Review Package for Unit 4 – Circular Motion and Gravitation

Physics 12
Unit 4A Provincial Package

1. The gravitational force of attraction between the Sun and an asteroid travelling in an orbit of radius 4.14×10^{11} m is 4.62×10^{17} N. What is the mass of the asteroid?

   A. 1.45×10^{9} kg
   B. 4.08×10^{9} kg
   C. 4.71×10^{16} kg
   D. 6.00×10^{20} kg

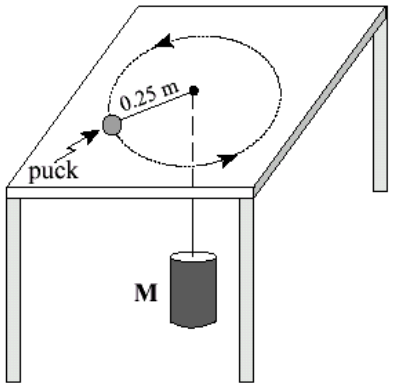
2. The orbital radius of Mars around the Sun is 1.52 times that of Earth's orbital radius. In Earth years, what is the period of revolution for Mars in this orbit?

   A. 0.66 years
   B. 1.5 years
   C. 1.9 years
   D. 3.5 years

3. What is the centripetal acceleration of the Moon in its orbit around the Earth?

   A. $0\ m/s^2$
   B. $2.7 \times 10^{-3}\ m/s^2$
   C. $1.6\ m/s^2$
   D. $9.8\ m/s^2$

4. A 0.055 kg puck is attached to a 0.150 kg mass **M** by a cord that passes through a hole in a frictionless table, as shown. The puck travels in a circular path of radius 0.25 m.



   What is the speed of the puck?

   A. 0.61 m/s
   B. 0.95 m/s
   C. 1.6 m/s
   D. 2.6 m/s

5. A child is riding on a merry-go-round which is rotating at a constant rate. Which of the following describes the child's speed, velocity, and magnitude of acceleration?

	SPEED	VELOCITY	MAGNITUDE OF ACCELERATION
A.	constant	constant	constant
B.	constant	changing	constant
C.	changing	constant	changing
D.	changing	changing	changing

6. A satellite is travelling around the Earth in an orbit of radius 4.47×10^{7} m. What is the mass of the satellite if it experiences a gravitational force of 3.00×10^{3} N?

   A. 4.37×10^{1} kg
   B. 3.06×10^{2} kg
   C. 2.14×10^{3} kg
   D. 1.50×10^{4} kg

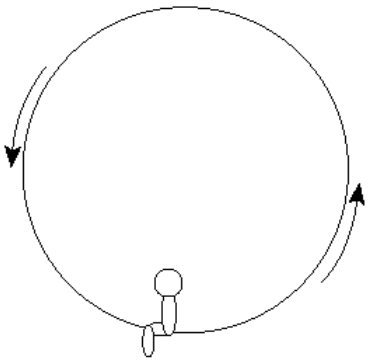
7. A circular space station of radius 120 m is to be rotated so that its astronauts experience an effect similar to that of a gravitational field. If the field is to be 5.0 m/s^2 at this radius, what should be the period of rotation of the space station?

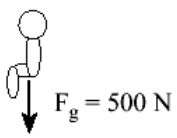
   A. 3.2×10^{-1} s
   B. 3.1×10^{1} s
   C. 5.1×10^{3} s
   D. 8.6×10^{4} s

8. On Earth, the maximum speed without skidding for a car on a level circular curved track of radius 40 m is 15 m/s. This car and track are then transported to another planet for the Indy Galactic 500. The maximum speed without skidding is now 8.4 m/s. What is the value of the acceleration due to gravity on this other planet?

   A. 1.8 m/s^2
   B. 3.1 m/s^2
   C. 4.3 m/s^2
   D. 5.5 m/s^2

9. A 500 N child travels in a circular path on a ferris wheel. Which free body diagram **best** shows the forces which could act on the child as she passes the lowest point?



A.


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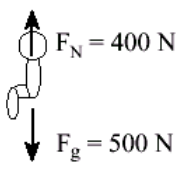

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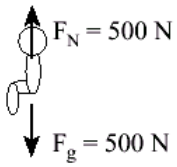

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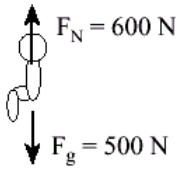


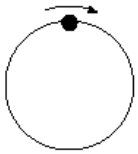
10. A satellite orbits a planet of mass 4.0×10^{25} kg at a velocity of 5.8×10^{3} m/s. What is the radius of this orbit?

A. 6.4×10^{6} m
B. 7.9×10^{7} m
C. 1.6×10^{8} m
D. 1.2×10^{19} m

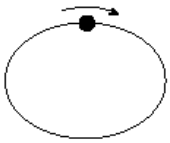
11. An object travels along a path at constant speed. There is a constant net force acting on the objec that remains perpendicular to the direction of the motion. Describe the path of the object.

A. linear

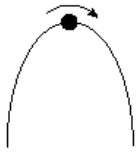
B. circular



C. elliptical



D. parabolic



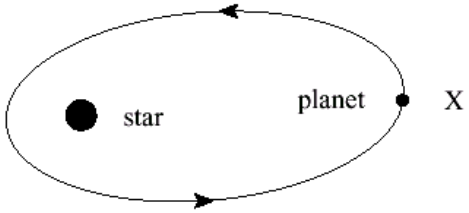
12. A satellite is placed in orbit around the Sun. The orbital radius of the satellite is twice the orbital radius of the Earth. What is the orbital period of this satellite?

A. 0.50 Earth years
B. 1.6 Earth years
C. 2.0 Earth years
D. 2.8 Earth years

13. Find the gravitational force of attraction between a 75 kg physics student and her 1 500 kg car when their centres are 10 m apart.

A. 7.5×10^{-8} N
B. 7.5×10^{-7} N
C. 740 N
D. 1.5×10^{3} N

14. A planet travels in an elliptical path around a star as shown.



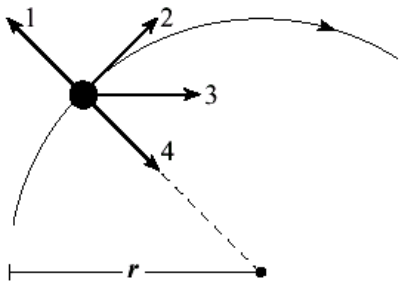
Describe the magnitude of the velocity and the acceleration of the planet at **X**.

	MAGNITUDE OF VELOCITY	MAGNITUDE OF ACCELERATION
A.	least	least
B.	least	greatest
C.	greatest	least
D.	greatest	greatest

15. What is the gravitational field strength at the surface of a star of mass 4.8×10^{31} kg and radius 2.7×10^{8} m?

A. 9.8 N/kg
B. 4.4×10^{4} N/kg
C. 4.9×10^{6} N/kg
D. 1.2×10^{13} N/kg

16. An object moves at a constant speed along a circular path as shown.



Which vector represents the velocity of the object at this particular point on the path?

A. 1
B. 2
C. 3
D. 4

17. What is the centripetal acceleration of a satellite having an orbital period of 6.1×10^{3} s while in a circular orbit of radius 7.2×10^{6} m?

A. 0 m/s^2
B. 5.2 m/s^2
C. 7.6 m/s^2
D. 9.8 m/s^2

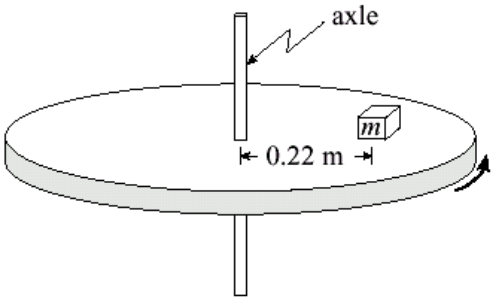
18. Two satellites, **X** and **Y**, are placed in orbit around a planet. Satellite **X** has a period of revolution of 3.6×10^{5} s and an orbital radius of 7.5×10^{8} m. If the orbital radius of satellite **Y** is 3.0×10^{9} m, what is its orbital period?

A. 9.1×10^{5} s
B. 1.4×10^{6} s
C. 2.9×10^{6} s
D. 5.2×10^{7} s

19. A 1 500 kg spaceship circles a planet once every 4.0×10^{5} s with an orbital radius of 3.6×10^{7} m. What is the mass of this planet?

A. 2.0×10^{11} kg
B. 1.2×10^{12} kg
C. 1.7×10^{23} kg
D. 2.6×10^{26} kg

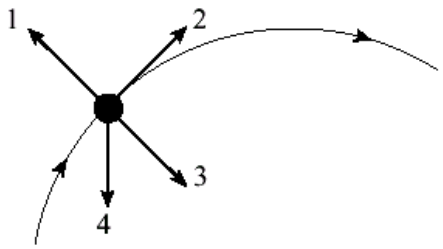
20. An object of mass ***m*** is on a horizontal rotating platform. The mass is located 0.22 m from the axle and makes one revolution every 0.74 s.



The friction force needed to keep the mass from sliding is 13 N. What is the object's mass?

A. 0.82 kg
B. 1.3 kg
C. 2.7 kg
D. 5.2 kg

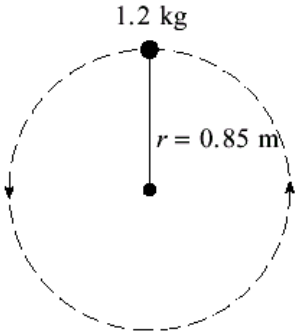
21. An object moves at a constant speed along a circular path as shown.



Which vector **best** represents the centripetal acceleration of the object at this point?

A. 1
B. 2
C. 3
D. 4

22. A 1.2 kg mass on the end of a string is rotated in a vertical circle of radius 0.85 m.



If the speed of the mass at the top of the circle is 3.6 m/s, what is the tension in the string at this location?

A. 6.5 N
B. 12 N
C. 18 N
D. 30 N

23. A certain planet has a mass of 3.3×10^{23} kg and a radius of 2.6×10^{6} m. What is the acceleration due to gravity on the surface of this planet?

A. $0.54\ \text{m/s}^2$
B. $3.3\ \text{m/s}^2$
C. $4.0\ \text{m/s}^2$
D. $9.8\ \text{m/s}^2$

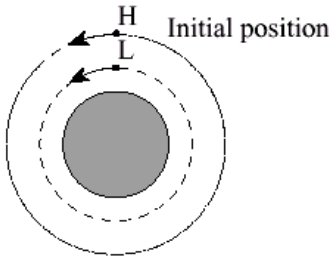
24. A person is on a horizontal rotating platform at a distance of 4.3 m from its centre. This person experiences a centripetal acceleration of $5.6\ \text{m/s}^2$. What centripetal acceleration is experienced by another person who is at a distance of 2.5 m from the centre of the platform?

A. $2.3\ \text{m/s}^2$
B. $3.3\ \text{m/s}^2$
C. $5.6\ \text{m/s}^2$
D. $9.6\ \text{m/s}^2$

25. A satellite travels in a circular orbit at a height of one Earth radius above the surface of the Earth. What is the satellite's orbital period? **(7 marks)**

26. a) A satellite is placed in circular orbit at an altitude of 4.8×10^{5} m above Earth's surface. What is the satellite's orbital period? **(5 marks)**

b) (i) As shown in the diagram below, two satellites pass over the same point on Earth's surface. Satellite H is in a higher orbit than satellite L.

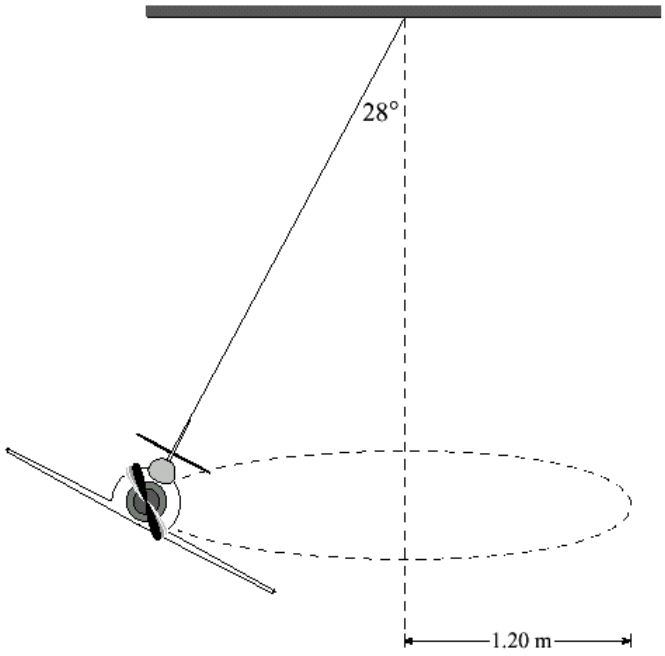


Which satellite, H or L, completes one orbit first? (Circle one) **(1 mark)**

A. satellite H
B. satellite L

(ii) Using principles of physics, explain your answer. **(3 marks)**

27. The diagram shows a toy plane flying in a circle of radius 1.20 m, supported by a string which makes an angle of $28°$ with the vertical. The tension in the string is 1.80 N.



a) What is the mass of the plane? **(3 marks)**

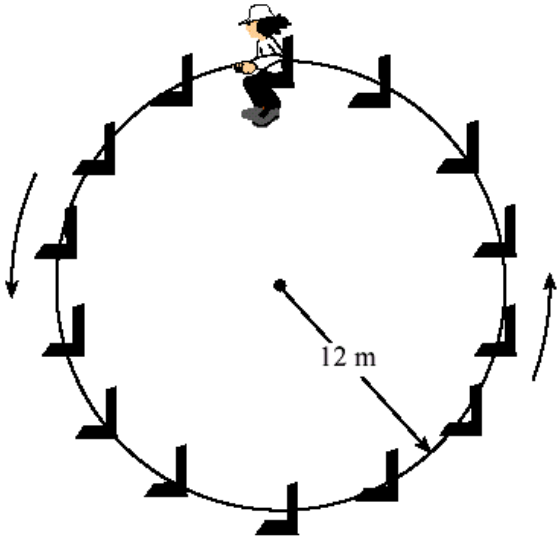
b) How long does the plane take to complete one orbit? **(4 marks)**

28. An astronaut stands on the surface of a planet of radius 2.6×10^6 m. An object dropped from the astronaut's hand accelerates at 3.2 m/s^2.

a) What is the mass of this planet? **(5 marks)**

b) What is the force of gravity on an 18 kg mass located on the surface of this planet? **(2 marks)**

29. A 35 kg child rides a ferris wheel of radius 12 m. The child moves in a vertical circle at a constant speed and completes one rotation every 9.0 s.



a) As the child travels over the top, what is the magnitude of the force that the seat exerts on the child? **(5 marks)**

b) How does the magnitude of the child's acceleration at the top of the ride compare to her acceleration at the bottom?

The child's acceleration at the top is: (circle one) **(1 mark)**

i) less than at the bottom.
ii) greater than at the bottom.
iii) the same as at the bottom.

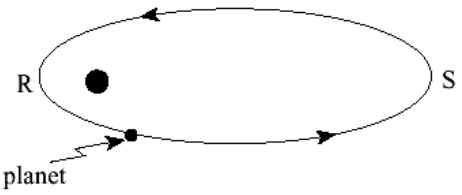
Explain your choice using principles of physics. **(3 marks)**

KEY

1. D
2. C
3. B
4. D
5. B
6. D
7. B
8. B
9. D
10. B
11. B
12. D
13. A
14. A
15. B
16. B
17. C
18. C
19. C
20. A
21. C
22. A
23. B
24. B
25. 1.4×10^4 s
26. a) 5.7×10^3 s
    b) i) satellite L
    ii) L completes one orbit first. The stronger gravitational field lower down requires a higher velocity to maintain a stable orbit.
27. a) 0.16 kg
    b) 3.0 s
28. a) 3.2×10^{23} kg
    b) 58 N
29. a) 138 N
    b) iii) same as at the bottom
    Since this child is moving in uniform circular motion her net force must be a constant centripetal force. The magnitude of the acceleration must therefore be constant.

Physics 12
Unit 4B Provincial Package

1. A planet is in orbit as shown in the diagram below.



The planet's gravitational potential energy will

A. be constant throughout its orbit.
B. always be equal to its kinetic energy.
C. increase as the planet goes from point R to point S.
D. decrease as the planet goes from point R to point S.

2. The work required to move an object in a planet's gravitational field can be determined graphically by calculating

A. the slope of a graph of gravitational force versus separation distance.
B. the area under a graph of gravitational force versus separation distance.
C. the slope of a graph of gravitational potential energy versus separation distance.
D. the area under a graph of gravitational potential energy versus separation distance.

3. What minimum kinetic energy would a spacecraft of mass 1.2×10^{4} kg need at the surface of the Earth so that it could escape to infinity?

A. 1.1×10^{4} J
B. 1.2×10^{5} J
C. 7.5×10^{11} J
D. An infinite amount

4. A 120 kg astronaut stands on the surface of an asteroid of radius 600 m. The astronaut leaves the surface with 15 J of kinetic energy and reaches a maximum height of 300 m above the surface. What is the mass of the asteroid?

A. 5.6×10^{11} kg
B. 2.2×10^{12} kg
C. 3.4×10^{12} kg
D. 5.1×10^{12} kg

5. A stationary object of mass m is on the surface of a planet of mass M and radius r. Which of the following gives the work required to move the object infinitely far away?

A. $W=\sqrt{\frac{GMm}{r}}$

B. $W=\frac{GMm}{r}$

C. $W=\frac{GMm}{2r}$

D. $W=\frac{GMm}{r^{2}}$

6. An object is located on the surface of a planet. The **work** required to remove this object from the planet's gravitational field depends on which combination of the following three variables: mass of the planet, mass of the object, and radius of the planet?

	MASS OF PLANET	MASS OF OBJECT	RADIUS OF PLANET
A.	Yes	Yes	Yes
B.	Yes	Yes	No
C.	Yes	No	Yes
D.	No	Yes	Yes

7. Relative to zero at infinity, what is the gravitational potential energy of a 7.2×10^{2} kg satellite that is at a distance of 3.4×10^{7} m from earth's centre?

A. -2.4×10^{11} J
B. -8.4×10^{9} J
C. 8.4×10^{9} J
D. 2.4×10^{11} J

8. A 900 kg satellite which is travelling at 8 600 m/s around a planet of mass 8.1×10^{25} kg has an orbital radius of 7.3×10^{7} m. What is the total orbital energy of this satellite relative to infinity? **(7 marks)**

9. A 1 250 kg rocket rests on the surface of the Earth. To what maximum distance from the Earth's centre would the rocket be lifted if 2.5×10^{10} J of work were done on it? **(7 marks)**

KEY

1. C
2. B
3. C
4. C
5. B
6. A
7. B
8. -3.3 X 10^{10} J
9. 9.39 X 10^{6} m