

### PHYSICS ADMISSIONS TEST

#### Mock Paper 1

**Time allowed: 2 hours**

*For candidates applying to Physics, Physics and Philosophy,  
Engineering, or Materials Science*

**Total 24 questions [100 Marks]**

Answers should be written on the question sheet in the spaces provided,  
and you are encouraged to show your working.  
You should attempt as many questions as you can.

**No tables, or formula sheets may be used.**

Answers should be given exactly and in simplest terms  
unless indicated otherwise.

Indicate multiple-choice answers by circling the best answer.  
Partial credit may be given for correct workings in multiple choice questions.

The numbers in the margin indicate the marks expected to be assigned  
to each question. You are advised to divide your time according to  
the marks available.

You may take the gravitational field strength  
on the surface of Earth to be  $g \approx 10\text{ms}^{-2}$

**Do NOT turn over until told that you may do so.**

1. For what values of  $\alpha$  does the equation  $\operatorname{cosec}^2(\theta) + \alpha \cot(\theta) = 0$  have multiple distinct real solutions, for  $0 < \theta < \pi$ ? (2)

A	B	C	D	E
$\alpha < -2$	$\alpha \leq -4$ or $\alpha \geq 4$	$\alpha < -2$ or $\alpha > 2$	$\alpha < -4$ or $\alpha > 4$	$-4 < \alpha < 4$

2. The Rydberg formula describes the energy levels of the hydrogen atom, where  $n$  is the quantum number for each level. (2)

$$E_n = -\frac{13.6\text{eV}}{n^2}$$

The  $H_\alpha$  emission line is commonly used in astrophysics to identify regions of active star formation. It has a wavelength of 658nm. Which atomic transition is responsible for the  $H_\alpha$  line?

A	B	C	D	E
$n = 3 \rightarrow 4$	$n = 3 \rightarrow 2$	$n = 2 \rightarrow 3$	$n = 3 \rightarrow 1$	$n = 4 \rightarrow 3$

$$c = 3 \times 10^8 \text{ ms}^{-1}, \quad e = 1.6 \times 10^{-19} \text{ C}, \quad h = 6.63 \times 10^{-34} \text{ m}^2\text{kgs}^{-1}$$

3. Molecules of nitrogen gas in a sealed container have a rms speed of  $517\text{ms}^{-1}$ . What is the temperature of the gas? (2)

A	B	C	D	E
$17^\circ\text{C}$	$22^\circ\text{C}$	$27^\circ\text{C}$	$32^\circ\text{C}$	$37^\circ\text{C}$

Molar mass of atomic nitrogen is 14g. Boltzmann constant  $k_B = 1.38 \times 10^{-23} \text{ m}^2\text{kgs}^{-2}\text{K}^{-1}$ . Avogadro's number  $N_A = 6.022 \times 10^{23}$