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

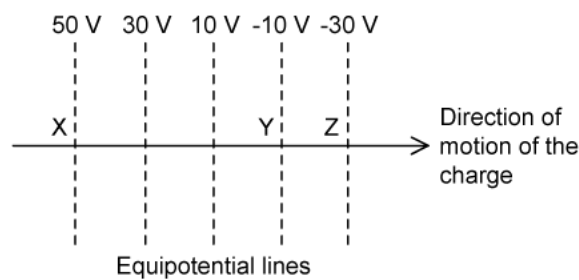**Percentage:** /100

Question 1

A proton with velocity of $1.5 \times 10^7 \text{ m s}^{-1}$ 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 2

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 3

The diagram shows four point charges at the corners of a square of sides $4a$.
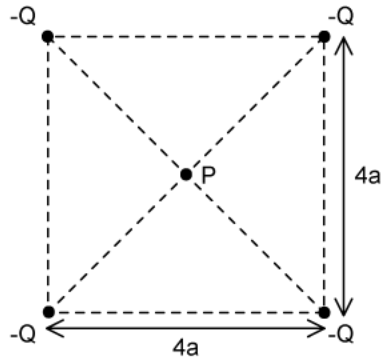
What is the electric potential at **P**, the centre of the square?

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

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

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

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

[1 mark]

Question 4

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. $\dfrac{4\pi^2\, mr}{GM}$

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

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

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

[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.

400 000 V   450 000 V

500 000 V

550 000 V

Cable at potential +600 000 V
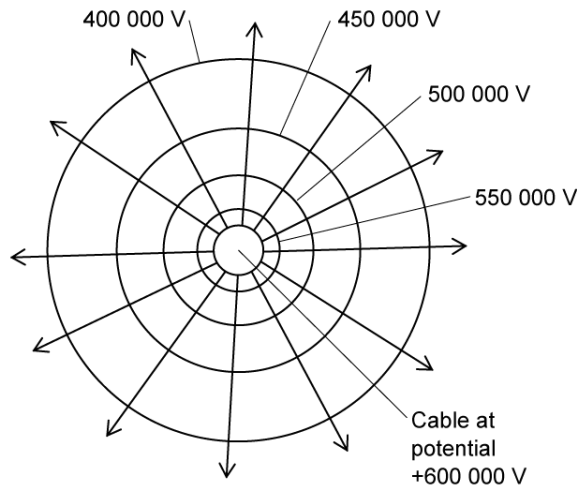
Assuming that the diagram has been drawn to scale, what is the the potential gradient near the surface of the cable?

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.

P ⟵   6.0 mm   ⟶ Q

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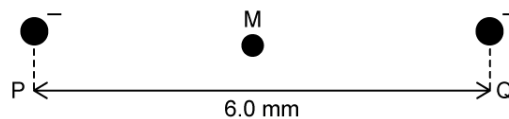
What would be the resultant electrical potential at a point 2.0 mm closer to Q?

A. −90 V

B. −72 V

C. −60 V

D. −48 V

[1 mark]

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.

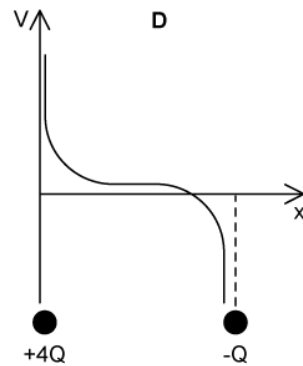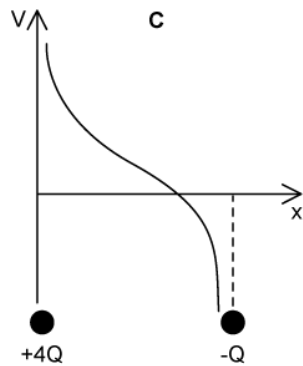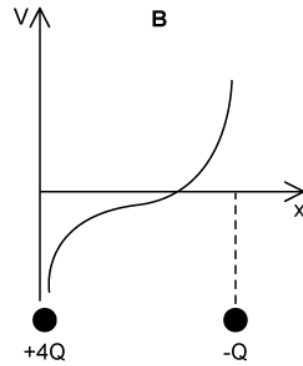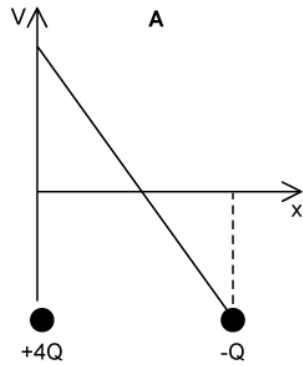Which statement can astronomers reasonably deduce?

   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]