New Syllabus NESA Questions:

1)

A satellite is orbiting a planet at a fixed altitude.

Which row of the table correctly identifies the magnitude of the work done by the forces on the satellite and the reason for this being the case?

	Magnitude of work done	*Reason*
A.	Zero	The net force on the satellite is zero.
B.	Zero	Gravity acts at 90 degrees to the direction of motion of the satellite.
C.	Greater than zero	The work done equals the kinetic energy of the satellite.
D.	Greater than zero	The work done equals the gravitational force multiplied by the length of the orbital path of the satellite.

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2)

Planet *X* has a mass twice that of Earth. The acceleration due to gravity on the surface of this planet is half that on the surface of Earth.

If Earth has a radius of 1, what is the radius of Planet *X*?

A. 1

B. 2

C. 4

D. 8

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3)

The table shows data about the solar system.

Planet	*Average distance from the Sun* (AU)	*Period* (days)
Mercury	0.389	87.77
Earth	1	365

What would be the period of another planet if it orbited the Sun at an average distance of 3.5 AU?

A. 8.4×10^2 days

B. 2.4×10^3 days

C. 1.1×10^4 days

D. 4.0×10^6 days

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4)

Two identical masses are placed at points P and Q. The escape velocity and circular orbital velocity of the mass at point P are $v_{P_{esc}}$ and $v_{P_{orb}}$. The escape velocity and circular orbital velocity of the mass at point Q are $v_{Q_{esc}}$ and $v_{Q_{orb}}$. The diagram is drawn to scale and X denotes the centre of Earth.

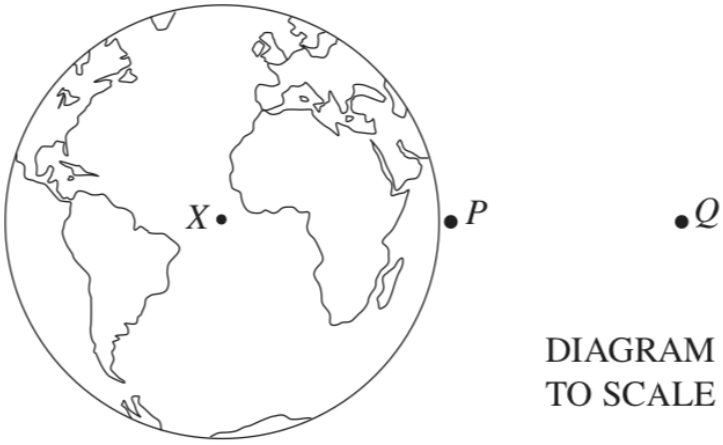


DIAGRAM
TO SCALE

The velocity for a body in circular orbit is given by $v_{orb} = \sqrt{\frac{GM}{r}}$.

What is the value of $\frac{v_{Q_{esc}}}{v_{P_{orb}}}$?

A. 0.5

B. 1

C. $\sqrt{2}$

D. 2

5)

Long-period comets, such as Comet Kohoutek, are believed to come from the Oort cloud that lies far beyond the outermost planets. In our solar system, Kohoutek travels in an elliptical orbit around the Sun and spends most of its time beyond the outermost planets. **3**

Explain how the motion of Comet Kohoutek in its orbit supports Kepler's second law. Include a diagram in your answer.

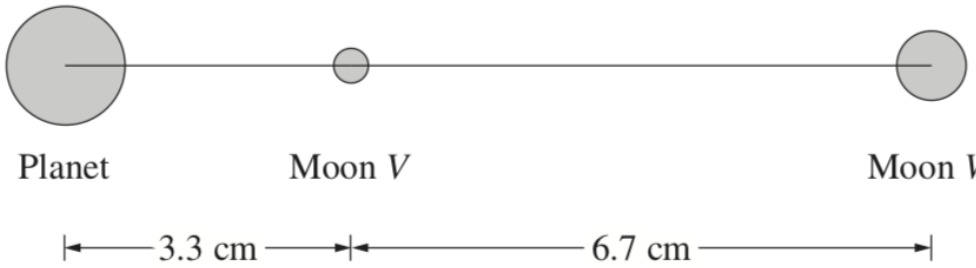
6)

A rocket carrying a satellite is launched from Earth. Once the rocket engine is switched off the satellite continues in an elliptical orbit.

Explain the satellite's changes in energy during this journey. (3 marks)

6)

A student used the following scale diagram to investigate orbital properties. The diagram shows a planet and two of its moons, *V* and *W*. The distances between each of the moons and the planet are to scale while the sizes of the objects are not. **4**



Complete the table to compare the orbital properties of Moon *V* and Moon *W*. Show relevant calculations in the space below the table.

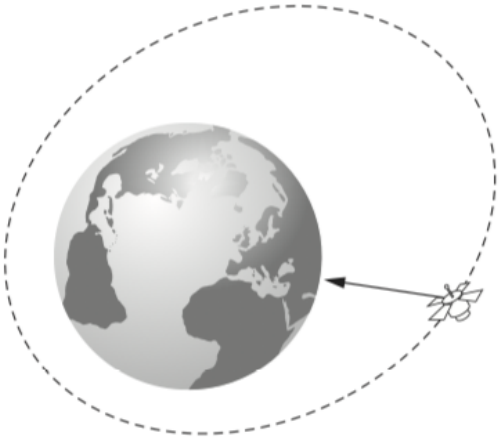
	Orbital radius (*W* relative to *V*)	*Orbital period* (*W* relative to *V*)	*Orbital velocity* (*W* relative to *V*)
Quantitative comparison			
Qualitative comparison			

Past HSC Questions:
2018:

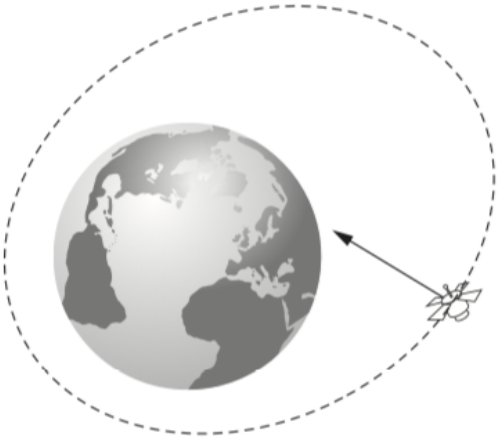
1 A satellite orbits Earth as shown.

Which diagram correctly shows the direction of the satellite's acceleration?

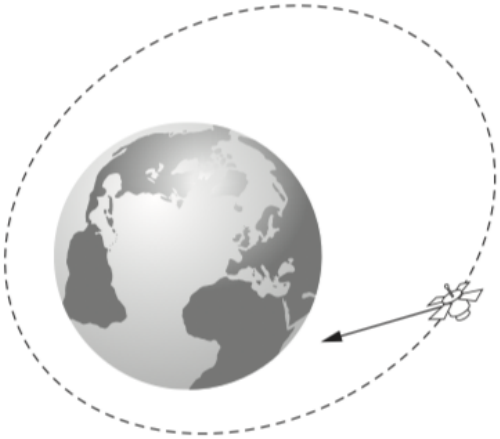
A.



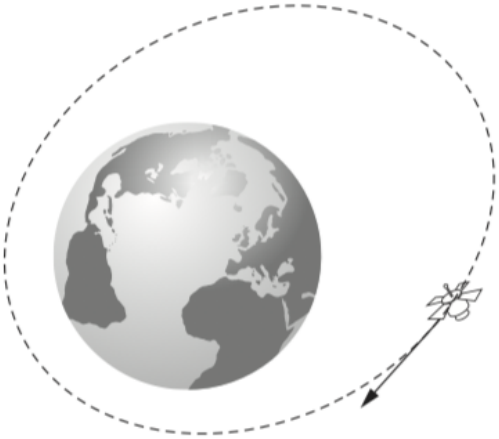
B.



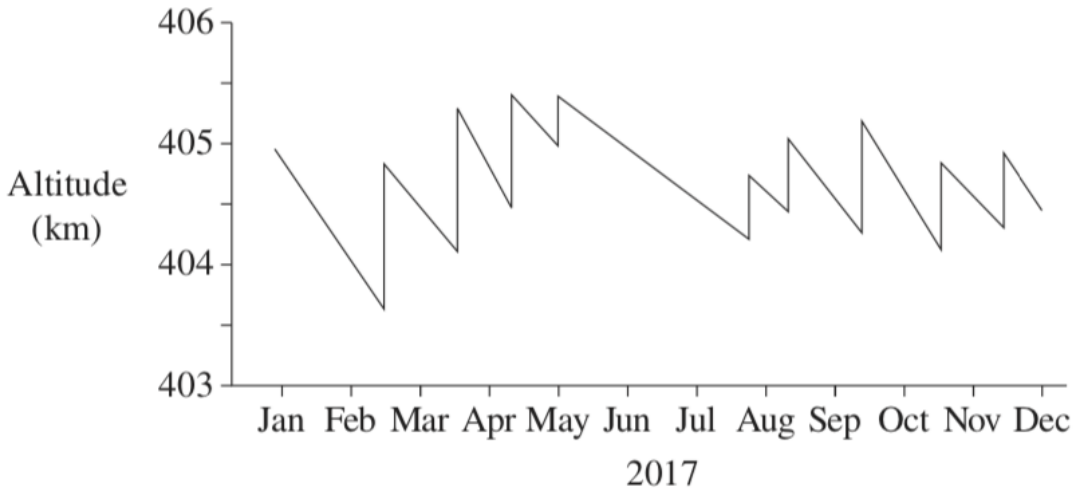
C.



D.



3 The graph shows the altitude of the International Space Station (ISS) during 2017.



The altitude can only be boosted by supply craft visiting the ISS.

Why does the altitude decrease in the times between height boosts?

A. Momentum of the ISS is being transferred to air molecules.

B. The moon's gravity changes the net force on the ISS as it orbits Earth.

C. The decrease in altitude makes it possible for a supply craft to reach the ISS.

D. The total mass of the ISS changes with the deliveries from each supply craft.

7 A planet X has twice the mass and twice the radius of Earth.

What is the magnitude of the gravitational acceleration close to the surface of planet X?

A. $\frac{1}{2}g$

B. $1\ g$

C. $2\ g$

D. $4\ g$

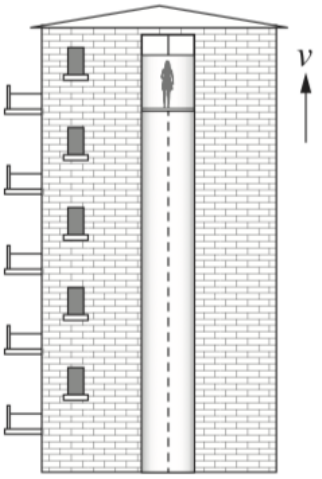
11 During the launch of a space vehicle from Earth, an astronaut feels an increased downward *g* force.

In which of the following situations would a person also feel an increased downward *g* force?

A.

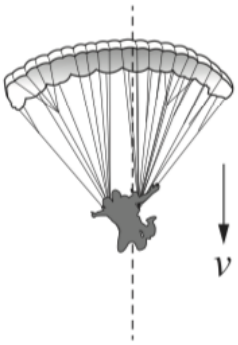
Roller-coaster speeding up

B.



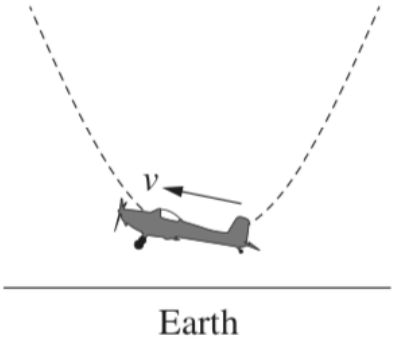
Lift slowing down

C.



Parachute falling at a constant velocity

D.



Plane pulling out of a dive

14 A pendulum can be used to determine the acceleration due to gravity using the relationship

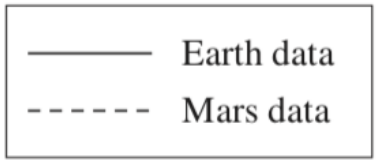
$$T = 2\pi\sqrt{\frac{l}{g}}$$

where T is the period and l is the length of the pendulum.

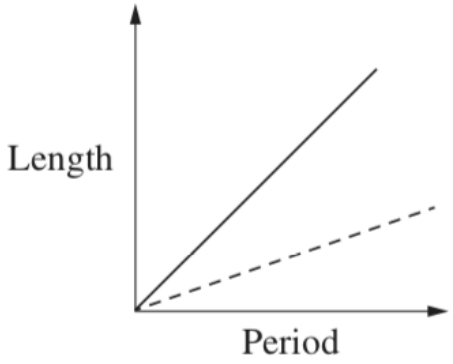
The acceleration due to gravity on the surface of Mars is less than that on Earth.

Which graph relates the variables for the pendulum correctly for both planets?

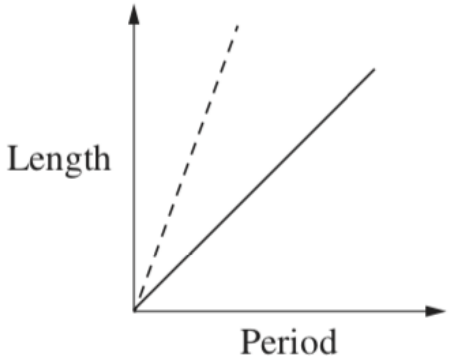
KEY



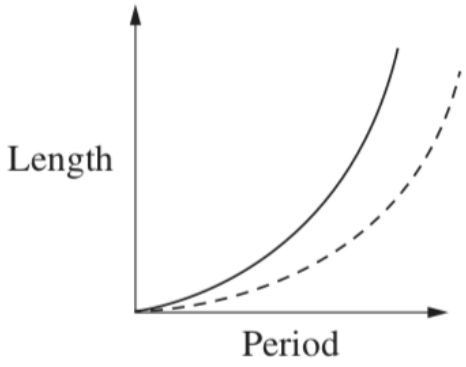
A.



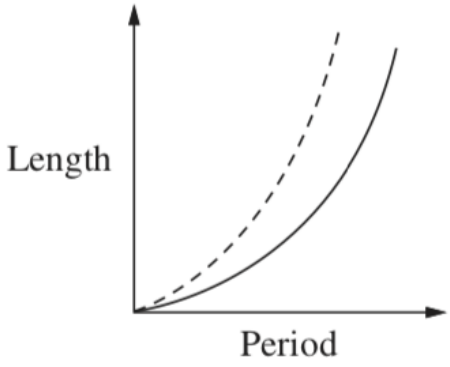
B.



C.



D.



Question 21 (4 marks)

(a) Compare the force of gravity exerted on the moon by Earth with the force of gravity exerted on Earth by the moon. **2**

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(b) The acceleration due to gravity on the moon is $1.6\ m\ s^{-2}$ and on Earth it is $9.8\ m\ s^{-2}$. Quantitatively compare the mass and weight of a 70 kg person on the moon and on Earth. **2**

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Question 28 (5 marks)

The radius of the moon is 1740 km. The moon's mass is 7.35×10^{22} kg. In this question, ignore the moon's rotational and orbital motion.

A 20 kg mass is launched vertically from the moon's surface at a velocity of $1200\ m\ s^{-1}$.

(a) Show that the change in potential energy of the mass in moving from the surface to an altitude of 500 km is 1.26×10^{7} J. **2**

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(b) Calculate the velocity of the 20 kg mass at an altitude of 500 km. **3**

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31)

(b) In November 2017, a new polar-orbiting weather satellite NOAA–20 was placed in orbit. Its orbital period is 100 minutes and it orbits Earth at an altitude of 870 km. The average radius of Earth is 6370 km.

(i) Explain ONE feature of NOAA–20's orbit that will make it better for monitoring climate than a geostationary satellite. **2**

(ii) Calculate the mass of Earth using the information provided about NOAA–20's orbit. The answer is different to that shown on the data sheet provided. **3**

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2017:

4 An astronaut with a mass of 75 kg lands on Planet *X* where her weight is 630 N.

What is the acceleration due to gravity (in m s^{-2}) on Planet *X*?

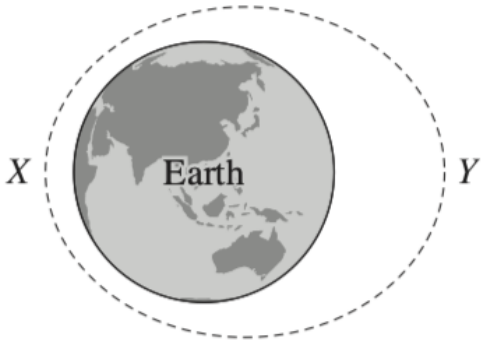
A. 0.12

B. 8.4

C. 9.8

D. 735

12 A satellite orbits Earth with an elliptical orbit that passes through positions *X* and *Y*.



Which row of the table correctly identifies the position at which the satellite has greater kinetic energy and the position at which it has greater potential energy?

	Greater kinetic energy	*Greater potential energy*
A.	*X*	*X*
B.	*X*	*Y*
C.	*Y*	*X*
D.	*Y*	*Y*

Question 24 (5 marks)

The escape velocity from a planet is given by $v = \sqrt{\frac{2GM}{r}}$.

(a) The radius of Mars is 3.39×10^6 m and its mass is 6.39×10^{23} kg. **2**

Calculate the escape velocity from the surface of Mars.

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(b) Using the law of conservation of energy, show that the escape velocity of an object is independent of its mass. **3**

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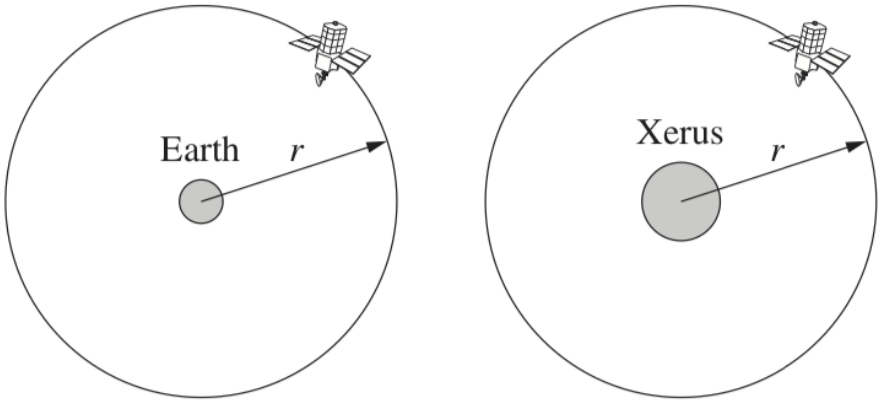
2016:

14 A satellite orbits Earth with period T. An identical satellite orbits the planet Xerus which has a mass four times that of Earth. Both satellites have the same orbital radius r.



What is the period of the satellite orbiting Xerus?

(A) $\frac{T}{4}$

(B) $\frac{T}{2}$

(C) $2T$

(D) $4T$

Question 21 (5 marks)

(a) Why does orbital decay occur more rapidly for satellites in a low-Earth orbit than for satellites in other orbits? **2**

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(b) Calculate the magnitude of the gravitational force that acts on a 50 kg satellite when it is 8000 km from Earth's centre. **3**

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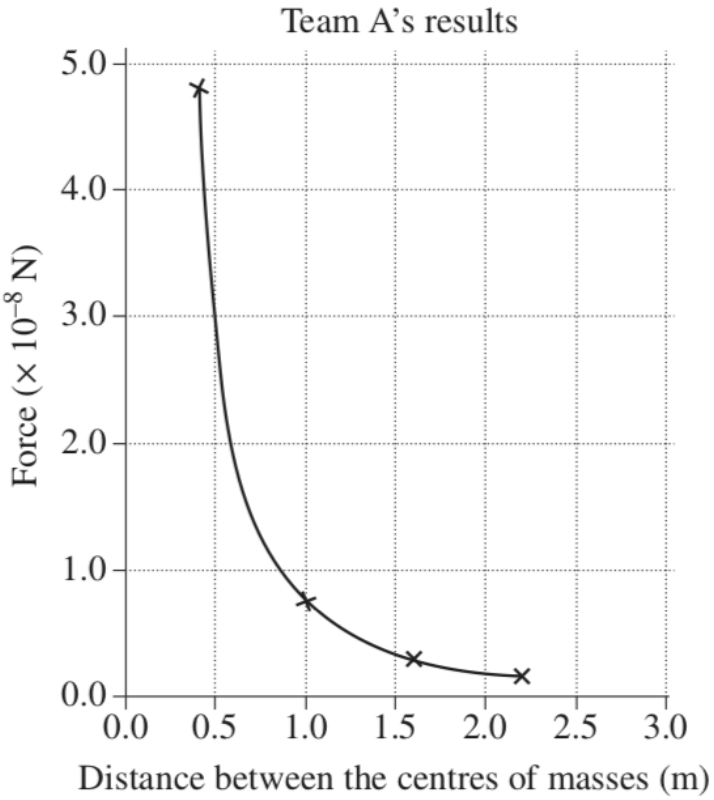
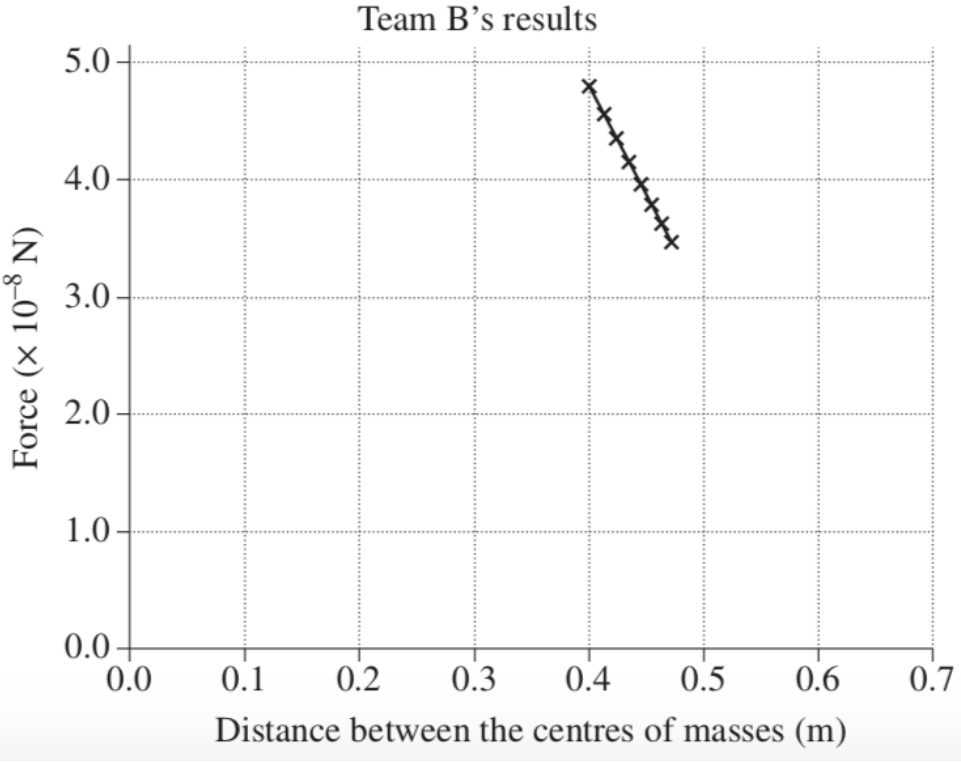
Question 25 (5 marks)

Two teams carried out independent experiments with the purpose of investigating Newton's Law of Universal Gravitation. Each team used the same procedure to accurately measure the gravitational force acting between two spherical masses over a range of distances.

The following graphs show the data collected by each team.





Question 25 (continued)

(a) Compare qualitatively the relationship between force and distance in the graphs. **2**

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(b) Assess the appropriateness of Team A's data and Team B's data in achieving the purpose of the experiments. **3**

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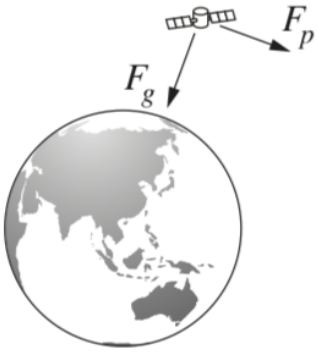
2015:

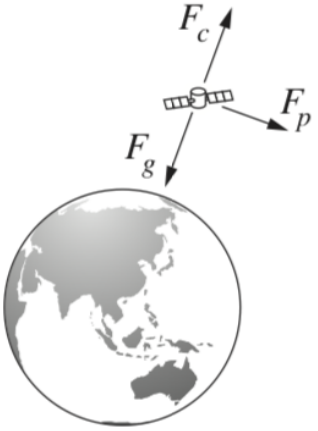
11 Which of the following diagrams correctly represents the force(s) acting on a satellite in a stable circular orbit around Earth?

F_g = gravitational force	F_p = propulsive force
F_c = centripetal force	F_r = reaction force

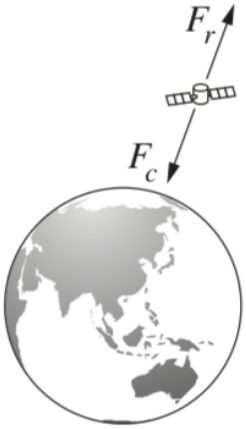
(A)



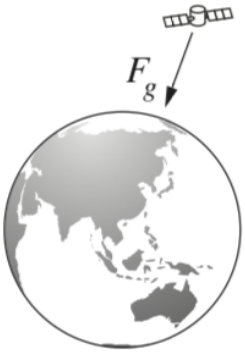
(B)



(C)



(D)



Question 26 (6 marks)

Consider the following two models used to calculate the work done when a 300 kg satellite is taken from Earth's surface to an altitude of 200 km.

You may assume that the calculations are correct.

Model X	*Model Y*
Data: $g = 9.8 \text{ m s}^{-2}$ $m = 300 \text{ kg}$ $\Delta h = 200 \text{ km}$ $W = Fs$ $= mg\Delta h$ $= 3 \times 10^2 \times 9.8 \times 2.0 \times 10^5$ $= 5.9 \times 10^8 \text{ J}$	Data: $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ $r_{\text{Earth}} = 6.38 \times 10^6 \text{ m}$ $r_{\text{orbit}} = 6.58 \times 10^6 \text{ m}$ $M = 6.0 \times 10^{24} \text{ kg}$ $m = 300 \text{ kg}$ $W = \Delta E_P$ $\Delta E_p = E_{p\,\text{final}} - E_{p\,\text{initial}}$ $= -\frac{GMm}{r_{\text{orbit}}} - \left(\frac{GMm}{r_{\text{Earth}}}\right)$ $= -1.824 \times 10^{10} - \left(-1.881 \times 10^{10}\right)$ $= 5.7 \times 10^8 \text{ J}$

(a) What assumptions are made about Earth's gravitational field in models *X* and *Y* that lead to the different results shown? **2**

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(b) Why do models *X* and *Y* produce results that, although different, are close in value? **1**

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(c) Calculate the orbital velocity of the satellite in a circular orbit at the altitude of 200 km. **3**

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2014:

6 A satellite is in a high orbit around the Earth. A particle of dust is in the same orbit.

Which row of the table correctly compares their potential energy and orbital speed?

	Potential energy	*Orbital speed*
(A)	Different	Same
(B)	Different	Different
(C)	Same	Same
(D)	Same	Different

15 Two masses have a gravitational force of 12 N between them.

If the distance between the masses is doubled, what would be the new gravitational force between them?

(A) 3 N

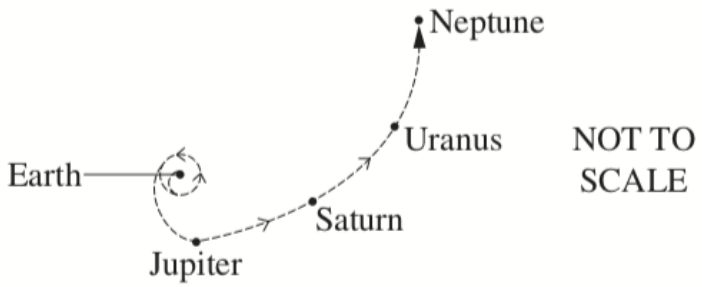
(B) 6 N

(C) 12 N

(D) 24 N

Question 27 (7 marks)

The diagram illustrates the path of a space probe launched from Earth and sent to Neptune.



(b) The space probe is placed in an orbit at an altitude of 188 km above Earth. **2**

Given Earth has a radius of 6380 km, calculate the period of this orbit.

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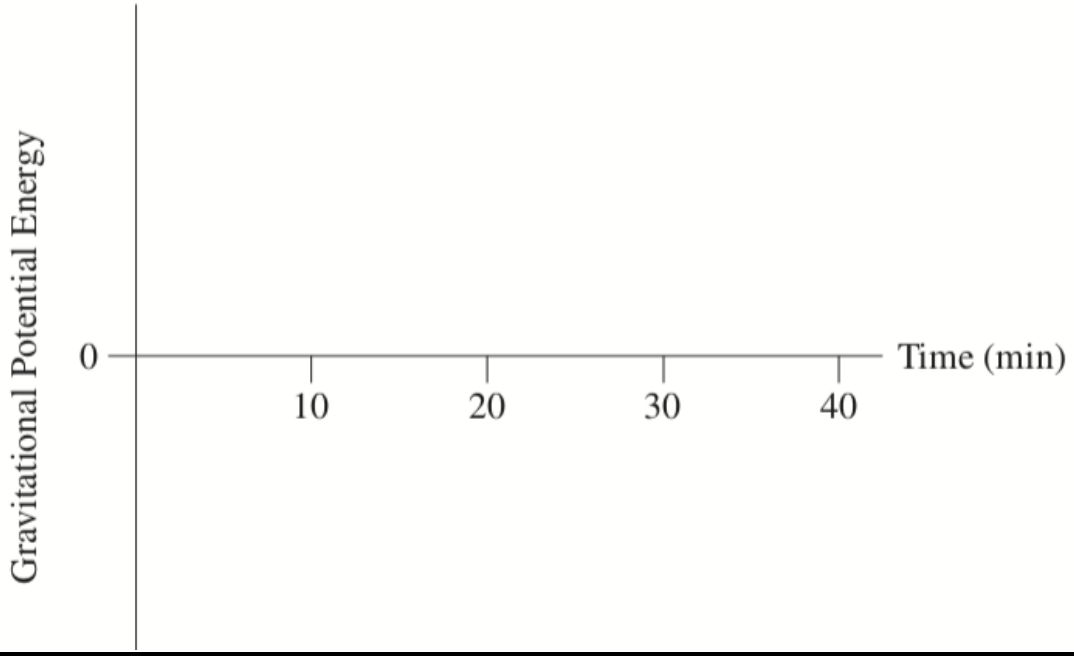
(c) It takes 10 minutes for the space probe to reach its orbit around Earth and it remains in orbit for several hours. **2**

Sketch a graph on the axes showing the changes in gravitational potential energy for the first 40 minutes.



2013:

Question 23 (5 marks)

A planet orbits the star, Pollux, at a distance of 1.64 astronomical units (AU). It takes 590 Earth days to complete one orbit.

(a) Why does the mass of the planet play NO role in determining its orbital speed around Pollux? **2**

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(b) A satellite orbits Pollux with a period of 365 Earth days. **3**

How far is the satellite from Pollux in astronomical units (AU)?

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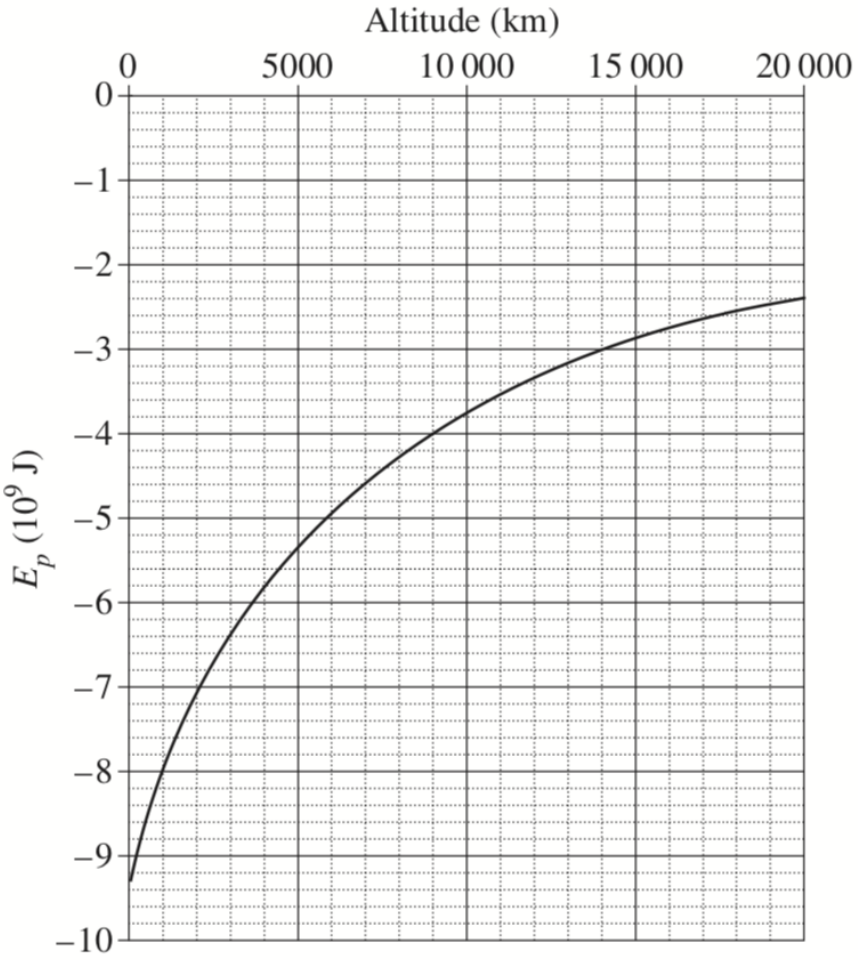
2012:

4 The graph shows how the gravitational potential energy (E_p) of a satellite changes with its altitude.



What is the change in gravitational potential energy of the satellite when its altitude is reduced from 14 000 km to 4000 km?

(A) -8.8×10^9 J

(B) -2.8×10^9 J

(C) 2.8×10^9 J

(D) 8.8×10^9 J

Use the data below to answer Questions 12 and 13.

Orbital period of the Moon around Earth	2.36×10^6 s
Mean orbital radius of the Moon	3.83×10^8 m
Mass of Earth	6.0×10^{24} kg
Mass of the Moon	7.35×10^{22} kg

12 What is the centripetal force experienced by the Moon due to Earth's influence?

(A) 2.0×10^{20} N

(B) 1.6×10^{22} N

(C) 4.7×10^{26} N

(D) 7.6×10^{28} N

13 What is the orbital period of an Earth satellite having an orbital radius half that of the Moon?

(A) 5.9×10^5 s

(B) 8.3×10^5 s

(C) 1.2×10^6 s

(D) 7.5×10^6 s

Question 21 (6 marks)

(a) Outline a first-hand investigation that could be performed to measure a value for acceleration due to gravity. **3**

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(b) How would you assess the accuracy of the result of the investigation? **1**

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(c) How would you increase the reliability of the data collected? **1**

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(d) How would you assess the reliability of the data collected? **1**

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2011:

1 What is the main cause of orbital decay of a satellite in low Earth orbit?

(A) Tidal effects of the Moon

(B) The Sun's gravitational field

(C) Friction between the atmosphere and the satellite

(D) The interaction of the solar wind with the satellite

2 A 60 kg object has a weight of 240 N on the surface of Planet X.

What is the acceleration due to gravity on the surface of Planet X?

(A) 0.25 m s^{-2}

(B) 4 m s^{-2}

(C) 250 m s^{-2}

(D) 14 400 m s^{-2}

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15 A marble rolls off a 1.0 m high horizontal table with an initial velocity of 4.0 m s^{-1}.

How long will it take the marble to hit the floor?

(A) 0.20 s

(B) 0.25 s

(C) 0.45 s

(D) 3.20 s

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16 A satellite is orbiting a planet at a constant speed.

Which of the following statements is correct?

(A) The satellite is not accelerating.

(B) The orbit of the satellite has a fixed radius.

(C) Fuel must be used to supply a constant thrust to the satellite.

(D) The centripetal force on the satellite is balanced by the gravitational force.

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20 A satellite, initially in a low Earth orbit, is moved to a new orbit where its gravitational potential energy is half its initial value.

What is the gravitational force experienced by the satellite in its new orbit?

(A) Half the initial force

(B) Twice the initial force

(C) Four times the initial force

(D) One quarter the initial force

Question 23 (7 marks)

A rocket launches a satellite into an orbit 350 km above Earth's surface. The weight of the satellite is 14.0 kN at launch, and is 12.6 kN when in orbit.

(Radius of Earth = 6380 km, mass of Earth = 5.97×10^{24} kg)

(a) Why does the weight of the satellite change? **1**

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(b) Calculate the orbital velocity of this satellite. **2**

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(c) Explain TWO effects that a reduction in altitude would have on the motion of this satellite. **4**

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2010:

1 The International Space Station orbits Earth at an altitude of approximately 330 km. Another satellite, Meteosat, is in geostationary orbit at an altitude of 36 000 km.

Which of the following correctly compares the orbital velocity and orbital period of these satellites?

	International Space Station	*Meteosat*
(A)	Greater orbital velocity	Shorter orbital period
(B)	Lesser orbital velocity	Shorter orbital period
(C)	Greater orbital velocity	Longer orbital period
(D)	Lesser orbital velocity	Longer orbital period

7 The acceleration due to gravity on the surface of Mercury is 3.6 $m s^{-2}$.

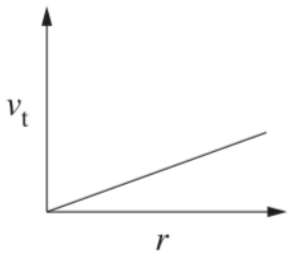
How much does a 2.0 kg brick weigh on Earth and on Mercury?

	Weight of brick on Earth	*Weight of brick on Mercury*
(A)	2.0 kg	2.0 kg
(B)	19.6 kg	7.2 kg
(C)	19.6 N	19.6 N
(D)	19.6 N	7.2 N

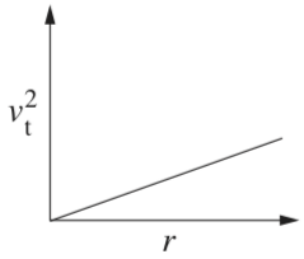
12 The terminal velocity (v_t) of a spherical object in Earth's atmosphere is proportional to the square root of its radius (r).

Which graph correctly shows this relationship?

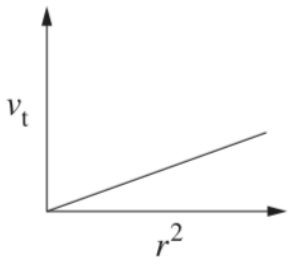
(A)



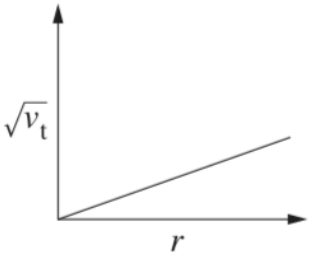
(B)



(C)



(D)



2009:

3 A satellite is moved from a geostationary orbit to a higher orbit.

Which statement about the orbit change is correct?

(A) During the move the gravitational potential energy decreases.

(B) The change in gravitational potential energy is independent of the mass of the satellite.

(C) The work done is the difference between the gravitational potential energy of the higher orbit and that of the geostationary orbit.

(D) The work done is the energy required to move the satellite, which is in the gravitational field, from a very large distance away, to the higher orbit.

5 During a lunar eclipse, Earth moves between the Sun and the Moon.

Sun Earth Moon

What happens to the force exerted by the Sun on the Moon?

(A) It increases.

(B) It decreases.

(C) It remains unchanged.

(D) It depends on the closeness of Earth to the Moon.

Question 16 (3 marks)

NASA recently landed a space probe on an asteroid found between the orbits of Earth and Mars. The 500 kg space probe had a weight of 2.5 N when it landed on the asteroid.

(a) What would be the weight of this space probe on the surface of Earth? **1**

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(b) Before landing on the asteroid, the space probe was placed in an orbit with radius 50 km. The orbital period was 5.9×10^4 s. **2**

What was the mass of the asteroid?

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2008:

1 An object on Earth has a weight of 490 N and experiences an acceleration due to gravity of 9.8 m s^{-2}. On Mars, this object would experience an acceleration due to gravity of 3.7 m s^{-2}.

On Mars, what would be the weight of this object?

(A) 490 N

(B) $\frac{490}{9.8}$ N

(C) $\frac{490}{9.8} \times 3.7$ N

(D) $\frac{490}{3.7} \times 9.8$ N

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2 Which of these statements best describes the forces acting on a satellite in orbit around Earth?

(A) Although gravity has no effect, there is still an outward force.

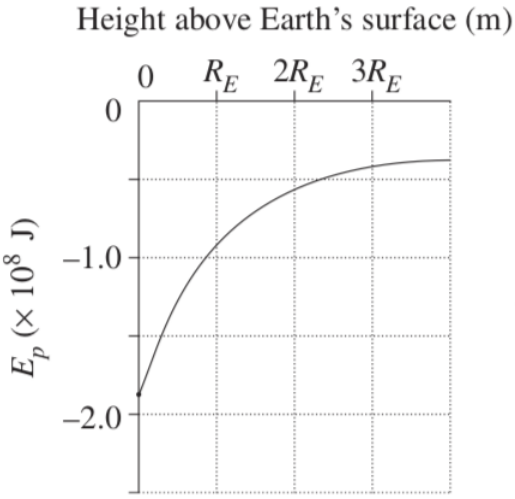
(B) The satellite is kept up by an outward force that balances the force due to gravity.

(C) Gravity is the only force acting on the satellite and this results in an inward acceleration.

(D) The effect of gravity is negligible, the satellite is kept in orbit by its momentum and the net force on it is zero.

Question 17 (5 marks)

The graph below represents the gravitational potential energy (E_p) of a mass as it is raised above Earth's surface.



R_E = 1 Earth radius

(a) From the graph, what is the gravitational potential energy of the mass when it is one Earth radius above Earth's surface? **1**

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(b) Use an equation to explain why the graph is a curve and not a straight line. **1**

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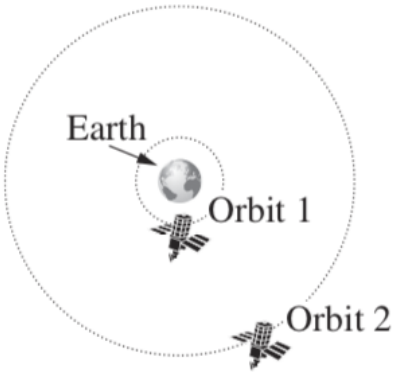
19)

(b) A satellite is propelled from Orbit 1 to Orbit 2 as shown in the diagram.



Orbit 2 has a radius of 27 000 km. What is the satellite's speed in this orbit? **3**

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(c) The radius of Orbit 2 is four times that of Orbit 1. What is the ratio of the new orbital period to the original period? **2**

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2007:

3 The gravitational potential energy of a given mass is known at both Earth's surface and at a fixed distance above Earth.

What CANNOT be determined by comparing these two values of gravitational potential energy?

(A) The mass of Earth

(B) The speed of rotation of Earth

(C) The escape velocity of a satellite from Earth

(D) The work done in moving between the two points

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4 The acceleration due to gravity on Earth's surface is g. Suppose the radius of Earth was reduced to a quarter of its present value while its mass remained the same.

What would be the new value of the acceleration due to gravity on the surface?

(A) $\frac{1}{16}g$

(B) $\frac{1}{4}g$

(C) $4g$

(D) $16g$

2006:

1 Given that G is the universal gravitational constant, and g is the magnitude of the acceleration due to gravity, which statement is true?

(A) The values of G and g depend on location.

(B) The values of G and g are independent of location.

(C) G is the same everywhere in the universe, but g is not.

(D) g is the same everywhere in the universe, but G is not.

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5 Two satellites, *X* and *Y*, are in circular orbits around Earth. Their masses are identical and their orbital radii are R and 16R, respectively.

What is the ratio of their orbital periods, $T_X : T_Y$?

(A) 1 : 4

(B) 1 : 16

(C) 1 : 32

(D) 1 : 64

Question 18 (3 marks)

An object is stationary in space and located at a distance 10 000 km from the centre of a certain planet. It is found that 1.0 MJ of work needs to be done to move the object to a stationary point 20 000 km from the centre of the planet. **3**

Calculate how much more work needs to be done to move the object to a stationary point 80 000 km from the centre of the planet.

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2005:

2 Why would a satellite in low orbit around Earth eventually fall to Earth?

(A) It is not in a geostationary orbit.

(B) Gravity is too strong at low orbits.

(C) The sun's solar wind pushes it out of orbit.

(D) The upper atmosphere gradually slows it down.

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3 The initial velocity required by a space probe to just escape the gravitational pull of a planet is called *escape velocity*.

Which of the following quantities does NOT affect the magnitude of the escape velocity?

(A) Mass of the planet

(B) Mass of the space probe

(C) Radius of the planet

(D) Universal gravitational constant

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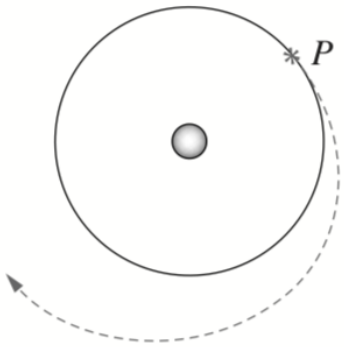
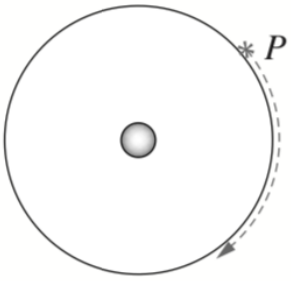
4 A space probe, *P*, is in a stable orbit around a small, distant planet. The probe fires a forward-facing rocket that reduces its orbital speed by half.

Which of the following best illustrates the subsequent motion of the probe?

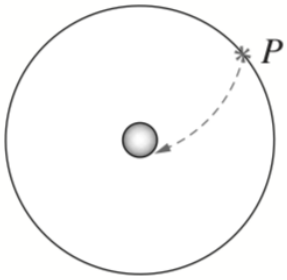
(A)



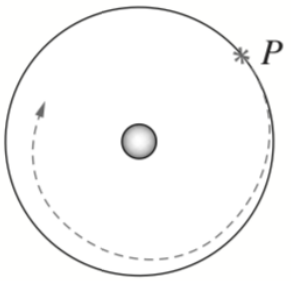
(B)



(C)



(D)



Question 16 (5 marks)

From nearest to furthest, the four satellite moons of Jupiter first observed by Galileo in the year 1610 are called Io, Europa, Ganymede and Callisto. For the first three moons, the orbital period **T** of each is exactly twice the period of the one orbiting immediately inside it. That is,

$$\mathbf{T}_{\text{Europa}} = 2 \times \mathbf{T}_{\text{Io}}$$

$$\mathbf{T}_{\text{Ganymede}} = 2 \times \mathbf{T}_{\text{Europa}}$$

The mass of Jupiter is 1.90×10^{27} kg, and the orbital radius of Io is 421 600 km.

(a) Use Kepler's Law of Periods to calculate Ganymede's orbital radius. **2**

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(b) Calculate Ganymede's orbital speed. **3**

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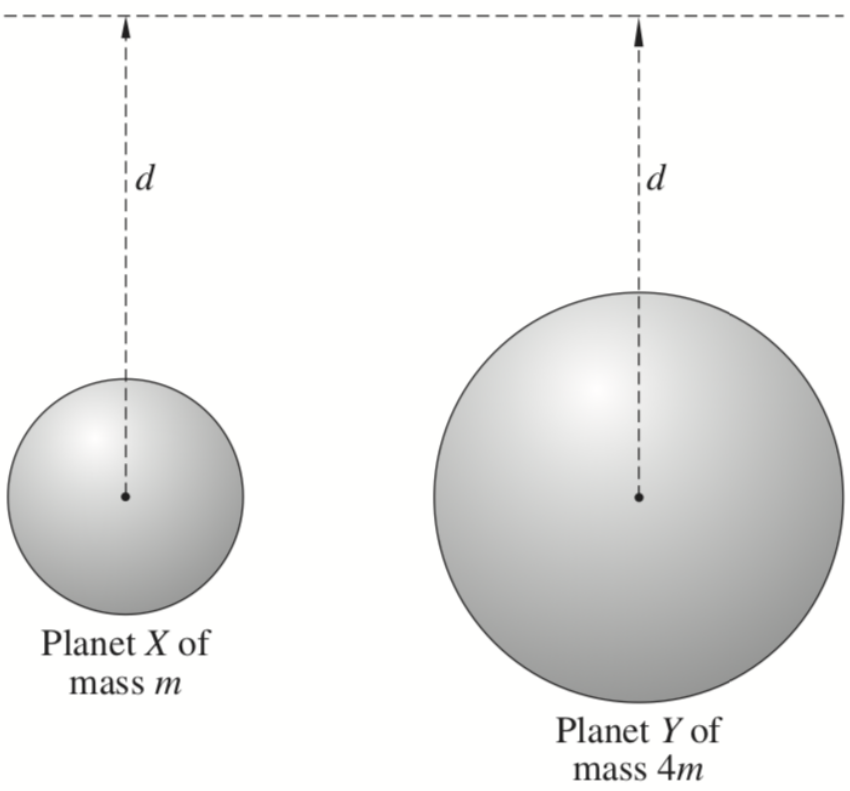
2004:

2 The diagram shows two planets X and Y of mass m and $4m$ respectively.



At the distance d from the centre of planet Y the acceleration due to gravity is $4.0\ \text{m s}^{-2}$.

What is the acceleration due to gravity at distance d from the centre of planet X?

(A) $1.0\ \text{m s}^{-2}$

(B) $2.0\ \text{m s}^{-2}$

(C) $2.8\ \text{m s}^{-2}$

(D) $4.0\ \text{m s}^{-2}$

3 A spaceship at a distance r metres from the centre of a star experiences a gravitational force of x newtons. The spaceship moves a distance $\frac{r}{2}$ towards the star.

What is the gravitational force acting on the spaceship when it is at this new location?

(A) $\frac{x}{2}$ newtons

(B) x newtons

(C) $2x$ newtons

(D) $4x$ newtons

Question 17 (6 marks)

In July 1969 the Apollo 11 Command Module with Michael Collins on board orbited the Moon waiting for the Ascent Module to return from the Moon's surface. The mass of the Command Module was 9.98×10^3 kg, its period was 119 minutes, and the radius of its orbit from the Moon's centre was 1.85×10^6 metres.

(a) Assuming the Command Module was in circular orbit, calculate

(i) the mass of the Moon; **2**

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(ii) the magnitude of the orbital velocity of the Command Module. **2**

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(b) The docking of the Ascent Module with the Command Module resulted in an increase in mass of the orbiting spacecraft. The spacecraft remained at the same altitude. **2**

This docking procedure made no difference to the orbital speed. Justify this statement.

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28)

(b) (i) The period of a simple pendulum can be used to calculate a value for g, using the relationship

$$T = 2\pi\sqrt{\frac{l}{g}}$$

where l = length of the pendulum string in metres.

An experiment was performed in which a pendulum 40.0 cm long had a period of 1.268 s.

Use these data to calculate a value for g and hence calculate the radius of Earth at this location.

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2003:

1 The weight of an astronaut on the Moon is $\frac{1}{6}$ of her weight on Earth.

What is the acceleration due to gravity on the Moon?

(A) $\left(\frac{6}{9.8}\right)\text{m s}^{-2}$

(B) $\left(\frac{9.8}{6}\right)\text{m s}^{-2}$

(C) $9.8\,\text{m s}^{-2}$

(D) $(9.8\times 6)\,\text{m s}^{-2}$

3 For a satellite moving in uniform circular motion around Earth, the centripetal force is provided by the gravitational force.

The mass of Earth is M_E.
The mass of the satellite is M_S.
The distance of the satellite from the centre of Earth is d.

Which of the following equations should be used to calculate the speed of this satellite?

(A) $v = \frac{GM_E}{d}$

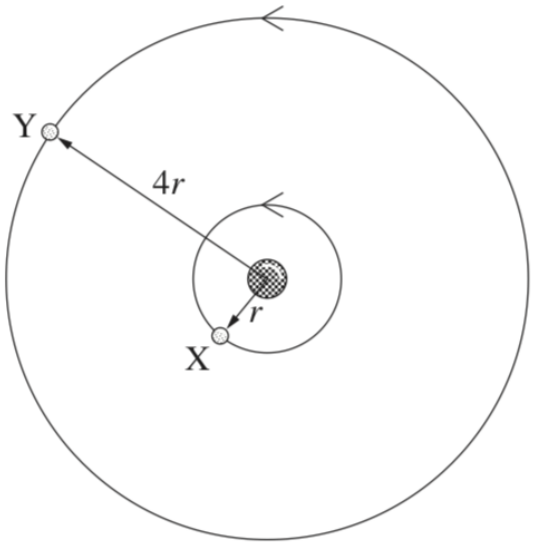
(B) $v = \sqrt{\frac{GM_E}{d}}$

(C) $v = \sqrt{\frac{GM_E}{d^2}}$

(D) $v = \sqrt{\frac{GM_E M_S}{d}}$

4 Two planets, X and Y, travel around a star in the same direction, in circular orbits.

Planet X completes one revolution about the star in time T. The radii of the orbits are in the ratio 1 : 4.



How many revolutions does planet Y make about the star in the same time T?

(A) $\frac{1}{8}$ revolution

(B) $\frac{1}{2}$ revolution

(C) 2 revolutions

(D) 8 revolutions

Question 17 (6 marks)

A satellite of mass 150 kg is launched from Earth's surface into a uniform circular orbit of radius 7.5×10^6 m.

(a) Calculate the magnitude of the gravitational potential energy E_p of the satellite. **1**

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(b) From this uniform circular orbit, the satellite can escape Earth's gravitational field when its kinetic energy is equal to the magnitude of the gravitational potential energy. **3**

Use this relationship to calculate the escape velocity of the satellite.

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2002:

3 The table shows the value of the acceleration due to gravity on the surface of Earth and on the surface of Mercury.

	Acceleration due to gravity (ms^{-2})
Earth	9.8
Mercury	3.8

A person has a weight of 550 N on the surface of Earth.

What would be the person's weight on the surface of Mercury?

(A) 56.1 N

(B) 213 N

(C) 550 N

(D) 1420 N

5 The table contains information related to two planets orbiting a distant star.

Planets	*Mass* (kg)	*Orbital radius* (m)	*Radius of planet* (m)	*Length of day* (s)	*Orbital period* (s)
Alif	1.21×10^{25}	4.00×10^{11}	8.0×10^{6}	9.5×10^{4}	8.75×10^{7}
Ba	1.50×10^{24}	8.00×10^{11}	4.0×10^{6}	4.7×10^{4}	____

The orbital period of the planet Ba can be determined by using data selected from this table.

What is the orbital period of the planet Ba?

(A) 3.10×10^{7} s

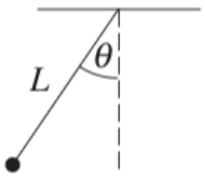
(B) 5.51×10^{7} s

(C) 1.39×10^{8} s

(D) 2.47×10^{8} s

Question 16 (8 marks)

Two students, Kim and Ali, performed an experiment to determine the acceleration due to gravity (g) using a simple pendulum consisting of a small mass hanging from a light string.



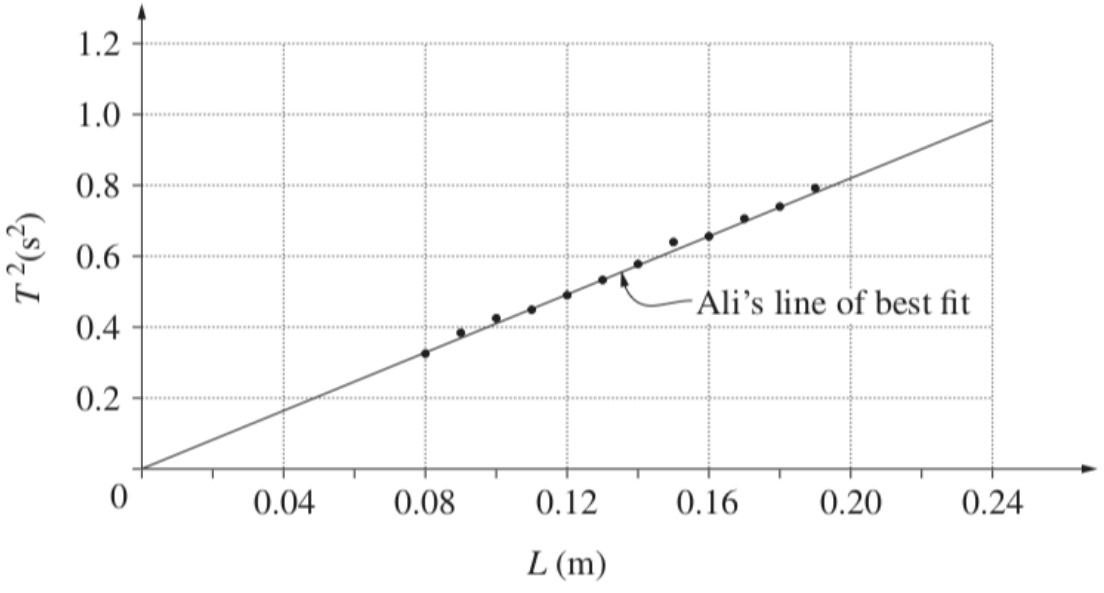
Their procedure was as follows:

1. Adjust the length of the string (L) to measure 0.08 m.
2. Hold the mass to the side to give a small angular displacement, θ.
3. Release the mass and measure the time for one period (T).
4. Record the result in a table.
5. Repeat using a string length (L) of 0.09 m and continue until the string length is 0.19 m (going up in 0.01 m increments, using the same initial angular displacement each time).
6. Calculate g using the relationship $T = 2\pi\sqrt{\frac{L}{g}}$.

The results are shown in the table:

L (m)	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19
T (s)	0.57	0.62	0.65	0.67	0.70	0.73	0.76	0.80	0.81	0.84	0.86	0.89

Kim used the data in the table to obtain a mean value for g. Kim's result was $g = 9.3\ \text{m s}^{-2}$. Ali used the results to produce the following graph. Ali's line of best fit was used to calculate g.



(a) Outline TWO changes that could be made to the experimental procedure that would improve its accuracy. **2**

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(b) Compare Kim's and Ali's methods of calculating g and identify the better approach. **3**

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(c) Calculate the value of g from the line of best fit on Ali's graph. **3**

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2001:

1 A person has a mass of 70.0 kg. What is the weight of the person at the Earth's surface?

(A) 70.0 kg

(B) 70.0 N

(C) 686 kg

(D) 686 N