

**Bab / Chapter 3 : Kegravitian / Gravitation**

- 1 Which of the following statement is correct about the gravitational forces acting on earth and moon ?

[Gravitational force of the earth against the moon =  $F_E$ ]

[Gravitational force of the moon against the earth =  $F_M$ ]

Pernyataan yang manakah adalah betul mengenai daya-daya graviti yang bertindak pada bumi dan bulan?

[ Daya graviti bumi terhadap bulan =  $F_B$  ]

[ Daya graviti bulan terhadap bumi =  $F_M$  ]

A  $F_E > F_M$

B  $F_E < F_M$

C  $F_E \geq F_M$

D  $F_E = F_M$

- 2 Given that the radius of the earth is  $R$  and the escape velocity on the surface of the earth is  $11 \text{ kms}^{-1}$ .

What is the escape velocity at the height of  $0.5R$  from the surface of the earth ?

Diberi jejari bumi ialah  $R$  dan halaju lepas di permukaan bumi ialah  $11 \text{ kms}^{-1}$ .

Berapakah halaju lepas pada ketinggian  $0.5R$  dari permukaan bumi ?

Hint / Petua :

$$v = \sqrt{\frac{2GM}{r}}$$

$v$  = escape velocity / halaju lepas

$G$  = gravitational constant / pemalar kegravitian

$R$  = distance from the centre of the earth / jarak dari pusat bumi

$M$  = mass of Earth / jisim Bumi

A  $9.0 \text{ kms}^{-1}$

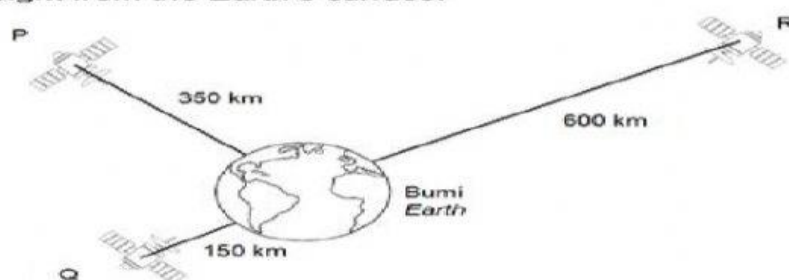
B  $8.0 \text{ kms}^{-1}$

C  $7.0 \text{ kms}^{-1}$

D  $6.0 \text{ kms}^{-1}$

- 3 Rajah 3 menunjukkan 3 buah satelit yang sama P, Q dan R yang berada pada ketinggian yang berbeza dari permukaan Bumi.

Diagram 3 shows three identical satellites P, Q and R which are located at different height from the Earth's surface.



Rajah 3  
Diagram 3

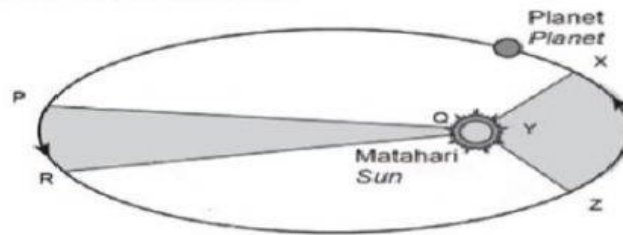
Yang manakah menunjukkan perbandingan yang betul?

Which one shows the correct comparison?

|   | Daya gravity, $F$<br>Gravitational Force, $F$ | Pecutan graviti, $g$<br>Acceleration due to gravity, $g$ |
|---|-----------------------------------------------|----------------------------------------------------------|
| A | $P > Q > R$                                   | $P < Q < R$                                              |
| B | $P < Q > R$                                   | $P < Q > R$                                              |
| C | $P < Q < R$                                   | $P > Q > R$                                              |
| D | $P > Q < R$                                   | $P > Q < R$                                              |

4

Rajah 4 menunjukkan luas yang dicakup dalam masa yang sama di kawasan PQR dan XYZ bagi suatu planet yang berputar mengelilingi Matahari.  
*Diagram 4 shows the area covered at the same time in the regions PQR and XYZ of a planet rotating around the Sun.*



Rajah 4  
 Diagram 4

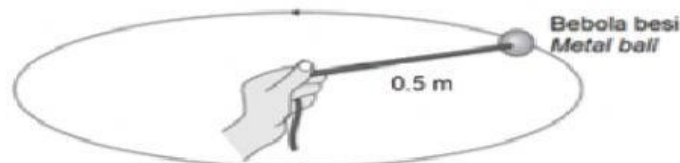
Antara berikut yang manakah benar tentang luas PQR dan XYZ?  
*Which of the following is true about area of PQR and XYZ?*

- A PQR = XYZ
- B PQR > XYZ
- C PQR < XYZ
- D PQR ≤ XYZ

5

Rajah 5 menunjukkan sebiji bebola besi berjisim 0.2 kg diikat pada hujung tali yang diputar secara mengufuk oleh seorang pelajar. Jejari bulatan ialah 0.5 m.

*Diagram 5 shows a metal ball of mass 0.2kg tied to the end of a string that is spin horizontally by a student. Radius of the circle is 0.5 m.*



Rajah 5  
 Diagram 5

Jika bebola besi itu berputar dengan kelajuan malar  $4 \text{ m s}^{-1}$ , hitungkan daya memusat.

*If the metal ball rotates at constant speed  $4 \text{ m s}^{-1}$ , calculate the centripetal force.*

- A 6.25 N
- B 6.40 N
- C 1600 N
- D 6400 N

6

Pecutan graviti di permukaan Bumi ialah  $g$  dan jejari Bumi ialah  $R$ . Pada jarak berapakah pecutan graviti dari permukaan bumi adalah  $\frac{1}{4}g$ ?

*The gravitational acceleration on the surface of the Earth is  $g$  and the radius of the Earth is  $R$ .*

*At what distance is the acceleration of gravity from the earth's surface  $\frac{1}{4}g$ ?*

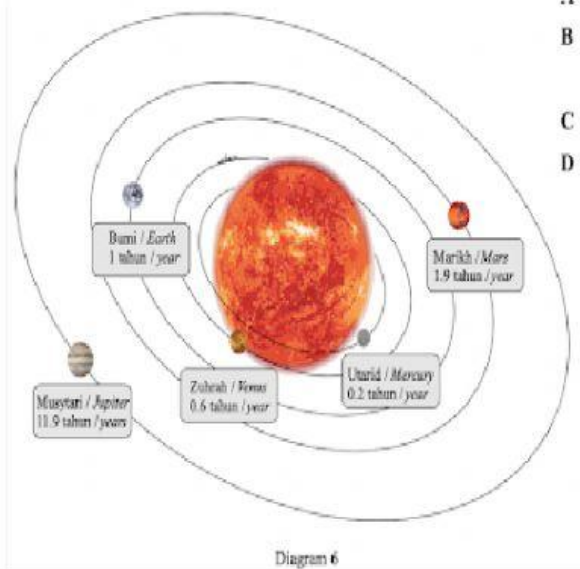
- A.  $\frac{1}{4}R$  dan  $2R$
- B.  $\frac{1}{4}R$  dan  $4R$
- C.  $\frac{1}{2}R$  dan  $2R$

- 7 Halaju lepas dari permukaan sebuah planet bergantung kepada  
*The escape velocity from the surface of a planet depends on*
- Jejari planet tersebut sahaja  
*the radius of the planet only*
  - Jisim planet tersebut sahaja  
*the mass of the planet only*
  - Jejari dan jisim planet tersebut  
*the radius and the mass of the planet*
  - Kekuatan medan gravity di permukaan planet tersebut sahaja  
*the gravitational field strength at the surface of the planet only*

- 8 A radar imaging satellite orbits around the earth at a height 500 km. what is the value of gravitational acceleration at the position of the satellite?  
*[ $G=6.67 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$ ,  $R=6.37 \times 10^6 \text{ m}$ ,  $M=5.97 \times 10^{24} \text{ kg}$ ]*

- |                           |                           |
|---------------------------|---------------------------|
| A $9.81 \text{ m s}^{-2}$ | C $8.15 \text{ m s}^{-2}$ |
| B $9.50 \text{ m s}^{-2}$ | D $8.44 \text{ m s}^{-2}$ |

- 9 Diagram 6 shows some planets in solar system.



From Diagram 6, what is the conclusion can be made?

- Radius of orbit is directly proportional with orbital period of planets.
- The square of radius of orbit is directly proportional with the cube orbital period of planets.
- The greater the size of planet, the greater the period of orbit.
- The cube of radius of orbit is directly proportional with the square orbital period of planets.

- 10 Which of the following statements are correct about geostationary satellite?

|     |                                                         |
|-----|---------------------------------------------------------|
| I   | Orbital period is 24 hours                              |
| II  | Above the same geographical location                    |
| III | Used in earth imaging, GPS and weather forecast         |
| IV  | Direction of motion same as direction of earth rotation |

- I, II, III
- I, II, IV
- I, III, IV
- II, III, IV

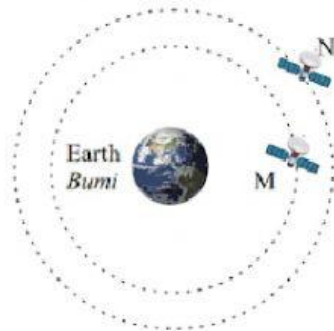
- 11 Berat seketul batu di Bumi adalah 19.62 N, berapakah beratnya di Bulan?  
 Kekuatan medan graviti Bulan adalah  $1.64 \text{ N kg}^{-1}$ .  
*Weight of a stone on Earth is 19.62 N, what is the weight on the Moon?*  
 The Moon gravitational field strength is  $1.64 \text{ N kg}^{-1}$ .

- 3.28 N
- 6.56 N
- 12.08 N
- 17.98 N



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Rajah 4 menunjukkan dua satelit, M dan N, dalam orbit yang berlainan mengelilingi Bumi. Orbit N terletak lebih jauh dari Bumi berbanding orbit M.  
 Diagram 4 shows two satellites, M and N, in different orbits around the Earth. The orbit of N is located further from the Earth than the orbit of M.



Rajah 4  
 Diagram 4

Antara perbandingan berikut, yang manakah betul?  
 Which of the following comparison is true?

- A Pecutan graviti pada N > Pecutan graviti pada M  
 Gravitational acceleration on N > Gravitational acceleration on M
- B Daya memusat pada N > Daya memusat pada M  
 Centripetal force on N > Centripetal force on M
- C Tempoh orbit N > Tempoh orbit M  
 Orbital period of N > Orbital period of M
- D Halaju mengorbit bagi N > Halaju mengorbit bagi M  
 Orbiting velocity of N > Orbiting velocity of M

13

Apakah yang menyebabkan pergerakan Bulan pada orbitnya?  
 What is the reason for the motion of the Moon on its orbit?

- A Daya graviti yang dikenakan oleh Matahari.  
 The gravitational force exerted by the Sun.
- B Daya graviti yang dikenakan oleh planet-planet.  
 The gravitational force exerted by the Planets.
- C Daya graviti yang dikenakan di Bumi oleh Bulan.  
 The gravitational force exerted on the Earth by the Moon.
- D Daya graviti yang dikenakan pada Bulan oleh Bumi.  
 The gravitational force exerted on the Moon by the Earth.

14

Tempoh satelit di orbit bulatan berjari R adalah T. Tempoh satelit lain dalam orbit bulat berjari 4R adalah

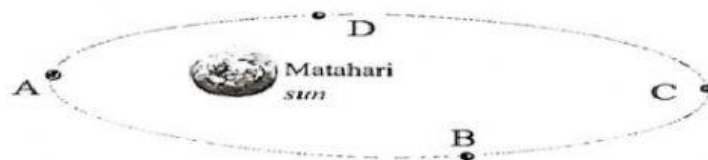
The period of a satellite in a circular orbit of radius R is T. The period of another satellite in circular orbit of radius 4R is

- A 8T
- B 2T
- C  $\frac{1}{4}T$
- D  $\frac{1}{2}T$

15

Rajah 4 menunjukkan empat kedudukan bagi sebuah planet yang bergerak mengelilingi Matahari mengikut orbit berbentuk elips.

Diagram 4 shows four positions of a planet that are moving around the Sun in an elliptical orbit.

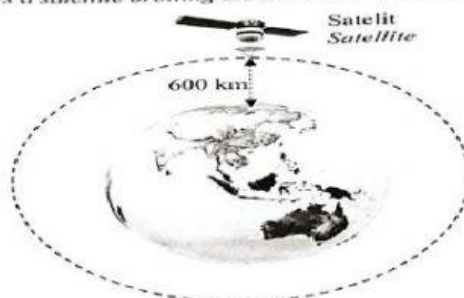


Rajah 4  
 Diagram 4

Pada kedudukan manakah A, B, C dan D, halaju planet tersebut adalah maksimum?  
 At which position, A, B, C or D, the velocity of the planet is maximum?

16

Rajah 5 menunjukkan sebuah satelit sedang mengorbit Bumi pada ketinggian 600 km.  
 Diagram 5 shows a satellite orbiting the Earth at a height of 600 km.



Rajah 5  
 Diagram 5

Hitungkan halaju linear satelit tersebut.  
 [Jejari Bumi =  $6.37 \times 10^6$  m]

Calculate the linear velocity of the satellite.  
 [Radius of Earth =  $6.37 \times 10^6$  m]

- A  $3.822 \times 10^3 \text{ m s}^{-1}$
- B  $4.968 \times 10^3 \text{ m s}^{-1}$
- C  $7.559 \times 10^3 \text{ m s}^{-1}$
- D  $9.799 \times 10^3 \text{ m s}^{-1}$

17

Rajah 4 menunjukkan dua jasad A dan B dengan jisim  $m_1$  dan  $m_2$  masing-masing. Jarak antara pusat keduanya ialah  $r$  dan daya graviti ialah  $F$ .

Diagram 4 shows two object A and B with mass  $m_1$  and  $m_2$  respectively. The distance between center of the objects is  $r$  and the gravitational force is  $F$ .



Rajah 4  
Diagram 4

Daya  $F$  akan berkurang sekiranya  
 $F$  will decrease if

A  $m_1$  bertambah  
 $m_1$  increases

C  $r$  bertambah  
 $r$  increases

B  $m_2$  bertambah  
 $m_2$  increases

D  $r$  berkurang  
 $r$  decreases

18

Rajah 5 menunjukkan seorang budak lelaki memusingkan seketul batu secara mengufuk.

Diagram 5 shows a boy whirling a stone horizontally.



Rajah 5  
Diagram 5

Apakah yang berlaku kepada batu itu jika benang putus secara tiba-tiba?  
What happen to the stone if the string suddenly breaks?

A Berpusing menjauhi budak lelaki itu.  
Spiral away from his hand.

B Terbang terus menjauhi budak lelaki itu.  
Fly directly away from the boy.

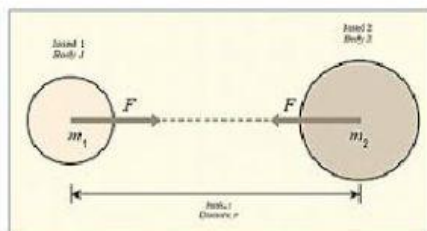
C Terbang terus mendekati budak lelaki itu.  
Fly directly towards the boy.

D Terbang mengikut garis tangen lintasan bulatan.  
Fly off and follow the tangent to its circular path.

19

Rajah 4 menunjukkan dua jasad A dan B dengan jisim  $m_1$  dan  $m_2$  masing-masing. Jarak antara pusat keduanya ialah  $r$  dan daya graviti ialah  $F$ .

Diagram 4 shows two objects A and B with mass  $m_1$  and  $m_2$  respectively. The distance between centre of the objects is  $r$  and the gravitational force is  $F$ .



Rajah 4  
Diagram 4

Pernyataan yang manakah betul tentang daya graviti,  $F$ ?

Which statement is correct about gravitational force,  $F$ ?

I Daya graviti,  $F$  akan berkurang sekiranya hasil darab  $m_1$  dan  $m_2$  berkurang  
Gravitational force,  $F$  decrease if the product of  $m_1$  and  $m_2$  decreases

II Daya graviti,  $F$  akan berkurang sekiranya hasil darab  $m_1$  dan  $m_2$  bertambah  
Gravitational force,  $F$  decrease if the product of  $m_1$  and  $m_2$  increases

III Daya graviti,  $F$  akan bertambah sekiranya jarak,  $r$  berkurang  
Gravitational force,  $F$  increases if distance,  $r$  decreases

A I dan II sahaja  
I and II only

B I dan III sahaja  
I and III only

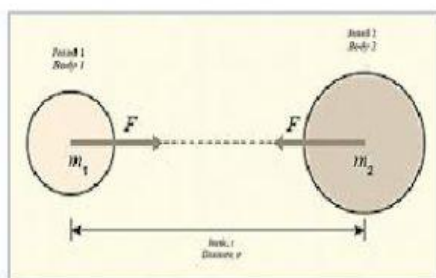
C II dan III sahaja  
II and III only

Antara berikut yng manakah benar mengenai satelit geopegun?  
Which of the following is true about geostationary satellite?

- |     |                                                                                                               |   |                                           |
|-----|---------------------------------------------------------------------------------------------------------------|---|-------------------------------------------|
| I   | Ia bergerak dalam arah yang sama dengan putaran bumi.<br><i>It moves in the direction of the earth orbit.</i> |   |                                           |
| II  | Tempohnya putarannya satu hari.<br><i>Its period of rotation is one day.</i>                                  |   |                                           |
| III | Orbitnya sentiasa atas Khatulistiwa Bumi.<br><i>Its orbit always above the Earth Equator.</i>                 |   |                                           |
| IV  | Ia tidak mengalami sebarang tarikan graviti.<br><i>It does not experience any gravitational pull.</i>         |   |                                           |
| A   | I, II dan III sahaja<br><i>I, II and III only</i>                                                             | C | IV sahaja<br><i>IV only</i>               |
| B   | I dan III sahaja<br><i>I and III only</i>                                                                     | D | II dan IV sahaja<br><i>II and IV only</i> |

Rajah 4 menunjukkan dua jasad A dan B dengan jisim  $m_1$  dan  $m_2$  masing-masing. Jarak antara pusat keduanya ialah  $r$  dan daya graviti ialah  $F$ .

Diagram 4 shows two objects A and B with mass  $m_1$  and  $m_2$  respectively. The distance between centre of the objects is  $r$  and the gravitational force is  $F$ .



Rajah 4  
Diagram 4

Pernyataan yang manakah betul tentang daya graviti,  $F$ ?

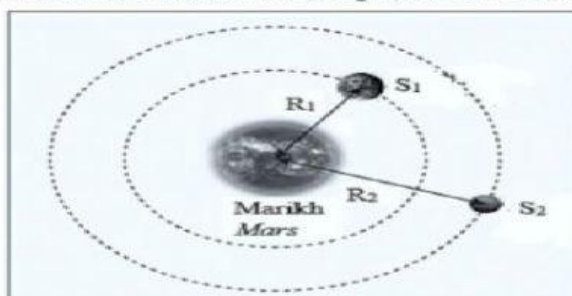
Which statement is correct about gravitational force,  $F$ ?

- |     |                                                                                                                                                                                                           |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I   | Daya graviti, $F$ akan berkurang sekiranya hasil darab $m_1$ dan $m_2$ berkurang<br><i>Gravitational force, <math>F</math> decrease if the product of <math>m_1</math> and <math>m_2</math> decreases</i> |
| II  | Daya graviti, $F$ akan berkurang sekiranya hasil darab $m_1$ dan $m_2$ bertambah<br><i>Gravitational force, <math>F</math> decrease if the product of <math>m_1</math> and <math>m_2</math> increases</i> |
| III | Daya graviti, $F$ akan bertambah sekiranya jarak, $r$ berkurang<br><i>Gravitational force, <math>F</math> increases if distance, <math>r</math> decreases</i>                                             |

- |   |                                             |
|---|---------------------------------------------|
| A | I dan II sahaja<br><i>I and II only</i>     |
| B | I dan III sahaja<br><i>I and III only</i>   |
| C | II dan III sahaja<br><i>II and III only</i> |

Rajah 5 menunjukkan dua buah satelit  $S_1$  dan  $S_2$  mengorbit Marikh dengan jejari orbit  $R_1$  dan  $R_2$  masing-masing.

Diagram 5 shows two satellites  $S_1$  and  $S_2$  and orbiting Mars with radius  $R_1$  and  $R_2$  respectively.



Rajah 5  
Diagram 5

Berapakah nisbah bagi tempoh  $S_1$  dan  $S_2$  jika nisbah jejari orbit  $S_1$  dan  $S_2$  ialah 9:16?

What is the ratio of period  $S_1$  and  $S_2$  if the ratio of radius orbit  $S_1$  and  $S_2$  is 9:16 ?

- |   |           |
|---|-----------|
| A | 729: 4096 |
| B | 81: 208   |
| C | 3: 4      |
| D | 27:64     |



23

Pernyataan yang manakah betul tentang satelit bukan geopegun?

*Which statement is correct about non-geostationary satellite?*

- I Ia bergerak dalam arah yang sama dengan putaran bumi.  
*It moves in the direction of the earth orbit.*
- II Tempoh putarannya lebih pendek atau lebih panjang daripada 24 jam.  
*Its period of rotation is shorter or longer than 24 hours.*
- III Berada di atas tempat yang berubah-ubah di permukaan bumi.  
*Above different geographical location.*

A I dan II sahaja  
*I and II only*

B I dan III sahaja  
*I and III only*

C II dan III sahaja  
*II and III only*

24

Johannes Kepler berjaya merumuskan tiga hukum yang menghuraikan gerakan planet mengelilingi Matahari.

*Johannes Kepler succeeded in formulating three laws that describe the movement of planets around the Sun.*

**"Kuasa dua tempoh planet adalah berkadar terus dengan kuasa tiga jejari orbitnya"**  
***"The square of the period of a planet's orbit is directly proportional to the cube of the orbital's radius"***

Hukum manakah merumuskan pernyataan di atas?

*Which law simplified the statement above?*

- A Hukum Kepler Pertama  
*Kepler's First Law*
- B Hukum Kepler Kedua  
*Kepler's Second Law*
- C Hukum Kepler Ketiga  
*Kepler's Third Law*

25

Rajah 9 menunjukkan sebuah satelit geopegun sedang mengorbit Bumi.

*Diagram 9 shows a geostationary satellite is orbiting the Earth.*



Rajah 9  
*Diagram 9*

Pernyataan manakah yang betul mengenai satelit tersebut?

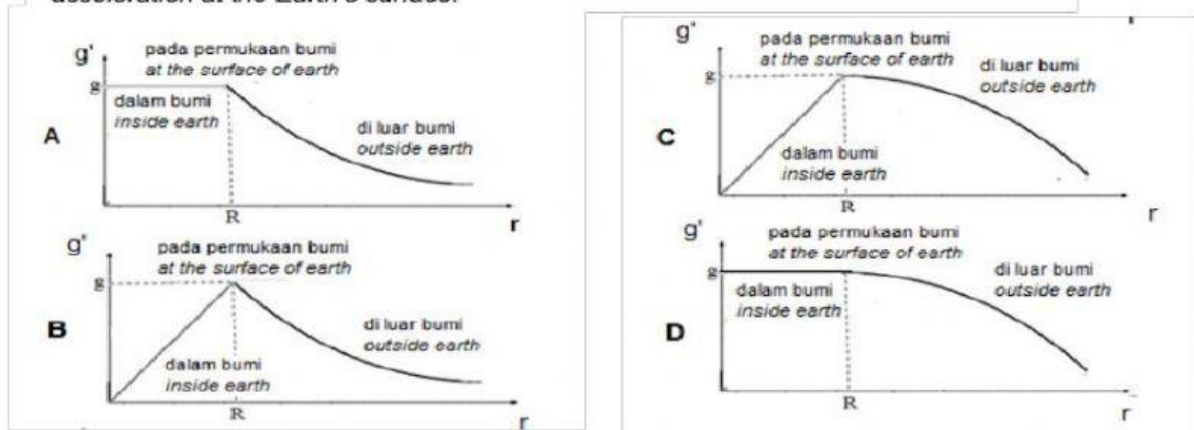
*Which statement is correct about the satellite?*

- A Tempoh orbit satelit adalah melebihi 24 jam  
*The orbital period of the satellite is more than 24 hours*
- B Tempoh orbit satelit adalah kurang daripada 24 jam  
*The orbital period of the satellite is shorter than 24 hours*
- C Satelit mempunyai arah gerakan sama dengan arah putaran Bumi  
*The satellite has direction of motion same as the direction of Earth rotation*
- D Satelit berada di atas lokasi geografi yang berlainan pada masa berlainan  
*The satellite is above different geographical locations at different times*

26

Graf yang manakah antara berikut menunjukkan perubahan pecutan disebabkan oleh graviti Bumi,  $g$  dengan jarak dari pusat Bumi,  $r$  di mana  $g$  adalah pecutan graviti di permukaan bumi.

Which of the following graphs shows the change in acceleration due to the Earth's gravity,  $g$  with the distance from the Earth's center,  $r$  where  $g$  is the gravitational acceleration at the Earth's surface.



27

Satelit M adalah 4 kali lebih jauh dari planet berbanding satelit N. Apabila satelit M mengambil masa 20 minggu untuk mengorbit planet tersebut, berapa lamakah masa untuk satelit N mengorbit planet itu?

Satellite M is 4 times farther from the planet than satellite N. When satellite M takes 20 weeks to orbit the planet, how long does it take for satellite N to orbit the planet?

- |                              |                                  |
|------------------------------|----------------------------------|
| <b>A</b> 2 minggu<br>2 weeks | <b>B</b> 2.5 minggu<br>2.5 weeks |
| <b>C</b> 4 minggu<br>4 weeks | <b>D</b> 4.5 minggu<br>4.5 weeks |

28

Halaju lepas dari bumi adalah  $11.2 \text{ km s}^{-1}$ . Planet lain mempunyai jisim 500 kali daripada jisim bumi dan jejari 20 kali daripada jejari bumi. Berapakah halaju lepas dari planet itu?

The velocity off the earth is  $11.2 \text{ km s}^{-1}$ . Other planets have a mass 500 times the mass of the earth and a radius 20 times the radius of the earth. What is the escape velocity from the planet?

- A**  $2.24 \text{ km s}^{-1}$   
**B**  $11.2 \text{ km s}^{-1}$   
**C**  $55.9 \text{ km s}^{-1}$   
**D**  $280 \text{ km s}^{-1}$

29

Antara berikut, yang manakah boleh diaplikasikan oleh Hukum Kegravitian Semesta?  
Which of the following can be applied by the Universal Law of Gravitation?

- A** Planet di sekitar Matahari  
The planets around the Sun  
**B** Bumi dan Bulan  
The Earth and the Moon  
**C** Bumi dan epal  
The Earth and the apple  
**D** Sebarang pasangan jasad  
Any pair of bodies