**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

General Certificate of Education Advanced Level

**PHYSICS**

Paper 6

**9702/06**

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**Answers**

**Option A**

**Astrophysics and Cosmology**

1. (a) Define

(i) The astronomical unit (AU),

**Solution**

The astronomical unit (AU) is the distance between Earth and Sun

(ii)The parsec (pc).

**Solution**

The parsec (pc) is the distance at which 1 AU subtends an angle of one arc-second

(b) Calculate the magnitude, in metres, of the parsec given that 1.0 AU = 1.5 × 1011m.

**Solution**

Arc = rθ

1.5 × 1011 =

1.0 pc = 3.09 × 1016 m

1. One model of the Universe is based on the ‘hot big bang’ and another is based on the ‘infinite and static’ concept.

(a)State two pieces of experimental evidence in support of a ‘hot big bang’ model.

**Solution**

1. 3 K microwave background radiation

2. Redshift of light from galaxies

(b) State Olbers’ paradox.

**Solution**

Olbers’ paradox = If Universe is static and infinite then every line of sight would end on a star so night would be as bright as day

(c)Explain why the ‘hot big bang’ model does not necessarily imply that the Universe will expand indefinitely.

**Solution**

Because it depends on mean density of matter in the Universe greater than a certain value, Universe will expand and then contract below this certain value, Universe will expand indefinitely

1. A telescope that will detect infra-red radiation has recently been put into Earth- orbit.
2. State two reasons why such a telescope is likely to operate more successfully in Earth-orbit than on the Earth’s surface.

**Solution**

* 1. absorption of IR by water vapour in atmosphere
  2. much stray IR at Earth’s surface

(b) Suggest, with a reason in each case, two types of object that are likely to be observed more effectively in the infra-red region of the spectrum than in the visible region.

**Solution**

1. Distant galaxies moving so fast that they are red-shifted into IR  
2. Cool objects (brown dwarfs) give off IR but not visible light

**Option F**

**The Physics of Fluids**

4. The Bernoulli equation for fluid flow may be expressed in the form



(a) State three conditions for this equation to apply.

**Solution**

1. Streamline
2. constant density
3. non-viscous

(b)An aerofoil has an effective area of 25m2. Air of density 1.2 kgm–3 flows over the aerofoil at a speed of 85ms–1 and under the aerofoil at 75ms–1. Calculate the lift force on the aerofoil.

**Solution**

Lift force = AΔp

= 25 × ½ × 1.2 × (852 – 752)

= 2.4 × 104 N

5. A glass tube of uniform cross-sectional area is sealed at one end and contains some sand. The tube floats upright in water as illustrated in Fig. 5.1.

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**B**

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The centre of mass of the tube and its contents is at C.

(a) (i) State what is meant by the *centre of buoyancy*.

**Solution**

Centre of buoyancy= Centre of mass of displaced fluid

(ii)On Fig. 5.1, mark the position of the centre of buoyancy of the floating tube. Label this point B.

**Solution**

On the picture

(iii) The tube is displaced slightly from the vertical. Explain why the tube returns to the vertical position when released.

**Solution**

Upthrust acts upwards through B

Weight acts downwards through C

These two forces provide a restoring couple

(b) Sand is gradually removed from the tube. State what change, if any, occurs in

(i)The depth of immersion of the tube,

**Solution**

The depth of immersion of the tube becomes less

(ii)The distance between the base of the tube and the centre of buoyancy B,

**Solution**

The distance between the base of the tube and the centre of buoyancy B decrease

(iii) The distance between the base of the tube and the centre of mass C of the tube and its contents.

**Solution**

The distance between the base of the tube and the centre of mass C of the tube

and its contents increases**.**

(c) For one particular mass of sand in the tube, the tube no longer stays floating vertically. State and explain the relative positions of C and of B for this to occur.

**Solution**

C and B act at the same position so it doesn’t provide a couple that restore the position.

1. (a)State what is meant by *turbulent flow*.

**Solution**

Turbulent flow is the non-steady flow of the fluid

(b)By reference to energy principles, explain why an increase in turbulence behind a car will increase the drag force on the car.

**Solution**

Turbulence represents (continuous) transfer of kinetic energy this transfer of energy per unit time represents power. Power = FD × speed so more power means larger FD

**Option M**

**Medical Physics**

1. (a)Outline the principles of production of X-rays in an X-ray tube. The detailed

structure and operation of an X-ray tube are **not** required.

**Solution**

Electrons accelerated / high speed electrons bombard metal target electrons

decelerated greatly → e.m. radiation wide range of decelerations gives continuous spectrum electrons in target atoms excited de-excitation of these electrons gives line spectrum

(b) The quality of the image on an X-ray plate depends on the sharpness and on the contrast. Explain what is meant by

(i)*Sharpness,*

**Solution**

Sharpness = ease with which edges of structures can be seen

(ii) *Contrast.*

**Solution**

Contrast = difference in darkening between structures

1. Fig. 8.1 shows parallel rays of light refracted by a defective eye.



It is assumed that all the refraction of the light takes place at the front surface of the eye.

1. It is assumed that all the refraction of the light takes place at the front surface of the eye.

**Solution**

Short sight (myopia)

(b) (i)In position AB on Fig. 8.2, draw a lens that could be used to correct the defect

**Solution**



(ii)Complete Fig. 8.2 by drawing the light rays through the lens and into the eye.

1. (a) (i) Distinguish between the *intensity* of a sound consisting of one frequency and its

*loudness*.

**Solution:**

Intensity: energy per unit area per unit time (normal to area), while

Loudness: subjective response to intensity

(ii) State what is meant by the *sensitivity* of the ear.

**Solution**

Sensitivity of the ear = the capability of the ear to distinguish between 2 different intensities of sound.

1. The minimum change in intensity level (*I.L.*) that can be detected by a certain person is 3 dB when the intensity level is 89 dB.

Calculate the ratio

**Solution**

Intensity level = 10 lg (

89 = 10 lg I / (1.0 °— 10–12)

89 =

I89 = 7.94 x 10–4 Wm–2

92=

I92 = 1.58 x 10–3 W m–2

Ratio =

= 1.0

**Option P**

**Environmental Physics**

1. (a) Draw a labelled diagram to show the main features of a solar panel.

**Solution**

(b) Suggest why, when installing a solar panel in the southern hemisphere, the panel should face northwards at noon.

**Solution**

Because by doing that, we can get the largest area normal to sunlight

1. Fig. 10.1 shows the variation with time of the Sun’s power incident per unit area of the Earth’s surface at one position in the southern hemisphere.



A solar panel has an area of 1.4m2 and is to be used to raise the temperature of water by a minimum of 15 K.

The efficiency of energy collection by the panel is 35% and the specific heat capacity of water is 4200 J kg–1K–1.

Use data from Fig. 10.1 to determine the maximum rate of flow of water through the panel so that the water may be heated for six hours each day.

**Solution**

Power = flow rate × c × Δθ

800 × 0.35 × 1.4 = flow rate × 4200 × 15

Flow rate = 6.2 × 10–3 kg s–1

1. (a) (i) State what is meant by an *adiabatic change*.

**Solution**

Adiabatic change is a change that involves fall or rise of temperature, pressure, and volume in a system, without any energy entering or leaving the system.

(ii) Suggest why, during the compression stroke of a petrol engine, the change is said to be adiabatic.

**Solution**

Because the changes take place quickly and there isn’t any energy flows in and out the petrol during the compression.

1. Fig. 11.1 represents one cycle of a four-stroke petrol engine.



On Fig. 11.1,

1. Mark with arrows the direction of the changes in the cycle,
2. Label with the letter E the section of the cycle during which the fuel is burned.
3. (a) (i) Suggest why, in some countries, the use of unleaded fuel, rather than leaded

fuel, has been introduced.

**Solution**

Because leaded fuel contains lead which will contaminate the air. Lead is also dangerous, not only for the environmental aspect, but also for our health since it can cause mental disorders.

(b) State two forms of pollution, other than air pollution, associated with the use of cars.

**Solution**

Sound pollution and visual pollution

(c) The use of wind generators for the production of electrical energy is said, by some, to be a renewable pollution-free alternative to generation using fossil fuels.

(i) Suggest what is meant by *renewable*.

**Solution**

Renewable means it can be renewed immediately and can be obtained easily without using any fossil fuels.

(ii) Discuss briefly the respects in which wind turbines can be considered to be ‘pollution-free’.

**Solution**

They produce no pollutants.

**Option T**

**Telecommunications**

1. (a) (i) Explain what is meant by *fibre-optic transmission* of a signal.

**Solution**

The signal which is transmitted as light pulses, passing through a glass fibre, as a result of total internal reflection.

(ii) Give two technological and two social advantages of fibre-optic transmission when compared with metal cable transmission.

*Technological*

**Solution**

1. Less noise

2. More effective in term of power needed to transmit the signal

*Social*

**Solution**

1. Cheaper

2. More secure

14. The input signal to a metal cable of length 75 m has a power of 0.60W. The output signal from the cable is 0.55W.

(a) (i) Suggest the main cause of this loss of power (attenuation) in the cable.

**Solution**

The cable’s internal resistance.

(ii) Calculate the signal attenuation, in dB km–1, of the metal cable.

**Solution**

Loss = 10 lg ()

= 10 lg ()

= 10 x -0.3778

= (-) 0.38

Loss per unit length = = 5.038 dB km-1

(b) The maximum uninterrupted length of cable for the transmission of a signal is limited not only by attenuation but also by noise.

(i) Explain what is meant by *noise*.

**Solution**

Noise is any unwanted / undesired disturbance within a useful frequency band in a communication channel.

(ii) Suggest two sources of noise in metal cables.

**Solution**

Molecular vibrations and pick-up of electromagnetic signal.

15. Discuss briefly the effects on society of the change to the transmission of

signals in digital, rather than analogue, form.

**Solution**

The change from analogue signals transmission into the digital ones brings some effects to the society, including:

1. Better signal result
2. Reducing the cost of each call since it has greater multiplexing
3. Making calls available for more people since it’s getting cheaper.
4. Great expansion of international calls
5. Development in internet technology