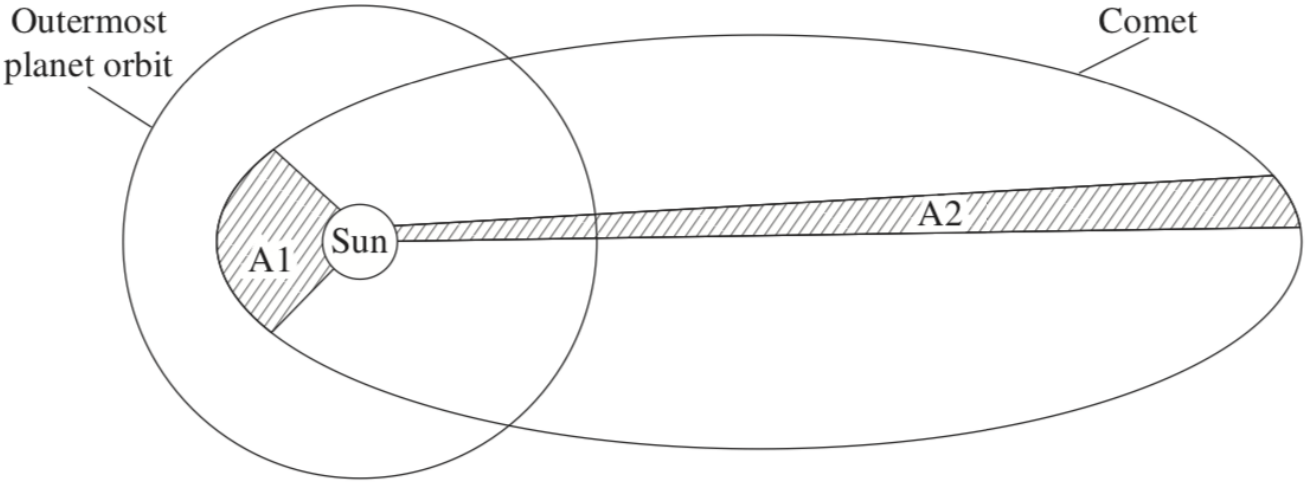
New Syllabus NESA Questions:

1) B
2) B
3) B
4) B
5)



Kepler's second law states that a line between the Sun and the comet sweeps an equal area in equal time, therefore its orbit travels a greater distance when it is closer to the Sun. As seen in the diagram, if A1 and A2 are equal areas, when the comet is closer to the Sun it needs to travel a greater distance in its orbit compared to when it's further away to sweep the same area in the same time. Kepler's second law is supported by Kohoutek's orbit.
It obeys the law and that is why most of its time is spent beyond the outermost planets, because it does not need to travel as fast to sweep the same amount of area compared to when it is closer to the Sun.

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6)

Marking guidelines:

Criteria	Marks
• Correctly completes the table • Provides relevant and correct working	4
• Correctly completes most of the table • Applies correct approach to calculate at least two of the ratios	3
• Provides some details of the table • Applies correct approach to calculate at least one of the ratios	2
• Provides some relevant information	1

Sample answer:

	Orbital radius (W relative to V)	*Orbital period (W relative to V)*	*Orbital velocity (W relative to V)*
Quantitative comparison	3.0	5.2	0.58
Qualitative comparison	Larger	Larger	Slower

Radius

$$\frac{r_W}{r_V} = \frac{10.0}{3.3}$$
$$= 3.0$$

Period

$$\frac{r_W{}^3}{T_W{}^2} = \frac{GM}{4\pi^2} = \frac{r_V{}^3}{T_V{}^2}$$
$$\left(\frac{r_W}{r_V}\right)^3 = \left(\frac{T_W}{T_V}\right)^2$$
$$3.0^3 = \left(\frac{T_W}{T_V}\right)^2$$
$$\frac{T_W}{T_V} = \sqrt{3.0^3}$$
$$= 5.2$$

Orbital velocity

$$v_W = \frac{2\pi r_W}{T_W}$$
$$= \frac{2\pi(3.0 r_V)}{5.2 T_V} \quad \begin{array}{l}\text{... see radius calculation}\\ \text{... see period calculation}\end{array}$$
$$= \frac{2\pi \times 3.0}{5.2}\ \frac{r_V}{T_V}$$
$$= \frac{3.0}{5.2} \times \frac{2\pi r_V}{T_V}$$
$$= \frac{3.0}{5.2} \times v_V$$
$$v_W = 0.58\ v_V$$

<u>Past HSC Syllabus Questions:</u>
<u>2018:</u>

1) A
3) A
7) A
11) D
14) C

Question 21 (a)

Criteria	Marks
• Identifies both equal force AND opposite directions	2
• Provides some relevant information	1

Sample answer:

The force of Earth on the moon is equal in magnitude to the force of the moon on Earth, but in the opposite direction.

Question 21 (b)

Criteria	Marks
• Correctly compares the mass and weight of the person on the moon and on Earth quantitatively	2
• Provides some relevant information	1

Sample answer:

Mass does not change due to gravity so the mass will be 70 kg on Earth and on the moon.

$W = mg$

$W_m = 70 \times 1.6 = 112$

Weight on moon = 112 N

$W_E = 70 \times 9.8 = 686$

Weight on Earth is 686 N

Question 28 (a)

Criteria	Marks
• Shows that the change in potential energy is 1.26×10^7 J	2
• Substitutes some information into a relevant equation	1

Sample answer:

Initial potential energy of mass

$$E_{pi} = -\frac{GMm}{r} = \frac{-6.67 \times 10^{-11} \times 7.35 \times 10^{22} \times 20}{1.74 \times 10^{6}}$$

$$= -5.64 \times 10^{7}\,\text{J}$$

Final potential energy of mass

$$E_{pf} = \frac{-6.67 \times 10^{-11} \times 7.35 \times 10^{22} \times 20}{2.24 \times 10^{6}}$$

$$= -4.38 \times 10^{7}\,\text{J}$$

$$\triangle E_p = E_{pf} - E_{pi} = 1.26 \times 10^{7}\,\text{J}$$

Question 28 (b)

Criteria	Marks
• Applies a correct process to calculate the velocity	3
• Applies the law of conservation of energy	2
• Substitutes some information into a relevant equation	1

Sample answer:

Initial $\quad E_{ki} = \frac{1}{2}mu^2 = \frac{1}{2} \times 20 \times 1200^2$

$$= 1.44 \times 10^{7}\,\text{J}$$

Final $\quad E_{kf} = E_{ki} - \triangle E_p$

$$= 1.44 \times 10^{7} - 1.26 \times 10^{7}$$

$$= 1.8 \times 10^{6}\,\text{J}$$

$$E_{kf} = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2E_{kf}}{M}} = \sqrt{\frac{2 \times 1.8 \times 10^{6}}{20}}$$

$$= 424\ \text{m s}^{-1}$$

Question 31 (b) (i)

Criteria	Marks
• Explains a relevant feature	2
• Provides some relevant information	1

Sample answer:

The altitude of NOAA-20 is much less than that of geostationary satellites, hence photographs will provide more detail about storms and cloud systems.

Answers could include:

Due to NOAA-20's short period polar orbit, it regularly passes over the entire surface of Earth to photograph changes in the atmosphere.

Question 31 (b) (ii)

Criteria	Marks
• Applies a correct process to calculate the mass of Earth	3
• Shows some appropriate calculations	2
• Provides some relevant information	1

Sample answer:

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$M = \frac{r^3 4\pi^2}{GT^2}$$

$$= \left(r_E + \text{altitude}\right)^3 \times \frac{4\pi^2}{GT}$$

$$= \frac{\left(6.37 \times 10^6 + 8.7 \times 10^5\right)^3 \times 39.48}{6.67 \times 10^{-11} \times \left(100 \times 60\right)^2}$$

$$= 6.24 \times 10^{24}$$

The mass of Earth is calculated to be 6.24×10^{24} kg

2017:

4) B

12) B

Question 24 (a)

Criteria	Marks
• Correctly calculates the escape velocity	2
• Substitutes into a relevant formula	1

Sample answer:

$$v = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 6.39 \times 10^{23}}{3.39 \times 10^{6}}}$$

$$= 5014.5 \text{ m s}^{-1}$$

$$= 5010 \text{ m s}^{-1} \text{ (rounded)}$$

Question 24 (b)

Criteria	Marks
• Shows that the escape velocity is independent of mass using the law of conservation of energy	3
• Relates the conservation of energy to the escape velocity of an object	2
• Provides some relevant information	1

Sample answer:

Escape velocity is the minimum velocity required for an object to attain an E_p of 0.

Hence escape velocity is attained when $E_k + E_p = 0$.

$$\frac{1}{2}mv^2 - \frac{GMm}{r} = 0$$

Rearranging:

$$\cancel{m}v^2 = \frac{2GM\cancel{m}}{r} \therefore \text{ the escape velocity is independent of the mass of the object.}$$

<u>2016:</u>

14) B

Question 21 (a)

Criteria	Marks
• Relates the reason for orbital decay to altitude of orbit	2
• Provides some relevant information	1

Sample answer:

Low-Earth orbit satellites encounter atmospheric drag due to their lower altitude. This drag reduces the orbital velocity causing orbital decay.

Question 21 (b)

Criteria	Marks
• Applies correct method to calculate magnitude and provides correct units	3
• Shows correct substitution into the equation without correct unit conversion OR without correct units	2
• Substitutes into a relevant formula	1

Sample answer:

$$F = \frac{Gm_1m_2}{r^2} = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 50}{(8000 \times 10^3)^2} = 312.7N$$

Question 25 (a)

Criteria	Marks
• Provides valid comparison between force and distance in the graphs	2
• Identifies a relationship between force and distance in one of the graphs	1

Sample answer:

Both graphs show that as distance increases, the force decreases. However, in Team A’s graph, the force between the masses decreases at a decreasing rate, whereas in Team B’s graph, the force decreases at a constant rate.

Question 25 (b)

Criteria	Marks
• Makes an informed judgement of the appropriateness of each data set	3
• Identifies strengths and/or weaknesses of the data set(s)	2
• Provides some relevant information	1

Sample answer:

Team A's data set has a good range but too few measurements for a valid relationship to be deduced.

Team B's data set has sufficient measurements but over an insufficient range of distances for a valid relationship to be deduced.

2015:

11) D

Question 26 (a)

Criteria	Marks
• Identifies assumptions made	2
• Provides relevant information about an assumption made	1

Sample answer:

Model X assumes the Earth's gravitational field is uniform/unchanging/linear from the surface upwards.

Model Y assumes the gravitational field changes with altitude.

Question 26 (b)

Criteria	Marks
• Provides correct reason	1

Sample answer:

Variations in gravitational attraction from the Earth's surface to an altitude of 200 km are sufficiently small to ensure the results from the two models are not significantly different.

Question 26 (c)

Criteria	Marks
• Applies a correct method to calculate velocity • States the correct units in the answer	3
• Shows understanding of the relationship between F_c and F_g and attempts at manipulating relevant formulae to find v OR • Attempts to calculate velocity using Kepler's law	2
• Substitutes into a relevant formula	1

Sample answer:

$$F_c = F_g$$

$$\frac{mv^2}{r} = \frac{GMm}{d^2}$$

$$v^2 = \frac{GM\cancel{m}\,\cancel{r}}{d^{\cancel{2}}\,\cancel{m}}$$

$$= \frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{6.58 \times 10^6}$$

$$= 6.08 \times 10^7$$

$$\therefore \quad v = 7797\,\text{m s}^{-1}$$

<u>2014:</u>

6) A

15) A

Question 27 (b)

Criteria	Marks
• Shows correct process to calculate the period	2
• Shows partial substitution into a relevant formula	1

Sample answer:

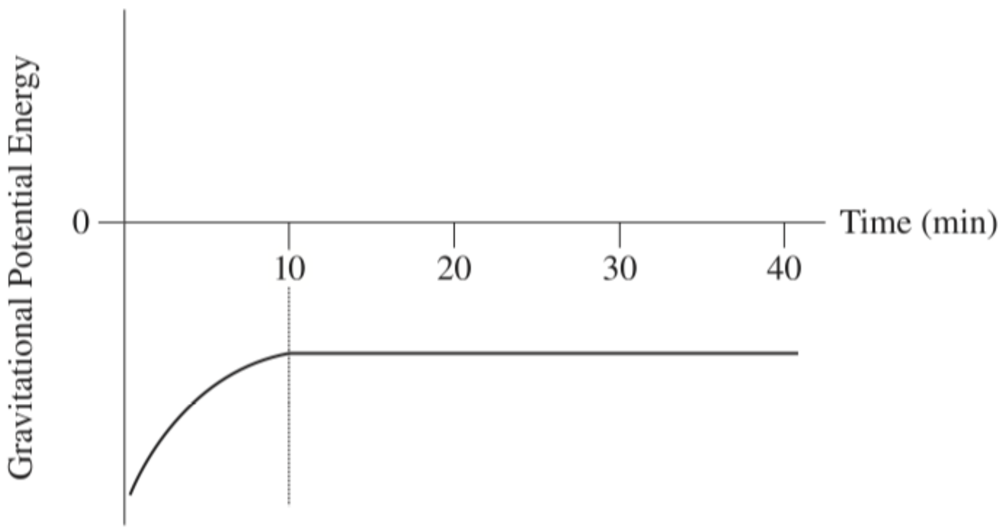
Orbit = 188 km above the surface, hence, R = 6380 km + 188 km = 6568 km

$$\frac{R^3}{T^2} = \frac{GM}{4\pi^2} \text{ hence } T = 2\pi\sqrt{\frac{\left((6380+188)\times 10^3\right)^3}{6.67\times 10^{-11}\times 6\times 10^{24}}} = 5286 \text{ sec} = 88.11 \text{ min}$$

Question 27 (c)

Criteria	Marks
• Sketches a correct graph	2
• Sketches a graph with a correct feature	1

Sample answer:



2013:

Question 23 (a)

Criteria	Marks
• Explains why the mass of the planet plays no role in determining its orbital speed	2
• Shows some understanding of the orbital speed of the planet	1

Sample answer:

The orbital velocity is determined by the planet's period and distance from the central mass, as described by Kepler's Laws. Therefore, the mass of the planet plays no role in determining its orbital speed around Pollux.

Question 23 (b)

Criteria	Marks
• Demonstrates correct process to calculate the distance required	3
• Relates period and radius of the 2 objects orbiting the central mass OR • Substitutes into correct equation to calculate constant	2
• Partial substitution into a relevant formula OR • Attempts to relate period and radius of the 2 objects orbiting the central mass	1

Sample answer:

$$\frac{r_x^3}{T_x^2} = \frac{r^3}{T^2} \qquad \frac{r^3}{365^2} = 1.27 \times 10^{-5}$$

$$\frac{1.64^3}{590^2} = \frac{r^3}{365^2} \qquad r^3 = \left(1.27 \times 10^{-5}\right) \times 365^2$$

$$r = \sqrt[3]{\left(1.27 \times 10^{-5}\right) \times 365^2}$$

$$= 1.19\ AU$$

2012:

4) B

12) A

13) B

Question 21 (a)

Sample answer:

[Investigation could use different methods, including being based on a pendulum or timing a falling mass.]

A computer-based timing system should be set up using a sensor to measure how long it takes for a mass to fall to the ground from several heights between 0.5 m and 3.0 m. To increase reliability several readings for each height should be recorded. The results should be plotted on a time^2 vs height graph. The acceleration due to gravity is equal to 2 x the reciprocal of the slope of the line of best fit.

Question 21 (b)

Sample answer:

The known value (measured using more accurate equipment) should be looked up for my location, as published, for example, on the National Measurement Institute website and compared to the measured value. The closer the measured value is to the reference value, the more accurate it is.

Question 21 (c)

Sample answer:

The same measurement (using the same procedure) should be repeated at each height several more times. Statistically this would reduce the uncertainty in the average of all the results for each height.

Question 21 (d)

Sample answer:

The difference between each of the measurements and the average reading for each height the object was dropped from should be compared. If there is a large variation in the readings (relative to the average value) then the data is not very reliable.

2011:

1) C
2) B
15) C
16) B
20) D

Question 23 (a)

Sample answer:

The gravitational field strength is less, due to an increase in altitude, ie $W = m\,g$.

Question 23 (b)

Sample answer:

$$\frac{m_s v^2}{r} = \frac{G m_s m_E}{r^2} \quad \therefore \; v = \sqrt{\frac{G m_E}{r}} = \sqrt{\frac{6.67\times10^{-11}\times5.97\times10^{24}}{6.73\times10^{6}}} = 7692 \text{ m.s}^{-1}$$

Question 23 (c)

Sample answer:

The speed of the satellite will increase as the gravitational potential energy is converted to kinetic energy.

The period of the orbit will be reduced, following Kepler's law that $\frac{r^3}{T^2}$ is a constant.

2010:

1) C

7) D

12) B

2009:

3) C

5) C

Question 16 (a)

Answers could include:

$$\begin{aligned} w &= mg \\ &= 500\times9.8 \\ &= 4900 \text{ N} \end{aligned}$$

Question 16 (b)

Answers could include:

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$\therefore M = \frac{4\pi^2 r^3}{GT^2}$$

$$= \frac{4\pi^2 \times \left(50 \times 10^3\right)^3}{6.67 \times 10^{-11} \times \left(5.9 \times 10^4\right)^2}$$

$$= 2.13 \times 10^{16}\ \text{kg}$$

Before 2009 there were no answers given for short answer please use a book like Excel Physics

<u>2008:</u>
1) C
2) C

<u>2007:</u>
3) B
4) D

<u>2006:</u>
1) C
5) D

<u>2005:</u>
2) D
3) B
4) D

<u>2004:</u>
2) A
3) D

<u>2003:</u>
1) B
3) B
4) A

<u>2002:</u>

3) B
5) D

2001:
1) D