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10.1 Describing Fields

Hard

PHYSICS

IB HL

EXAM PAPERS PRACTICE

10.1 Describing Fields

Question Paper

Course	DP IB Physics
Section	10. Fields (HL only)
Topic	10.1 Describing Fields
Difficulty	Hard

Time allowed: 20

Score: /10

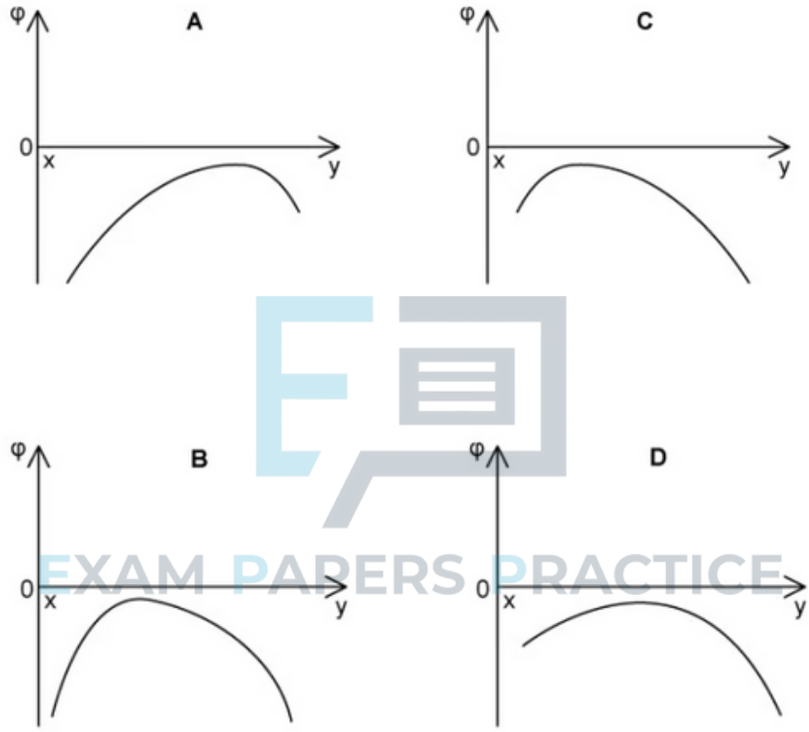
Percentage: /100

Question 1

The relative positions of a binary star system is shown below:

The line XY joins the surface of the star of mass m to the surface of the star of mass $M > m$. Assume the stars have the same diameter.

Which graph correctly represents the variation of the gravitational potential ϕ along the line XY?



[1 mark]

Question 2

The shape of equipotential surfaces in the gravitational field depends on perspective.

The image below shows equipotential surfaces (represented by dotted lines) due to the Earth's gravitational field in a 'local' frame of reference (close to the Earth's surface) and in a 'non-local' frame of reference (far from the Earth's surface):

Diagram for local frame of reference:

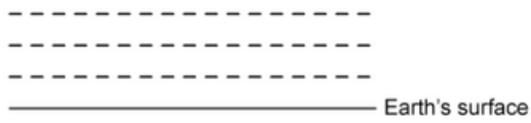
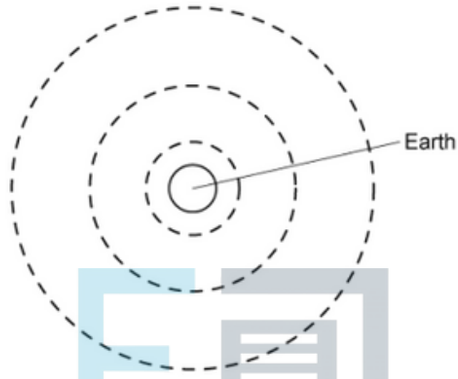


Diagram for Non-local frame of reference:

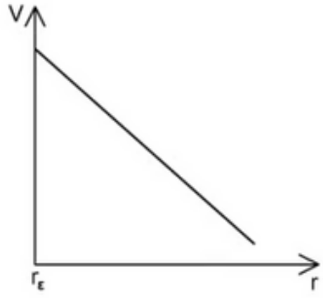


Which line, **A** to **D**, in the table shows the variation of gravitational potential V with radial distance r from the Earth's surface?

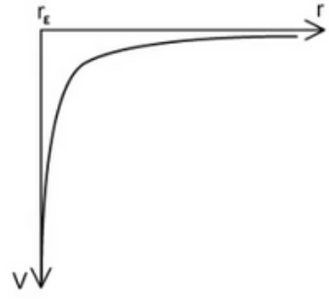
You may assume each dotted line represents equal changes in potential ΔV and that r_E represents the radius of the Earth.

A.

Local:

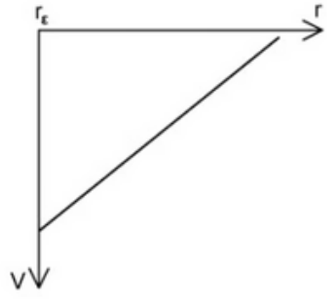


Non-local:

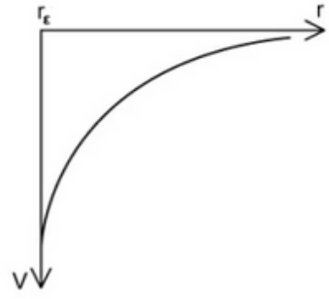


B.

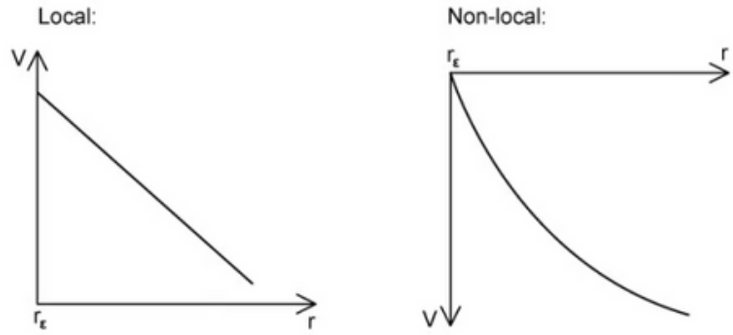
Local:



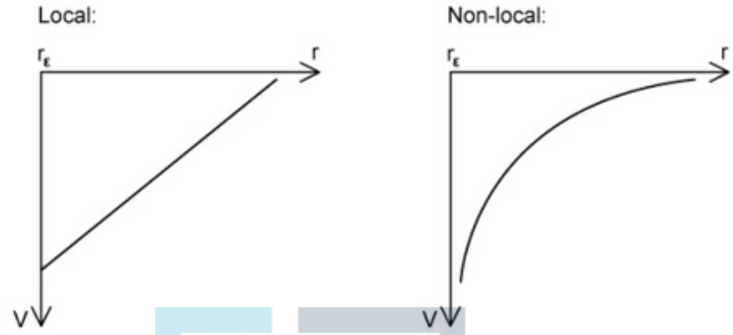
Non-local:



C.



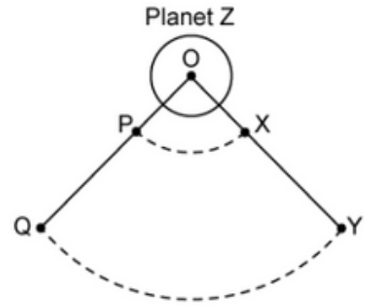
D.



[1 mark]

Question 3

Planet Z, with centre O, is shown in the figure below.



The radial distances OP is equal to the OX, and OQ is equal to OY, such that PX and QY are loci of Planet Z.

Which of the following statements is incorrect?

A. The work done by the gravitational field on a test mass moving from P to Q is negative

B. The gravitational field does zero work on a test mass moving along the locus PX

C. $\frac{V_X}{V_Q} = \frac{OY}{OX}$

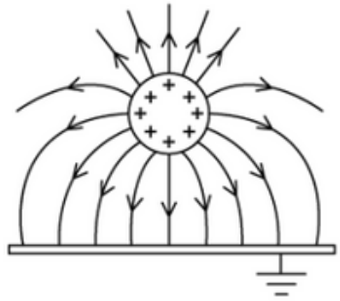
D. The work done by an external force to move a test mass from Y to X is positive

[1 mark]

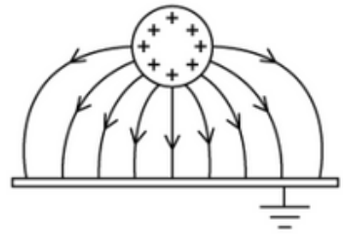
Question 4

What is the electric field pattern between a conducting sphere and an earthed metal plate?

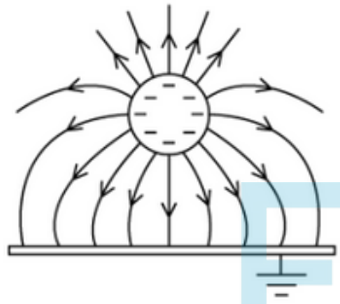
A



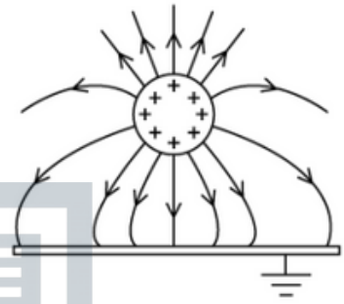
B



C



D

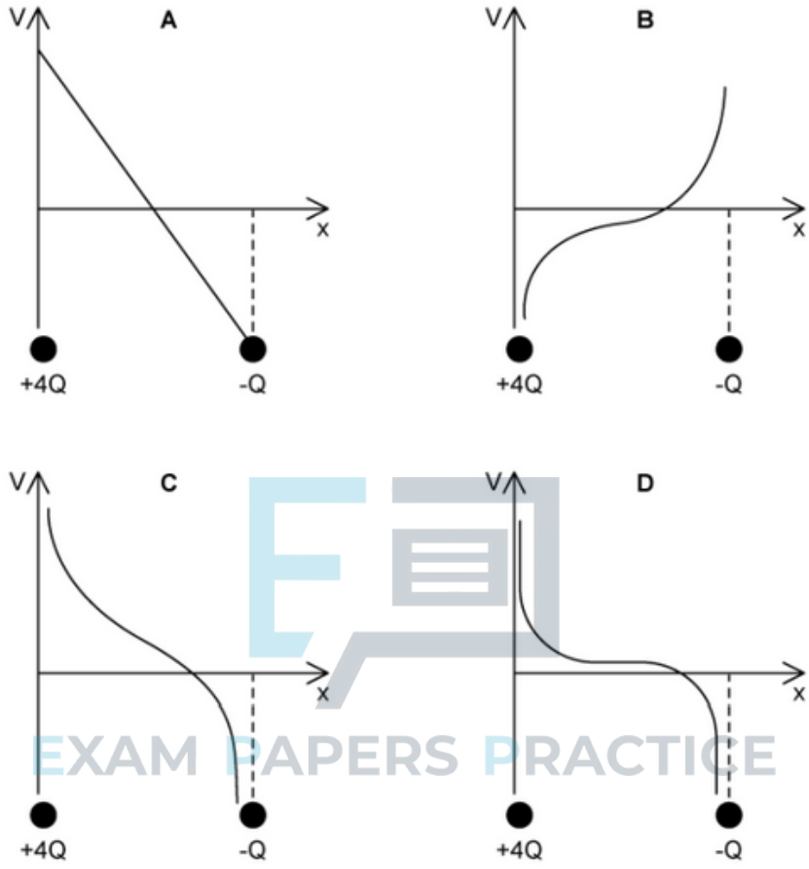


[1 mark]

Question 5

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]

Question 6

Which of the following statements about gravitational fields is correct?

A. The gravitational potential is zero whenever the gravitational field strength is zero

B. The gravitational potential is negative because the gravitational field is repulsive

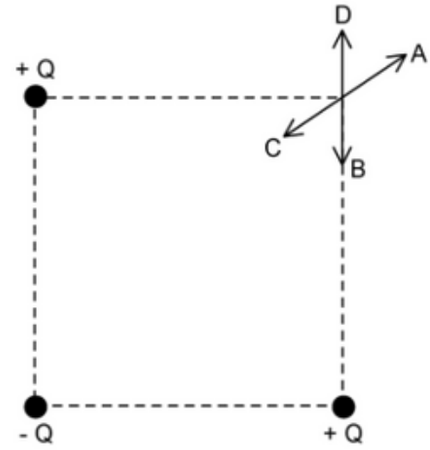
C. The gradient of the gravitational potential at a point is inversely proportional to the radial distance from some massive body

D. The area under a field strength–distance curve represents the change in gravitational potential between two points

[1 mark]

Question 7

Point charges, each of magnitude Q are placed at three corners of a square as shown in the diagram.

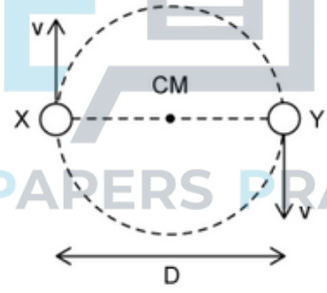


What is the direction of the resultant electric field at the fourth corner?

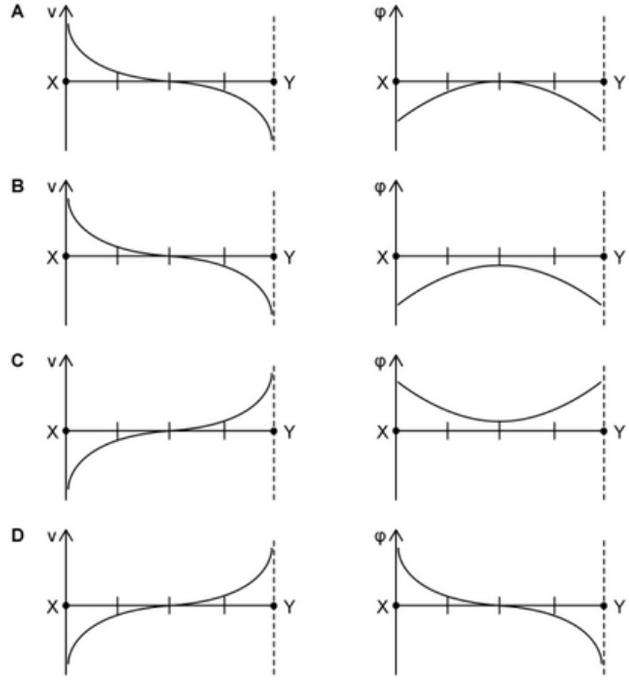
[1 mark]

Question 8

Two objects X and Y of equal mass, *m* and distance, *D* apart move with a constant speed *v* in circular orbit about their common centre of mass CM. X has a charge of +6.0 nC and Y has a charge of −6.0 nC.

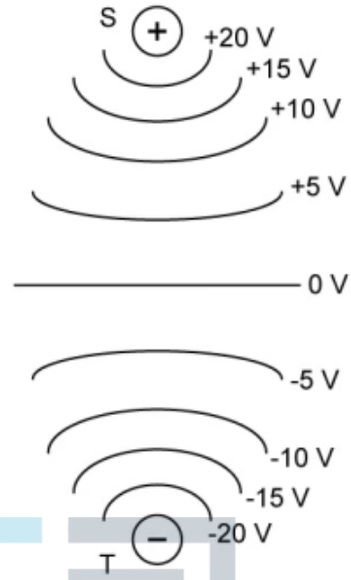


Which graphs shows the electric potential, *V* and gravitational potential, φ, against position along the straight-line joining X and Y?

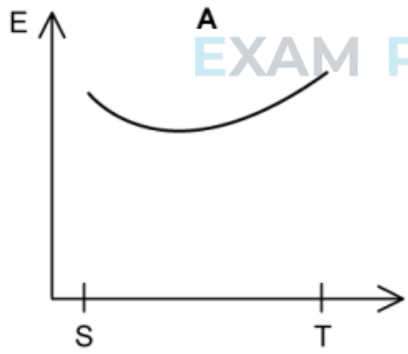


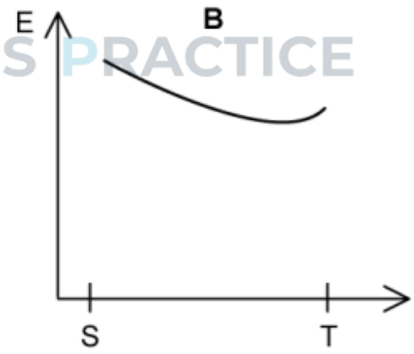
Question 9

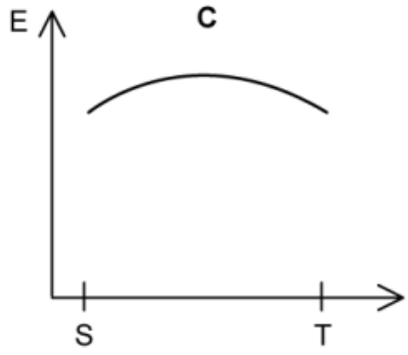
A positive charge is placed at S and a negative charge is placed at T. The electric potential at different points between the charges is shown below.

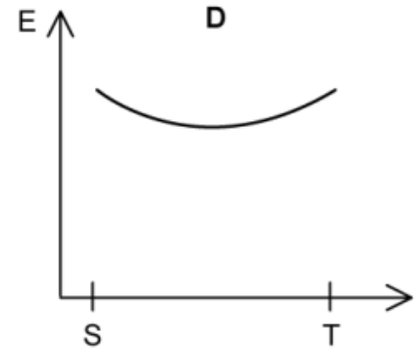


Which graph correctly shows the variation with *x* along the line ST of the electric field strength, *E*?





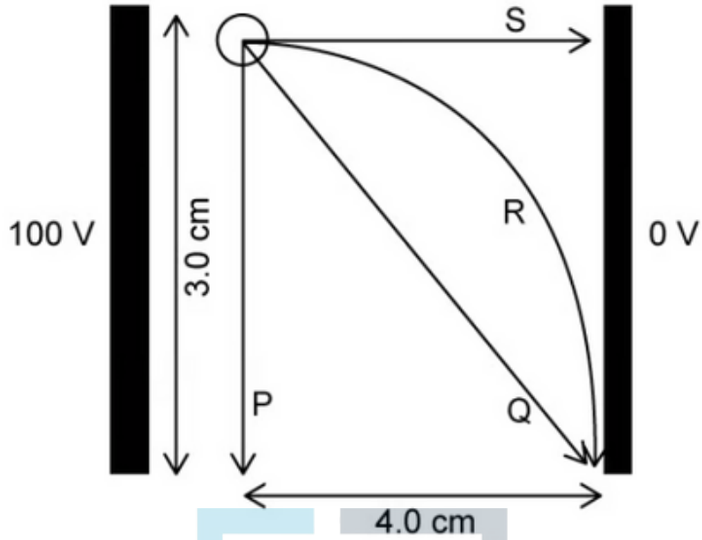




[1 mark]

Question 10

A weighted, positively charged sphere is released from rest, in a vacuum, between two parallel, vertical metal plates one at +100 V and the other grounded. The sphere is initially 4.0 cm from the edge of the grounded plate and 3.0 cm from the bottom of the plates. The sphere takes one of the paths P, Q, R or S and reaches the end of its trajectory in 60 ms.



By choosing the correct path, what is the speed of the sphere at the end of its trajectory?

A. $\frac{1}{6}\ \text{m s}^{-1}$

B. $\frac{5}{6}\ \text{m s}^{-1}$

C. $\frac{5}{3}\ \text{m s}^{-1}$

D. $\sqrt{\frac{3}{5}}\ \text{m s}^{-1}$

[1 mark]