Cambridge International Examinations
Cambridge Pre-U Certificate

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

0001449622

PHYSICS (PRINCIPAL) **9792/02**

Paper 2 Part A Written Paper **May/June 2015**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
You are advised to spend about 1 hour 30 minutes on this section.

Section B
Answer the **one** question.
You are advised to spend about 30 minutes on this section.
The question is based on the material in the Insert.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
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4	
5	
6	
7	
8	
Total	

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

This document consists of **22** printed pages, **2** blank pages and **1** insert.

DC (RW/FD) 97071/3

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Data

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

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	$W = \frac{1}{2}QV$
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	$E = -\dfrac{\mathrm{d}(N\Phi)}{\mathrm{d}t}$
Hall effect	$V = Bvd$
time dilation	$t' = \dfrac{t}{\sqrt{1-\dfrac{v^2}{c^2}}}$
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	$\dfrac{\mathrm{d}N}{\mathrm{d}t} = -\lambda N$
	$N = N_0 e^{-\lambda t}$
	$t_{\frac{1}{2}} = \dfrac{\ln 2}{\lambda}$
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	$\Delta p\Delta x \geqslant \dfrac{h}{2\pi}$
	$\Delta E\Delta t \geqslant \dfrac{h}{2\pi}$
Wien's displacement law	$\lambda_{max} \propto \dfrac{1}{T}$
Stefan's law	$L = 4\pi\sigma r^2 T^4$
electromagnetic radiation from a moving source	$\dfrac{\Delta\lambda}{\lambda} \approx \dfrac{\Delta f}{f} \approx \dfrac{v}{c}$

Section A

You are advised to spend about 1 hour 30 minutes answering the questions in this section

1 Fig. 1.1 shows a speed-time graph for a car moving in a straight line. The graph has been divided into 5 stages A, B, C, D and E.

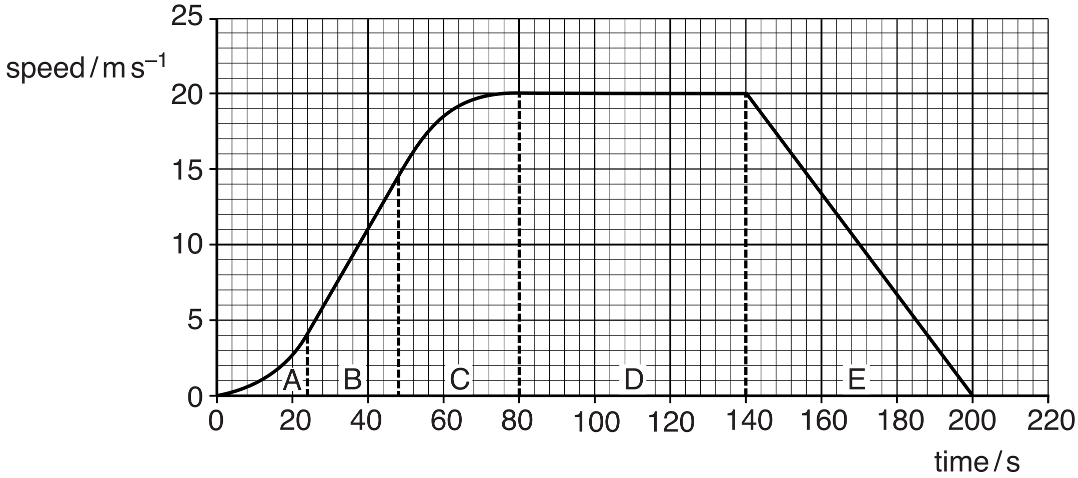

Fig. 1.1

(a) (i) During stage B the acceleration of the car is constant and positive.

Describe, without calculations, the acceleration of the car during stages A, C and E by completing the following sentences.

During stage A, the acceleration is .... and ....

During stage C, the acceleration is .... and ....

During stage E, the acceleration is .... and ....

[3]

(ii) Describe the motion of the car during stage D.

....[1]

(b) Calculate the acceleration of the car during stage B.

acceleration = ... m s^{-2} [2]

(c) (i) Using Fig. 1.1, estimate the distance that the car travels during the whole 200 s.

distance = ... m [5]

(ii) Estimate the uncertainty in your answer to **(c)(i)** and explain your reasoning.

....

....

uncertainty = ... m [3]

[Total: 14]

2 **(a)** Explain what is meant by

(i) an elastic material, ...

....[1]

(ii) a plastic material, ...

....[1]

(iii) a tough material, ...

....[1]

(iv) a brittle material. ....

....[1]

(b) Explain what is meant by a malleable material and give an example of a malleable material in use.

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....[2]

(c) Fig. 2.1 is a stress-strain graph of a polymer.

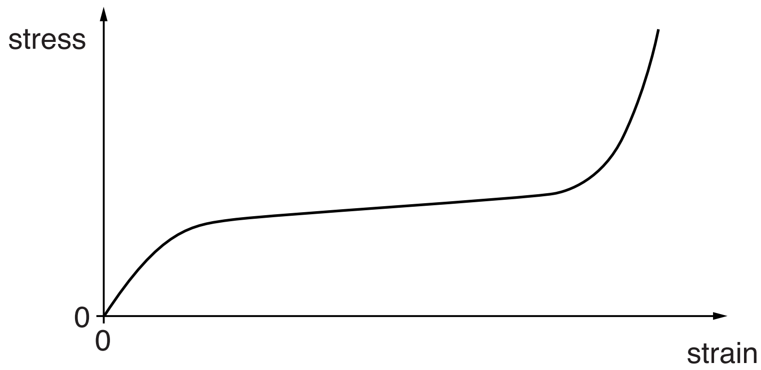

Fig. 2.1

Explain the shape of the graph in terms of the microstructure of the polymer.

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....[3]

[Total: 9]

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3 **(a)** A vertical distance of 560 m separates a low point P and a high point Q on a mountain.

Calculate the gravitational potential difference between P and Q and give a suitable unit for your answer.

gravitational potential difference = ... unit .... [2]

(b) A mountaineer of total mass 68 kg climbs from P to Q in 5.0 hours.

(i) Calculate the average power required for the mountaineer to make the climb.

power = ... W [3]

(ii) Calculate how many chocolate bars would be required by the mountaineer to supply the energy for the climb from P to Q.

Each chocolate bar stores 450 kJ of energy. The metabolic efficiency of the human body is about 15%, which can be assumed to be the efficiency of the mountaineer.

number of chocolate bars = ... [2]

[Total: 7]

4 Fig. 4.1 shows a potential divider used to provide variable amounts of electrical power to a resistor of 30.0 Ω resistance.

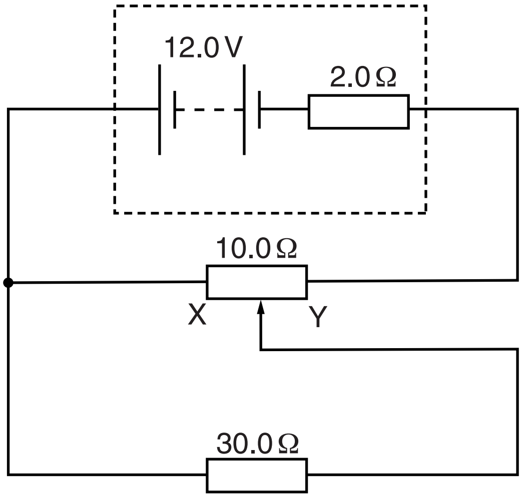

Fig. 4.1

The potential divider is supplied with power from a source of electromotive force 12.0 V and internal resistance 2.0 Ω. The potential divider resistor has a resistance 10.0 Ω. The contact on the slider can move between position X and position Y to give a linear change with distance in resistance between zero and 10.0 Ω respectively.

(a) Calculate the potential difference across the 30.0 Ω resistor when

(i) the slider is at X,

potential difference = ... V [1]

(ii) the slider is at Y,

potential difference = ... V [2]

(iii) the slider is half-way between X and Y.

potential difference = ... V [3]

(b) Calculate the power supplied to the 30.0 Ω resistor when the slider is at Y.

power = ... W [2]

[Total: 8]

5 **(a)** **(i)** State the conditions needed for a stationary sound wave to be formed.

....

....

....[2]

(ii) A stationary sound wave is set up in a horizontal tube containing air. Fig. 5.1 shows the displacement nodes and displacement antinodes along the length of the tube.

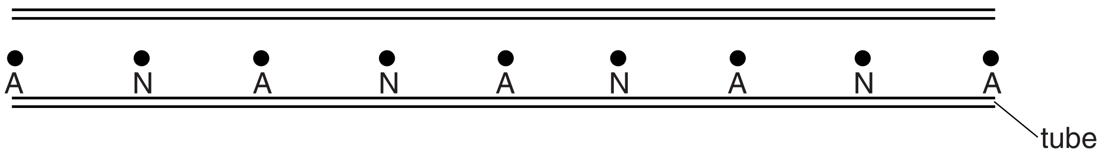

Fig. 5.1

Describe the movement of air molecules on either side of a node and hence, state what happens to the pressure at a node during one cycle of oscillation.

....

....

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....[3]

(b) **(i)** The speed of sound v in an aluminium rod is given by the equation

$$v = \sqrt{\frac{E}{\rho}}$$

where E is the Young modulus of the metal and ρ is its density.

Aluminium has a Young modulus of 69.0 GPa and a density of 2710 kg m^{-3}.

Calculate the speed of sound in the aluminium rod.

speed of sound = ... m s^{-1} [2]

(ii) A solid aluminium rod of length 0.850 m is dropped on to a metal plate, as shown in Fig. 5.2.

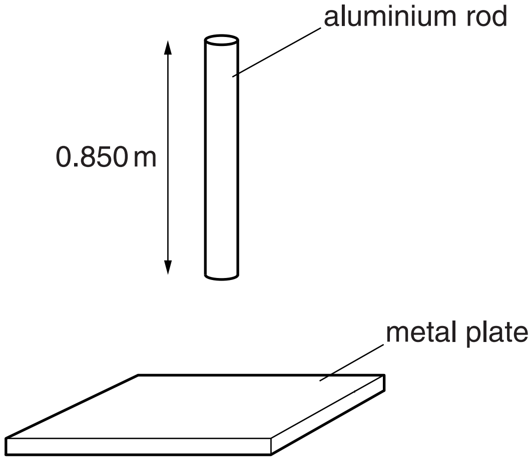

Fig. 5.2

As the rod hits the metal plate, a sound wave is generated in the rod. This wave travels along the length of the rod and is reflected from the top end. When the reflected sound wave reaches the bottom of the aluminium rod, it creates a force that causes the rod to bounce off the metal plate.

Calculate the time the aluminium rod is in contact with the metal plate.

time = ... s [2]

(iii) Describe a method that could be used for measuring this time, using an electronic measuring device.

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....

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....[3]

[Total: 12]

6 **(a)** The α-particle scattering experiment led to a fundamental change in the concept of an atom.

(i) Sketch a labelled diagram of the apparatus used in this experiment.

[2]

(ii) State **two** observations that were made **and** explain the deductions that followed from these observations.

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....[4]

(iii) Fig. 6.1 is a two dimensional drawing frequently used to represent a three dimensional atom.

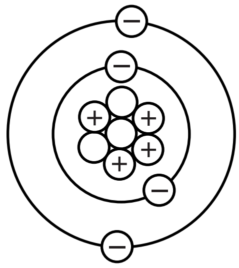

Fig. 6.1

Other than it being in two dimensions, state in what respect Fig. 6.1 is misleading about the nucleus.

....

....[1]

(b) All isotopes of uranium are radioactive.

(i) When a nucleus of uranium-238 decays, it emits an α-particle and forms a nucleus of thorium (Th).
Write the nuclear transformation equation for the decay of uranium-238.

The proton number of uranium (U) is 92.

[2]

(ii) Explain how uranium is used in nuclear power stations to produce large quantities of electrical power.

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....[3]

[Total: 12]

7 **(a)** Describe, using a diagram, a demonstration of the photoelectric effect in which the photoelectric current is measured.

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....[5]

(b) In an experiment on the photoelectric effect using a photocell, the photoelectric current I was plotted against the potential difference V accelerating the photoelectrons. Fig. 7.1 shows a graph of I against V.

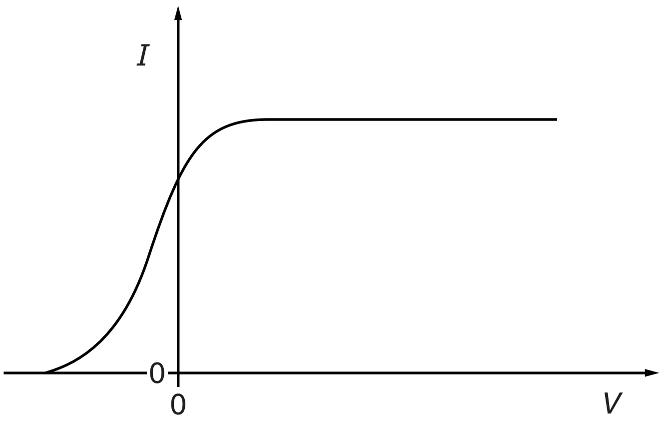

Fig. 7.1

(i) On Fig. 7.1 draw a sketch graph showing the effect of repeating the experiment using the same photocell, but with weaker illumination. [2]

(ii) State the important conclusion about the kinetic energy of photoelectrons that can be deduced from the graph you have drawn in **(b)(i)**.

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....[1]

(c) The minimum energy required to liberate photoelectrons from a particular photocathode, the work function, is 2.30 eV. The photocathode is illuminated by a lamp emitting electromagnetic radiation of wavelength 1.12×10^{-7} m.

Calculate

(i) the work function in joules,

work function .... J [1]

(ii) the maximum kinetic energy of emitted photoelectrons.

maximum kinetic energy = ... J [4]

[Total: 13]

Section B

You are advised to spend about 30 minutes answering this section.
Your answers should, where possible, make use of any relevant Physics.

8 An island is separated from the mainland by a stretch of water 26 km wide at the narrowest point.

An engineering company proposes linking the island to the mainland with a submerged floating tunnel. Fig. 8.1 shows the proposed tunnel.

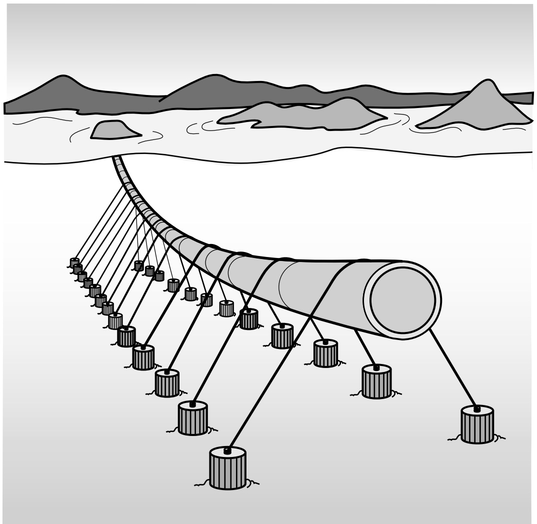

Fig. 8.1 (not to scale)

The tunnel is assembled from hollow, cylindrical sections. The sections are manufactured on land and the open ends are sealed with plastic sheeting. This traps air in the sections which are then loaded on to a ship by crane. Once immersed in the sea, at a depth of 30 m, the sections are joined together and held in place by steel cables mounted in heavy blocks fixed to the seabed.

Fig. 8.2 shows one section of the tunnel.

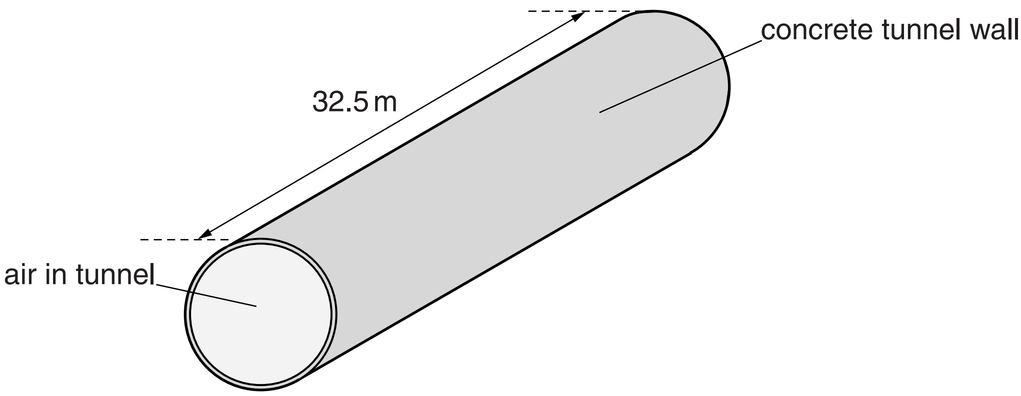

Fig. 8.2 (not to scale)

Each cylindrical section of the tunnel has a length of 32.5 m. The tunnel has an internal diameter of 7.30 m and concrete walls that are 62.0 cm thick. The density of concrete is 2420 kg m^{-3}.

(a) Concrete is a material that is strong under compressive stress.

Explain why tunnel sections are under compressive stress.

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....[1]

(b) Fig. 8.3 shows a cross-section through one of the tunnel sections.

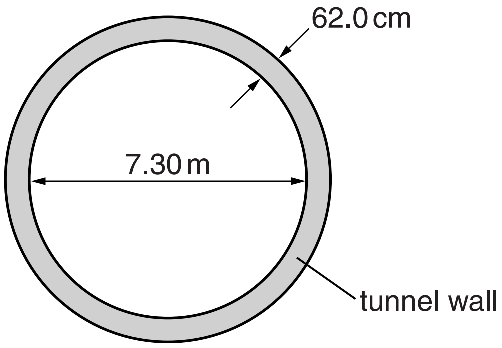

Fig. 8.3 (not to scale)

(i) Calculate the mass of one section of the tunnel.

mass = ... kg [2]

(ii) Use the Principle of Archimedes to calculate the upthrust that acts on each section of the tunnel when it is immersed in the sea and is a part of the complete tunnel. The density of the seawater in this stretch of water is 1020 kg m^{-3}.

upthrust = ... N [2]

(c) When the tunnel is complete, a downward force, provided by three cables on each section of the tunnel, maintains equilibrium. This downward force is due to the cables holding the tunnel in place. The size of this force is affected by the weight of the air trapped in the tunnel section.

The weight of the air trapped in the tunnel section is 1.72×10^4 N.

(i) During construction, a sealed section of the tunnel is held in the air by a crane. The weight of the air trapped inside is ignored and the lift provided by the crane is assumed to be equal to the weight of the concrete.

Suggest **two** reasons why, in this case, ignoring the weight of the trapped air is justified.

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....

....[2]

(ii) Show that the downward force on each section of the tunnel due to the three cables is approximately 6.7×10^6 N.

[2]

(d) The downward force of 6.7×10^6 N is due to three long cables that pass over the top of each section of the tunnel. The two ends of every cable are mounted in heavy blocks fixed to the seabed.

Fig. 8.4 shows the three cables that pass over the top of one section of the tunnel and hold it in place. Each of the three cables passing over one of the sections of the tunnel is 250 m long.

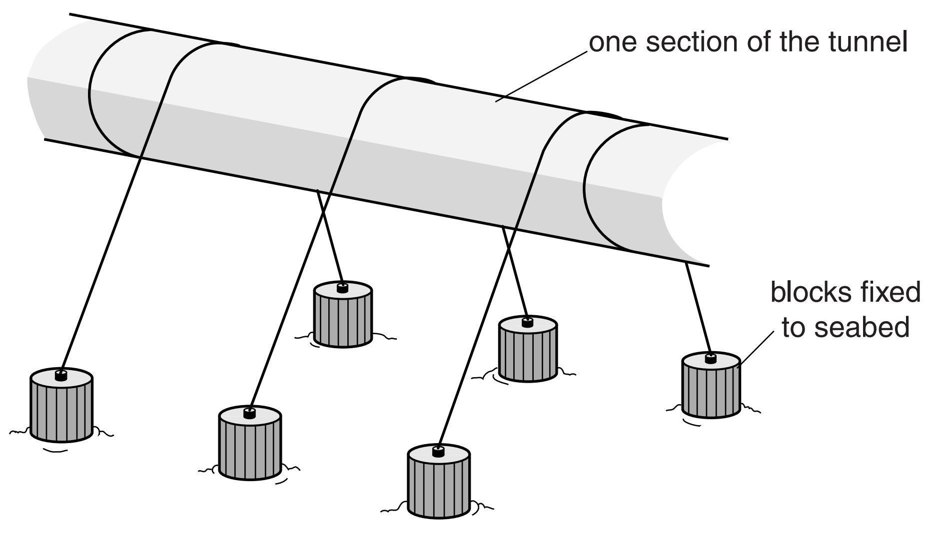

Fig. 8.4 (not to scale)

Fig. 8.5 shows one of these three cables and its two ends mounted in heavy blocks fixed to the seabed.

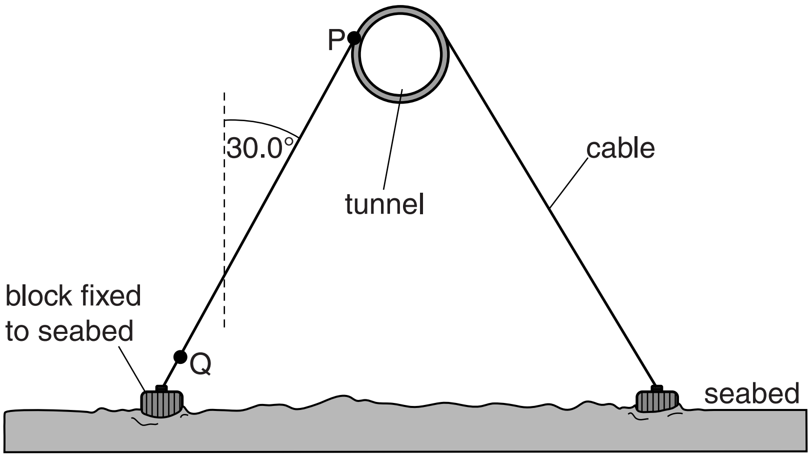

Fig. 8.5 (not to scale)

Each half of the cable is inclined at an angle of 30.0° to the vertical.

(i) By drawing a vector diagram to scale, determine the tension T_P in the cable at point P.

State the scale of the diagram.

scale = ...cm : .... N

T_P = ... N
[4]

(ii) The steel cables are made from many strands of steel wire and the total cross-sectional area of the steel in each cable is 62.1 cm^2.

1. Calculate the tensile stress in the cable at point P.

stress = ... $N\,m^{-2}$ [1]

2. The Young modulus of steel is $1.93 \times 10^{11}\,N\,m^{-2}$.

Calculate the extension that this stress would produce in one of the 250 m long cables.

extension = ... m [2]

(e) The stress in the steel cables is not constant along their length.

Suggest a reason for this **and** state how the stress at point Q in Fig. 8.5 compares with the stress at point P.

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....

....[2]

(f) For many years, submerged floating tunnels (SFT) have been proposed for many fixed-link crossings, but none has actually been built.

Discuss the advantages and disadvantages of such tunnels. You may use information from any of the extracts.

Your answer should concentrate on the social, safety and economic effects of these tunnels.

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