10.1 Describing Fields

Question Paper

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

Time allowed: 70

Score: /56

Percentage: /100

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Question 1a

(a)
Define the terms:

(i)
Gravitational field

[2]

(ii)
Electrostatic field

[2]

[4 marks]

Question 1b

An equation to describe field strength is:

$$field\ strength = \frac{X}{Y}$$

(b)
Define X and Y in the equation above.

[2]

[2 marks]

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Question 1c

(c)
Based on your answer to part (b), define the terms in the following equations:

(i)

$$g = \frac{F}{m}$$

[1]

(ii)

$$E = \frac{F}{Q}$$

[1]

[2 marks]

Question 1d

The following text is about uniform electrostatic and gravitational fields.

(d)
Complete the following sentences by circling the correct words:

A gravitational field is a region of space in which objects with **mass / charge** will experience a force.

The direction of the gravitational field is always directed **away from / towards** the centre of the mass.

Gravitational forces are always **attractive / repulsive** and cannot be **attractive / repulsive**.

An electric field is a region of space in which objects with **mass / charge** will experience a force.

The electric field strength is a vector quantity, it is always directed **away from / towards** a positive charge and **away from / towards** a negative charge.

Opposite charges (positive and negative) **repel / attract** each other and like charges (positive-positive or negative-negative) **repel / attract** each other.

[6]

[3 marks]

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Question 2a

(a)

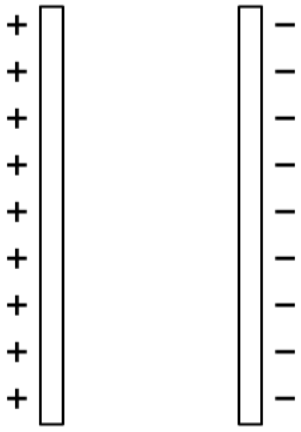
Draw the electric field lines around the positive and negative point charges below.

[3

[3 marks]

Question 2b

The diagram shows two parallel plates of opposite charge.



(b)

Draw the electric field lines between the two plates.

[3]

[3 marks]

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Question 2c

Electrostatic fields can be radial or uniform.

(c)
State the defining features of the equipotentials for:

(i)
A radial field

[2]

(ii)
A uniform field

[3]

[5 marks]

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Question 2d

(d)

(i)
On the diagram from part (a), draw the equipotential lines.

[2]

(ii)
On the diagram from part (b), draw the equipotential lines.

[2]

[4 marks]

Question 3a

(a)
State the definition for the gravitational potential at a point.

[2]

[2 marks]

Question 3b

(b)
Explain why gravitational potential is always negative.

[2]

[2 marks]

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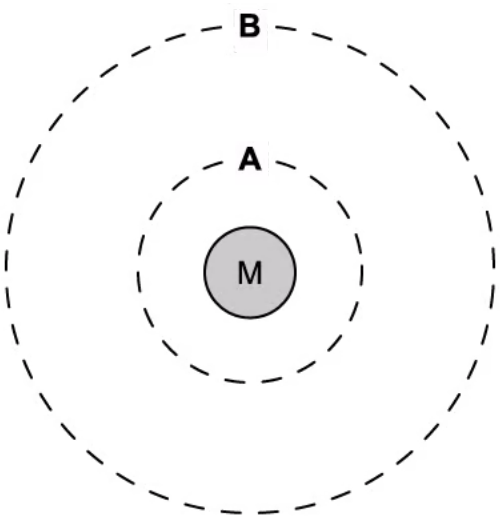
Question 3c

A satellite orbiting the moon, M, is moved from orbit A to orbit B:



The gravitational potential due to the moon of each of these orbits is:

Orbit A: $-2.10\ MJ\ kg^{-1}$
Orbit B: $-1.65\ MJ\ kg^{-1}$

(c)
Calculate the gravitational potential difference as the satellite moves from orbit A to orbit B.

[3]

[3 marks]

Question 3d

The satellite has a mass of 950 kg.

(d)
Calculate the work done in moving the satellite from orbit A to orbit B.

[2]

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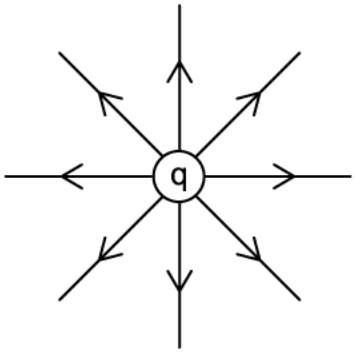
[2 marks]

Question 4a

The diagram shows the electric field lines of a charged conducting sphere of radius *r* and charge *q*.



(a)
State and explain the charge on the conducting sphere.

[2]

[2 marks]

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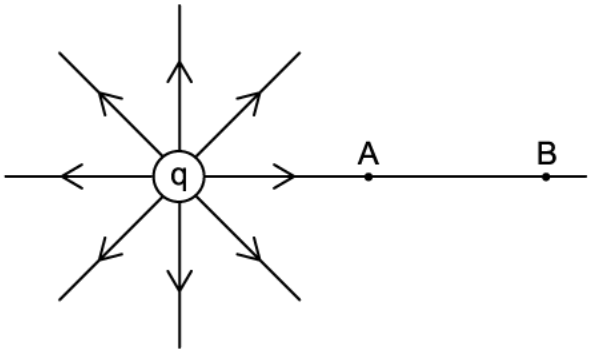
Question 4b

Two points A and B are located on the same field line.



(b)
Explain why electric potential decreases from A to B.

[2]

[2 marks]

Question 4c

A proton is placed at A and released from rest. The magnitude of the work done by the electric field in moving the proton from A to B is 2.5×10^{-16} J. Point A is at a distance of 0.1 m from the centre of the sphere and point B is at a distance of 0.5 m.

(c)
Calculate the electric potential between points A and B.

[3]

[3 marks]

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Question 4d

(d)
The concept of potential is also used in the context of gravitational fields. Suggest why scientists describe different types of fields using the same terminology.

[1]

[1 mark]

Question 5a

The gravitational potential, V_g around a planet can be calculated using the equation:

$$V_g = -\frac{Gm}{r}$$

Where G is the gravitational constant, m is the mass of the planet and r is the distance from the centre of the planet.

The mass of the Earth is 5.97×10^{24} kg.

(a)
Calculate the gravitational potential at a point 4.23×10^{7} m from the centre of the Earth.

[2]

[2 marks]

Question 5b

The gravitational potential on the surface of the Earth is -6.25×10^{7} J kg^{-1}.

(b)
Calculate the gravitational potential difference between the surface of the Earth and a point 4.23×10^{7} m from the centre of the Earth from part (a).

[3]

[3 marks]

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Question 5c

(c)

Calculate the work done in taking a 5.0 kg mass from the surface of the Earth to a point 4.23×10^7 m from the centre of the Earth.

[2]

[2 marks]

Question 5d

(d)

(i)

State the magnitude of the gravitational potential at a point where the Earth's gravitational effect is negligible.

[1]

(ii)

Calculate the gravitational potential difference between the Earth's surface (from part b) and the point where the Earth's gravitational effect is negligible

[3]

(iii)

Calculate the work done in taking the 5.0 kg mass from the surface of the Earth to the point where the Earth's gravitational effect is negligible.

[2]

[6 marks]

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