Cambridge Assessment International Education

Cambridge Pre-U

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0123456789

PHYSICS **9792/02**

Paper 2 Written Paper **For examination from 2020**

SPECIMEN PAPER **2 hours**

You must answer on the question paper.

You will need: Insert (enclosed)

INSTRUCTIONS
- Section 1: answer **all** questions.
- Section 2: answer **the** question. The question is based on the material in the insert, which is a copy of the pre-release material.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION
- The total mark for this paper is 100.
- The number of marks for each question or part question is shown in brackets [ ].

For Examiner's Use	
1	
2	
3	
4	
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6	
7	
8	
Total	

This specimen paper has been updated for assessments from 2020. The specimen questions and mark schemes remain the same. The layout and wording of the front covers have been updated to reflect the new Cambridge International branding and to make instructions clearer for candidates.

This syllabus is regulated for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document has **20** pages. Blank pages are indicated.

Data

gravitational field strength close to Earth's surface	$g = 9.81\,\text{N}\,\text{kg}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19}\,\text{C}$
speed of light in vacuum	$c = 3.00 \times 10^{8}\,\text{m}\,\text{s}^{-1}$
Planck constant	$h = 6.63 \times 10^{-34}\,\text{J}\,\text{s}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F}\,\text{m}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\text{N}\,\text{m}^{2}\,\text{kg}^{-2}$
electron mass	$m_e = 9.11 \times 10^{-31}\,\text{kg}$
proton mass	$m_p = 1.67 \times 10^{-27}\,\text{kg}$
unified atomic mass constant	$u = 1.66 \times 10^{-27}\,\text{kg}$
molar gas constant	$R = 8.31\,\text{J}\,\text{K}^{-1}\,\text{mol}^{-1}$
Avogadro constant	$N_A = 6.02 \times 10^{23}\,\text{mol}^{-1}$
Boltzmann constant	$k = 1.38 \times 10^{-23}\,\text{J}\,\text{K}^{-1}$
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\,\text{W}\,\text{m}^{-2}\,\text{K}^{-4}$

Formulae

uniformly accelerated motion

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

$$v^2 = u^2 + 2as$$

$$s = \left(\frac{u+v}{2}\right)t$$

heating

$$\Delta E = mc\Delta\theta$$

change of state

$$\Delta E = mL$$

refraction

$$n = \frac{\sin\theta_1}{\sin\theta_2}$$

$$n = \frac{v_1}{v_2}$$

diffraction	
single slit, minima	$n\lambda = b\sin\theta$
grating, maxima	$n\lambda = d\sin\theta$
double slit interference	$\lambda = \dfrac{ax}{D}$
Rayleigh criterion	$\theta \approx \dfrac{\lambda}{b}$
photon energy	$E = hf$
de Broglie wavelength	$\lambda = \dfrac{h}{p}$
simple harmonic motion	$x = A\cos\omega t$
	$v = -A\omega\sin\omega t$
	$a = -A\omega^2\cos\omega t$
	$F = -m\omega^2 x$
	$E = \frac{1}{2}mA^2\omega^2$
energy stored in a capacitor	$W = \frac{1}{2}QV$
capacitor discharge	$Q = Q_0 e^{-\frac{t}{RC}}$
electric force	$F = \dfrac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$
electrostatic potential energy	$W = \dfrac{Q_1Q_2}{4\pi\varepsilon_0 r}$
gravitational force	$F = -\dfrac{Gm_1m_2}{r^2}$
gravitational potential energy	$E = -\dfrac{Gm_1m_2}{r}$
magnetic force	$F = BIl\sin\theta$
	$F = BQv\sin\theta$
electromagnetic induction	$E = -\dfrac{d(N\Phi)}{dt}$
Hall effect	$V = Bvd$
time dilation	$t' = \dfrac{t}{\sqrt{1-\dfrac{v^2}{c^2}}}$
length contraction	$l' = l\sqrt{1-\dfrac{v^2}{c^2}}$
kinetic theory	$\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$
work done on/by a gas	$W = p\Delta V$
radioactive decay	$\dfrac{dN}{dt} = -\lambda N$
	$N = N_0 e^{-\lambda t}$
	$t_{\frac{1}{2}} = \dfrac{\ln 2}{\lambda}$
attenuation losses	$I = I_0 e^{-\mu x}$
mass-energy equivalence	$\Delta E = c^2\Delta m$
hydrogen energy levels	$E_n = \dfrac{-13.6\,\text{eV}}{n^2}$
Heisenberg uncertainty principle	$\Delta p\Delta x \geqslant \dfrac{h}{2\pi}$
Wien's displacement law	$\lambda_{\max} \propto \dfrac{1}{T}$
Stefan's law	$L = 4\pi\sigma r^2T^4$
electromagnetic radiation from a moving source	$\dfrac{\Delta\lambda}{\lambda} \approx \dfrac{\Delta f}{f} \approx \dfrac{v}{c}$

Section 1

You are advised to spend about 1 hour and 30 minutes answering this section.

1 **(a)** **(i)** State the difference between a vector and a scalar quantity.

....

....

.... [1]

(ii) Give two examples of each.

scalar	vector
1.	1. ....
2.	2. .... [2]

(b) **(i)** Fig. 1.1 represents three vectors A, B and C.

Draw a sketch diagram in the space to the right of Fig. 1.1, to represent a vector D as the sum of the three vectors A, B and C.

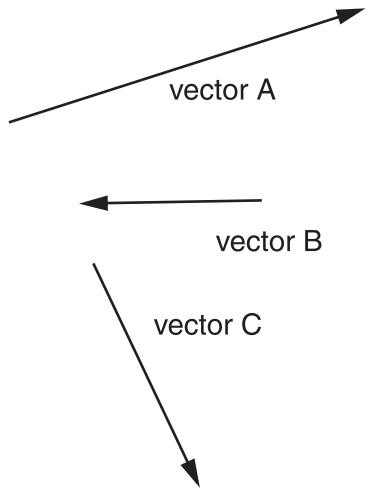

Fig. 1.1 [2]

(ii) Fig. 1.2 represents a vector E of magnitude 37 units.
Calculate the magnitudes of the components of vector E in the *x*-direction and in the *y*-direction.

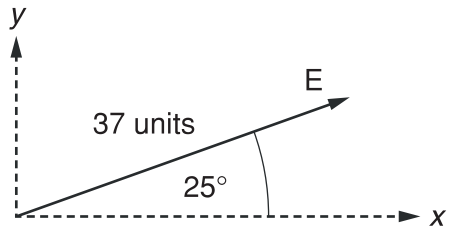

Fig. 1.2 (not to scale)

component in *x*-direction = ... units

component in *y*-direction = ... units [2]

[Total: 7]

2 **(a)** From the definition of work done, show that power = force × velocity.

....

....

....

.... [2]

(b) A car of mass 850 kg travelling at a constant speed of 12.0 m s^{-1} has a power output of 1800 W.

Determine

(i) the driving force,

driving force = ... N [1]

(ii) the total resistive force on the car.

resistive force = ... N [1]

(c) The car in **(b)** accelerates from 12.0 m s^{-1} with an initial acceleration of 2.50 m s^{-2}.

Calculate

(i) the rate of change of momentum of the car,

rate of change of momentum .... kg m s^{-2} [2]

(ii) the new driving force.

new driving force = ... N [1]

(d) After accelerating, the car in **(c)** reaches a constant speed of 36.0 $m s^{-1}$. The resistive force on the car is proportional to its speed squared.

Calculate

(i) the new resistive force on the car at 36.0 $m s^{-1}$,

resistive force = ... N [2]

(ii) the new power output.

power output = ... W [1]

[Total: 10]

3 Fig. 3.1 is a diagram of a domestic electrical circuit. The circuit allows many electrical components to be individually switched on or off. The supply voltage is 240 V.

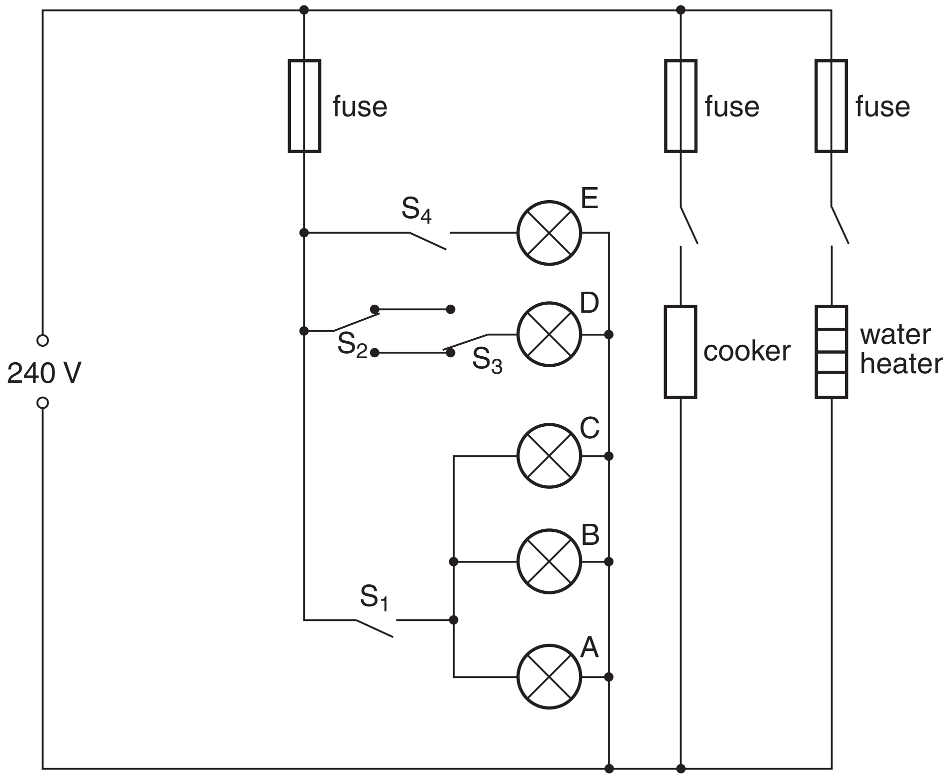

Fig. 3.1

(a) (i) The water heater has a resistance of 20 Ω. Calculate the power of the water heater.

power = ... W [3]

(ii) Calculate the time it will take the water heater to raise the temperature of 33 kg of water from 20 °C to 60 °C, assuming no heat loss. The specific heat capacity of water is 4200 J kg^{-1} °C^{-1}.

time = ...s [2]

(b) (i) State the effect of closing switch S_1.

.... [1]

(ii) Explain how switches S_2 and S_3 control lamp D.

....

....

.... [2]

(iii) Calculate the resistance of lamp E, which is rated 10 W.

resistance = ... Ω [2]

(c) All the electrical sockets in a house are connected to a circuit called a ring main. The circuit is connected between P and Q to the 240 V supply as shown in Fig. 3.2.

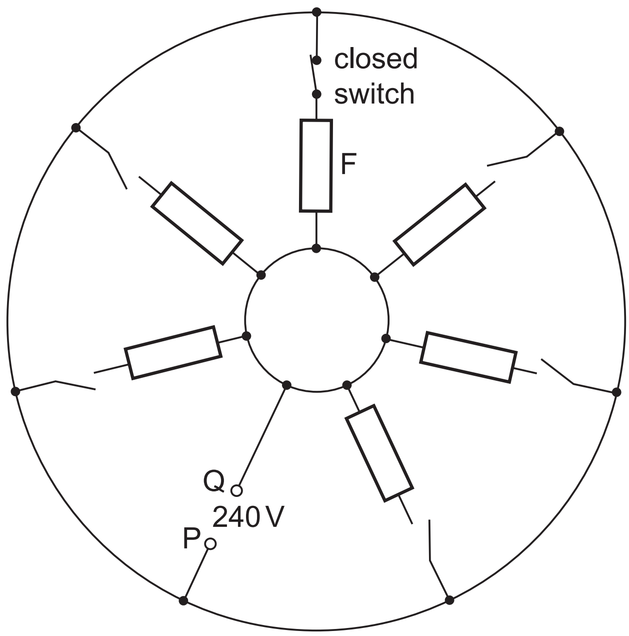

Fig. 3.2

(i) All the switches are open except the one to a computer at F, which is closed as shown. Draw arrows on Fig. 3.2 to show the paths of the current when the computer is in use at an instant in time when P is positive. [2]

(ii) Suggest two advantages of using a ring main.

1. ....

....

2. ....

.... [2]

[Total: 14]

4 **(a)** Describe the basic difference between the following terms. You may use diagrams to illustrate your answers.

(i) a *transverse* wave and a *longitudinal* wave

....

.... [2]

(ii) a *polarised* wave and a *non-polarised* wave

....

.... [2]

(iii) a *standing* wave and a *progressive* wave

....

.... [3]

(b) (i) The light from a sodium lamp is analysed using an instrument containing a diffraction grating. The diffraction grating has 500 lines per millimetre. A spectral line in the second order spectrum is at an angle of 36.09°.

Use the equation $n\lambda = d\sin\theta$ to calculate the wavelength of the light causing this spectral line.

wavelength = ... m [3]

(ii) There is another second order spectral line at 36.13°.

Calculate the wavelength of the light causing this line.

wavelength = ... m [1]

(iii) The spectral lines are viewed using a lens of aperture *b*.

Use the Rayleigh criterion to find the approximate minimum size of the aperture that is able to resolve the two spectral lines.

minimum size = ... m [3]

[Total: 14]

5 **(a)** In a fission process a neutron collides with a uranium-235 nucleus and causes a nuclear reaction summarised by the following equation.

$$^{1}_{0}n + ^{235}_{92}U \rightarrow ^{P}_{Q}X \rightarrow ^{R}_{54}Xe + ^{90}_{38}Sr + 3^{1}_{0}n + \text{energy}$$

(i) Give the numerical values of P, Q and R.

P = ...

Q = ...

R = ...
[2]

(ii) State the feature of this equation that indicates that a chain reaction may be possible.

....

.... [1]

(b) A strontium-90 nucleus emits a β^- particle and decays to yttrium (Y). The decay has a half-life of 28 years.

(i) Write the nuclear transformation equation for the emission of the β^- particle.

[2]

(ii) State the number of electrons in a neutral atom of yttrium.

number = ... [1]

(iii) In a laboratory source of strontium-90, the number of atoms present in the year 2012 was 2.36×10^{13}.

Calculate the number of strontium atoms that will be present in the source in the year 2124 (112 years later).

number = ... [3]

[Total: 9]

6 **(a)** The equation $hf = \Phi + \frac{1}{2}mv_{max}^2$ is used in the theory of the photoelectric effect.

Describe the photoelectric effect and explain what the three terms in the equation represent.

....

....

....

....

....

....

....

....

....

....

.... [6]

(b) Describe an experiment used to determine v_{max} in the equation in **(a)**. You should include a diagram showing the arrangement and electrical circuit.

....

....

....

....

....

....

....

.... [4]

(c) The photoelectric effect was important in the development of a photon theory of electromagnetic radiation.

(i) State one observation of the photoelectric effect that cannot be explained using the wave model.

....

....

.... [1]

(ii) Explain how the **wave** model fails to account for this observation.

....

....

.... [1]

(iii) Explain how the **photon** model can account for this observation.

....

....

.... [1]

[Total: 13]

7 A uniform block of rectangular cross-section is at rest on a rough ramp as shown in Fig. 7.1.

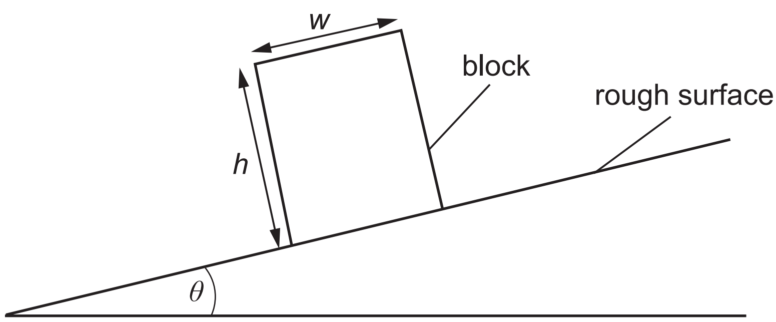

Fig. 7.1 (not to scale)

mass of block = 2.80 kg
width w of block = 10.0 cm
height h of block = 15.0 cm
coefficient of static friction between block and ramp μ_s = 0.600
coefficient of kinetic friction between block and ramp μ_k = 0.550

The right-hand end of the ramp is slowly raised increasing θ. Eventually, the block moves.

Use the data to predict whether the block will topple or slide as the ramp is raised. Support your answer with appropriate explanations and calculations.

....

....

....

....

....

....

....

....

....

.... [8]

[Total: 8]

End of Section 1

Section 2

You are advised to spend about 30 minutes answering this section.
The questions in this section may refer to the pre-released material provided as an Insert to this paper.
Your answers should, where possible, make use of any relevant Physics.

8 **(a)** Fig. 8.1 shows how the current I in an a.c. transmission line varies with time t.

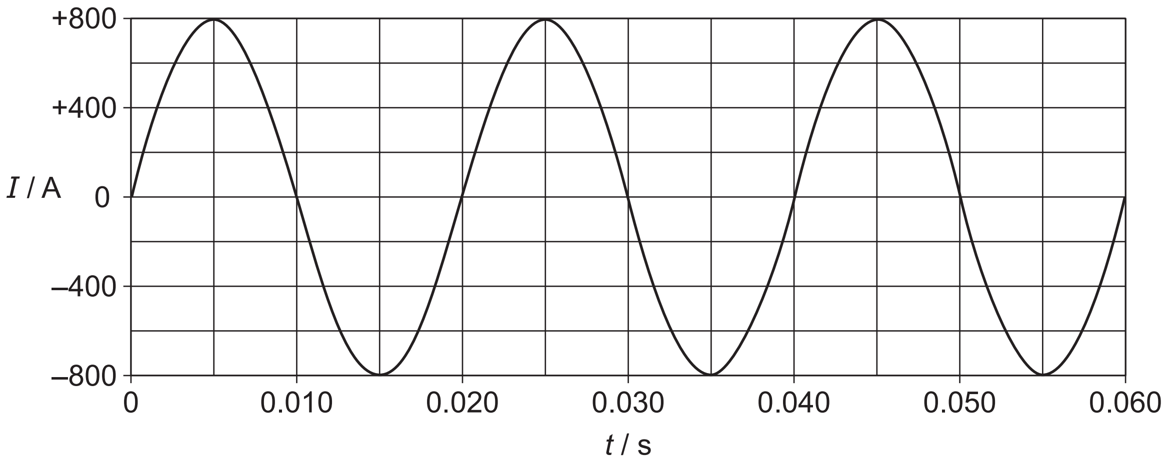

Fig. 8.1

Fig. 8.2 shows how the voltage V across the transmission line varies with time t.

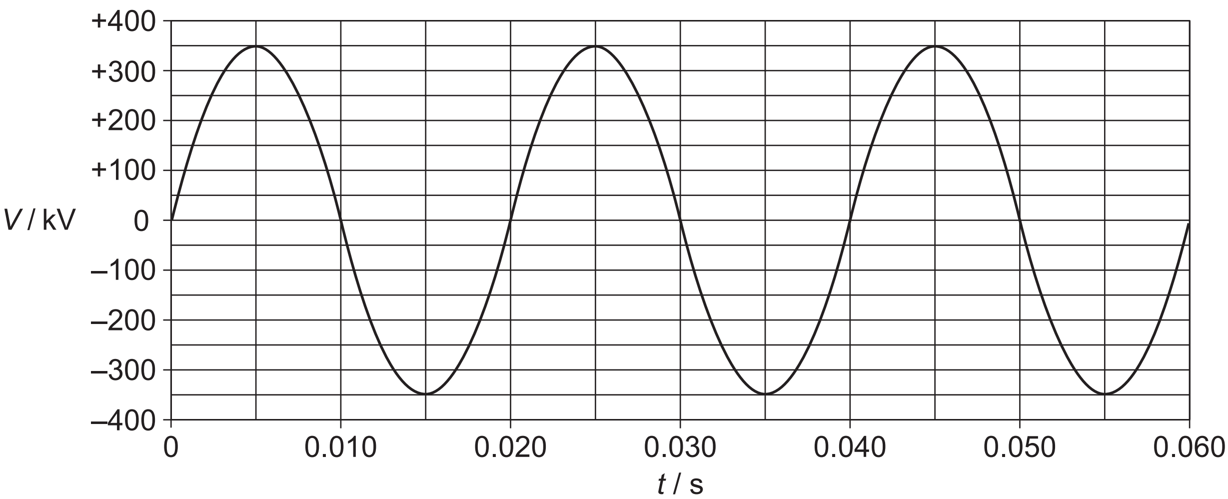

Fig. 8.2

(i) **1.** State the peak value of the current in the wire.

peak value of current = ... A [1]

2. State the peak value, in volts, of the voltage across the wire.

peak value of voltage = ... V [1]

(ii) Determine the power delivered by the transmission line at

1. $t = 0.015\,s$,

power = ... W

2. $t = 0.030\,s$.

power = ... W
[2]

(iii) Using information from **(a)(ii)** and Fig. E1.1 in Extract 1 of the Insert, sketch a graph on the axes of Fig. 8.3 to show how the power P delivered by the transmission line varies with time. [3]

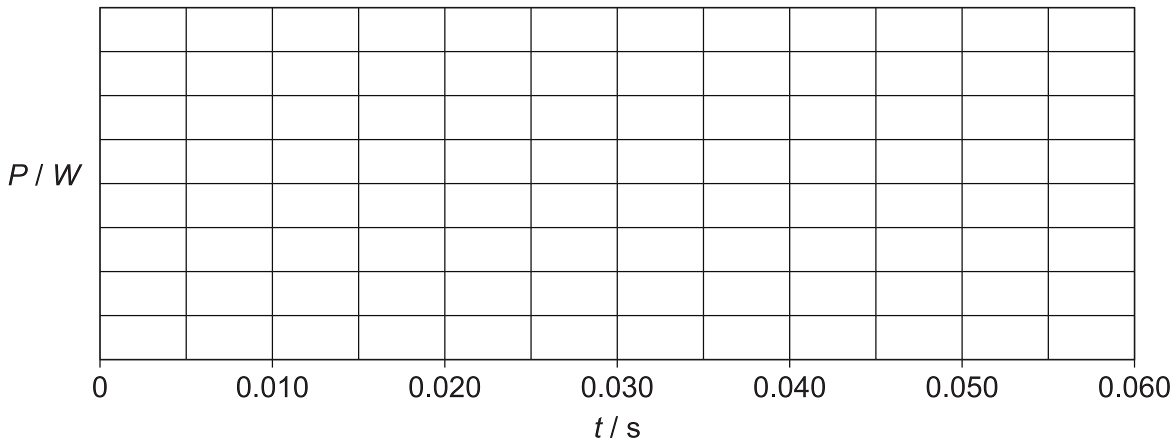

Fig. 8.3

(iv) It is suggested that this transmission line is used in a high voltage direct current (HVDC) transmission system delivering a current of 800 A at a constant voltage of 350 kV.

Draw a line on Fig. 8.3 to show the power that would be delivered by this HVDC line as time varies. [2]

(v) Explain how the graph you drew on Fig. 8.3 shows that the average power delivered by the HDVC transmission line would be much greater than that delivered by the line when transmitting a.c.

....

....

....[2]

(b) A cylindrical copper wire in the transmission system has a diameter of 3.00 cm and a length of 580 km. There is an a.c. of frequency 50.0 Hz in the wire.

(i) Use information from Extract 4 of the Insert to calculate the skin effect depth for the wire when it carries this current.

skin effect depth = ... m [1]

(ii) Assume that when there is an alternating current in the cylindrical copper wire, the current flows only in the region between the surface of the wire and a depth equal to the skin effect depth and there is no current at the centre of the cylindrical wire.

Use the value from **(b)(i)** to calculate the cross-sectional area of the region of the wire in which this current flows.

cross-sectional area = ... m^2 [2]

(iii) The resistivity of copper is $1.72 \times 10^{-8}\,\Omega\,m$. Calculate the resistance of the wire for this current.

resistance = ...Ω [2]

(iv) The peak value of the a.c. in the wire is 800 A. Calculate the maximum rate at which heat (thermal energy) is generated in the wire. Express the answer in megawatts.

heat (thermal energy) = ... MW [2]

(c) An undersea transmission cable consists of two parallel, metal conductors separated by an insulator. This arrangement is similar to a parallel-plate capacitor and so the undersea cable has a capacitance which can be determined.

Fig. 8.4 shows a capacitor of capacitance *C* connected directly to an alternating voltage supply of peak value V_0 and of frequency *f*.

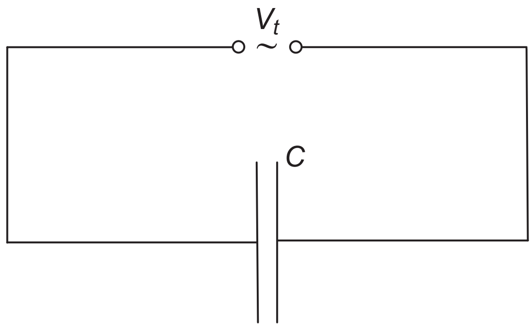

Fig. 8.4

(i) State an expression for the charge Q_t stored on the capacitor at time *t*.

....

.... [1]

(ii) Explain why there is a current in the circuit in Fig. 8.4.

....

.... [1]

(iii) The current I_t in the circuit is given by the expression

$$I_t = 2\pi f C V_0 \cos(2\pi f t).$$

1 Suggest why the peak current in the circuit depends on the frequency of the a.c. supply.

....

.... [1]

2 Determine an expression for the capacitive reactance for the circuit in Fig. 8.4 and give its unit.

....

.... [1]

3 An undersea transmission cable of length 200 km, has a capacitance per unit length of $7.00 \times 10^{-7}\,\mathrm{F\,km^{-1}}$. The cable is tested by being connected to an alternating voltage of peak voltage 350 kV and of frequency 50.0 Hz. There are no connections at the other end of the cable. The resistance of the cable is negligible.

Calculate the peak value of the current in the transmission cable.

peak value of current = ... A [2]

(iv) Suggest one disadvantage of transmitting an alternating voltage using an undersea cable that has a large capacitance.

....

.... [1]

[Total: 25]

End of Section 2