10.2 Fields at Work

Question Paper

Course	DP IB Physics
Section	10. Fields (HL only)
Topic	10.2 Fields at Work
Difficulty	Medium

Time allowed: 20

Score: /10

Percentage: /100

Question 1

The mass of Jupiter is m_J and the mass of its moon Europa is m_E.

If their radii is given by r_J and r_E respectively, what is the ratio $\frac{escape\ velocity\ of\ Europa}{escape\ velocity\ of\ Jupiter}$?

A. $\sqrt{\frac{m_E\ r_E}{m_J\ r_J}}$

B. $\sqrt{\frac{m_E\ r_J}{m_J\ r_E}}$

C. $\sqrt{\frac{m_J\ r_J}{m_E\ r_E}}$

D. $\sqrt{\frac{m_J\ r_E}{m_E\ r_J}}$

[1 mark]

Question 2

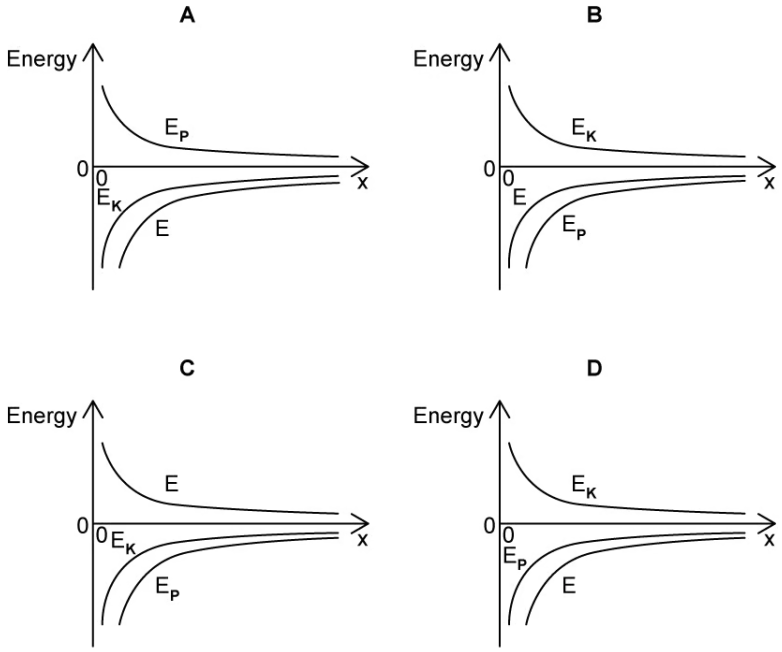
A satellite of mass 2000 kg is in the Earth's gravitational field. It moves radially from a point where the gravitational potential is –40 MJ kg^{-1} to a point where the gravitational potential is –10 MJ kg^{-1}. What is the direction of movement of the satellite and the change in its gravitational potential energy?

	Direction of movement of satellite	Change in gravitational potential energy / GJ
A.	Parallel to a field line	60
B.	Antiparallel to a field line	30
C.	Along an equipotential	30
D.	Antiparallel to a field line	60

[1 mark]

Question 3

Which graph shows how the kinetic energy E_K, the potential energy E_P and the total energy E of the international space station varies with distance x from the centre of Earth?



[1 mark]

Question 4

A probe is launched from the surface of the Earth, which has a radius R, at half the required escape velocity.

What is the maximum height from the surface the probe will reach, before returning to the ground (with a bang)?

A. R

B. $\frac{R}{2}$

C. $\frac{R}{3}$

D. $\frac{R}{4}$

[1 mark]

Question 5

The radius of the Sun is approximately 700 000 km. If all of its mass were compressed into a certain radius, it would collapse into a black hole, which is known to be a body from which "not even light can escape".

Which length gives the best estimate for the radius at which the Sun's mass would collapse into a black hole?

Use the following data:

- Mass of the Sun = 2×10^{30} kg
- Speed of light = 3×10^{8} m s^{-1}
- Gravitation constant = 6.67×10^{-11} N m^{2} kg^{-2}

A. 3 mm

B. 3 cm

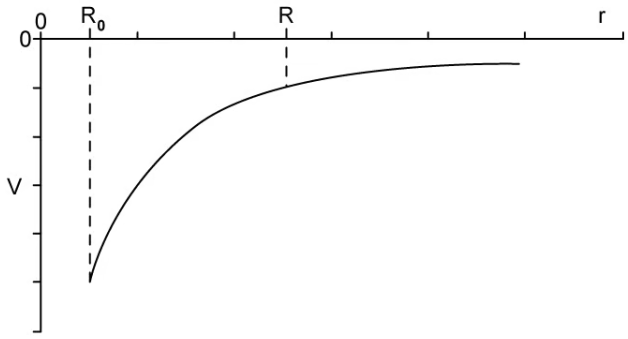
C. 3 km

D. 3×10^{5} km

[1 mark]

Question 6

The graph shows the variation of gravitational potential V with distance r from the centre of a spherical planet of mass M and radius R_0.



Which statement best describes how to determine the gravitational field strength at a distance $r = R$ from the planet?

A. The area enclosed by the horizontal axis, the line $r = R_0$, the line $r = R$, and the curve

B. The gradient at the point $r = R$

C. The inverse of the gradient at the point $r = R$

D. The negative of the gradient at the point $r = R$

[1 mark]

Question 7

The gravitational field strength is *g* and the gravitational potential is *V* at the surface of Earth, which has a radius of *r*.

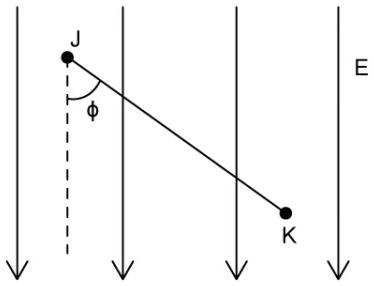
Which row in the table gives the correct value of the gravitational field strength and the gravitational potential at a height of 2*r* from Earth's surface?

	Gravitational field strength	Gravitational potential
A.	$\frac{g}{3}$	$\frac{V}{3}$
B.	$\frac{g}{4}$	$\frac{V}{2}$
C.	$\frac{g}{9}$	$\frac{V}{3}$
D.	$\frac{g}{16}$	$\frac{V}{2}$

[1 mark]

Question 8

A particle of charge *q* is at point J in a uniform electric field of strength *E*. It is moved along a straight line joining point J to point K which is at an angle of Φ to the field lines, as shown in the diagram below.



If the length of the path is *JK*, what is the change in electric potential energy of the charge *q* between J and K?

A. $EqJK \cos \Phi$

B. $EqJK \sin \Phi$

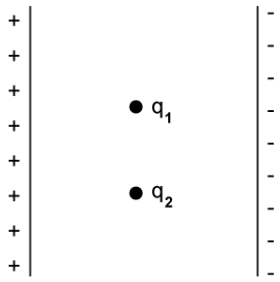
C. $Eq \tan \Phi$

D. $EqJK$

[1 mark]

Question 9

Two positively charged particles, q_1 and q_2, are released from rest half-way between two oppositely charged parallel plates in a vacuum. The particles strike the negatively charged plate at the same time.



Neglecting gravitational effects, which of the following statements is correct?

A. The particles have the same charge only

B. The particles have the same mass only

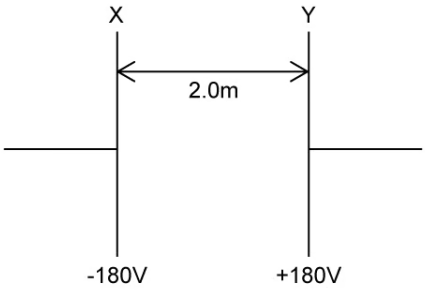
C. The particles have the same mass and charge

D. The particles have the same charge to mass ratio

[1 mark]

Question 10

Two charged parallel metal plates, X and Y, are separated by a distance of 2.0 m. X is charged to a potential of −180 V and Y is charged to a potential of +180 V.



What is the magnitude and direction of the electric field strength at a point exactly mid-way between plates X and Y?

	Magnitude of electric field strength / V m^{-1}	Direction
A.	180	To the right
B.	180	To the left
C.	360	To the right
D.	360	To the left

[1 mark]