IB PHYSICS

Name: ____________________________________

Period: ________ Date: ____________________

\# Marks: **69** Raw Score: ____ IB Curve: ____

DEVIL PHYSICS

BADDEST CLASS ON CAMPUS

CHAPTER 10 TEST REVIEW

1. A spacecraft travels away from Earth in a straight line with its motors shut down. At one instant the speed of the spacecraft is 5.4 km s^{-1}. After a time of 600 s, the speed is 5.1 km s^{-1}. The average gravitational field strength acting on the spacecraft during this time interval is

A. 5.0×10^{-4} N kg^{-1}

B. 3.0×10^{-2} N kg^{-1}

C. 5.0×10^{-1} N kg^{-1}

D. 30 N kg^{-1}

(Total 1 mark)

2. The weight of an object of mass 1 kg at the surface of Mars is about 4 N. The radius of Mars is about half the radius of Earth. Which of the following is the best estimate of the ratio below?

$$\frac{\text{mass of Mars}}{\text{mass of Earth}}$$

A. 0.1

B. 0.2

C. 5

D. 10

(Total 1 mark)

3. An astronaut in orbit around Earth is said to be "weightless". This is due to the fact that the

A. gravitational force on the astronaut is zero.

B. astronaut and the spacecraft experience the same acceleration.

C. astronaut and the spacecraft experience the same gravitational force.

D. gravitational field at the position of the spacecraft is zero.

(Total 1 mark)

4. The mass of a planet is twice that of Earth. Its radius is half that of the radius of Earth. The gravitational field strength at the surface of Earth is g. The gravitational field strength at the surface of the planet is

A. $\frac{1}{2}g$.

B. g.

C. $2g$.

D. $8g$.

(Total 1 mark)

5. A small sphere X of mass M is placed a distance d from a point mass. The gravitational force on sphere X is 90 N. Sphere X is removed and a second sphere Y of mass $4M$ is placed a distance $3d$ from the same point mass. The gravitational force on sphere Y is

A. 480 N.

B. 160 N.

C. 120 N.

D. 40 N.

(Total 1 mark)

6. Gravitational potential

(a) Define *gravitational potential* at a point in a gravitational field.

....

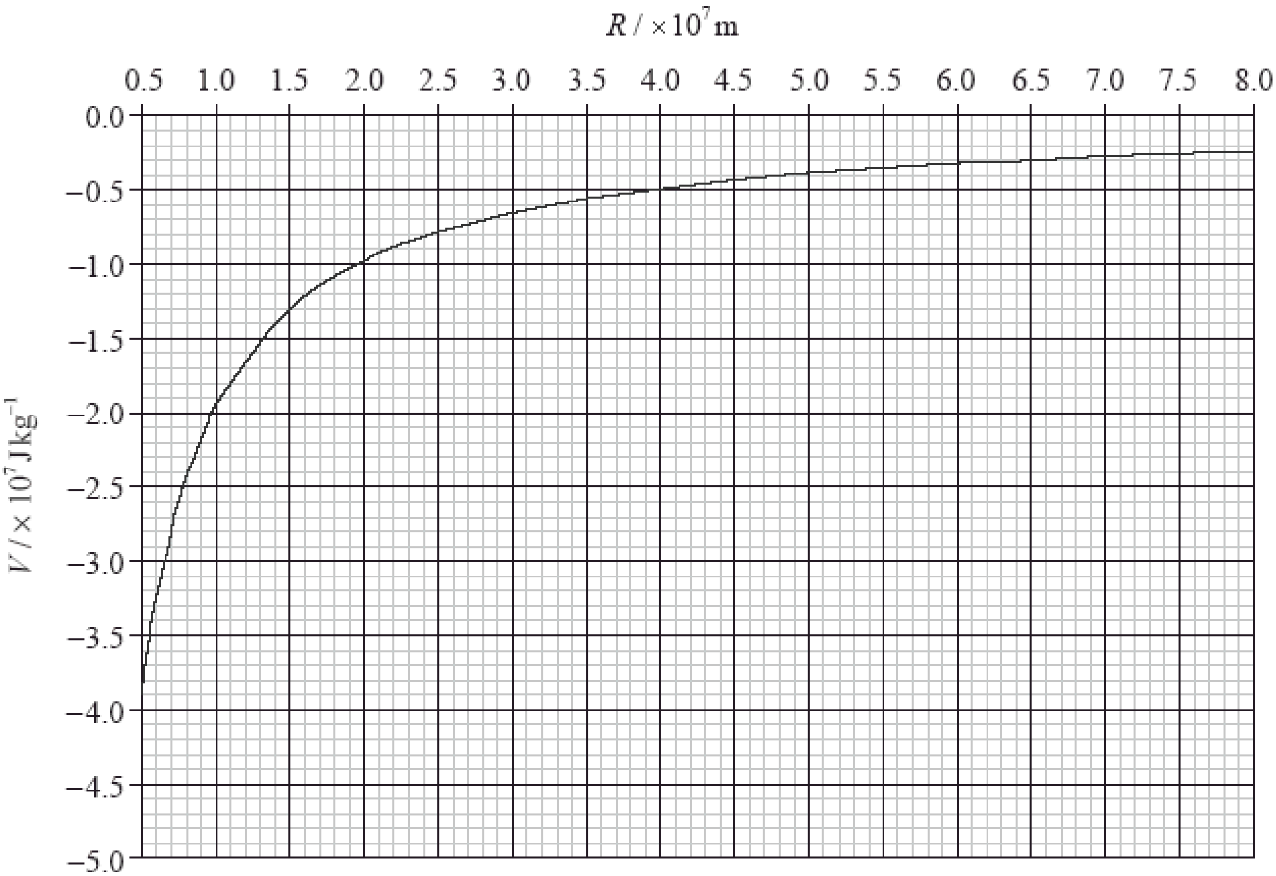
....

....

....

(3)

(b) The graph below shows the variation with distance R from the centre of a planet of the gravitational potential V. The radius R_0 of the planet = 5.0×10^6 m. Values of V are not shown for $R < R_0$.



Use the graph to determine the magnitude of the gravitational field strength at the surface of the planet.

....

....

....

....

....

(3)

(c) A satellite of mass 3.2×10^3 kg is launched from the surface of the planet. Use the graph to determine the minimum launch speed that the satellite must have in order to reach a height of 2.0×10^7 m above the surface of the planet. (You may assume that it reaches its maximum speed immediately after launch.)

....

....

....

....

....

....

(4)

7. A spacecraft moves from point X to point Y in the gravitational field of Earth. At point X, the gravitational potential is –14 MJ kg^{-1}. At point Y, the gravitational potential is –2 MJ kg^{-1}. Which of the following describes the direction of the motion of the spacecraft relative to Earth and the change in gravitational potential?

	Direction of Motion	Change in gravitational potential
A.	towards Earth	+12 MJ kg^{-1}
B.	towards Earth	–12 MJ kg^{-1}
C.	away from Earth	+12 MJ kg^{-1}
D.	away from Earth	–12 MJ kg^{-1}

(Total 1 mark)

8. A satellite is in orbit about Earth. The satellite moves to an orbit closer to Earth. Which of the following correctly gives the change in the potential energy and the kinetic energy of the satellite?

	change in potential energy	change in kinetic energy
A.	decreases	increases
B.	decreases	decreases
C.	increases	increases
D.	increases	decreases

(Total 1 mark)

9. The mass of a planet is M and its radius is R. In order for a body of mass m to escape the gravitational attraction of the planet, its kinetic energy at the surface of the planet must be at least

A. $\frac{GMm}{R}$

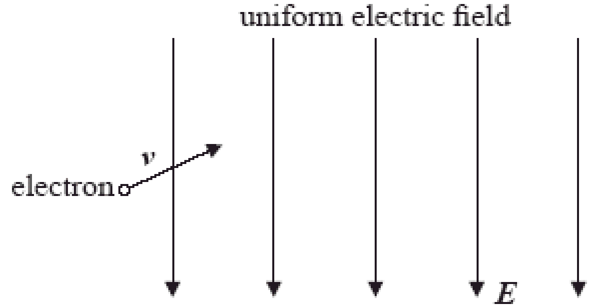
B. $\frac{GMm}{R^2}$

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

D. $\frac{GM}{R^2}$

(Total 1 mark)

10. The diagram below shows a uniform electric field of strength $\boldsymbol{E}$. The field is in a vacuum.



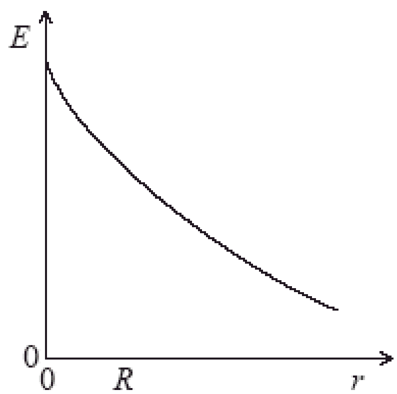
An electron enters the field with a velocity $\boldsymbol{v}$ in the direction shown. The electron is moving in the plane of the paper. The path followed by the electron will be

A. parabolic.
B. in the direction of $\boldsymbol{E}$.
C. in the direction of $\boldsymbol{v}$.
D. circular.

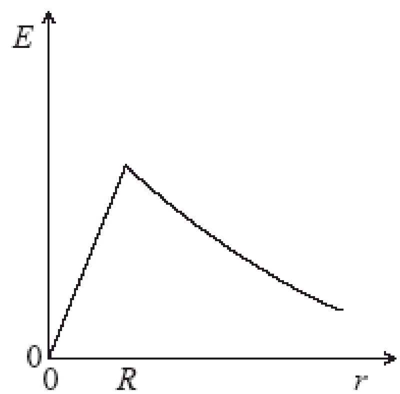
(Total 1 mark)

11. The radius of a charged spherical conductor is R. Which of the following graphs best shows how the magnitude of the electrical field strength E varies with distance r from the centre of the sphere?

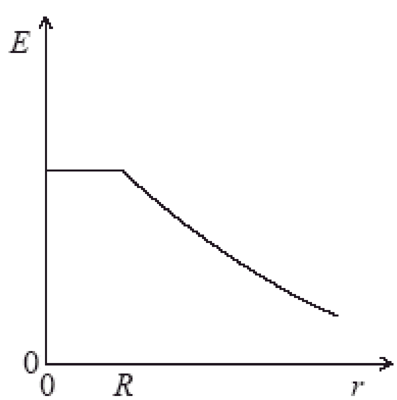
A.



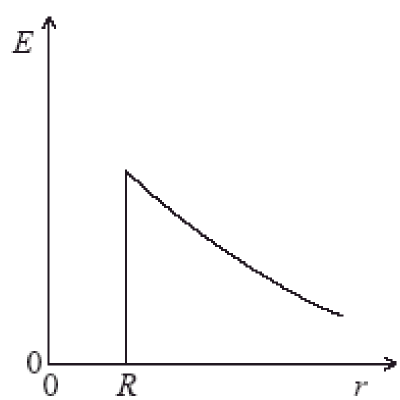
B.



C.



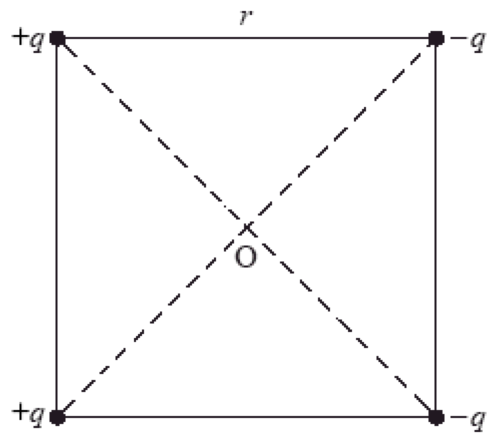
D.



(Total 1 mark)

12. Four point charges of magnitudes $+q$, $+q$, $-q$, and $-q$ are held in place at the corners of a square of side r.

The Coulomb constant is k. Which of the following is the electrical potential at the centre of the square O?



A. 0

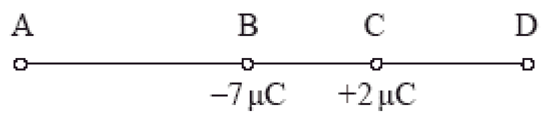
B. $\frac{4kq}{r}$

C. $\frac{4kq\sqrt{2}}{r}$

D. $\frac{-4kq\sqrt{2}}{r^2}$

(Total 1 mark)

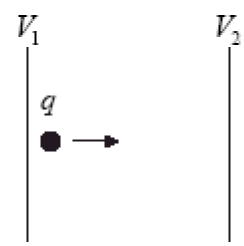
13. Two isolated point charges, –7 μC and +2 μC, are at a fixed distance apart. At which point is it possible for the electric field strength to be zero?



(not to scale)

(Total 1 mark)

14. The diagram below shows a particle with positive charge q accelerating between two conducting plates at potentials V_1 and V_2.



Which of the following is the kinetic energy gained by the charge in moving between the plates?

A. V_2q

B. V_1q

C. $(V_1 - V_2)q$

D. $(V_2 - V_1)q$

(Total 1 mark)

15. This question is about electric and gravitational fields

(a) State, in terms of electrons, the difference between a conductor and an insulator.

....

....

(1)

(b) Suggest why there must be an electric field inside a current-carrying conductor.

....

....

....

....

....

(3)

(c) The magnitude of the electric field strength inside a conductor is 55 N C^{-1}. Calculate the force on a free electron in the conductor.

....

....

(1)

(d) The electric force between two point charges is a fundamental force as is the gravitational force between two point masses. State **one** similarity between these two forces and **one** difference (other than the fact that one applies to charge and the other to mass).

Similarity: ....

....

Difference: ....

....

(2)

(e) The force on a mass of 1.0 kg falling freely near the surface of Jupiter is 25 N. The radius of Jupiter is 7.0×10^{7} m.

(i) State the value of the magnitude of the gravitational field strength at the surface of Jupiter.

....

(1)

(ii) Calculate that the mass of Jupiter is about 1.8×10^{27} kg.

....

....

....

....

....

(2)

16. This question is about orbital motion.

(a) A satellite, of mass m, is in orbit about Earth at a distance r from the centre of Earth. Deduce that the kinetic energy E_K of the satellite is equal to half the magnitude of the potential energy E_P of the satellite.

....

....

....

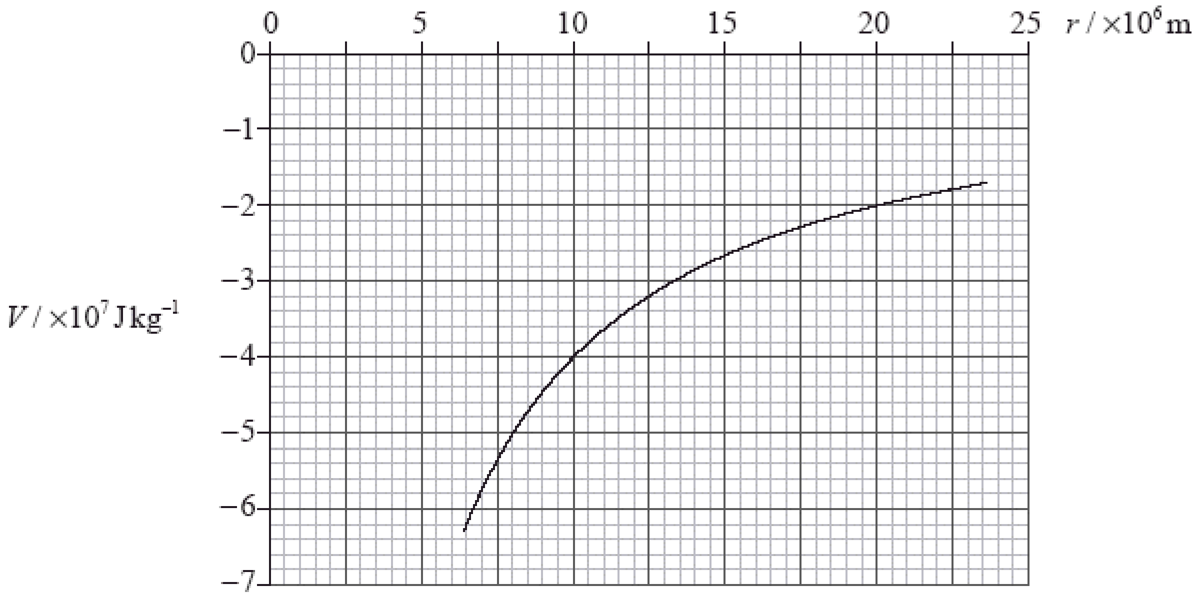
....

....

....

(3)

(b) The graph shows the variation with distance r of the Earth's gravitational potential V. Values of V for $r < R$, where R is the radius of Earth, are not shown.



The satellite in (a) has a mass of 8.2×10^2 kg and it is in orbit at a distance of 1.0×10^7 m from the centre of Earth. Using data from the graph and your answer to (a), calculate for the satellite

(i) its total energy.

....

....

....

....

(2)

(ii) its orbital speed.

....

....

....

....

(2)

(iii) the energy it must gain to move to an orbit a distance 2.0×10^7 m from the centre of the Earth.

....

....

....

....

(2)

17. This question is about a lightning discharge.

(a) Define *electric field strength*.

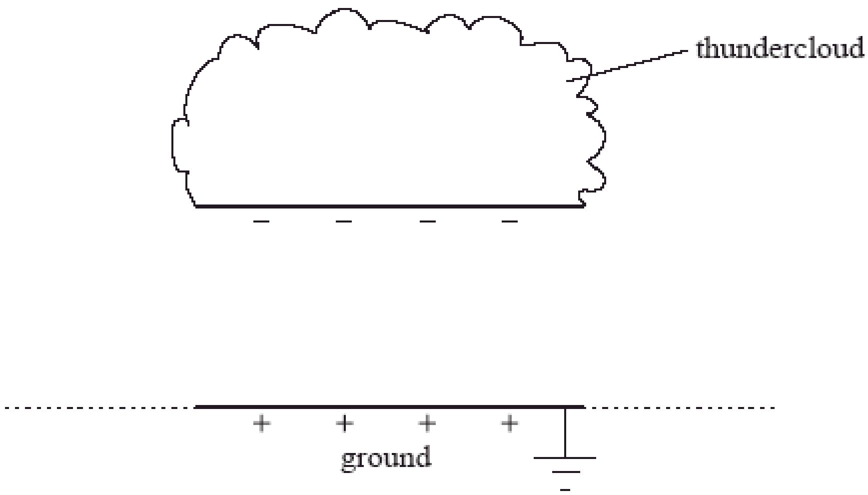
....

....

....

(2)

(b) A thundercloud can be modelled as a negatively charged plate that is parallel to the ground.



The magnitude of the charge on the plate increases due to processes in the atmosphere. Eventually a current discharges from the thundercloud to the ground.

On the diagram, draw the electric field pattern between the thundercloud base and the ground.

(3)

(c) The magnitude of the electric field strength E between two infinite charged parallel plates is given by the expression

$$E = \frac{\sigma}{\varepsilon_0}$$

where σ is the charge per unit area on one of the plates.

A thundercloud carries a charge of magnitude 35 C spread over its base. The area of the base is 1.2×10^7 m^2.

(i) Determine the magnitude of the electric field between the base of the thundercloud and the ground.

....

....

....

....

....

....

(3)

(ii) State **two** assumptions made in (c)(i).

1. ....

....

2. ....

....

(2)

(iii) When the thundercloud discharges, the average discharge current is 1.8 kA. Estimate the discharge time.

....

....

....

....

....

(3)

(iv) The potential difference between the thundercloud and the ground before discharge is 2.5×10^8 V. Determine the energy released in the discharge.

....

....

....

....

....

....

....

(4)

18. This question is about motion of a charged particle in an electric field.

(a) An α-particle of mass $4u$ and charge $+2e$ is accelerated from rest in a vacuum through a potential difference of 2.4 kV. Show that the final speed of the α-particle is 4.8×10^5 m s^{-1}.

....

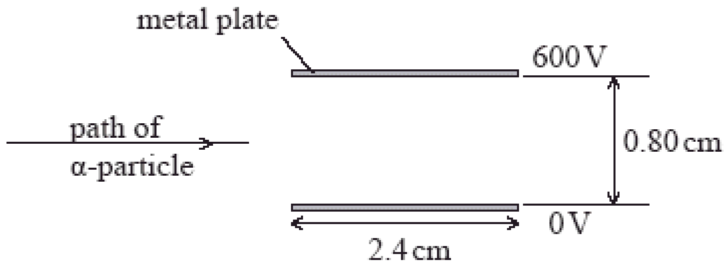
....

....

....

(2)

(b) The α-particle is travelling in a direction parallel to and mid-way between two parallel metal plates.



(not to scale)

The metal plates are of length 2.4 cm and their separation is 0.80 cm. The potential difference between the plates is 600 V. The electric field is uniform in the region between the plates and is zero outside this region.

(i) Calculate the magnitude of the electric field between the plates.

....

....

....

(2)

(ii) Show that the magnitude of the acceleration of the α-particle by the electric field is 3.6×10^{12} m s^{-2}.

....

....

....

(2)

(c) (i) Calculate the time taken for the α-particle to travel a horizontal distance of 2.4 cm parallel to the plates.

....

....

(1)

(ii) Use your answers in (b)(ii) and (c)(i) to deduce whether, as the α-particle passes between the plates, it will hit one of the plates.

....

....

....

....

....

(3)