energy.

$\Delta E_K = (\gamma - 1)mc^2$

$= (3.2 - 1) \times 9.1 \times 10^{-31} \times (3.0 \times 10^8)^2$ — 1 mark

$= 1.8 \times 10^{-13} \text{ J}$ — 1 mark