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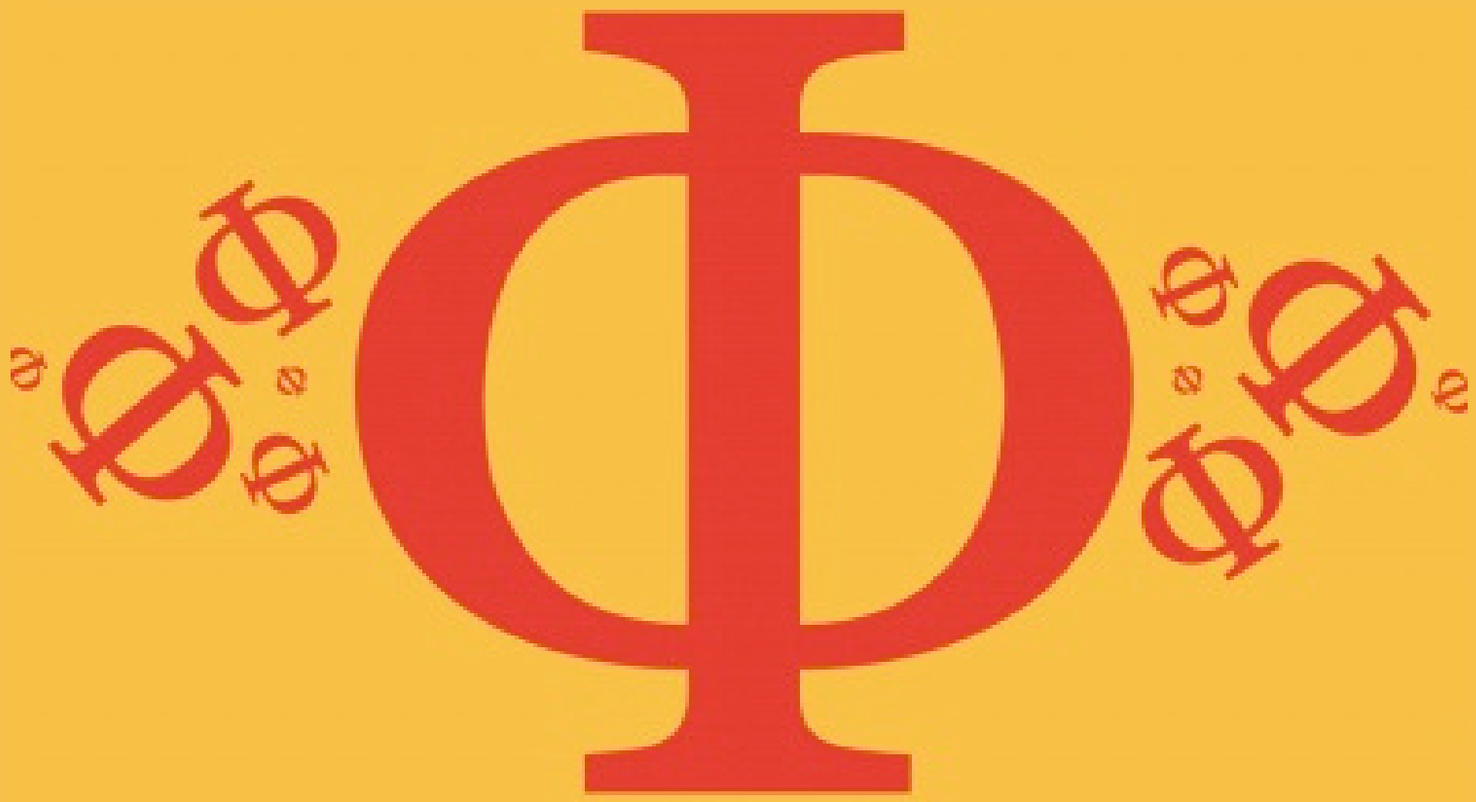
10.2 Fields at Work

Hard



PHYSICS

IB HL

EXAM PAPERS PRACTICE

10.2 Fields at Work

Question Paper

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

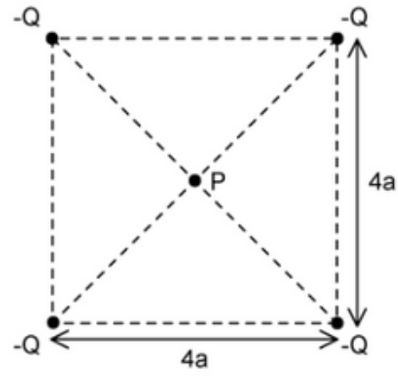
Time allowed: 20

Score: /10

Percentage: /100

Question 1

The diagram shows four point charges at the corners of a square of sides 4*a*.



What is the electric potential at **P**, the centre of the square?

A. $-\frac{Q}{\pi\varepsilon_0 2\sqrt{2a}}$

B. $-\frac{Q}{\pi\varepsilon_0 4\sqrt{2a}}$

C. $-\frac{Q}{2\pi\varepsilon_0 a}$

D. $-\frac{Q}{4\pi\varepsilon_0 a}$

[1 mark]

Question 2

The Earth has radius, *r* and mass *M*. Which expression could be used to calculate the minimum time, *T* of one Earth-day for the material at the equator to just remain on the surface?

A. $\frac{4\pi^2 mr}{GM}$

B. $\frac{2\pi r^3}{GM}$

C. $\frac{4\pi^2 r^3}{GM}$

D. $2\pi\sqrt{\frac{r^3}{GM}}$

Question 3

A proton with velocity of 1.5×10^{7} m s^{-1} moves normally into a uniform magnetic field of flux density 0.30 T. Which is the best estimate of the radius of curvature of the path of the proton?

A. 5×10^{-38} m

B. 5×10^{-3} m

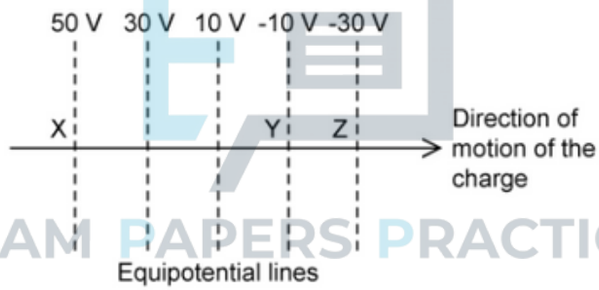
C. 5×10^{-1} m

D. 5 m

[1 mark]

Question 4

The diagram shows a uniform electric field in which equipotential lines are placed 3.0 cm apart.



A charge of −6.0 nC is placed at the equipotential line **X**.

Which of the following statements is correct?

A. The charge is in an electric field directed from Z to X and has a gain of 4.8×10^{-7} J of kinetic energy moving from X to Z

B. The charge is in an electric field directed from X to Y and has a loss of 2.4×10^{-7} J of kinetic energy moving from Y to Z

C. The charge is in an electric field directed from X to Y and has a gain of 1.2×10^{-7} J of kinetic energy moving from Y to Z

D. The charge is in an electric field directed from X to Z and has a loss of 1.2×10^{-7} J of kinetic energy moving from Y to Z

[1 mark]

Question 5

A space probe with mass m is launched from the surface of the Earth's equator into orbit. The total energy E_t given to the space probe is:

$$E_t = \frac{3GMm}{4\,r_E}$$

where G is the gravitational constant and M and r_E are the mass and radius of Earth.

What is the height of the space probe's orbit above the Earth's surface?

A. r_E

B. $2r_E$

C. $3r_E$

D. $4r_E$

[1 mark]

Question 6

Two satellites, X and Y, of equal mass, orbit a planet at radii R and $2R$ respectively.

Which one of the following statements is correct?

A. X has more kinetic energy and more potential energy than Y

B. X has more kinetic energy and less potential energy than Y

C. X has less kinetic energy and more potential energy than Y

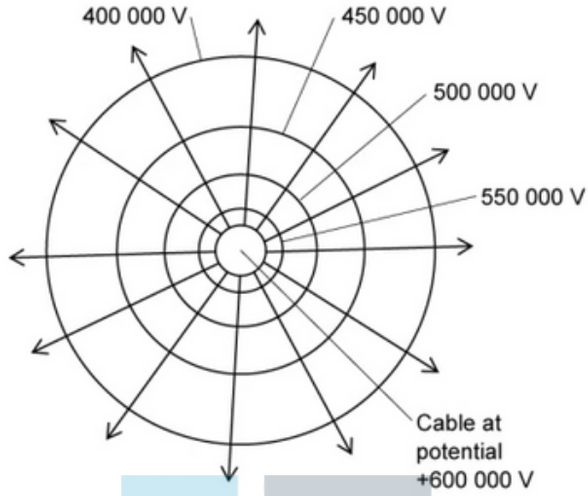
D. X has less kinetic energy and less potential energy than Y

[1 mark]

Question 7

A cable used in high-voltage electrical transmission has a radius of 3.0 mm. The diagram shows the circular cross-section of the cable with electrical field lines denoting areas of equipotential.

In the instant shown the potential of the cable is + 600 000 V.



Assuming that the diagram has been drawn to scale, what is the the potential gradient near the surface of the cable?

A. $-25 \times 10^6\,V\,m^{-1}$

B. $-50 \times 10^6\,V\,m^{-1}$

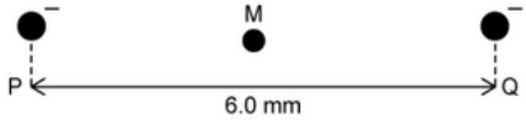
C. $-75 \times 10^6\,V\,m^{-1}$

D. $-125 \times 10^6\,V\,m^{-1}$

[1 mark]

Question 8

Two identical negative point charges, P and Q, are separated by a distance of 6.0 mm. The resultant electric potential at point M, which is mid-way between the charges, is -40 V.



What would be the resultant electrical potential at a point 2.0 mm closer to Q?

A. -90 V

B. -72 V

C. -60 V

D. -48 V

Question 9

Observations are made on two separate planetary system's suns of mass M_1 and mass M_2.

Their orbiting planets, P_1 and P_2 have masses of m_1 and m_2, and are observed to have identical orbits in shape and magnitude. P_1 completes an orbit in a quarter of the time taken by P_2.

Which statement can astronomers reasonably deduce?

A. $M_1 = M_2$ and $9m_1 = m_2$

B. $M_1 = 16\,M_2$ and $m_1 = m_2$

C. $4\,M_1 = M_2$

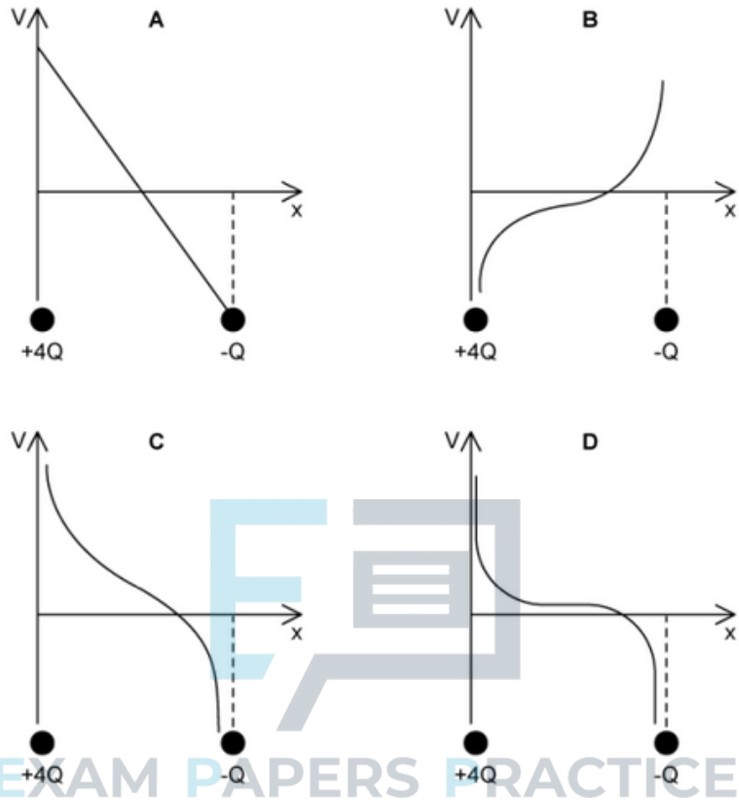
D. $M_1 = 16\,M_2$

[1 mark]

Question 10

Two points charges of +4Q and –Q are placed 150 mm apart.

Which of the following graphs shows the variation of the potential *V* against the distance *x* along the line joining the two point charges?



[1 mark]