Practice Question Set For A-Level
Subject : Physics
Paper-1 Topic: Further Mechanics

Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Mark Schemes

Q1.

(a) G has greater mass with evidence from diagram ✔1

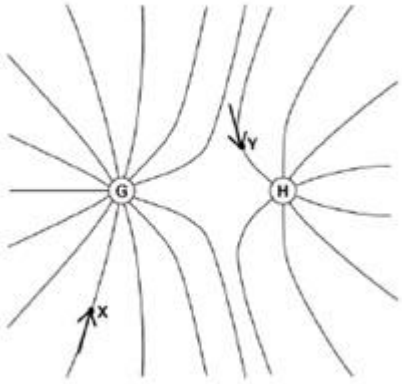
Explanation based on gravitational field strength or gravitational potential ✔2

E.g.
ALTERNATIVE A
G has greater mass because null point is closer to H ✔1
G field equals that of H at a greater distance from null than H ✔2

ALTERNATIVE B
G has greater mass because the density of field lines is greater ✔1
Density of field lines depends on mass ✔2
Allow arguments based on potential maximum at null point.

2

(b) The lines given tangential arrows at X and Y that flow towards **G** and **H** respectively. ✔



Condone arrow heads only but if arrows are drawn in full they must not follow a curved line.
*Arrows are acceptable if drawn alongside X and Y but must not be further away than the **X** or **Y** label.*

1

(c)

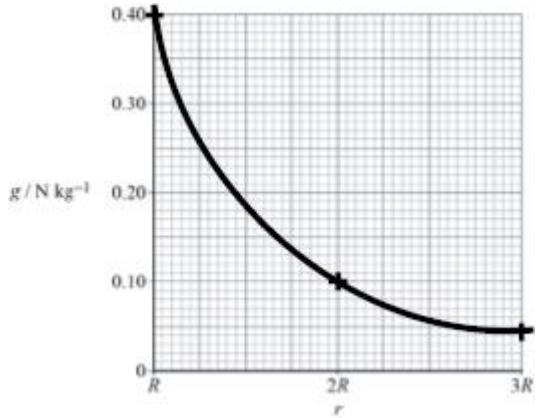
$$R = \left(\left\{ \frac{GM}{g} \right\}^{1/2} = \left\{ \frac{6.67\times10^{-11}\times2.0\times10^{20}}{0.40} \right\}^{1/2} \right) = 1.8 \times 10^{5}\ (\text{m}) \checkmark$$

1

(d) Sketch must pass through coordinates (R, 0.40), ($2R$, 0.10) and ($3R$, 0.044) ✔

Must be within one 1/2 small division of coordinates requested.

If plotted points differ a little from the line drawn then plotted points take priority.



1

(e) ALTERNATIVE A

(The area underneath) represents the energy transferred/work done (for an object) of 1 kg / unit mass ✔1a

Accept reverse direction $2R$ to R with appropriate direction of energy transfer/gravitational potential.

OR

(area is) energy transferred to/work done on the object per unit mass when it is moving from R to $2R$ ✔1a✔2a

In each alternative, the first answer is only awarded MP1. The second, fuller answer scores MP1 and MP2.

ALTERNATIVE B

change in gravitational potential ✔1b

OR

increase in gravitational potential when moving from R to $2R$ ✔1b✔2b

R may be given as 1.8×10^5

2

(f) Use of $F = \frac{GMm}{r^2}$ to find the force between **P** and **H** ✔1

($F_{(PH)} = 1.8 \times 10^{13}$ N)

✔1 $F_{(PH)} = \frac{6.67\times10^{-11}\times3.0\times10^{25}\times2.0\times10^{20}}{\left(1.5\times10^{11}\right)^2}$

✔2 *Mark is for the use of the equation allowing for ecf from candidate's force calculation.*

✔3 *Correct answer only, no ecf this interim calculation may be subsumed in the next mark.*

(Calculation of the resultant force

Use of $F_{total} = \left(F_{(PH)}{}^2 + F_{(PG)}{}^2\right)^{1/2}$ ✔2

$\left(F_{\text{total}} = \left[\left(1.8 \times 10^{13}\right)^2 + \left(6.4 \times 10^{12}\right)^2\right]^{1/2}\right)$

$F_{\text{total}} = 1.9 \times 10^{13}$ ✓3

Use of $a = \frac{F}{m} = \frac{1.9\times10^{13}}{2.0\times10^{20}}$ = 9.4 to 9.5 × 10^{-8} (m s^{-2}) ✔4

✔4 *Allow ecf from* F_{total}

Condone the vector addition of the acceleration to obtain the answer

acc^n due to G = 3.91 × 10^{-8} m s^{-2}

acc^n due to H = 8.9 × 10^{-8} m s^{-2}

4

(g) The resultant force is not (centripetal and continually) directed towards the centre of **H**.
OR
A circular orbit does not follow a gravitational equipotential (owtte) ✔

Condone lack of "resultant"

The answer can focus on the conditions necessary for circular motion eg the need for a centripetal force.

Or

At different locations on a circular path the total gravitational potential energy is different which requires energy which is not provided.

NB stating that the force is not perpendicular to the motion does not count as a full explanation as the motion has not been established.

1

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Q2.

(a) Centripetal force acts inwards / towards the centre of rotation ✔

Links reaction force to centripetal force ✔

2

(b) Equates forces AND states **either** centripetal force with correct symbols✔

$F = m_A r\omega^2$

$F = m_B (L - r)\omega^2$

In MP1 condone: equations containing v; use of ω_A *and* ω_B *for the angular velocities.*

cancelling ω✔

$m_A r\cancel{\omega^2} = m_B(L - r)\cancel{\omega^2}$

$r = \frac{m_B L}{m_A + m_B}$

E.g.

In MP2 it must be clear that the angular velocity and not the velocity.

2

(c) The angular speed is the same for A & B or

Rotational radius for B less than that for A ✔

Both of these points AND $v = r\omega$ so velocity of A is greater.✔

Alternative for MP2:
Both of points in MP1 AND
A travels greater distance in the same time.

2

(d) Use of safety factor e.g. maximum stress << 0.300 GPa ✔

$F = ma = 1.32 \times 10^6 \times 3.7$✔ $(= 4.9 \times 10^6 \text{ N})$

$A = \frac{F}{\sigma}$ valid substitution ✔

$\sqrt{\frac{4A}{\pi}}$ ✔ (expect > 0.144 m)

Valid justification for selection of maximum stress used e.g. using a stress that is from the linear / elastic section of the graph or reference to either safety factor or trying to limit weight of cable. ✔

Alternative for MP1: they can work through for a stress of 0.3 GPa and then increase the diameter, if justified as a safety factor. Do not allow use of stress ≈0.3 GPa for full marks.
Allow ecf for stress and force

5

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