1.	A	7.	C	13.	C	19.	D	25.	B	31.	A
2.	D	8.	A	14.	B	20.	C	26.	C	32.	B
3.	B	9.	A	15.	A	21.	D	27.	D	33.	D
4.	C	10.	B	16.	B	22.	A	28.	C		
5.	C	11.	A	17.	D	23.	D	29.	B		
6.	D	12.	C	18.	A	24.	A	30.	B		

1

(a)	Power absorbed by water	
	= energy absorbed in one second by water	
	$= mc_w\Delta T_w + ml_v + mc_s\Delta T_s$	1M
	$= (2)(4200)(100 - 20) + (2)(2.26 \times 10^6) + (2)(2000)(160 - 100)$	
	$= 5.43 \times 10^6$ W	1A
(b)	The glass house traps the warm air inside.	1A
Or	The infra-red radiation emitted by the pipe is trapped inside the house.	1A
(c)	It should be made of good conductor such as metal.	1A
	Its surface should be dull black in colour.	1A
(d)	The mirror absorbs some of the solar energy.	1A
Or	The pipe reflects some of the solar energy.	1A
Or	Some of the solar energy reflected by the mirror does not fall on the pipe.	1A

2.

(a) 3 (atm) (1 mark if only the pressure due to sea water is given) 1 **1**

(b) (i) $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$\frac{18.0}{273 + 27} = \frac{P_2}{273 + 21}$ 1

$P_2 = 17.6$ (atm) 1 **2**

(ii) $n_0 = n_1 + n_2$ 1

$P_0 V_0 = P_1 V_0 + P_b V_b$

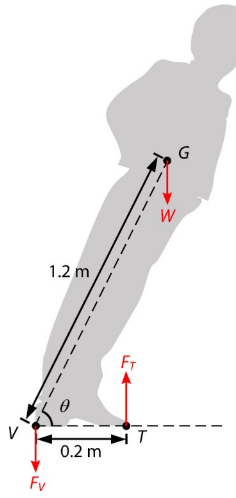
$(17.6)(0.02) = P_1(0.02) + (3)(0.01)$ 1

$P_1 = 16.1$ (atm) 1 **3**

(iii) $\frac{17.6 - 16.1}{17.6}$ 1

$= 0.085$ 1 **2**

3. (a)



(1A for any correct force, 2A for all correct)

(b) No, **1A**

There must be a net clockwise moment by W which cannot be cancelled without the shoes. **1A**

(c) Taking moment about T,

net moment = 0

$F_V(0.2) = W(1.2\cos\theta - 0.2)$ $\Rightarrow$ $(1800)(0.2) = (700)(1.2\cos\theta - 0.2)$ **1M**

$\therefore\ \theta = 53.5°$ **1A**

4. (a) PE lost by X = mgh

= (0.2) (9.81) (0.5) 1M

= 0.981 J 1A

(b) KE gained by $Y = \frac{1}{2}mv^2$

$= (0.5)(0.1)(1)^2$ 1M

= 0.05 J 1A

(c) By the law of conservation of energy

P.E lost by X = KE gained by X and Y + PE gained by Y + work done against friction 1M

$0.981 = (0.5)(0.1 + 0.2)(1^2) + (0.1)(9.81)(0.5\sin 30°) + f(0.5)$

$f = 1.17$ 1A

5. (a) (i) $\frac{GMm}{r^2} = \frac{mv^2}{r}$ 1M

$g_o \frac{R_E^2}{r^2} = \frac{v^2}{r}$ 1M

$v^2 = 9.81 \frac{(6.4\times10^6)^2}{(6.4\times10^6+2.4\times10^5)}$

$v = 7779.1 \approx 7.78 \times 10^3$ m s^{-1} 1A

(ii) $mg_1 = \frac{mv^2}{r}$ 1M

$= \frac{(60)(7779.1)^2}{(6.4\times10^6+2.4\times10^5)} = 547$ N 1A

(b) The weight of the astronaut is all used for centripetal acceleration, therefore the astronaut is no longer being pulled to the floor. 1A

6. (a)

For the first red fringe, $\tan\theta = \frac{0.56}{1} \Rightarrow \theta = 29.2°$ 1 A

(b)

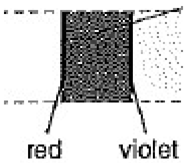
Grating spacing $= \frac{0.001}{700} = 1.43 \times 10^{-6}$ m 1 M

By $d \sin\theta = n\lambda$,

$\lambda = \frac{d\sin\theta}{n} = \frac{1.43\times10^{-6}\times\sin 29.2°}{1} = 6.98\times10^{-7}$ m 1 M

∴ The wavelength of the red light is 6.98×10^{-7} m. 1 A

(c) 1A+1A



7

(a) The two diffracted waves arrive at *P* in antiphase. 1

As a result, destructive interference occurs at *P*. 1

(b) **(i)** Path difference at *Q* = 18.5 – 14 = 4.5 cm = 1.5λ 1

Therefore, destructive interference occurs at *Q*. 1

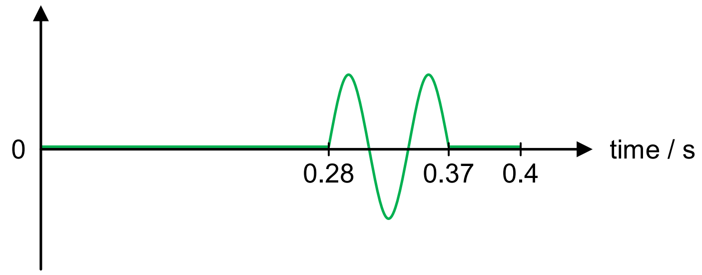
(ii) Wave speed $= \frac{0.03}{0.06}$ 1

$= 0.5$ m s^{-1}

Time of travel $= \dfrac{0.14}{0.5}$ 1

$= 0.28$ s 1

(iii)



(One and a half complete vibration) 1

(Correct time for the start and end of vibration) 1

8.

(a) **(i)** The electric field between the plates points from *B* to *A*. 1A 1

> **Guidelines**
>
> Since the magnetic force acts towards the right, the electric force acts towards the left. The electric field lines point towards plate *A*.

(ii) When the proton moves between the deflecting plates, the electric force on it is balanced by the magnetic force.

$QE = QvB$ 1M

$v = \dfrac{E}{B}$

$= \dfrac{1.5 \times 10^5 \text{ N C}^{-1}}{0.1 \text{ T}}$

$= 1.5 \times 10^6 \text{ m s}^{-1}$ 1A 2

(b) **(i)** When the proton leaves slit *C*, the proton undergoes circular motion. The centripetal force is provided by the magnetic force on the proton.

$\dfrac{mv^2}{r} = QvB$ 1M

$r = \dfrac{mv}{QB}$

$= \dfrac{1.67 \times 10^{-27} \text{ kg} \times 1.5 \times 10^6 \text{ m s}^{-1}}{1.6 \times 10^{-19} \text{ C} \times 0.1 \text{ T}}$

$= 0.15656$ m 1A

Distance between *C* and *D* $= 2r$

$= 2(0.15656 \text{ m})$

$= 0.313$ m 1A 3

(ii) Particle *X* undergoes circular motion after passing through *C*.

Radius of the circular path $= \dfrac{1.5 \times 10^6 \text{ m s}^{-1} \times 8 \times 10^{-7} \text{ s}}{\pi}$ 1M

$= 0.38197$ m

$\dfrac{mv^2}{r} = QvB$

$m = \dfrac{QBr}{v}$ 1M

$= \dfrac{1.6 \times 10^{-19} \text{C} \times 0.1 \text{ T} \times 0.38197 \text{ m}}{1.5 \times 10^6 \text{ m s}^{-1}}$

$= 4.07 \times 10^{-27}$ kg 1A 3

9. (a) $R = \frac{1}{20} \cdot \frac{\rho \ell}{A} = 1.5\,\Omega$ **1M + 1A**

(b) (i) $R_{\text{lamp}} = \frac{V^2}{P} = \frac{12^2}{24} = 6\,\Omega$

$I = \frac{V}{R_{\text{lamp}}} = \frac{12}{1.5 + 1.5 + 6} = 1.33\text{ A}$ **1M**

$\therefore P_{\text{lamp}} = I^2 R = 10.7\text{ W}$ **1M + 1A**

(ii) $P_{\text{loss}} = I^2(1.5 \times 2) = 5.33\text{ W}$ **1A**

(c) (i) $V_2 = 12 \times \frac{500}{100} = 60\text{ V}$ **1M + 1A**

(ii) $I = \frac{24}{60} = 0.4\text{ A}$ **1M**

$P_{\text{loss}} = I^2 \cdot (1.5 + 1.5) = 0.48\text{ W}$ **1M + 1A**

(iii) $V_1 = 60 + I \cdot (2 \times R) = 61.2\text{ V}$ **1M**

$\frac{N}{10} = \frac{61.2}{12} \Rightarrow N = 510$ **1M + 1A**

10.

(a)	Attach an elastic thread to the trolley and stretch the thread to pull the trolley down the friction-compensated runway.	1A
	Record the acceleration and the total mass of the trolley.	1A
	Repeat by adding one and two mass bars to the trolley in turn.	1A
	Precaution: The thread should be stretched to the same length all the way down the runway. <u>Or</u> The thread should be stretched to the same length in all trials.	1A
(b)	To ensure that the pulling force from the elastic thread is the net force acting on the trolley.	1A
(c)	*a* should be inversely proportional to *m*. or $a \propto \frac{1}{m}$	1A

11.

	Solutions	Marks
(a) (i)	By $\Delta E = \Delta mc^2$,	1M
	loss in total mass $= \dfrac{\Delta E}{c^2} = \dfrac{2.79 \times 10^{-11}}{(3.00 \times 10^8)^2} = 3.10 \times 10^{-28}$ kg	1A
(ii)	Loss in total mass $= \dfrac{3.10 \times 10^{-28}}{1.661 \times 10^{-27}} = 0.187$ u	1M
	$235.044 \text{ u} + m = 141.916 \text{ u} + 90.923 \text{ u} + 3m + 0.187 \text{ u}$	1M
	$m = 1.01$ u	1A
	The mass of a neutron is 1.01 u.	
(b) (i)	Number of U-235 atoms in the fuel $= \dfrac{1.0 \times 10^4}{235.044 \times 1.661 \times 10^{-27}}$	1M
	$= 2.561 \times 10^{28}$	
	$\approx 2.56 \times 10^{28}$	1A
(ii)	Total energy released $= 2.561 \times 10^{28} \times 2.79 \times 10^{-11} = 7.15 \times 10^{17}$ J	1A