Physics

Standard level

Paper 2

Markscheme

Question	Answer	Note	Marks
1 (a)	$mgh = \frac{1}{2}mv^2$ $(2.0\text{ kg})\left(9.81\text{ m s}^{-2}\right)(3.0\text{ m}) = \frac{1}{2}(2.0\text{ kg})v^2$ 58.86 $v^2 = 58.86$ $v = 7.67$	✔ Correct application of conservation of mechanical energy ✔ Substitution of correct values ✔ Final correct answer with unit	3
1 (b)	$\text{Kinetic Energy } = \frac{1}{2}mv^2$ $\frac{1}{2}(2.0\text{ kg})\left(7.67\text{ m s}^{-1}\right)^2 = 58.86\text{ J}$	✔ Correct substitution into kinetic energy formula ✔ Correct final answer (Accept 58.9 J)	2
1 (c)	$W = Fd$	✔ Recognition that work done = kinetic energy	3

	$Fd = 58.86\ \text{J}$ $(4.0\ \text{N})d = 58.86\ \text{J}$ $d = \frac{58.86}{4.0} = 14.72\ \text{m}$	✔ Correct substitution of values ✔ Correct final answer with unit (Accept 14.7 m)	
1 (d)	The total energy of an isolated system remains constant; energy cannot be created or destroyed but can be transformed from one form to another. ✔ The block's gravitational potential energy is converted into kinetic energy as it slides down the ramp. On the rough surface, the kinetic energy is then converted into thermal energy due to work done by friction. ✔		2

Question	**Answer**	**Note**	**Marks**

2 (a)	$mg = \rho V g$ ✔ $V = \frac{m}{\rho}$ $V = \frac{240}{1000}$ $V = 0.24\ \mathrm{m}^3$ ✔		2
2 (b)	$s = ut + \frac{1}{2}at^2$ $a = \frac{2s}{t^2}$ ✔ $a = \frac{2(8)}{8^2}$ $a = 0.25\ m\ s^{-2}$ $F_{net} = ma$ ✔ $F_{net} = (240)(0.25)$ $F_{net} = 60\ N$ Force from fan: $F_{fan} = \frac{\Delta p}{\Delta t}$ $F_{fan} = \frac{\Delta m}{\Delta t} v$ ✔ $F_{fan} = (16)(5.0)$ $F_{fan} = 80\ N$ Resistive force: $F_{net} = F_{fan} - F_r$ $F_r = 80 - 60$ $F_r = 20\ N$ ✔		4

Question	Answer	Note	Marks
3 (a)	$F = PA$ $F = P(2\pi r^2 + 2\pi rl)$ ✔ $F = 170000(2\pi(0.025)^2 + 2\pi(0.025)(0.15))$ $F \approx 4700\ N$ ✔		2
3 (b)	$n = \frac{m}{M_r}$ $n = \frac{0.35 + 0.21}{29}$ $n \approx 0.0193\ mol$ ✔ $PV = nRT$ $T = \frac{PV}{nR}$ ✔ $T = \frac{(170000)(\pi(0.025)^2(0.15)}{(0.0193)(8.31)}$ $T \approx 312\ K \approx 39°C$ ✔	Do not award final answer mark if given in *K* only	3

Question	Answer	Note	Marks
4 (a)	$L = \frac{5\lambda}{2}$ $L = \frac{(5)(12)}{2}$ $L = 30\ cm$ ✔		1

4 (b)	$f = \frac{c}{\lambda}$ $f = \frac{3 \times 10^8}{0.12}$ $f \approx 2.5 \times 10^9\ Hz$ ✔		1
4 (c)	Cube A will not be heated up ✔ as it is at the position of a node ✔		2
4 (d)	$Q = mc\Delta T$ $Q = (0.005)(3350)(30)$ $Q \approx 500\ J$ ✔		1

Question	Answer	Note	Marks
5 (a)	Anticlockwise ✔		1
5 (b)	$\frac{mv^2}{r} = qvB$ ✔ $r = \frac{mv^2}{qvB}$ $r = \frac{mv}{qB}$ $r = \frac{p}{qB}$ ✔		2
5 (c)	$T = \frac{2\pi r}{v}$ $T = \frac{2\pi mv}{qvB}$ $T = \frac{2\pi m}{qB}$ ✔ Not dependent on the particle's velocity as no *v* term/all variables are independent of *v* ✔		2

Question	Answer	Note	Marks
6 (a)	3 ✔		1
6 (b)	Slow down neutrons ✔ to increase collisions between neutrons and nuclei ✔		2
6 (c)	Nuclear fission converts nuclear potential energy into kinetic energy of the fission fragments and neutrons. ✔ The binding energy per nucleon changes significantly during fission, resulting in a large release of energy. ✔ The mass defect in nuclear reactions is much larger than in chemical reactions, leading to greater energy release via $E = mc^2$. ✔		3

6 (d)	$\Delta m = 235.043923 - 136.907084 - 95.934284$ $\Delta m = 2.202555\ u$ ✔ $P = \frac{2.202555}{235.043923}(7.0 \times 10^{-7})(3.0 \times 10^{8})^2$ ✔ $P \approx 5.90 \times 10^{8}\ W \approx 590\ MW$ ✔		3
6 (e)	$Q = mL$ $\frac{\Delta m}{\Delta t} = \frac{P}{L}$ $\frac{\Delta m}{\Delta t} = \frac{5.9 \times 10^{8}}{2268}$ $\frac{\Delta m}{\Delta t} \approx 2.6 \times 10^{5}\ g\ s^{-1}\ [\approx 2600\ kg\ s^{-1}]$ ✔		1

Question	Answer	Note	Marks
7 (a)	Nuclear fusion is the process by which energy is produced in stars. ✔ Fusion requires very high temperature to overcome electrostatic repulsion between nuclei. ✔ High density is also required so that collisions between nuclei are frequent. ✔		3
7 (b)	Award up to **3 marks**, for any of the following well-explained points: Higher mass stars have shorter lifespans because they consume their fuel more rapidly. Lower mass stars (like the Sun) evolve into red giants and end as white dwarfs.	Marks to be awarded for three distinct, relevant points.	3

	Higher mass stars evolve into supergiants and may end as neutron stars or black holes after a supernova. The mass determines the balance between radiation pressure and gravitational collapse throughout the star's life.		
7 (c)	$p(\text{arc-seconds}) = \frac{1}{d(\text{parsecs})} = \frac{1}{4.0} = 0.25 \text{ arc-seconds}$	✔ Correct formula ✔ Correct substitution	2
7 (d)	There is an equilibrium between outward radiation pressure from fusion reactions and inward gravitational forces; this balance maintains the star's stability. ✔		1