

Instructions

加斯林塔佛 Questions: Only THREE of the eight questions in Section 2 should be attempted. Time: It is recommended that students spend 1 hour 45 minutes on this section (approximately 30 minutes on each question with 15 minutes reading time). Marks: The maximum mark for each of these questions is 20.

Question answers

Answers can be written on loose paper or examination booklets. Graph paper and formula sheet should be available. Students should ensure their name and school is clearly written on their answer sheets.

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Section 1 and Section 2 of Paper 2 may be sat in one session of three hours. Alternatively, the paper may be sat in two sessions, 1 hour 15 minutes for Section 1 and 1 hour 45 minutes for Section 2. If the paper is taken in two sessions, students should not receive Section 2 until the start of the second session, and should not be allowed to return to their answers to Section 1.

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12th November 2010

Paper 2

Section 2 antitute ## # '& PE Important Constants

	Speed of light	C R	$3.00 \ge 10^8$	ms ⁻¹	
ante ta	Planck constant	ħ	6.63 x 10 ⁻³⁴	Js ^林 ····································	ľ.
Stiller	Electronic charge	e 👘	1.60 x 10 ⁻¹⁹	C Maxillar Maxill	ju.
	Mass of electron	m_e	9.11 x 10 ⁻³¹	kg	
onto far.	Permittivity of a vacuum	ε ₀	8.85 x 10 ⁻¹²	Fm ⁻¹	
	Acceleration due to free fall	8	9.81	ms ²²	h.
Stilling	Gravitational constant	G	6.67 x 10 ⁻¹¹	Nm ² kg ⁻²	, U
	Avogadro's number	Ν	$6.02 \ge 10^{23}$	Mol	
onto far.	Mass of Earth	M_E	5.9700 x 10 ²⁴	kg 🙀 🖗	
	Mass of Moon	M_M	$7.35 \ge 10^{22}$	kg ^k	d.
Stiller	Radius of Earth	R_E	6.38×10^3	km million million	,a,
	Radius of the Moon	R_M	1.74 x 10 ⁶	m	
	Earth – Moon distance	R _{EM}	3.84 x 10 ⁸	m 1/2 1/2 1/2 1/2	
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mutitute ## # '\$ The specific heat capacity of water is 4182 J kg⁻¹ K⁻¹. The melting temperature of lead is 327 C. The specific heat capacity of solid lead is 136 $J \text{ kg}^{-1} \text{ K}^{-1}$.

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- b) A stream of particles, each of mass *m* and kinetic energy *E*, is collimated into a parallel beam of cross-sectional area *A*. The particles are incident at a rate of the smooth place. smooth plane surface and rebound elastically.
 - (i) Derive an expression for the pressure on the surface.
 - 面动机推荐林谱像 (ii) Why would the pressure differ if the surface were rough?
- maximue ## 3 PS c) A photon of wavelength λ has momentum p and energy E_{λ} .
 - (i) Determine the relation between p and E_{λ} .
 - An electric light bulb emits 20 W of radiation uniformly in all directions.
 - (ii) What is the maximum radiation pressure on a surface placed 2.0 m away from the bulb?

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(iii)State the conditions under which this occurs. matilute ## # '\$ 1% matitule ## # '& R matine # # 3 PE

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· 13. 19% · 3. 1% · % (%) mistitute ### a) A stone is projected with a speed u at a small angle α to the horizontal ground. It impacts on the ground at a distance d, having reached a maximum height h. At time tits velocity makes an angle θ with the horizontal.

Determine in terms of u and α : maximue ## # ' K

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- (i) The time taken, T_g , to reach the ground and the distance d.

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加加新林塔院 (ii) The maximum height, h, reached. (iii)An expression for the form (iii)An expression for the radius of curvature of the trajectory, R, at height h. (iv)Express R in terms of d and h.

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- (v) Sketch a graph of $\tan \theta$ against t, indicating the key points on the graph.
- [16]^{+'3} ^{1%} (vi)Deduce, from (v), that there are no pair of points on the stone's trajectory,
- mutute # # '3 with velocities that are perpendicular if α less than 45°. mistitute ##

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加斯林资格 b) A car, mass m, travels across a parabolic bridge of horizontal length d and maximum height h, the same values as in (a), at a constant speed v. Determine the reaction force, N, exerted by the bridge on the car at height h for any value of v. What advantage could be obtained by adding a spoiler to the car?

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Figure 5.a

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 - (ii) Determine the equilibrium displacement x_{e_i} in terms of M, L and k. [10] % Willing the the state 柳林荡

b) If mass M is released from its initial rest position, with the wire horizontal:

(ii) Write down an expression for the kinetic energy of the mass in terms of x (iii)Deduce the maximum value of x, x_m . (iii)Deduce the maximum value of x, x_m .

For z much smaller than unity the approximation, institute # mstitute 3

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stitute # # 13 PK Desititute ## # 18 (i) Explain the photoelectric effect.
(ii) Derive a relation between the kinetic conditions. (ii) Derive a relation between the incident photon frequency, v, and the electron kinetic energy for a photocathode with work function φ .

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- (iii) How does the classical explanation of this phenomenon differ from the
- positive and negative V, in the presence of a constant beam of photons in a photoelectric experiment.
 How could one graphically in the presence of a constant beam of photons in a photoelectric experiment. (iv)Sketch a graph of current, I, against voltage, V, from anode to cathode, for
- (v) How could one graphically determine φ from measurements of photon wavelength and electron velocity?

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mailute # # (b) In a photoelectric experiment the measurements of stopping potential, V_s , against frequency, f, were obtained and are contained in the table below

V_s / V	0.60	1.0	1.4	1.8	2.2
$f/10^{14}{ m Hz}$	6.0	7.0	8.0	9.0	10

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(i) The threshold frequency f_{0} . mininte # # 'S PL

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(ii) The value of h. na.

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而动机能称林等除 Multille # # 3 PS Multille # # 3 PE institute the to Star institute the tot 's the b) A rocket, mass M_R , is launched from the Earth. Its motors are used only near the Earth's surface in order to give the rocket *just* sufficient energy to reach the Moon. With the the the the the Once the fuel is exhausted the rocket has initial velocity v. Assume no relative motion 加加斯林道際 of the Earth – Moon system.

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- (i) the distance from the Earth's centre, d_E , at which the velocity of the rocket is least.
- Militute [14]**** % may make. (ii) the initial velocity of the rocket, v, justifying any approximations you withit the the 's matine # # 3 multille # # 3



a) A rock sample has 1.0×10^{23} uranium nuclei which are in radioactive equilibrium with radium nuclei. How many radium nuclei are present? The half lives of uranium and radium are respectively 1.4×10^{17} s and 5.1×10^{10} s.

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Calculate:

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- (i) The rate of emission of gamma-rays from the source.
- (ii) The percentage of gamma-rays absorbed.

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- The age of the wood. (i)
- (ii) The uncertainty in the age. mating # # 3 PE Matine # # 'S R antitute ## # '\$ 1%

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