InkPhysics

ANSWER BOOK

The field concept

Gravitational fields · Year 13

AQA 3.7.1 · CIE 13.1.2, 13.3.3 · OCR A 5.4.1(a), 5.4.1(c), 5.4.1(e), 6.2.2(d)

14 questions · 36 marks

NAVY EDITION

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SECTION A · Warm-up

A1 A region in which a body experiences a non-contact force (1); due to a property of the body such as its mass or charge (1). [2]

A2 Gravitational field: mass; electric field: (static) charge (1); magnetic field: moving charge (or a permanent magnet) (1). [2]

A3 $g = F/m = 19.6/2.0$ (1)
$g = 9.8$ N kg^{-1} (1) [2]

A4 The arrow shows the direction of the (gravitational) force on a mass placed at that point (1); the spacing shows the strength of the field, with closer lines meaning a stronger field (1). [2]

A5 At a crossing point the field (force) would have two different directions at once (1); the force on a body at any point acts in only one direction, so lines cannot cross (1). [2]

SECTION B · Standard

B1 Similarity: both obey an inverse-square law with separation (or both act at a distance) (1). Differences: gravitational force is always attractive whereas the electric force can be attractive or repulsive (1); the electric force between two charged particles is very much stronger than the gravitational force between them (1). [3]

B2 $g = F/m = 40/5.0$ (1)
$g = 8.0$ N kg^{-1} (1) [2]

B3 Force per unit mass on a small test mass placed at the point, $g = F/m$ (1); unit: N kg^{-1} (or m s^{-2}) (1). [2]

B4 Use of $F = mg$ with each field strength (1)
P: $350 \times 1.3 = 455$ N; Q: $350 \times 0.90 = 315$ N; R: $350 \times 2.2 = 770$ N (1)
The lander is safe on P and Q; on R its weight exceeds 600 N (1). [3]

B5 Over laboratory distances the change in distance from the Earth's centre is negligible, so the magnitude of g is effectively constant (1); the field lines are effectively parallel and equally spaced, which is a uniform field (1). Over the distances travelled by a satellite, both the strength and the direction of the field change appreciably: the lines converge on the Earth's centre, so the field must be treated as radial (1). [3]

SECTION C · Stretch

C1 Point mass: lines are radial (1); directed inwards towards the mass, with spacing increasing with distance as the field weakens (1). Near the Earth's surface: lines are parallel, vertical and directed downwards (1); equally spaced, showing the field strength is the same everywhere in the region (1). [4]

C2 $g = F/m = 82/10$ (1)
$g = 8.2$ N kg^{-1} (1)
Directed towards the centre of the planet (1). [3]

C3 There is only one type of mass (1); masses always attract each other, so the gravitational force is always attractive (1). Charge exists in two types, positive and negative: like charges repel and unlike charges attract, so the electric force can act in either sense (1). [3]

C4 Along the line, the two fields act in opposite directions: each points towards its own body (1). Moving from one body to the other, one field weakens while the other strengthens, so at some point their magnitudes are equal and the resultant is zero (1). The point is closer to the moon: the moon's smaller mass produces the weaker field, so the point of equality must lie nearer to it (1). [3]