

## MARK SCHEME for the May/June 2006 question paper

### 9702 PHYSICS

9702/06

Paper 6

Maximum raw mark 40

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the *Report on the Examination*.

The minimum marks in these components needed for various grades were previously published with these mark schemes, but are now instead included in the Report on the Examination for this session.

- CIE will not enter into discussion or correspondence in connection with these mark schemes.

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### Option A - Astrophysics and Cosmology

- 1 Planet: almost circular orbits B1  
all in nearly the same plane B1
- Comet: highly elliptical orbits B1  
in many different planes B1 [4]
- 2 (a) (mean) density M1  
of matter in the Universe A1 [2]
- (b) (i) symmetrical curve below given line M1  
touching given line at 'present time' A1 [2]
- (ii)  $H_0$  not known with any certainty B1  
mass of matter in the Universe not known B1  
extent of Universe unknown B1 [3]  
*(allow 1 of the last 2 marks for  $\rho_0$  not known)*
- 3 1 light-year = 0.306 pc (allow 0.3 pc) C1  
 $1.3 \times 10^{10}$  light-years =  $3.98 \times 10^3$  Mpc C1  
 $v = H_0 d$  C1  
speed =  $60 \times 3.98 \times 10^3 = 2.39 \times 10^5 \text{ km s}^{-1}$   
ratio =  $(2.39 \times 10^5 \times 10^3) / (3.0 \times 10^8)$   
= 0.8 A1 [4]
- 4 e.g. vast expense (M1)  
money could be spent on humanitarian aid (A1)
- observations possible that cannot be made on Earth (M1)  
since atmosphere limits observations (A1)
- technological/scientific developments on Earth (M1)  
greater understanding of Universe (M1)  
leads to 'spin off' benefits for individuals (A1)
- Any sensible comments, 1 each to max 5 B5 [5]

### Option F - The Physics of Fluids

- 5 (a) conservation of volume/mass/density or incompressible B1 [1]
- (b) conservation of energy B1 [1]
- 6 (a) air near jet is moving at speed OR water in jet is moving at speed B1  
higher speed air has a lower OR high-speed water has lower pressure B1  
pressure  
(because) air is dragged along by OR air is drawn into water jet B1  
water jet  
air (outside pump) is not moving OR loss of air reduces pressure B1 [4]
- (b) (i) air/water in pump has a higher speed M1  
so greater pressure difference A1 [2]

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- (ii) no change in speed of air OR reference to greater  $\rho$  in Bernoulli eqn **M1**  
so no change in pressure OR greater pressure difference **A1** [2]  
difference

*(allow any logical argument based on liquid causing more/less drag on air)*

- 7 (a) eddy currents have kinetic energy OR cause extra drag **M1**  
eddy currents caused by movement of the car OR energy required to overcome drag **A1**  
extra energy (of eddy currents) is derived from car's fuel **A1** [3]
- (b) (i) power = force  $\times$  speed **B1**  
so power =  $\frac{1}{2}C_D A \rho v^2 \times v$  and  $A$  and  $\rho$  are constants **B1** [2]
- (ii)  $84 \times 10^3 = \frac{1}{2} \times 0.34 \times 1.8 \times 1.1 \times v_{\max}^3$  **C1**  
 $v_{\max} = 63 \text{ m s}^{-1}$  **A1** [2]
- (iii)  $P = \frac{1}{2} \times 0.34 \times 1.8 \times 1.1 \times (63 + 9)^3$  **C1**  
 $P = 126 \text{ kW}$  **C1**  
ratio =  $126 / 84 = 1.5$  **A1** [3]

### Option M - Medical Physics

- 8 (a) alternating voltage **B1**  
applied across (piezo-electric) crystal **B1**  
causes crystal to vibrate **B1**  
crystal dimensions such as to give resonance (in US range) **B1** [4]
- (b) wavelength at 1 MHz is shorter **B1**  
so greater detail is possible **B1** [2]
- 9 e.g. used as a scalpel (1)  
further detail: causes (explosive) vaporisation of intracellular water (1)  
CO<sub>2</sub> laser (1)  
IR radiation strongly absorbed by water (1)  
laser beam focused to give high power density (1)  
no/very little bleeding (1)  
accurate guidance (1)
- e.g. repair of retina (1)  
further detail: focused laser beam onto retina (1)  
melts tissue and forms a weld (1)  
(pulsed) ruby or argon laser (1)
- any two examples: named (1) plus further detail (2)* **B6** [6]
- (allow up to two marks for each diagnostic technique)*
- 10 (a) minimum intensity (of sound) detected **M1**  
where intensity = (sound) power per unit area at a stated frequency **A1**  
value is  $1 \times 10^{-12} \text{ W m}^{-2}$  **B1**  
at 3 kHz (*allow 2 kHz  $\rightarrow$  3 kHz*) **B1** [4]

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- (b) (i) intensity =  $(0.14 \times 10^{-6}) / (54 \times 10^{-6}) = 2.6 \times 10^{-3} \text{ W m}^{-2}$  C1  
 $L = 10 \lg (2.6 \times 10^{-3}) / (1 \times 10^{-12})$  C1  
= 94 dB A1 [3]
- (ii) comment e.g. would be perceived as being loud  
could cause tinnitus over a short period of time  
could cause deafness over a long period of time  
higher level than is acceptable in the workplace
- any appropriate comment, 1 mark* B1 [1]

### Option P - Environmental Physics

- 11 (a) at times of low usage of electrical power B1  
water pumped from low-level to high-level reservoir B1  
at times of high/sudden demand for electrical power B1  
water released to pass through turbines B1 [4]
- (b) electrical energy generated =  $78 \times 10^6 \times 4.0 \times 3600 = 1.12 \times 10^{12} \text{ J}$  C1  
energy to be stored =  $(1.12 \times 10^{12}) / 0.75 = 1.5 \times 10^{12} \text{ J}$  C1  
 $1.5 \times 10^{12} = \rho Vgh$  C1  
=  $1.0 \times 10^3 \times V \times 9.8 \times 95$   
 $V = 1.6 \times 10^6 \text{ m}^3$  A1 [4]
- 12 (a) law: it is impossible to convert all of a given amount of thermal energy into work B1  
(that is)  $W < Q_H$  B1  
 $(Q_H - W)$  is energy rejected at temperature  $T_L$  B1 [3]
- (b)  $W/Q_H = 1 - T_L/T_H$  B1 [1]
- (c) efficiency =  $1 - 313/393$  C1  
= 0.20 A1 [2]
- 13 (a) (i) e.g. industry setting up  
people preparing to go to work  
starting to cook breakfast  
  
*(allow any two sensible suggestions, 1 each)* B2 [2]
- (ii) e.g. change in temperature with use of heaters/air conditioning  
holiday or workday with more power used by industry when not on holiday  
  
*(allow any two sensible suggestions, 1 each)* B2 [2]

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- (b) (i) sudden increase in demand (as appliances are used) B1
- (ii) increased demand in the afternoon B1 [2]
- (allow any two sensible suggestions in (i) and (ii))*

### Option T - Telecommunications

- 14 (a) (instantaneous) displacement of information signal determines the frequency of the carrier wave M1  
A1 [2]
- (b) (i) 12 V B1 [1]
- (ii) 650 kHz B1 [1]
- (iii) 550 kHz B1 [1]
- (iv) 3000 B1 [1]
- 15 (a) analogue-to-digital converter (*do not allow ADC*) B1 [1]
- (b) controls the time at which samples are taken B1 [1]
- (c) enables higher frequency components in signal to be 'detected' B1 [1]
- 16 (a) electromagnetic shielding for the inner conductor  
the braid is earthed B1  
B1 [2]
- (b) increased bandwidth means more information can be carried  
so more calls can be transmitted simultaneously  
fewer links are required B1  
B1  
B1 [3]
- 17 (a) e.g. cross-talk/cross-linking  
interference/picking up atmospherics/picking up man-made radiation  
white noise associated with vibrating atoms  
  
*(any two, 1 each)* B2 [2]
- (b) (i) number of dB =  $10 \lg (P_2/P_1)$   
 $35 = 10 \lg (P/\{7.6 \times 10^{-6}\})$   
 $P = 0.024 \text{ W}$  C1  
A1 [2]
- (ii) number of dB =  $10 \lg (2.6/0.024) = 20.3$   
length =  $20.3/5.8 = 3.5 \text{ km}$  C1  
A1 [2]